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ABSTRACT PROCEEDINGS

SUPPLY CHAIN TRANSFORMATION IN THE DIGITAL ECONOMY

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15-16 NOVEMBER 2018

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INTRODUCTION

This is the 10th international conference organised by the Centre for Logistics Research at Thammasat Business School, Thammasat University and the Excellence Centre in Logistics and Supply Chain Management, Chiang Mai University. This is major event for researchers in transport, logistics, supply chain and value chain management especially in the Asia Pacific region. This year's event in Okinawa (Japan), is a continuation of past successful conferences held in Chiang Mai (Thailand), 2009; Queenstown (New Zealand), 2010; Malé (Maldives), 2011; Chiang Mai (Thailand), 2012; Kyoto (Japan), 2013; Kuala Lumpur (Malaysia), 2014; Lyon (France), 2015; Singapore, 2016 and Bangkok (Thailand), 2017. This year's event is held during November 15th to 16th, 2018 and is hosted by The University of Marketing and Distribution Science based in Kobe, Japan.

Under the theme of "**Supply Chain Transformation in the Digital Economy**", the following topics were welcomed at the conference:

- Procurement & Supply Management
- Planning & Forecasting
- Relationship & Collaboration
- Production Planning & Operations
- Inventory Fulfilment
- International Logistics
- Humanitarian Logistics
- Maritime Logistics
- Logistics Services Providers
- Logistics Development Policies
- Supply Chain Design/Configuration
- Supply Chain Risk Management
- Sustainable Supply Chain
- Production & Inventory
- Supply Chain Performance
- Global Supply Chain
- Multimodal Transport
- Freight Logistics
- E-Logistics
- Logistics Facilitation

The conference best paper will be invited and considered for publication in the International Journal of Logistics Research and Applications.

WELCOME ADDRESS FROM THE CONFERENCE CHAIRS

On behalf of the organizing committee, we would like to welcome all participants to the 10th International Conference on Logistics and Transport (ICLT2018). It has been a decade since the first conference was hosted in Chiang Mai (Thailand). This ICLT conference is expected to continue on an annual basis in order to facilitate the sharing of ideas, research findings, and teaching directions related to logistics and supply chain from an academic perspective.

The theme for this year's event is "Supply Chain Transformation in the Digital Economy". This highlights the role of information technology in the ever-evolving supply chain practices and its endless economic possibilities in the current digitalisation era. "Supply Chain Transformation in the Digital Economy" is an important concept. It can be used as a guiding principle to help improve firms' resources, capabilities and operational efficiencies through sustainability across the entire supply chain continuum. The challenge to harmonise these subtle changes between supply chain members remains a critical issue.

We would like to sincerely thank all presenters, reviewers, our scientific committees, and keynote speakers for their appreciated contribution. We cannot forget the important contribution of our sponsors, SeaOil (Public) Co. Ltd, Wice Logistics (Public) Co. Ltd., and CPL Group (Public) Co. Ltd who have supported us through the years. This year we welcome the support of Cabinet Office of Okinawa Development, Ryuku Kaiun Kaisha and Nichirei Logistics Group Inc.

We also apologise in advance if there are any difficulties you may encounter while participating the conference. Finally, we hope that you will enjoy this conference and we hope that the deliberations will be fruitful and successful.

Ruth Banomyong
ICLT General Chair

Apichat Sopadang
ICLT General Chair

WELCOME ADDRESS FROM THE LOCAL CHAIR

As host of organizing committee, we would like to welcome all participants to the 10th International Conference on Logistics and Transport (ICLT 2018, Okinawa).

We are pleased to be able to welcome those of you that have been with us for some time now as well as those of you who are new to our group. Today marks our 10th annual conference and we are very proud to be able to host this memorable conference today here at Okinawa with all of you.

Your strong support and active participation have made the ICLT 2018 an excellent event. We have many papers and many people registered. The quality of programs is world –top class, and the spectrum of topics is very current and broad.
I would like to express my gratitude to all of you who so generously helped us make this event come together smoothly.
Fortunately, local organization and enterprise also support our program. We collaborate program with Okinawa Trade Association and we are able to set up special session for them on the first day.

Okinawa is located at the Japanese southernmost tip and is the strong relationship with Asia for a long time. So Okinawa has own unique culture. We would like to hope all participants enjoy Okinawa culture as well as academic conference.

We prepare conference tour on the 2nd day after conference, we enjoy visiting Cold warehouse and also Awamori factory for helping your experience in Okinawa.

We would like to express our thanks all presenters, reviewers and keynote speakers for their contribution. We also apologize in advance if there are any difficulties you may encounter while participating the conference. Finally, we hope that you will enjoy this conference and we hope that the deliberations will be fruitful and successful.

Prof. Takayuki Mori,
10th ICLT, Local Chair

CONTENTS

APPLICATION OF COPULA AND VAR IN RISK APPRAISAL FOR CUSTOMER DEMAND IN LUBRICANT OIL WHOLESALE BUSINESS

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Introduction

The sales data of Lampang Lube Oil Company was used in the study. The company is a distributor of PTT lubricants in Lampang and northern Thailand retailing and wholesaling only for PTT lubricants trade mark. With the highly appreciation from PTT company, then this company got more discount rate than other competitors. No inventory shortage or highly customer's satisfaction is the strictly service policy for this company. Besides no inventory shortage, time to delivery is also set as short as possible. To acknowledge the customers demand, store display and salesman are applied. Industrial lubricants grade for the industrial sector are also included in the company business.

In practice, forecasting of customer demand in supply chain is very difficult, and in some cases, it couldn't be predicted due to unstable demand of goods or services. This will cause the bullwise effect in the supply chain. Therefore, the accuracy or the risk of forecasting techniques has to study and interpret. Risk is the ability to measure and accomplish the purpose of the task successfully under decisions, budgets, deadlines, time frames, and technical constraints, such as project planning as a series of activities to do certain event in the future using limited resources to proceed for success under limited time frames. This is a future action plan and risk can happen at any time due to uncertainty and limitation of resources of projects. Project administrators must manage their project risks to reduce problems and make the projects successful as targeted effectively and efficiently. In financial problem, many researchers adopted the Copola function technique for investment risk analysis. This Copola function has been studied since 1940 by Hoeffding (1940) and developed continuously since postwar by Frechet (1951). However, according to the study of Sklar (1959, 1973), Copula is a cointegration function of distributed random variables, which present a constant copula pattern on the interval of [0, 1]. That means we can tell the relationship between random variables without considering the marginal distribution. In various studies associated with Copula function, the Copula appears in a variety of applications. It is said that Copula is a model created when the relationship is not independent among the factors that are important to portfolio of investment. It was also found that Copula can help create the diversification of the risk in portfolio of investment (Kole et al., 2007). For risk appraisal, Value-at-Risk (VaR) was introduced by Guildimann (1980) who the lead researcher of J.P.Morgan investment bank. VaR was applied to manage the investment risk within the organization. VaR refers to the maximum loss resulting from investing in securities for a period of time. This is a measure of the amount of risk that could be incurred by holding securities at a certain time and at a specified level of confidence. In terms of finance, it can be said that VaR is the most popular measure of risk because VaR measures using the amount of money, such as baht and US dollars, which is easy to understand and measurable. A value of VaR is the maximum expected loss within a certain time period (usually a number of days) with a certain level of statistical confidence (% of confidence level). The higher the VaR, the riskier it is. However, this also means that it is not likely to damage more than that. The convenience of VaR in interpretation makes it possible for financial institutions and regulators of the world's financial institutions, such as the Basel Supervisory Board of Switzerland, the US central bank or financial institutions, often sets limits on VaR for risk mitigation. If each trading day of securities or financial instruments calculate the VaR of the whole group to be within the limit, it is considered safe. It means that in that day, if the money invested results in severe damage or the worst case scenario, it is still not over the ceiling.

From our study, application of Copula method and VaR are most in the financial engineering; however still cannot find for forecasting risk appraisal. Thus, to apply Copula and VaR for forecasting risk appraisal is a new challenge. This research aims to propose a method to identify the forecast risk

value using the Copula method and VaR in order to identify the risk of forecast violation by using the best predictive methods in the selected methods to forecast customer demand. ANN, ARIMA, SETAR and LSTAR methods were used to forecast.

Literature Review

In this research, the risk assessment of customer demand in lubricant wholesaling business based on the customer demand in 10 products was studied. Theories and research related to forecasting by using ANN, ARIMA, SETAR, and LSTAR methods, as well as Copula and VaR to find the relationship of the data used to create data model were evaluated for the risk containing the following relevant details. For the delivery of raw materials, Ngniatedema et al. (2013) investigated the conditions leading to a reduction in production costs when the delivery time of the supplier for goods, raw materials, and the inventory level at the beginning of the production process are in a delay time frame. These factors are in a form that shows that it is in the best position to maximize the benefits. There are delivery of the supplier and the delivery of raw materials in a suitable frame enabling us to create a model that can lower production costs with better productivity, as well as increase customer service level at an adequate level of inventory. Forecasting may use the same conceptual approach but using different tools will produce different results. Talha and Olaf (2009) applied ARIMA method to forecast using different computer programs which resulted in different results. If the programs were more complete, it would have better forecasting results. In the studies related to the importance of timely delivery of goods or raw materials, the program can make the work more efficient, increase productivity, reduce violations, and inventory costs. In order to forecast, there are many important ways for businesses or the management of the stock market and its activities. Wilson and Sharda (1994) had the idea of the Artificial Neural Network from Artificial Intelligence (AI), which refers to a process of reasoning imitation with the ability to remember and apply from experience. For the study using the Artificial Neural Network on financial forecast, Carvalhal and Ribeiro (2007) found that the Artificial Neural Network was effective in forecasting. Jing Li (2011) tested the Self Threshold Autoregressive (SETAR) to forecast many models. Ana et al. (2015), Chan et al. (2015) used the SETAR method to forecast NYMEX oil prices, investment in the Tungsten Market, and other prices which are efficient in terms of forecasting. Kalbkhani et al. (2017) used Logistic Smooth Transition Autoregressive (LSTAR) to forecast stock prices, and also compared LSTAR with other methods. There are a variety of effective methods of forecasting. In this paper, we are interested in using different instruments, ANN, ARIMA, SETAR and LSTAR, to forecast customer demand. Each method has efficient and different operating concept in forecasting. Then we compare the results to find the best method with the least violation value. Olson and Wu (2010) stated that operations need to identify and categorize risks. They conducted a study on the review of research related to supply chain risk management to identify and categorize risks, case studies, and models for problem solving and specific attitudes of supply chain risk by classifying within the supply chain involving many risks such as an internal risk and the factors related to the organization such as an external risk. In the study of risk-related research, it is evident that risk is present in every activity. Manufacturers may be exposed to risk in the event that they have a relationship or may not be related to each other. If the risk can be reduced, it will benefit the company.

Copola, the statistical theory that Sklar (1959) first proposed, has been applied in various fields. Until later, Li (2000), director of Riskmetric's Credit Derivatives Group, succeeded in using the Copola method to describe the co-relation of the credit assets generated by group investment for determining the price of the Collateralized Debt Obligation (CDO) of credit assets. As a result of the successful implementation of Li (2000), the Copola method has been applied extensively by scholars and practitioners in financial management to measure the risk of investing in securities and determining the price of financial derivatives based on several factors (Khanthawit, 2010). Yingying et al. (2016) and Berger (2016) used the Coppola and VaR methods as a basis for finding correlation, analysing, and reducing the risk of data requirements for better reliability and estimation than older methods. It also stated that the *t*-Copula method could find the correlation value more effectively than the Gaussian Copula method. Copula method can find the relationship of various data sets with different data distributions by using VaR to evaluate risks and to identify possible violations of events. In this research,

we applied VaR through the Copula model to identify the forecasting risk by applying the predictive violation to find the relationship and identify the risk.

Methodology

Risk appraisal with VaR through the Copula model includes the following steps.

1. Prepare the data in the form of growth rate. Convert customer demand data into chronologically-ordered time series of the 10 products and convert them into growth rate from the past three years before forecasting.

$$R_i = \frac{S_t - S_{t-1}}{S_{t-1}} \quad (1)$$

2. Forecast the growth rate of 10 products by using four methods: ANN, ARIMA, SETAR and LSTAR through the *R* Project for Statistical Computing (*R*). Forecast the customer demand by using ANN, ARIMA, SETAR and LSTAR methods.

2.1 For ANN method using NNET time series model 1-3-1 network with 10 weights, select the method with least Akaike Information Criterion (AIC). The Akaike's Information Criterion (AIC) can be calculated as follows.

$$AIC = \log \hat{\sigma}^2 + 2\frac{p+q}{T} \quad (2)$$

when $\hat{\sigma}^2$ = estimated value of e_t variance

ANN is a mathematical model used to simulate complex systems with nonlinear components. ANN architecture consists of layers of neuron or node linked together. The first layer is the input layer, and the last layer is the output layer. Between the input and output layers, there may be a number of hidden layers. As ANN model has many forms, in training, input and expected output are installed into ANN. In order to study ANN, adjust w_{ij} weight of each layer to provide the predicted value which is close to the actual value as much as possible. The most common function used to measure the violation between actual and predicted values is the Mean Squared Violation. For the operation of BPNN, first, determine the initial weight and violation. Calculate the predictive value from input data. Calculate the violation based on the differences between the actual and predicted values. Then return the violation of output layer back to the other layers of ANN to re-adjust the w_{ij} weight to reduce the violation.

2.2 The ARIMA method includes three parameters: AR, I, and MA. This study forecasted by selecting the most appropriate method, the method which has the least value of AIC from Parameters 101, 102, 201 and 202. Forecasting by using Box-Jenkins method developed by Box and Jenkins (1976) is based on the ARIMA (Autoregressive Integrated Moving Average) model, which is a single-variable time series in the past until the present to predict future data covering the results that include seasonal time series, as well as processes or systems that are non-stationary. The analysing processes are as follows.

(1Identification

$$y_t = y_{t-1} + \varepsilon_t \quad (3)$$

(2Autoregressive Process

Autoregressive process) AR(p)) refers to AR system indicating time series data depends on the p level of the delay information of the past, which can be written in the equation as follows.

$$y_t = \delta_0 + \delta_1 y_{t-1} + \delta_2 y_{t-2} + \ldots + \delta_p y_{t-p} + e_t \quad (4)$$

(3Moving Average Process

Moving average process) MA(q)) is MA system indicating that the time series depends on the present violation as well as the violation of the q level of delay information in the past, which can be written in the equation as follows.

$$y_t = \tau_0 + e_t - \varphi_1 e_{t-1} - \varphi_2 e_{t-2} + \ldots + -\varphi_q e_{t-q} \quad (4)$$

In case of non-stationary data, ARIMA)*p*,*d*,*q* (model will be:

$$\Delta^d y_t = \delta_0 + \delta_1 \Delta^d y_{t-1} + \delta_2 \Delta^d y_{t-2} + \ldots + + \delta_p \Delta^d y_{t-p} + e_t - \varphi_1 e_{t-1} - \varphi_2 e_{t-2} + \ldots + - \varphi_q e_{t-q} \quad (6)$$

when Δ^d = Data Variance Rank

2.3 By using SETAR method, only j parameter is used, $j=1$ or $j=2$ based on equation)8). This study forecasted by using the most optimal method which has the least value of Akaike Information Criterion (AIC). Let y_t be a time series of interest which generates the observed data $(y,\ldots,y)$, with pre-sample values $(y, y, \ldots, y_{n-p+1})$. A two-regime self-exciting threshold autoregressive (SETAR) model of order p is written as

$$y_t = \left(\beta_1 + \sum_{j=1}^{p} \beta_{1j} y_{t-1} \right) 1(y_{t-1} > \gamma) + \left(\beta_2 + \sum_{j=1}^{p} \beta_{2j} y_{t-j} \right) 1(y_{t-1} \le \gamma) + e_t \quad (7)$$

where $\hat{\beta}_{ij}$ denotes the least squares estimation of the coefficient and conditional on $\hat{\gamma}$. By construction, the residual is at zero. The residual was not re-scaled since preliminary simulations showed little effect of rescaling. Let h denote the forecast horizon. The *h*-step ahead forecast, conditional on the last *p* observations of y_t, can be computed as follows.

$$\hat{y}_{t+h} = \left(\hat{\beta}_{10} + \sum_{j=1}^{p} \hat{\beta}_{1j} \hat{y}_{t+h-j} \right) 1(\hat{y}_{t+h-1} > \hat{\gamma}) + \left(\hat{\beta}_{20} + \sum_{j=1}^{p} \hat{\beta}_{2j} \hat{y}_{t+h-j} \right) 1(\hat{y}_{t+h-1} \le \hat{\gamma}) \quad (8)$$

where $\hat{y}_t = y_t(t = n, n-1, \ldots, n-p+1)$.

2.4. The LSTAR method uses one parameter, $p(p=1 \text{ or } p=2)$, in equation (9). This study forecasted by selecting the most appropriate method with the least AIC value. Smooth Transition Autoregressive model was developed by Teräsvirta and Anderson (1992), which is one of the models of Regime Switching, but is obviously different from the Markov Switching model that the STAR model has a transition variable, which is a variable that can collect data. Therefore, it is possible to identify the function used in any regime to describe the behavior of variables. However, the Markov Switching model cannot store variables that indicate a situation. Therefore, functions cannot be specified and changed. However, it is only possible to predict the probability of using any Regime to describe the variables being considered. Also, the probability of using a regime is constant at a certain value. Enders (1995) stated that the Smooth Transition Autoregressive model makes autoregressive parameters slow. To consider the Smooth Transition Autoregressive model, the Nonlinear Autoregressive Model (NLAR) has been adapted.

The value of y_{t-1} will lead to the use of the STAR model in general as follows.

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_p y_{t-p} + \theta \left\lfloor \beta_0 + \beta_1 y_{t-1} + \ldots + \beta_p y_{t-p} \right\rfloor + \varepsilon_t \quad (9)$$

when y_t is a dependent variable at certain time (t) y_{t-1} is a dependent variable time a $t-1; i=1,\ldots,p$

α_0, β_0 is a stable value α_n, β_n is an autoregressive coefficient $n=1,\ldots,p$

θ is a transition function ε_t is an violation value

STAR model has two changing functions: Logistic and Exponential. This study used Logistic (LSTAR) function.

3. Growth rate forecasting violation can be calculated by subtracting the actual value of growth rate with forecasting value, and the results will be the growth rate forecasting violation (e)

4. Estimation of growth rate forecasting violation rate of customer demand was conducted using the Copula't model with the *R* Project for Statistical Computing program (*R*)

4.1. Find ρ and ν values starting from conversing growth rate forecasting violation of customer demand on each product (e), cumulative distribution function (CDF), to find ρ and ν value using the 4 forecasting methods.
4.2. Model Copula't for CDF Estimation (CDF) using Copula't model with ρ and ν value was conducted by forecasting 10,000 CDF data of the 10 products and converse them from the 4 forecasting methods back from Cumulative Distribution Function (CDF) value to growth rate forecasting violation of customer demand from the estimation with the Copula't model.

5. Evaluate the Value at Risk (VaR) using growth rate forecasting violation of customer demand growth with the Copula't model, where the violation value represents the volatility and volatility represents the risk of data. The VaR of each product can be calculated by using growth rate forecasting violation of customer demand with the Copula't model of all 10 products. Data were used to balance the importance of each product (equal to 0.1), and the data of 10 products were integrated into the total VaR of all products by sequencing the data in ascending order. Find the median of the growth rate forecast data of customer demand with the Copula't model based on the confidence level.

6. Risk appraisal of business by explaining the risk value showed that the risk value of data enabled entrepreneurs to know the risk of selling their products. The results of risk value will help entrepreneurs to make a decision to join or continue to do the business. It can also evaluate and compare with other businesses, and such risk value can be used to compare with other products or other business groups, including the loss or profit to entrepreneurs as well. In the past, the entrepreneurs normally evaluated by assessor or personal judgment, which made it unsure since it involved with different ideas. Through this method, the risk value will be used to reflect the truth without any prejudice or opinions enabling the entrepreneur to make the decision easier to join or continue the business.

Growth rate forecasting

After converting the growth rate data of customers, we forecasted the growth rate by using ANN, ARIMA, SETAR, and LSTAR methods. The data of growth rate forecasting violation of customer demand were identified for VaR through the Copula model to show the risk value for all 10 products and total risk value for all 10 products from all four methods. Then we compared the risk value of the customer demand from the four methods to find an appropriate forecasting method to determine the risk value.

Preparation for Forecasting

We prepared daily customer need data based on 10 products. The data were sorted by using time series data. Daily sales information was from January 2, 2013 to December 30, 2015, 594 cases in total.

Finding VaR

We started from the preparation of the growth rate data by gathering information on the customer demand and converted it to the form of growth rate. As the growth rate data of customer demand in each product was daily data, some of the products have low customer demand on a daily basis, resulting in a sharp drop of customer demand while some products have high customer demand, resulting in a significant increase in the growth rate data. After converting customer demand into the growth rate value of customer demand, the data were forecasted.

Regarding the forecasting stage of customer demand in each of the four products, it started from forecasting the growth rate of customer demand in each product using the four methods: ANN, ARIMA, SETAR, and LSTAR through the R Project for Statistical Computing (*R*) to illustrate MAD, RMSE and MAPE values as shown in Table 1.

	Method	SUM e	MAD	RMSE	MAPE
Turbo	ANN	873.43	1.48	2.50	2.45
	ARIMA	1373.34	2.32	4.86	5.47
	SETAR	1034.03	1.75	3.60	2.95
	LSTAR	1128.59	1.91	3.35	4.38
Max1L	ANN	8403.32	14.19	40.44	12.37
	ARIMA	10030.82	16.94	43.92	25.75
	SETAR	8421.68	14.23	40.42	12.44
	LSTAR	8412.84	14.21	40.14	12.46
Max0.8L	ANN	6107.29	10.32	35.22	5.66
	ARIMA	7305.91	12.34	38.49	11.95
	SETAR	6535.66	11.04	35.59	6.55
	LSTAR	6399.57	10.81	34.87	8.33
Max2T	ANN	3826.80	6.46	20.82	9.91
	ARIMA	5557.48	9.39	37.26	14.94
	SETAR	4998.44	8.44	34.53	6.14
	LSTAR	3579.43	6.05	20.29	9.06
Commonrail	ANN	1662.94	2.81	7.40	3.58
	ARIMA	2362.71	3.99	10.88	7.80
	SETAR	1916.43	3.24	8.78	3.39
	LSTAR	1798.33	3.04	7.74	5.50
HLP	ANN	2479.77	4.19	9.12	5.53
	ARIMA	3215.00	5.43	10.43	10.68
	SETAR	2549.19	4.31	9.18	6.38
	LSTAR	2549.99	4.31	9.18	6.39
NGV	ANN	2462.62	4.16	9.09	9.64
	ARIMA	3099.11	5.23	11.60	7.30
	SETAR	2553.83	4.31	10.32	4.06
	LSTAR	2542.65	4.30	10.31	4.22
Plus	ANN	2035.49	3.44	10.84	2.80
	ARIMA	3492.36	5.90	15.37	11.23
	SETAR	2495.66	4.22	12.27	3.74
	LSTAR	2399.95	4.05	11.60	6.37
Premeir	ANN	1554.99	2.63	7.94	2.37
	ARIMA	2085.90	3.52	9.18	7.58
	SETAR	1631.46	2.76	8.14	2.72
	LSTAR	1644.07	2.78	8.15	2.75
Semi	ANN	1313.00	2.22	4.86	4.05
	ARIMA	3461.53	5.85	11.71	7.97
	SETAR	2671.11	4.51	9.97	3.93
	LSTAR	2671.29	4.51	9.98	3.94

Table 1: Growth rate forecasting violation of customer demand in each product from the four forecasting methods

From Table 1, e is the growth rate forecasting violation of customer demand which will be used for making the Copula't model from the four forecasting methods of 10 products.

Risk Identification Procedure

We identified the risk value of each customer demand in the four forecasting methods and received the total risk of customer demand by using VaR method through the Copula model.

Finding ρ and v values

We started from converting the growth rate forecasting violation of customer demand for each product (e) to the Cumulative Distribution Function (CDF). Then created Copula't using Method Spearman through the *R* Project for Statistical Computing (*R*) to find the ρ and v values and values from the four forecasting methods.

ρ represents the relative value of each product between Product 1 and Product 10, which may be in the same or opposite direction, and the v value is the Degree of Freedom = 5 to create a model for CDF estimation.

Modelling from Copula't for CDF value estimation

We estimated the CDF value from the Copula't model using ρ and v values to estimate 10,000 data of CDF from 10 products. Then converted the data from the 4 methods from the Cumulative Distribution Function (CDF) to the growth rate forecasting violation value of customer demand by estimating the value of the Copula't model. This estimation will allow the data to be dispersed into normal distribution.

Evaluation of VaR

The evaluation of VaR employs the growth rate forecasting violation of customer demand from the estimation with the Copula't model, where the violation value represents the volatility and volatility shows the risk of data using all 10 products, 10,000 data, $x_{1j}, x_{2j}, \ldots, x_{10j}$ and the total estimation of all products $\hat{x}_j$ when $j - 1, \ldots, 10000$ at 95% confidence level and 99%. Monte Carlo Simulation was used for data analysis.

Total VaR of all products

Simulation of total data relationship can be calculated by equation (10).

$$\sum_i x_{ij} \times w = \hat{x}_j \tag{10}$$

$x =$ Growth rate forecasting violation of customer demand from the estimation using Copula't model of each product

i = product 1 to10 j = data sequence 1 to10 ,000

w = 10/1 is weighting the importance of each product (equally)

$\hat{x}_j$ = Data of growth rate forecasting violation of customer demand from estimation with the Copula't model of all products, sequence *j*

Based on the data of growth rate forecasting violation of customer demand from the estimation of the Copula't model of the product from the four forecasting methods, VaR can be calculated by using $\hat{x}_j$ and by sorting in ascending order.

Find the median of $\hat{x}_j$ data by using ANN forecasting method based on the required confidence level. Examples of ANN forecasting method are as follows.

95% Loss = 0.6102 95% Gain = 0.6100

99% Loss = 0.8789 99% Gain = 0.8770

The total VaR value of all products can be explained as follows.

95% Gain means that all 10 products have 5% chance to increase sales (0.6183) * 100 = 61.83 units, 100 + 61.83 = 161.83 units from the original sales 100 units.

99% Gain means all 10 products have a 1% chance to increase sales (0.8750) * 100 = 87.50 units, 100 + 187.50 = 187.50 units from the original 100 units.

95% Loss means all 10 products have a 5% chance of decreasing sales (0.6189) * 100 = 61.89 units, 100 - 61.89 = 38.1146 units from the original sales 100 units.
99% Loss means that all 10 products have a 1% chance of decreasing sales (0.8757) * 100 = 87.57 units, 100 - 87.57 = 12.4321 units from the original sales 100 units.
After knowing the VaR and total VaR values of all products from the four forecasting methods, an appropriate growth rate forecasting method, ARIMA, can be selected because if it is the high VaR, it can better predict the chance of losing or getting higher value with less violation.

Selecting appropriate VaR

Finding the right forecasting method for predicting the growth rate of customer demand can be conducted by focusing on VaR value, the highest among the four forecasting methods in each product. This is because if there is a high VaR value, if it is the high VaR, it can better predict the chance of losing or getting higher value with less violation. To select appropriate VaR, VaR values from the four methods were compared with the real value of the customer growth rate. If the real value of the customer growth rate is over the given VaR, this is considered a violation. Then the violations were gathered for consideration. The method with the least violation is considered the most appropriate because it has the highest reliability as shown in Table 2. Find an appropriate forecasting method of VaR for all products as illustrated in Table 2.

	%vaR	Growth Rate Values of Customer Demand Exceeding VaR Values				Least Violation Method
		ANN	ARIMA	SETAR	LSTAR	
Products	95%Gain	162	154	162	162	ARIMA
	99%Gain	135	130	135	135	
	95% Loss	43	28	53	43	
	99% Loss	1	1	2	1	
Violation (%)	95%Gain	27.27	25.93	27.27	27.27	
	99%Gain	22.73	21.89	22.73	22.73	
	95% Loss	7.24	4.71	8.92	7.24	
	99% Loss	0.17	0.17	0.34	0.17	

Table 2 Selection table for VaR of appropriate total products from the four forecasting methods

Table 2 shows that an appropriate forecasting method for VaR is ARIMA, which has less violation than other methods. When considering the percentage of violation, at VaR 95%, Loss 99%, the violation is not higher than confidence interval. In general, VaR method is only used to quantify negative VaR.

Conclusion and Recommendations

When considering the value of a product risk, including 10 products, the ARIMA methodology should be used to predict the growth rate of customer demand. It is possible that tomorrow there will be a 5% chance that the demand of all 10 products combined is reduced to no more than 65.70%, which is in line with customer demand looking back to the total data of all 10 products. With the VaR that will lower sales, entrepreneurs may have to increase their promotional prices to increase sales.

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A STUDY OF THE ATTRACTIVENESS OF AIRLINE CARGO SERVICE INFLUENCING FREIGHT FORWARDERS' CHOICE

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Introduction

With the new era of digital globalization, the air cargo industry has continued to function as a key architect of world trade and has doubled in volume every years. For Air cargo, according to Boeing (2017), the demand increased a modest 1.9 percent in 2015. Air cargo traffic will progressively speed up in 2016 and 2017 and will remain in long-term trend growth in 2018. Boeing (2017) also indicated that world air cargo traffic is forecasted to grow with an average of 4.2 percent per year over the next 20-30 years as shown in Figure 1. Overall, world air cargo traffic will grow from 223 billion RTKs in 2015 to 509 billion RTKs in the year 2035. Domestic China and Intra-Asia are ranked first in term of air cargo growth, with 6.2% growth

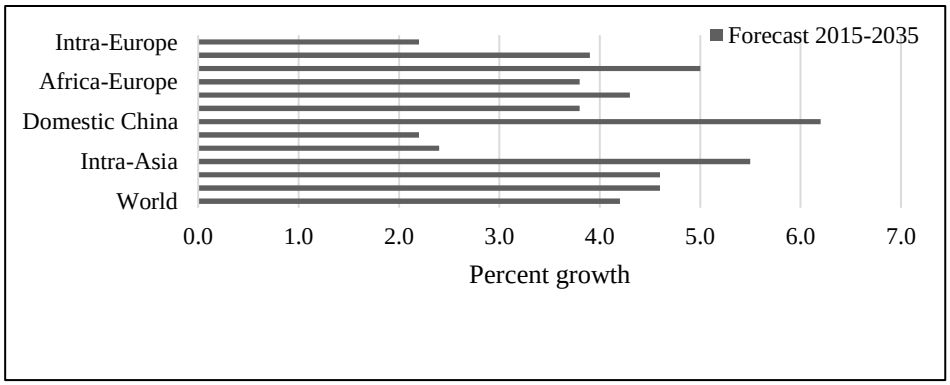

Figure 1: World air cargo traffic forecast by a percentage
Source: Organized by Author; (Boeing, 2017)

Air cargo transport involves a series of services from origins to destinations to move cargo through a shipper, a forwarder, a road transporter (or trucker), an airline (or carrier), and a consignee (Derigs et al., 2009). The shipper requests the commodity to be sent at a low cost and at the required service level. The forwarder performs as the ''middle man'' between the shipper and the airlines. The road transporter provides the ground transportation services before and after air transport. The airline receives, stores, transfers, tracks, loads and unloads cargo, and assigns and manages capacity. The consignee receives the shipment (Kasilingam, 2003) as present in figure 2.

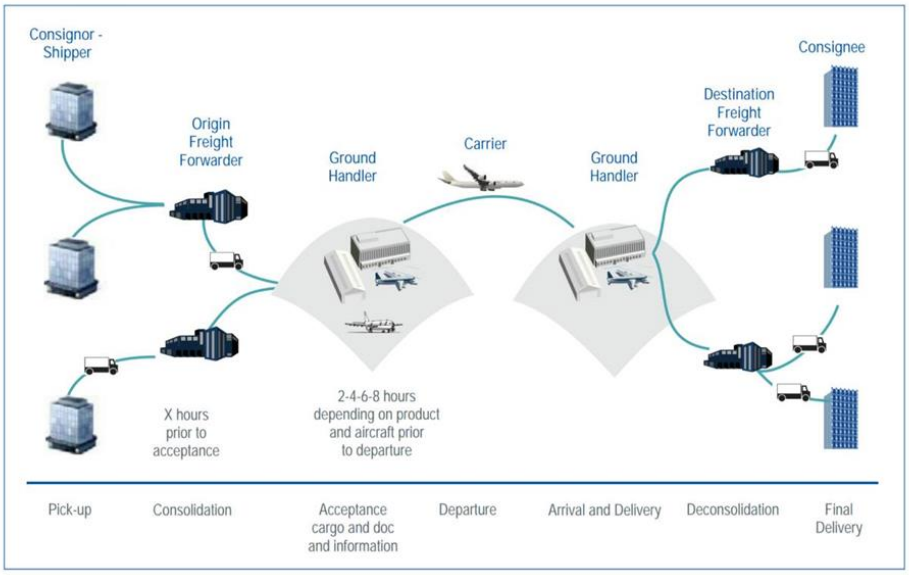

Figure 2: Physical Handling Flow (IATA, 2017)

Airlines are challenged to manage air cargo operations resourcefully by emerging strategic operation plans that allow these airlines to quickly adapt and respond to changes in the global competitive environment (Nobert and Roy, 1998; Ferguson et al., 2013). In order to react to such challenges, an increasing amount of research has been showed to address the problems in air cargo operations. Nevertheless, most problems, real-world problems in particular, keep on unsatisfactorily solved, relatively because of the complexities of air cargo operations. Therefore, this study aims to present the challenges faced by the airline cargo transport industry which is the perspective of freight forwarders that effect to the choice of airline cargo.

The rest of this paper is organized as follows. Section 2 describes the literature review for air cargo transport and the freight forwarder's perspective. Section 3 highlights the case study of Thailand. Section 4 presents the summary.

Literature Review

For the literature review, this study consider two perspectives which are air freight forwarder's perspective and factors selection process.

The freight forwarder's perspective

The majority of extant literature focuses on the air cargo operations of airlines, and only a few discuss those of freight forwarders. Xue and Lai (1997) presented an integer programming model for container selection and cargo loading to minimize the total cost. Chew et al. (2006) suggested a stochastic dynamic programming model for the short-term capacity planning of the freight forwarder; the model was used to define the additional short-term capacity. While container loading segments many similarities with aircraft loading, such as the need to consider volume and weight, container loading has some unique characteristics. Chan et al. (2006) developed a decision support system to optimize the cost related to air cargo pallet selection and loading. Huang and Chi (2007) studied how a freight forwarder should consolidate its shipments to utilize the quantity discounts offered by airlines. Wu (2008) built an optimization model to help logistics managers make decisions on how to rent containers from airlines with different weight and volume limits. Li et al. (2009) discussed research issue and developed a large-scale neighborhood search heuristic to determine the container loading plan. Wu (2010) extended his 2008 study to an uncertain environment and formulated a stochastic mixed 0–1 integer model to determine the booking types and quantities of containers, as well as a containerization plan to minimize the total rental cost. Wu (2011) further extended his research to incorporate the decision of renting and returning the number of containers by using a two-stage recourse model with allowance of later transport. Tang (2011) developed a scenario decomposition-genetic algorithm to solve the pure

and mixed container loading problem. Chan et al. (2012) developed a multi-agent-based system based on the cargo information obtained by radio-frequency identification (RFID) technology to assist freight forwarders in flight planning.

The literature has only focused the problem of market demand estimation and capacity booking when consider the freight forwarder perspective. The freight forwarder forecasts demand by integrating factors, such as trend, seasonality, and ad-hoc events. Then, the forwarder allocates capacity from several airlines and from the long-term contract and the spot market to maximize the expected profit under demand uncertainty and market prices, subject to transport budgets, departure time (e.g., morning or night flight), service priority, and capacity allocation from the airlines. However, as freight forwarders have to select airline to deliver the cargo, it has to be the significant factors which affected to the freight forwarder selection. This study focus on those factors which give the opportunities for airlines in order to improve their services.

Factors selection method

Location selection among a set of alternatives along with numerous contradictory criteria is a multiple criteria decision making (MCDM) problem. The objective of this research is to select the most appropriate location among alternatives for a regional aviation hub in the Northern part of Thailand. MCDM methods support decision makers solve complex decision problems involving conflicting criteria in a systematic and consistent way. Mardani, Zavadskas, Khalifah, Jusoh, and Nor (2016) show that use of MCDM methods has significant growth in the field of transportation systems.

MCDM includes many methods such as AHP, TOPSIS, PROMETHEE, SAW, and the newest method - Best-Worst Methods. Between these methods, only TOPSIS and AHP were found to be used most in air transport study. Marvelous efforts have been consumed and noteworthy advances have been completed towards the development of several MCDM methods for solving different types of decision problems (Yeh, Deng, and Pan (1999); Triantaphyllou (2000). In spite of this, there is no generally accepted approach for the general MCDM problem (Yeh, Deng, & Chang, 2000), and the proof of the decision outcome remains generally an open issue. The outcome is quite regularly reliant on the method used.

There are many ways and methods to evaluate location selection. Therefore, to select the suitable method, it is depends on the research objective and data collection. This research utilizes two MCDM methods, Best-Worst Method to define the weights of criteria and VIKOR to rank alternatives and select the best alternative. Best-Worst Method (which is developed based on AHP model) is used to define the weights in the hierarchy of criteria. VIKOR as a compromise ranking method are used for ranking and selection process in order to be assured in selecting the best alternative. Another reason for using these methods is their successful applications to the MCDM problems in the literature.

Best-Worst Method is the latest MCDM technique proposed by Rezaei (2015), which is based on pairwise comparisons to acquire the weights of alternatives and criteria respective to several criteria. It reduces the number of pairwise comparison by only executing reference comparison which means that experts are only required to define the preference of best criterion over other criteria and the preference of all criteria over the worst criterion, using on a 1-9 scale. By removing secondary comparisons this method is much more efficient and easier to obtain weights in an MCDM problem. This method had been used in a variety of contexts such as supplier selection (Rezaei, Nispeling, Sarkis, & Tavasszy, 2016), sustainable supply chain (Sadaghiani, Ahmad, Rezaei, & Tavasszy, 2015), energy efficiency of buildings (Parmarth Gupta, Anand, & Gupta, 2017), urban sewage treatment technologies sustainability assessment (Ren, Liang, & Chan, 2017), and measuring university-industry PhD projects efficiency (Salimi & Rezaei, 2016).

The literature on VIKOR and Fuzzy VIKOR methods is reviewed by Yazdani and Graeml (2014) for a total of 198 papers with 9 main application areas from 2002 to 2014, by Gul, Celik, Aydin, Gumus, and Guneri (2016) for a total of 343 papers with 13 main application areas from 1998 to 2015 and by Mardani, Zavadskas, Govindan, Amat Senin, and Jusoh (2016) for a total of 176 papers with 15 main application areas from 2004 to 2015. Uludag and Deveci (2013) applied Fuzzy VIKOR and Fuzzy TOPSIS methods to a potential city airport location selection problem by assessing thirty-four sub-criteria under nine main criteria (geographical specifications, climatic conditions, infrastructure conditions, costs,

transportation, the possibility of extension, legal restrictions and regulations, potential demand, environmental and social effects) for five location alternatives. Milosevic and Naunovic (2013) adopted VIKOR for determining the most suitable location for a sanitary landfill facility from three alternatives by evaluating thirty-two sub-criteria under five main criteria (hydrogeological criteria, meteorological criteria, spatial criteria, socio-political criteria, and legal and economic criteria) and use fuzzy AHP for determining weighting coefficients of the evaluation criteria. Liu, You, Chen, and Fan (2014) proposed an extended VIKOR method based on the interval 2-tuple linguistic variables to select the best disposal site for municipal solid waste among four alternatives considering four criteria (adjacent land use, climate, road access, and cost). Mokhtarian, Sadi-Nezhad, and Makui (2014) proposed Interval Valued Fuzzy VIKOR as a reliable method to select a appropriate location for digging some pits for municipal wet waste landfill. Pankaj Gupta, Mehlawat, and Grover (2016) proposed an extended VIKOR method using trapezoidal intuitionistic fuzzy numbers and apply it to the plant location selection problem with six criteria (skilled workers, expansion possibility, availability of acquirement material, investment cost, transport facilities, and climate) and three location alternatives. Hariz, Dönmez, and Sennaroglu (2017) completed Geographical Information Systems (GIS) analysis to classify feasible incinerator locations based on economic, environmental and social criteria and then use AHP, VIKOR and PROMETHEE methods to select the best location for a central healthcare waste incinerator.

The information provided indicates that there has been very few studies of location selection for a freight forwarder's perspective in the journal papers, therefore, presented MCDM problem and significant factors for evaluating factors is considered as the main contribution of this research to the literature.

Methodology

Factor weighting using Best-Worst Method (BWM)

Multi-criteria decision-making (MCDM) is a significant branch of decision-making concept. As mentioned in Chapter 2, the latest MCDM method is Best-worst method was selected for this research. The step of BWM was describe below (Razaei, 2015);

Step 1: Build the set of decision criteria. In this step, the criteria ($C_1, C_2,\ldots,C_n$) that should be used are considered. This step is done by factor screening process at the very beginning of the phase. The structure of the criteria can be built as the hierarchy level as shown in Figure 3

Step 2: Select the best criteria (most important) and the worst criteria (least important). In this step, the decision-makers identify each criteria and decide the most- and least important among the criteria. There are no comparison process in this step

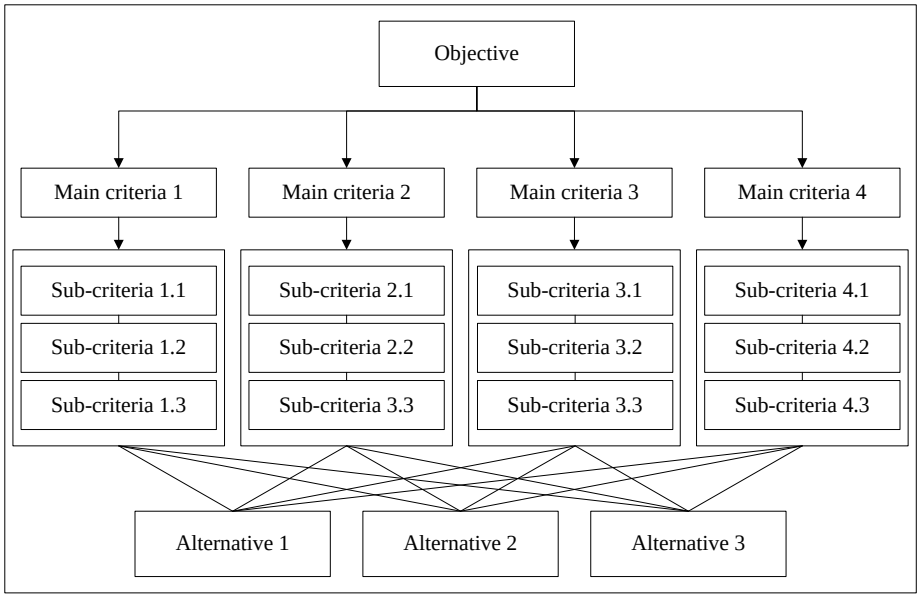

Figure 3 Criteria structure Source: Organized by Author

Step 3: Determine the preference of best criteria over all other criteria using the number between 1 and 9, as shown in Table 5.1. The value of 1,3,5,7,9 characterize equal importance, weak importance, essential importance, demonstrated importance, and extreme importance, respectively; while the value 2,4,6, and 8 are used to compromise between the values. The result of Best-to-Others vector would be:

$$A_B = (a_{B1}, a_{B2}, \dots, a_{Bn})$$

Where a_{Bj} represent the preference of the best criteria B over criterion j. It is clear that $a_{BB} = 1$

Table 1 The fundamental scale of absolute numbers

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another: its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Source: Saaty (2008)

Step 4: Determine the preference of all criteria over the worst criteria using the number between 1 and 9, as shown in Table 1. The result of Best-to-Others vector would be:

$$A_w = (a_{1w}, a_{2w}, \dots, a_{nw})$$

Where a_{jw} represent the preference of the criterion j over the worst criteria W. It is clear that $a_{WW} = 1$

Step 5: Find the optimal weights$(W_1^*, W_2^*, \dots, W_n^*)$. The optimal weight for the criteria is the one where, for each pair of W_B/W_j and W_j/W_w, the $W_B/W_j = a_{Bj}$ and $W_j/W_w = a_{jw}$. The next step is to satisfy these condition for all. The solution, where the maximum absolute difference $\left|\frac{W_B}{W_j} - a_{Bj}\right|$ and $\left|\frac{W_j}{W_w} - a_{jw}\right|$ for all j is minimized, should be made. Considering the non-negativity and sum condition for the weights, the following problem is resulted;

$$\begin{aligned}
&\text{Min } \xi \\
&\text{s.t.} \\
&\left|\frac{W_B}{W_j} - a_{Bj}\right| \le \xi, \text{ for all j} \\
&\left|\frac{W_j}{W_w} - a_{jw}\right| \le \xi, \text{ for all j} \\
&\textstyle\sum_j W_j = 1 \\
&W_j \ge 0, \text{ for all j} \qquad (1)
\end{aligned}$$

Solving problem (1), the optimal weights $(W_1^*, W_2^*, \dots, W_n^*)$ and ξ* are obtained.

The last step is to test the consistency through calculation, modifying it if necessary to get an acceptable consistency. Table 2 shows the order of the consistency index table according to study of Razaei, (2015) which is used to calculate Equation (2). The consistency ratio for Best-Worst Method using ξ and the corresponding consistency index, as follow;

$$\text{Consistency Ratio} = \frac{\xi^*}{Consistency\ Index} \qquad (2)$$

Table 2 Consistency Index (CI) table

a_{BW}	1	2	3	4	5	6	7	8	9
CI	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

Source: Razaei, (2015)

Case study of Thailand

In according to shippers or freight forwarders, the decision making to select airlines to carry their shipments are several criteria regarding to mostly time to reach destinations. Besides of that, there are factors that can defeat the lead time to reach destinations performed by airline services and performance. The decision is not only by shippers or freight forwarders but also airline operation as following details:

- Destination
  The destinations served by airlines are considered significant because the shippers will ship their goods or cargo to destinations ordered by their buyers. They cannot ship their cargo to other destinations without service order. This is initially clear and important to the shippers to decide on which airlines they will select to use for carrying their cargo to their desired destinations at buyers/consignees' final destinations. The cargo must arrive the destination of consignees.

- Flying time/Distance
  The flying time and distance is another key factor that the shippers need to consider to select airlines. The preferred time and distance is certainly shorter is better to meet the lead time to

deliver cargo to consignees or buyers at their factories. The shorter flying time and distance become important and preferable factors for shippers on choices of airlines who offer shorter service to consignees. There would not be a detour operating time and distance to be accepted by shippers and consignees.

- Aircraft types and cargo space
  There are several types of aircrafts with narrow-body and wide-body aircrafts. The cargo compartment of such two types of aircrafts are different in carrying capacity. Even the same type of aircraft can also different depending on airline design of cargo belly. The shippers with small shipments with proper dimension that can fit in can consider to select narrow-body airlines to carry cargo to their destinations while the shippers with bulky or skid cargo need to consider only wide-body airlines. Not only that the shippers with skid, long, heavy and/or oversize cargo have to select airlines with sufficient and capable aircrafts to carry such odd cargo. Basically, weight and dimension of cargo must be able to load/unload into airline aircrafts. The shippers shall be aware of this condition.

- Airfreight transport fare
  The fee is one of the main criteria for shippers to choose airlines to ship their cargo. The costly offer from some airlines may make shippers to decide to use other airlines. On the other hand, low cost offer may influence shippers to move from legacy airlines to airlines with much cheaper costs as nowadays, the shipping market is highly competitive and there are thousands of airlines who compete to offer a good deal to shippers. Of course, lower costs of transport fee bring more revenue to shippers and save more expense to consignees.

- Number of transit/transfer
  In order to meet the time line to deliver cargo to consignees, some numbers of transit/transfer are acceptable but unquestionably, only limited numbers are satisfactory. There are several operational handling activities at transit/transfer airports. This means that there might be irregularities such as missing, damage or pilferage to the cargo that may not arrive in a due time or properly. This leads to unfavorable to consignees and shippers to the selected airlines.

Factor weighting using Best-Worst Method (BWM)

After conducting the experts' group discussion for factor selection process, in this step, a structured interview was applied in order for determining the weight and significance of each variable. The survey is conducted and delivered to the experts in the in the management level who came from related aviation industry such as Airports of Thailand, airline, and freight forwarders. Below are the step of the method to calculate the weight of each criteria.

Step 1: Determine a set of criteria; this step consider the criteria that should be used which already done by the group discussion. Five variables were selected for this step

Step 2: Determine the best (the most important criteria) and the worst criteria (the least important criteria); in this step, the decision makers decided the criteria without any comparison. Table 3 show the results that the most important criteria is regional plan and the least important criteria is general topographic of vicinity.

Table 3 Determine the best and worst criteria

Criteria	Rank
Airfreight transport fare	Best
Number of transit/transfer	Worst

The next step is to construct Best-Worst method to investigate the weights and priority of each variable. The analysis were made on a scale from 1 to 9. Table 4 presents the final weights of each criteria. Among the 5 criteria, the experts decided that Airfreight transport fare was the most important variable. The result show the weight of Airfreight transport fare to be 0.1815. The experts agreed that

the airfreight transport fare is main criteria for shippers to choose airlines to ship their cargo. In addition, the consistency ratio (CR) was all smaller than 0.1; therefore, the results were considered to be reliable.

Table 4 Factor weighting summary

Criteria	Weight	Rank
Airfreight transport fare	0.375	1
Number of transit/transfer	0.042	5
Destination	0.241	2
Flying time/Distance	0.157	4
Aircraft types and cargo space	0.185	3

Currently, the air freight transport business among airlines is highly competitive due to more and more airlines enter the market. Airlines now compete each other to find cargo from shippers. Most of shippers appoint freight forwarders to arrange shippers' shipments to consignees' destinations on their behalf. Then, the decision making from freight forwarders are crucial to airlines. Airlines make sales and promotion approach to the forwarders. Some of them may not know the significant criteria that the forwarders aim for. This study is to simplify airlines to understand major criteria from the forwarders to select airlines to transport their shipments.

Table 4 presents significant criteria for airlines to acknowledge the significance. Airfreight transport fare is ranked as first as nowadays, every business attempts to provide products with the lowest cost as possible to earn more yield of its products. Airfreight transport fare is one of the major costs to traders. Airlines offer the best fare to forwarders. On the other hand, forwarders now open bidding for each shipment and have airlines to bid for that business. This business trend re-emphasizes on the outcome of this research that forwarders focus on reasonable airfreight transport fare while number of transit/transfer is the least important forwarders as long as airlines carry cargo to the final destinations and meet their lead-time. There is not much influence to forwarders to select airlines. At the same service standard, airlines who offer the lowest airfreight transport fare will be selected by forwarders. In reality, airlines offer different services and standards. Pricing is the most important but still need to consider other factors as well.

There are other criteria that airlines can offer to forwarders together with pricing. Destination is also important to meet forwarders' expectation. Airlines without destinations, that forwarders wish to send cargo to, are useless. The shippers will specify destinations to deliver cargo to its customers or consignees. Therefore, the destinations are strictly identified. Other than destination, aircraft types and cargo space and flying time/distance are ranked in the middle of the result. These two criteria shall be together along with destination. As mentioned earlier, without preferred destinations by shippers, airlines will not be selected. Therefore, airlines with shippers' preferred destinations need to focus on airfreight transport fee because such airlines have the strongest point of sales for destination criteria with good transport rate. The airlines will be attractive to forwarders' choice. If the airlines even have suitable aircraft types and cargo space and flying time/distance that meet cargo requirement such as volume and dimension or lead time. Such airlines will be preferable to gain the selection by forwarders. Then, airline attractiveness will be more interesting to forwarders and considered a simple case for airlines to win the attractiveness.

However, airlines without forwarders' desired destinations are difficult to win the business at all as there is no destination. Nevertheless, airlines can find partnered airlines or trucking companies to extend their network to meet the desired destination. The partnered airlines (receiving airlines or second/third legs) shall meet the basic criteria of the transferring airlines (first leg) of destination, aircraft types and cargo space and flying time/distance. As long as pricing is right. Destination can offer. Cargo can be loaded into aircraft. The lead-time is met properly. The airlines will be choices of forwarders. Likewise, trucking companies are widely used in Europe, Australia, USA, Japan, etc. The trucker can even transport from destination airports to where airplanes cannot land. Airlines can offer forwarders to send such cargo with customs clearance service directly to consignee's factories. This would be more beneficial to shippers and consignees as one stop service for all parties. At transferring points, there

might be irregular ties occurred such as damaged, missing, pilferage cargo. This is unpleasant to forwarders at all. Still, pricing is vital to forwarders to consider with connecting points offered from airlines.

This research recommends airlines without forwarders' desired destinations to find transporting partners no matter with interline airlines or truckers to expand their network. This would bring such airlines more attractive to forwarders together with pricing and dissolve the destination criteria.

Conclusion

Even though airfreight transport fare is significant to forwarders to choose airlines for transporting their good. Other criteria are important as well to make an offer to forwarders. Airlines must consider their services to offer the completed services in order to earn more business. These five criteria shall be altogether to make a strategic approach from airlines. Without one of each, the selection will not be completed. Nowadays, forwarders prefer to have all-in service and charge as long as cargo arrive destinations without irregularity and leaving all operation works to airlines based on such five criteria examined from industrial experts and academic methodology. This research is sophisticatedly combined between actual practices and academic section to reveal significant criteria that airlines should be aware of and touch upon to all practitioners.

Reference

Can be furnished upon request.

A SYSTEMATIC REVIEW ON PSYCHOLOGICAL FACTORS ENCOURAGING CARPOOLING

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Introduction

Since 1970s, studying on carpool has begun (Ferguson, 1997). It has an aim to encourage individuals to carpool in order to fulfil many purposes such as reducing resources consumption, mitigating traffic congestion, and reducing car usage, and improving environmental situation (Chan and Shaheen, 2012).

Carpool can be defined in various meanings depended on different views such as the role of participants (drivers or riders), relationships of carpoolers, profit generation, the length of detouring, and trip purposes (see, e.g., Dickinson *et al*. 2015; Shaheen and Cohen, 2018). In this manuscript, carpool components are follows: 1) carpoolers are one driver sharing the use of her/his privately owned car and one or more riders; 2) both have the same origin and destination sharing a common route; 3) carpoolers must not live in the same household (this allows for friends/friend-of-friends, neighbours, co-workers, and strangers); 4) riders may or may not share some expense with the driver; and 5) the driver does not aim at profit making (i.e., received cash just to cover costs or purely donation).

Through times, carpooling has not been popular among travellers but researchers are always called for effective carpool intervention programs (e.g., Koppelman *et al*., 1993; Chan and Shaheen, 2012; Gheorghiua and Delhommeb, 2018). The more understanding of barriers and benefits of carpooling the more the success of intervention programs (Margolin *et al*., 1978; Tischer and Dobson, 1979; Wang *et al*., 2018). Regarding factors encouraging carpooling, researchers found that early and most of research on these factors focused less on psychological aspect (De Almeida Correia *et al*., 2013; Neoh *et al*., 2017).

This manuscript conducts a systematic review on psychological factors encouraging carpool behaviour (hereafter psychological factors). A concept of consumer buying behaviour borrowed from marketing is applied to capture psychological factors investigated in literature. The manuscript starts with literature review and follows by the methodology. Next, reports of the search and psychological factors appeared in the literature are illustrated. Finally, discussions and conclusion are presented.

Literature review

Internet-based technology has improved the capacity of ride-matching services which is expected to help increase more sustainable mobility (Chan and Shaheen, 2012; Shaheen and Cohen, 2018). Still, researchers and matching agencies are struggling to find market mechanisms that help attract participants (Furuhata *et al*., 2013; Stiglic *et al*., 2015). This two-sided matching is based on "how efficiently and effectively suitable matches can be found" and this creates of the chicken-and-egg problem to matching agencies (Stiglic *et al*., 2015, p.30). In the perspective of economics, in order to "attract buyers [riders], an intermediary [matching agency] should base of registered sellers [drivers], but these will be willing to register only if they expect many show up" (Caillaud and Jullien, 2003, p.310). To increase the availability of matches is to build critical mass by motivating both drivers and riders and changing their behaviours (Nielsen *et al*., 2015). As the influences of factors on carpoolers depend on whether they are drivers or riders (Neoh *et al*., 2017; Park *et al*., 2018), this shows that different roles have different needs, wants, and motivations (Nielsen *et al*., 2015).

Many transportation researchers see traveller' behaviour as consumer behaviour (e.g., Margolin *et al*., 1978; De Almeida Correia *et al*., 2013; Standing *et al*. 2018). This is because "transportation is affected by human behaviour through its consumers (drivers, riders, vehicle buyers, and shippers)" (McFadden, 2007, p.269). Consumers may select a transport mode choice depended on discouraging and encouraging factors (Stern, 1999). Among three levels of analyses, other than physical analogies and economic optimisation, transport researchers may understand traveller's behaviour from insights

provided by psychological concepts (McFadden, 2007). Previous studies on carpool encouraging factors focused on instrumental factors and demand modeling; there is lack of research on psychological factors (De Almeida Correia *et al*., 2013; Nielsen *et al*., 2015; Neoh *et al*. 2017).

Based on the fact that economics and psychology are the foundation of marketing (Hunt, 2010), understanding psychological factors of carpoolers from the perspective of marketing should be advantageous. Kotler and Armstrong (2010) proposed a set of characteristics affecting consumer behaviour (i.e., cultural, social, personal, and psychological) and provided definitions of psychological aspect as follows. Motivation refers to an individual's needs that drive one to behave and seek satisfaction. Perception refers an individual's meaningful of the world derived from the process of select, organise, and interpret information one perceived. Learning refers to an individual's behaviour changes that influenced by experience. Beliefs refer to an individual's descriptive thoughts. Finally, attitudes refer to an individual's relatively consistent evaluations, feelings, and tendencies toward an object or ideas. Transportation researchers also suggest definitions of psychological factors in various meanings (see, e.g., De Almeida Correia *et al*., 2013; Devarasetty *et al*., 2014; Neoh *et al*., 2017). Comparing these definitions should be studied in future research. The other characteristics in the set suggested by Kotler and Armstrong (2010) should be explored further.

Systematic review

To understand what those psychological factors are, this study conducts the systematic review due to three reasons. First, the method is a fundamental scientific activity that helps identify key scientific contributions to the field (Tranfield *et al*., 2003; Booth *et al*., 2012). Second, it helps researchers conduct an exhaustive and comprehensive searching with a protocol entailing a series of standard techniques minimising bias and error (Tranfield *et al*., 2003; Grant and Booth, 2009). Last, it shows us what is known, remains unknown and, guides us future research questions (Grant and Booth, 2009).

The review method followed the guideline provided in Booth *et al*. (2012). Due to one limitation of accessing to offline journals, this manuscript aims only for electronic databases. Three databases and one database host were chosen. ISI Web of Science (ISI) and Transport Research Information Services (TRIS) were selected as similar to the previous study adopting systematic search method (Neoh *et al*., 2017). Scopus and ProQuest were further chosen as the former is comprehensive and multidisciplinary in nature than ISI (Meho and Yang, 2007), and the latter serves as a database host. Keywords were "carpool" and other equivalent words (i.e., rideshare, liftshare, and carshare) as the literate suggested that these words are used interchangeably (Neoh *et al*., 2017; Gheorghiua and Delhomme, 2018). Regarding timespan, articles in three databases were searched spanning from 1970 to 2018 (early August), except for ISI which allowed us to search the oldest one appeared since 2001. Aiming to know the key scientific contributions on psychological factors, only the articles written in English and published through peer-reviews journals were selected. Duplicated articles were screened out. An article's title, abstract, and keywords were explored based on this manuscript's definition of carpool and Kotler and Armstrong (2010)'s definitions of psychological factors. Only articles explicitly showing that they studies on the topic of carpool behaviour and psychological factors were chosen. It should be noted that the systematic review method is not free from limitations as it is oriented with a qualitative appraisal (Grant and Booth, 2009). Determining inclusion or exclusion of an article is subject to biases such as the authors' determinations in selections of databases and papers. Future research should explore this research question with other review methodologies. It should further expand a search to other databases and consider published-offline and conference papers as well as white papers. In total, there are thirty-four articles that met the criteria (see Table 1).

Database	ISI	TRIS	Scopus	ProQuest
Initial results	813	734	1087	249
Carpool-related articles	214	152	254	39
Carpool-related psychological factors	21	24	26	3
Total articles excluding duplications			34	

Table 1: The search results of four databases

Search results

The first article studied on psychological factors was written by Horowitz and Sheth in 1977. There are only ten articles for almost three decades before the year 2004, the year of technology-enabled ride-matching (Chan and Shaheen, 2012). Figure 1 suggests that since 2004, articles have been published increasingly. Interestingly, there are five articles published since January of 2018. This suggests that researchers are increasingly interested in this topic. This may be because of the awareness of sustainable mobility as well as the advances in ride-sharing technology (Shaheen and Cohen, 2018). Twenty-eight articles are published in transportation-related journals (see Table 2).

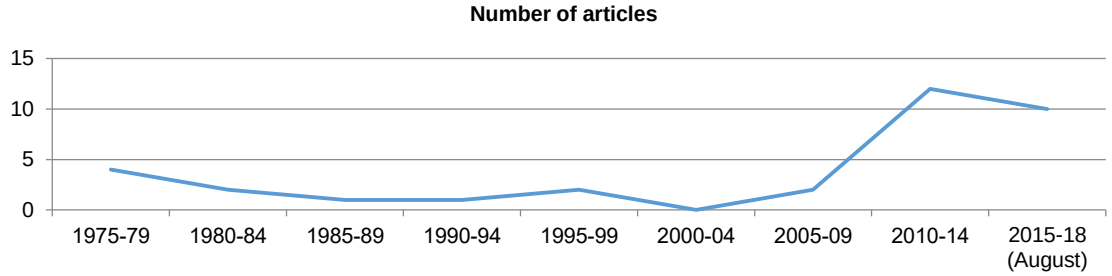

Figure 1: Numbers of articles published in a period of five years

Journal	Num	Journal	Num
Journal of the Transportation Research Board	8	Journal of the Eastern Asia Society for Transportation Studies	1
Transportation Research Part A	7	Journal of Advanced Transportation	1
Transportation Research Part D	2	Environment and Behavior	1
Transportation Research Part F	1	Journal of Services Marketing	1
Transportation	4	Bulletin of the Psychonomic Society	1
Transportation Planning and Technology	3	Journal of Applied Social Psychology	1
Transport Policy	3		

Table 2: Numbers of articles published in each journal

Regarding to methodology, consistent with Neoh *et al*. (2017), most articles are empirically driven. Survey data drawing from various sources such as highways, high-occupancy vehicle (HOV) lanes, and government survey was mostly used. Few articles conducted research in theoretically driven manner (e.g., Dickinson *et al*., 2018; Neoh *et al*., 2018) and adopted alternative methods such as in-depth interview (Owens, 1981), focus group (Malodia and Singla, 2016), and ethnographic interview (Gergen, 1973). Data in most articles were collected in Western countries (i.e., US, Canada, UK, French, Portugal, Netherlands, Denmark, and New Zealand). Only two are non-Western countries which are India (Malodia and Singla, 2016) and Japan (Yotsutsuji *et al*. 2013).

Borrowing models and theories from other related-disciplines could be useful for future research (Neoh *et al*., 2017). In-depth interview, focus group, and experimental design should be used more in future studies. Understanding carpooler behaviour is an understanding of changes in people which is not easy (Nielsen *et al*., 2015). Future research should adopt various methodologies and explore more in non-Western countries, especially, a country that does not have a HOV lane. This lane is an intervention method that offers rewards (i.e., travel time savings) to carpoolers. Reward is offered in order to increase the frequency of responding of people (Gergen, 1973). Without such reward, carpooler's motivations might be different. Intention-behavioural gap is another serious issue. Owen (1981) found that attitudes toward carpooling did not affect behaviour. Nielsen *et al*. (2015) also suggested that individuals hardly shift transportation mode. Stated preference is subject to limitation. It is also sensitive to socially desirable bias when researchers asked respondents about environmental-related questions (Malodia and Singla, 2016). Longitudinal study might mitigate this limitation. A good example of such study is the study by Wang and Chen (2012); however, the authors studied on household carpooling. Longitudinal study comparing stated and revealed preferences on psychological

factors for non-household carpooling should be used in future research.

Psychological factors

Twenty-five articles do not specify the role of carpoolers (see Table 3). This is consistent with Neoh *et al*. (2017). The set of none-specified factors should be further considered in future research by testing the factors regarding the role of carpoolers. In this set, there are four factors (altruistic, perceived peer pressure, positive attitude towards group members, and a sense of belonging to the community) that have not been tested regarding on the role of participants. Among all of thirty-four articles, nine articles studied the factors separately on either drivers or riders (see Table 4). Three factors in the set of factors for drivers (economic advantages, pro-environmental, responsibilities to one's family) and one factor in the set of factors for riders (socialisation) show conflict results. Future research should continue to test these factors. Furthermore, five factors from the set of factors for drivers (i.e., prosocial, empathy, shared experience, companionship, positive attitude towards carpooling) should be tested on the role of riders. Furthermore, emotional-related factors (e.g., empathy, frightening, anxiety, enjoyment, trust) have been rarely tested in the literature. It should be noted that, in Neoh *et al*. (2018), one possible reason explaining why the latent named "responsibilities to one's family" was not significant is that the latent might not be purely emotional-related factors (i.e., "caring"). As emotion is a part of psychological factors (Kotler and Armstrong, 2010), future research should study more on these factors as well as other types of emotions.

Factors that do not clarify the role of participants		Authors
Significant/found	Non-significant/not found	
Convenience, Pleasant, Comfort, Economic advantages	n/a	Horowitz and Sheth (1977)
Convenience, Schedule flexibility, Cost-saving, Safety	Comfort	Margolin *et al*. (1978)
Cost-saving, Socialisation	n/a	Tischer and Dobson (1979)
Convenience, Comfortable	n/a	Dumas and Dobson (1979)
Friendship, Convenience, Enjoyment, Positive attitude towards the group	n/a	Owens (1981)
Pro-environmental	n/a	Flannelly and McLeod (1989)
Commute cost	n/a	Young (1995)
Prosocial, Trust	Pro-environmental	Van Lange *et al*. (1998)
Save time, Enjoyment, Pro-environmental, Socialisation Cost-saving	n/a	Li *et al*. (1998)
n/a	Pro-environmental, Cost-saving	Buliung *et al*. (2009)
Cost-saving, Pro-environmental, Socialisation	n/a	Canning *et al*. (2010)
Unspecified motivations	Cost-saving, Altruistic	Buliung *et al*. (2010)
Cost-saving	n/a	Correia and Viegas (2011)
Cost-saving	n/a	Akar *et al*. (2012)
n/a	Pro-environmental, Cost-saving	Buliung *et al*. (2012)
Saving money, Reliability of carpooling, Socialisation, Saving time	n/a	Abrahamse and Keall (2012)
Socialisation	n/a	DeLoach and Tiemann (2012)
Positive attitude towards group	n/a	De Almeida Correia *et*

Factors that do not clarify the role of participants		Authors
Significant/found	Non-significant/not found	
members		*al* (2013)
Cost-saving, Flexibility, Comfortable, Socialisation	n/a	Nielsen *et al* (2015)
Economical advantages, Pro-environmental, Positive feelings towards carpooling	n/a	Malodia and Singla (2016)
Pro-environmental, Comfortable	n/a	Delhomme and Gheorghiu (2016)
Prosocial, A sense of belonging to the community, Convenience, Monetary gains, Personal benefits	n/a	Guyader (2018)
Pro-environmental, Financial incentives, Schedule reliability, Perceived peer pressure, Positive attitude towards carpooling	n/a	Gheorghiu and Delhomme (2018)
n/a	Trust, A sense of community	Dickinson *et al*. (2018)

Table 3: Psychological factors which the articles do not specify the role of carpoolers

Despite the fact that technologies facilitating ride-sharing have shaped traveller' behaviour (Dickinson *et al*., 2015), only seven articles conducted research under the context of ride-matching technologies. Five articles studied in the context of web-based ride-matching technologies: Carpool Zone (Buliung *et al*., 2009, 2010, 2012); Let's Carpool (Abrahamse and Keall, 2012). Three articles used ride-matching apps: Notteko! (Yotsutsuji *et al*., 2013); FacePorter (Tahmasseby *et al*., 2016); BlaBlaCar (Guyader, 2018). Future research should study psychological factors under the context of ride-matching technology.

Factors for drivers		Authors
Significant/found	Non-significant/not found	
Economic advantages	n/a	Levin (1982)
Convenience	Cost-saving, Pro-environmental	Arbour-Nicitopoulos *et al*. (2012)
Prosocial	n/a	Yotsutsuji *et al*. (2013)
Prosocial, Empathy, Shared experience, Socialisation, Enjoyment, Trust, Safety	Monetary incentives, Frightening, Uncomfortable	O'Brien and Dunning (2014)
Companionship, Convenience, Positive attitude towards carpooling	n/a	Devarasetty *et al*. (2014)
Pro-environmental, Convenience	Monetary incentives	Tahmasseby *et al*. (2016)
Convenience, Socialisation, Flexibility, Cost-saving	n/a	Park *et al*. (2018)
n/a	Responsibilities to one's family	Neoh *et al*. (2018)
Factors for riders		**Authors**
Significant/found	Non-significant/not found	
Comfort, Convenience	n/a	Levin (1982)
Socialisation, Enjoyment	Anxiety	O'Brien and Dunning (2014)
Convenience, Time savings, Monetary savings	Pro-environmental, Socialisation	Shaheen *et al*. (2016)
Pro-environmental, Monetary savings, Convenience	n/a	Tahmasseby *et al*. (2016)

Factors for drivers		Authors
Significant/found	Non-significant/not found	
Safety, Flexibility, Cost-savings	n/a	Park *et al*. (2018)

Table 4: Psychological factors regarding the role of carpoolers

Discussion and conclusion

De Almeida Correia *et al*. (2013) stated that attracting individuals to carpool could be done through psychological interventions. There are eight common factors for both drivers and riders (i.e., Cost-saving, Convenience, Flexibility, Safety, Trust, Socialisation, Enjoyment, Pro-environmental). These should be useful for practitioners who seek to create an intervention program. For any intervention program, the benefits proposed and messages communicated to individuals should be at least consisted of these encouraging factors. Since governments and public agencies (e.g., environmental agencies, and traffic management agencies) are interested in reducing urban problems by means to promote efficient car use, the factors found in this manuscript might increase the effectiveness of intervention campaigns. Regarding business implication, companies desire to increase their users and aim at addressing the problem of chicken-and-eggs (Furuhata *et al*., 2013). Psychological factors might be helpful for their carpool programs and schemes to build the critical mass.

Important evidence found in the results is that there are articles found significances and non-significances of the same psychological factor. For example, perceived environmental concerns were significant in some studies but not in the others. Shaheen *et al*. (2016) found that environmental and socialization motivations were not major factors for riders of casual carpool. However, in the latter study, Gheorghiu and Delhomme (2018) found that these motivations emerged in the later trips of carpooling. This is also the same to other encouraging factors such as socioeconomics (see, e.g., DeLoach and Tiemann, 2012). This evidence gives us some senses that carpool behaviour might be better understood through different stages. As individuals' motivations change due to experiences they receive (Kotler and Armstrong (2010), psychological factors that make individuals start, maintain, and stop carpooling might be different. One can see in the case of casual carpool in the study by O'Brien and Dunning (2014). Carpoolers reported that they did not know each other but later on they quickly became mutual friends. This also supports findings of Gheorghiu and Delhomme (2018) by suggesting that the relationship between drivers and riders were changing dynamically through time that they participated in carpooling. We expect that the results from previous studies both significant and non-significant might be all indeed significant if researchers test them according to a particular stage of carpool cycle. Developing the carpool cycle might be an urgent need (Neoh *et al*. 2017).

Some studies explored the formation of carpool (Abrahamse and Keall, 2012), experiences of carpoolers (O'Brien and Dunning, 2014; Guyader, 2018), and the reasons explaining why carpoolers had stopped carpooling (Akar *et al*., 2012; Nielsen *et al*., 2015). These articles could serve as a guideline for developing the carpool cycle. Factors discouraging carpooling could also be illustrated in the perspective of the factors encouraging car use (Abrahamse and Keall, 2012). For example, individuals disliked carpooling because they felt lack of flexibility and carpooling made them depending on others while solo driving was in the opposite. This is not surprise and consistent with Neoh *et al*. (2018) who conducted a study examining on car-use motivations and concluded a set of carpool motivations. Knowing the carpool cycle may allow researchers to understand more of carpool behaviour and know more how to encourage them to carpool via carpool programs and schemes (Neoh *et al*., 2017). Transportation researchers might need theories from other related domains to develop the carpool cycle. Theory in marketing is not new for transportation researchers. For example, market segmentation is the approach frequently used in marketing filed to understand consumer behaviour (Smith, 1956) and have been used in three articles found in the search results (Margolin *et al*., 1978; Koppelman *et al*., 1993; Nielsen *et al*. 2015). As mentioned at the beginning, researchers have requested for an effective marketing campaigns and interventions in order to promote sustainable mobility. Market segmentation theory alone applied in research on carpool might sufficiently to help understand complexities of carpoolers. Transportation researchers may now need to borrow other theories from marketing (e.g., consumer behaviour, consumer buying decision making, and social marketing), conceptualise them in

the context of carpool, and develop a framework that helps understand a holistic view of carpool behaviour.

This systematic review contributes to three folds. First, it used the theory from marketing as the basis understanding of psychological factors of carpooling. Second, based on the systematic review of this manuscript, this is the first systematic review on psychological factors of carpooling. Finally, based on the results from the search, this study illustrated the trend of research on carpool-related psychological factors, summarised factors used in the articles, and suggested several future research on this topic.

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A STRUCTURED APPROACH TO REDESIGN DEMAND-DRIVEN SUPPLY CHAINS

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Introduction

Changes in the competitive intensity and, therefore, on the attractiveness of an industry in terms of shareholder value (Rappaport, 1987), trigger often the necessity for a company to review its corporate strategy. As a result, the customer value proposition is assessed and adjusted, leaving the supply chain function the responsibility to deliver it at optimum cost, capital investment and risk exposure.

How to structure a supply chain and its required components (Persson and Olhager, 2002; Sharifi et al., 2006) to support the value proposition (Fawcett et al., 2007) is the core of supply chain design. The redesign of an existing supply chain is, however, a challenge for most practitioners. Although academia (Fisher, 1997; Christopher and Towill, 2000, and Lee, 2002), has provided different general frameworks about the different types of supply chain design and emphasized the need to match them to company goals, reality is often too complex and too uncertain to identify, evaluate and select the best design choices along supply chain functions.

Recognizing this challenge, Stevens (1989) asserts that “a structured approach” is “required” for effectively designing a supply chain. However, only a handful of structured and empirically supported approaches do transcend simplified type-match concepts. Addressing this gap, the aim of our study is to provide a practitioner-oriented approach of redesigning a supply chain that aims at selecting the most appropriate supply chain configurations ready to be implemented that deliver both, sustainable competitive advantage and shareholder value while simultaneously considering the risks of implementation. This approach aims not to create theory but to build on existing academic concepts and to link them in a structured way resulting in a novel redesign approach to pragmatically deal with the complexity and uncertainty of demand-driven supply chains as being typical in the fast-moving-consumer-goods (FMCG) sector. The result is a 6-step approach that combines state-of-the-art supply chain theory with lessons learned from case studies to provide a guideline for practitioners.

For the purpose of this research, the case study method (Yin, 2014) was adopted as overarching research strategy while abductive analysis was applied as the methodological approach for qualitative data analysis (Timmermans and Tavory, 2012). Accordingly, a creative iterative process of “theory matching” between literature research and two case studies took place in an attempt to find an approach that combines theoretical knowledge with real-life observations.

The current section gives an introduction on the overall topic, provides the rational and the aim of this research as well as its contributions. In the following sections, the theoretical background of supply chain design in its wider context is established, including a short review of relevant academic literature focussing on the research aim and addressing the research gap. The section methodology provides an understanding of how this research was designed and conducted, containing the justification of the strategy selected. The development of six theoretical propositions deriving from academic literature builds the bridge between theory and empirical results from two case studies that provide insight into practical supply chain design issues and their solutions. As a result, the preliminary redesign approach is developed as a logical result of the previous sections. Finally, the last section summarizes the outcome of this study, outlines its limitations and contribution and refers to further steps.

Theoretical background

The significance of supply chains has been growing since their appearance. The enhancing opportunities and capabilities of supply chain management brought a change in the competition between firms, as today rather supply chains are competing than single companies (Lambert and Cooper, 2000). Supply chain can be defined as a flow-oriented network of companies which secure firstly the flow of

goods from producers towards customers and the efficient flow of information and money in the opposite direction (Mabert and Venkataramanan, 1998), including the management of relationship and cooperation (Lambert and Cooper, 2000).

Although supply chains are of strategic importance for performance, profitability and competitiveness of companies, the structure of these value chains are only rarely the result of a profound planning. They are rather an outcome of trends and evolution without clear guidance. However, without a formal construction plan, an uncontrolled evolution can lead to malfunction hindering the attainment of their ambitions and objectives (Nel and Badenhorst-Weiss, 2010). Here comes the importance of guided and planned supply chain design into the focus of supply chain managers.

For the purposes of this work, we embrace the definition of Melnyk et al., (2014) who define supply chain design as the identification of the desired strategic outcomes for the firm and the development, implementation, and management of the resources, processes, and relationships (within the firm and across the supply chain) that seek to make the attainment of such desired outcomes inevitable over time. Inherently, supply chain design encompasses the development and implementation of a supply chain strategy (Nel and Badenhorst-Weiss, 2010) and is, therefore, a dynamic concept (Melnyk et al., 2014), since it must be adjusted or redesigned as business environment changes.

Supply chain design rules the construction of a supply chain from the most basic principles and contains the decisions or choices taken to build it. It influences the relationship of members in the supply chain, the performance assessment arrangements and the transparency throughout the chain. Furthermore, supply chain design directs the alignment between the environment and the strategy of firms and addresses the problems, the supply chain is dedicated to resolve (Melnyk et al., 2014). The overall goal of supply chain design is to deliver customer value while positively impacting shareholder value (Christopher and Ryals, 1999). However, the formulation of an effective supply chain design can be “extremely difficult” (Kotzab et al., 2003), especially in the demand-driven FMCG industry.

On the downstream side, commercial markets are characterized by sophisticated and demanding consumers that leads to a high fragmentation, i.e. a transition from the old idea of a uniform, homogeneous “mass market” to much smaller segments where consumers seek for individual solutions (Christopher, 1996). While market segmentation is a long-established concept, the implications for supply chain design have not been widely recognized (Godsell and Harrison, 2006), since there are other factors such as products characteristics that might also shape the supply chain. On the upstream side, commercial markets are served by globe-spanning operations that are dynamic networks of interconnected firms and industries. However, those global networks are exposed to different degrees of uncertainty that cannot be neglected (Christopher and Peck, 2004). Obviously, a reliable supply represents a lower challenge in design than an uncertain one.

Lee (2002) structures the design process by providing a typology framework based on the degree of uncertainty at both sides of a supply chain. The four types of supply chain design, efficient, risk-hedging, responsive and agile, represent a high-level guide to identify which sets of choices need to be considered when configuring a supply chain.

Supply chain design choices are manifold. Academia differentiates between fundamental choices that advocate integration as the key success factor of any type of supply chain (Frohlich and Westbrook, 2001), efficiency-oriented choices (Jasti and Kodali, 2015), which strive for higher productivity, waste reduction and thus, optimal cost along the supply chain; and flexibility-oriented choices (Trigeorgis and Reuer, 2017) that focus on real options, as an effective way to deal with uncertainty, limiting supply chain risks while capturing unexpected benefits, increasing flexibility and thus, the resilience of the supply chain (Avanzi et al., 2013). To select the proper choice for each function of the supply chain is a critical step in the construction process. It depends on the supply chain type, its specific goals, and the attributes required for the customer serving process.

The last piece of complexity of supply chain design is added when quantifying its impact on shareholder value. While calculating the economic value added of a supply chain decision in a stable business environment is straightforward (Rappaport, 1987), the same procedure under uncertainty requires different methods, such as the real option valuation theory (Brandão and Dyer, 2005).

Despite of the importance of supply chain design, most of the academic contributions (Fisher, 1997, Christopher and Towill, 2000, Lee, 2002, Cigolini et al., 2004, Martinez-Olvera and Shunk, 2006)

do not transcend the type-and-match approach, barely achieving a level of detail that allows implementation. Recent approaches by Schnetzler (2007), Nel and Badenhorst-Weiss (2010), Melnyk et al. (2013) and Perez-Franco et al. (2016) compensate those weaknesses to a great extent but still miss ways to pragmatically deal with market complexity, identification or selection of design choices or their quantitative evaluation.

Methodology

The suggested redesign approach was developed by adoption of a qualitative multi-method study (Saunders et al., 2012), combining case study research (Yin, 2014) and abduction as guiding principles for gaining empirically based insights. Abduction analysis is a qualitative data analysis approach aimed at generating creative and innovative insights. It emphasizes, that the researcher enters the field with a deepest theoretical base and nurtures surprising empirical findings against theoretical expertise in an inferencing process to move back and forth between data and theory (Timmermans and Tavory, 2012). The suggested preliminary 6-step redesign approach emerged as a methodological result from combining theoretical knowledge and real-life observations from case studies.

Case study research is particularly suitable where prevalent theories are extended to emerging phenomena to derive novel propositions (Eisenhardt, 1989), to capture and formalise the knowledge of practitioners, develop theories from practice, and then move on to the testing stage (Benbasat et al., 1987). It enables to gain rich insights through the collection of contextual data in a contemporary real-world setting (Eisenhardt, 1989). The cases selected are both European manufacturing and distributing companies operating in different FMCG sectors, food/spices and fashion jewellery. This favours to analyse their intuitive redesign approaches and to work out similarities and distinctions.

The lead researcher's role in the explanatory multiple case study was two-fold: as a participating professional practitioner and as an observer. As a professional practitioner, the researcher worked in both companies, actively participating in their supply chain redesign process in 2007-2010 at the spice company and in 2011-2012 at the fashion jewellery company. As an observer, the researcher retrospectively examines data of both organisations, like archival records, personal communications and participant observation. Hence, this study benefits from the alteration of two different paradigms, "inquiry from inside" which is the researcher's involvement in the organization and "inquiry from outside", whereby the researcher is detached from the organizational setting (Everend and Louis, 2001). Thus, the academic work is enriched by the experience of the practitioner that provides deep insights while reliability is increased by the credibility of the researcher (Iacono et al., 2009).

Applying abduction, firstly theoretical propositions were derived from investigating, analysing and synthesizing academic literature. Secondly, conducting case study research strategy, the issues and findings from two FMCG companies in their supply chain redesign process, were analysed looking for evidence to support the scope, sequence, relevance and impact of the propositions raised previously. In the process of data analyses the researcher iteratively moved between data and theory.

To improve the development of theory in the area of supply chain, four stages can be identified: conceptualise, build, test and refine (Zhong, 2015). Whereas the development of the suggested 6-step approach falls into "building" stage, the next stage of "testing" is where the suggested 6-step redesign approach is verified against reality, which currently happens in the context of a 10-month industry project. Test results fall outside the scope of this paper.

Development of theoretical propositions

This section provides the background of academic literature that led to the development of six theoretical propositions (P1 till P6), that were triangulated with the research cases of the following section. They build the backbone of the suggested redesign approach. Whereas P1 investigates the trigger for supply chain redesign, the following propositions (P2-P6) refer to different steps of the redesign process.

The trigger for supply chain redesign

Fawcett (2007) claims that supply chain design is a proactive approach for delivering customer value. Rappaport (1987) stresses that a company's ability to generate future cash flows (an essential element of shareholder value) is the prerequisite for its further existence. Future cash flows can only be generated if a supply chain performs well, following that supply chain performance is dependent on its structural design (Persson and Olhager, 2002).

- *P1: Supply chain redesign in FMCG is triggered by a sustainable decline of shareholder value*

Demand analysis

Today, supply chains are designed from the "customer backwards" compared to previous from the "factory outwards" (Christopher, 2011). Accordingly, demand analysis has been advocated to segment supply chains by academics of the "lean-agile school" (Godsell et al., 2011). To profile demand at item level is a "practical and relatively quick approach" that reconciles the apparently conflicting product and customer-oriented approach, enabling companies to reduce downstream complexity while identifying the different supply chain segments companies need to address (Godsell et al., 2011).

- *P2: An effective redesign starts with a detailed demand analysis at item level*

Supply analysis

Lee (2002) adds the supply side and its level of uncertainty to demand analysis.

- *P3: Supply uncertainty needs to be assessed as well*

Identification of supply chain segments and their goals

Lee (2002) further structures the design process by providing a typology framework based on the degree of uncertainty at both sides of a supply chain, supply and demand. The resulting four supply chain segments, efficient, risk-hedging, responsive and agile, and the goals each segment strives to achieve, represent a high-level guide to identify which sets of supply chain choices need to be considered when configuring a supply chain.

- *P4: Supply chain segments and their specific goals guide the redesign process*

Assessment of current supply chain capabilities and identification of alternative design choices

The framework of Perez-Franco et al. (2014 and 2016) provides a useful approach to assess current supply chain capabilities per segment and function against its goals and to identify alternative design choices if goals are not sufficiently achieved.

- *P5: Supply chain segments needs to be assessed on its degree of goal achievement and alternative design choices need to be identified*

Quantitative evaluation

Rappaport (1987) states that management has to choose alternatives that are expected to deliver greatest sustainable competitive advantage and thus greatest customer value as they also create greatest shareholder value. Rappaport's (1987) shareholder value approach measures the financial impact of supply chain design choices. It is a static valuation method, which assumes that future expected cash flows are known with certainty and risk premium does not change. However, business conditions are often volatile, outcomes are uncertain, investments are high and the risk of losing everything is real. Yet, the upside potential can be huge. To compensate the deficiency of shareholder value approach, it is complemented with real option valuation models (Brandão and Dyer, 2005) that better reflect the flexible nature of decision taking under uncertainty. Real option valuation models (ROV) are considered an integral part of the shareholder value approach. Among the ROV methods aimed mainly at practitioners, binomial-lattice-based models (Gilbert, 2004), Monte Carlo simulations and the Datar-Mathews method (Mathews and Datar, 2007) are the most commonly used.

- *P6: Alternative choices need to be evaluated on their impact on shareholder value*

Case studies

Research cases

Both companies are European real-world companies in the FMCG sector. To conceal their true identities, they are named SpiceCo (spice company) and CrystalCo (fashion jewellery company).

SpiceCo is a regional manufacturer and distributor of spices and seasonings. Founded in 1881, SpiceCo served only its local retailer market until 1991, when it started an aggressive expansion into Central Eastern European markets. In 2007, SpiceCo supply chain consisted of a central production facility and 19 country warehouses that served 20 markets with a total assortment of 4.500 items in 18 different languages. Their product life cycles were rather long, spanning several years.

CrystalCo is a global manufacturer and retailer of fashion jewellery. In 2011, their supply chain network consisted of a global distribution centre and a glass factory in a Central European country plus seven factories located in Asia. Glass components were produced in the main factory in Europe and shipped to factories in Asia where metal frames were moulded and glued together with the glass parts. Eventually, the final product was returned from Asia to Central Europe for global distribution. CrystalCo had a network of 10.000 retail shops in approximately 70 countries and an assortment of 1.500 items, out of which 1.000 items were basic products with product life cycles of 24 months. The remaining 500 items were seasonal products with product life cycles of 6 months. CrystalCo offered two different design collections per year.

Findings

Both cases were retrospectively assessed on the six theoretical propositions that derived from critical review of academic literature as presented in the previous section.

- *P1: Supply chain redesign in FMCG is triggered by a sustainable decline of shareholder value*

SpiceCo: After 15 years of expansion and growth (1991-2006), the controlling department detected a deterioration of operational performance (out-of-stock rate increased from 2% to 6% and the service level decreased from 98% to 93,5%) and a slow but continuous decline of profitability. The latter was not only the result of lower sales prices in the new CEE markets, but also due to a significant increase of supply chain costs (logistics costs, lost sales, penalty costs, inventory costs). After some failed trials for improvement led by the production function, SpiceCo decided to set-up a supply chain organisation and to give its new supply chain manager the responsibility to redesign its supply chain.

CrystalCo: End of 2010, marketing was raising the need of having shorter lead times (4 months) to enable more collections during the year. They considered this as a way to enhance sliding customer traffic in the shops, since new, aggressive competitors entered the fashion jewellery market a couple of years before depriving their market share. To compensate for the loss of volume, CrystalCo had already opened new shops, widened its assortment, increased sales prices and spent more on advertising. Nevertheless, by end of 2010, profits showed a clear downward trend.

Similarities: Changes in the business environment triggered operational inefficiencies that led to customer dissatisfaction. The following deterioration of company cash flows and subsequently declining shareholder value ultimately set in motion the supply chain redesign process.

- *P2: An effective redesign starts with a detailed demand analysis at item level*

SpiceCo's redesign process was production-driven. Running at 98% utilization, production aimed to free up capacity by introducing an integrated planning software that would optimize changeover time and inventory level, based on an accurate sales forecast. However, once SpiceCo started analysing historical demand data, they quickly realised that forecast accuracy was strongly driven by market maturity. Mature markets where SpiceCo had reached more than 30% market share showed an average forecast accuracy of over 75%, whereas younger markets had a more volatile demand with a forecast accuracy below 50%. Latter often triggered unplanned production changeovers, expedite supplier orders and in the end, unfulfilled customer demand.

CrystalCo's redesign process was marketing-driven with a thorough analysis of customer demand on market and product level. The length of a product's lifecycle resulted to be the main driver of forecast accuracy. Basic products that had remained in the assortment longer than 2 years showed an average

forecast accuracy of above 70%, while novelty products with less than 6 months product life cycle had a forecast accuracy of below 40%. Since CrystalCo's market share was significant in all the countries in scope, no other factors seemed to affect forecast accuracy.
Similarities: In a natural reaction of make-to-stock production, both companies were striving for higher efficiency as a result of forecast improvements. They started their assessment with a detailed analysis of their demand at item level resulting in a subsequent demand segmentation: SpiceCo from a market point of view, CrystalCo from a product perspective.

- *P3: Supply uncertainty needs to be assessed as well*

SpiceCo: Both of SpiceCo's demand segments, mature and young markets, were served by one central production facility. Due to its high utilization, the responsiveness of the factory was limited, as unexpected demand fluctuations could not be served shortly. Furthermore, although the general delivery performance of its suppliers (European spice traders) was quite satisfactory (over 90% service level within 2 weeks lead time), there were some critical spices that counted for less than 10% of the total raw material assortment but were essential elements in nearly any final product of spice mixture. These critical spices stood out by their poor availability in times of high price speculation. As these weaknesses on the supply side had a negative impact on the sales performance of SpiceCo, they were quickly identified as critical spots to be addressed and properly solved later on.

CrystalCo: Since one of the redesign goals of CrystalCo was the reduction of production lead times, a detailed value chain analysis along the different steps of the supply side was performed. CrystalCo is to a high degree a vertical integrated company with low uncertainty along their supply side. However, splitting and offshoring of low-added-value production activities to Asia, combined with large lot sizes, were detected as the main reasons for long lead times.
Similarities: The initial demand analysis was complemented by a supply assessment, where the degree of supply uncertainty was evaluated along with the reasons for other supply weaknesses.

- *P4: Supply chain segments and their specific goals guide the redesign process*

SpiceCo quickly realized that it needed two different supply chain segments to serve their mature and young markets. The first supply chain segment basically matched the current efficient configuration characterized by high production utilization, relatively long lead times of 3 weeks and optimal stock levels supported by the high average forecast accuracy of the mature markets. The second supply chain segment for young markets needed to be more responsive, with a lead time below 1 week, in order to cope with the higher demand volatility.
CrystalCo drew similar conclusions out of their demand/supply analysis. The quite predictable demand of basic products could be further served by the current supply chain configuration, since low demand uncertainty along the lead time of 4 months could be simply mitigated by reasonable safety stocks. However, novelty products required a responsive supply chain with a lead time of less than 2 months.
Similarities: Goal formulation for each of the supply chain segments was intuitively done by both companies. It helped to narrow the search of alternative supply chain choices during the next steps.

- *P5: Supply chain segments needs to be assessed on its degree of goal achievement and alternative design choices need to be identified*

SpiceCo: After an evaluation of all functions of their supply chain, SpiceCo identified two bottlenecks that strongly limited their ability to shorten lead times and to quicker react to the unpredictable demand of young markets. The first bottleneck was the high degree of utilization of the production facility. The second was the unreliability of raw materials supply when price speculation occurred. As alternative design choices to the production capacity issue, SpiceCo considered either an investment in additional machines or subcontracting the additional capacity, on a needed basis, to third-party manufacturers preferably located in or close to the young markets. For the raw material supply issue, SpiceCo considered either to source directly in the country of origin or dramatically increase their safety stock level for the affected raw materials from 4 to 12 weeks. An additional choice was the implementation of an integrated planning system, considered as a pre-requisite to improve operations by SpiceCo.

CrystalCo: After a detailed evaluation of the operational feasibility of different design choices CrystalCo concluded that the key to reduce production time was to re-consolidate all three production steps (glass, metal and gluing activities) within one location, eliminating interfaces and enabling a more flow-oriented manufacturing. Therefore, the only alternative was to build a new stand-alone factory for novelty products that could respond to demand within 4 weeks instead of 4 months due to vertical integration.

Similarities: Although both companies excelled during the assessment of their current supply chains, they struggled when identifying alternative choices. In both cases, external consultants had to be involved to support, share best practices and bring in new ideas.

- *P6: Alternative choices need to be evaluated on their impact on shareholder value*

SpiceCo: Using a simulation tool, actual and forecasted demand and production data of the past 260 working days, SpiceCo modelled the necessary additional production capacity required to reduce out-of-stocks from 6% to 3% and to identify the periods when additional capacity was needed. Simulation results showed a need of only 15% additional capacity during 60 days. Therefore, to buy additional capacities from a third-party manufacturer would be cheaper compared to an own investment, despite of decreased profit margin. In the case of raw material supply issue, SpiceCo decided for the increased safety stock rather than direct sourcing. Although direct sourcing showed a higher cash flow, SpiceCo considered, they did not have the necessary skills set to pursue such an international initiative.

*CrystalCo'*s evaluation of the novelty product factory was complex since several aspects had to be taken into consideration. To guarantee shorter lead time, the production flow had to be newly designed including the capacity requirements of each station. Furthermore, the facility location and the resultant divestments in Asia had to be decided. Finally, the potential of additional sales as a result of a higher product availability and more collections needed to be estimated. Confronted with uncertain data, CrystalCo decided to build up a small pilot factory based in Eastern Europe to serve the European market and postpone further expansion based on later results.

Similarities: Both companies insisted on a cash-flow evaluation to support decision-making. In some cases though, the ease of implementation of some choices led the decision into other directions. In other cases, both companies had to use simulation tools or split and delay decisions in order to reasonably deal with uncertainty. Lastly, there was also a case (software implementation) with negative cash flow but positively decided, since that was considered as a fundamental choice for the company.

Preliminary 6-step redesign approach

The results of the case study research guided not only the selection of the appropriate supply chain theories, techniques and aids, but also the decision about the right sequence of the approaches used.

Step 1: Demand profiling

The suggested approach starts by analysing the demand side of the supply chain. Demand profiling techniques (Godsell et al., 2011) are used to identify different market segments by analysing each item on relevant market characteristic criteria as product lifecycle duration, time window for delivery, volume, variety and variability (Christopher and Towill, 2000). To avoid unnecessary complexity, it is recommendable to choose which two criteria are most relevant for demand profiling before collecting and assessing the respective quantitative data. A graphical analysis enables a quick identification of market segments to be served by different supply chain configurations. The formulation of the requirements of each market segment would be the key outcome of this step.

Step 2: Supply assessment

An assessment of the supply side is to be performed across all supply chain functions. It aims to identify not only the degree of supply uncertainty, i.e. the reliability of the supply process in terms of quantity, quality and time, but also any other weaknesses in the current supply chain design that would hinder it to fulfil the requirements of the newly identified market segments.

Step 3: Identification of supply chain segments

Based on the typology model of Lee (2002), the generic types of the targeted supply chain segment(s) (efficient, risk-hedging, responsive and agile) as well as their key attributes to address the market requirements of step 1 and the supply weaknesses of step 2 are identified.

Step 4: Assignment of design choices

We found helpful to develop a list of generic design choices for each supply chain segment type. Generic choices are arranged along the different functions of a supply chain and can be classified as fundamental choices (Frohlich and Westbrook, 2001), efficiency-oriented choices (Jasti and Kodali, 2015) or flexibility-oriented choices (Trigeorgis and Reuer, 2017). The more "agile" a supply chain is, the higher the number of potential flexibility-oriented choices and lower the extent of efficiency-oriented choices will be. In the case of "efficient" supply chains, the relation is the other way around. In both cases, a share of fundamental choices is needed since they set the basis for integration and collaboration in the supply chain. In this sense, generic choices can be acknowledged as an aid for the practitioner when redesigning a supply chain.

The assignment of the most appropriate generic choices to the particular supply chain segment in evaluation is the result of a systematic process where the interdependence among the different functions of the supply chain as well as the alignment with key attributes of step 3 are considered. The approach of Perez-Franco et al. (2016) as a logical bridge between market requirements, supply chain attributes, supply chain functions and generic choices can be used to perform this task. In addition to the selected generic choices, practitioners are encouraged to define customized design choices to address other, still unattended, supply weaknesses identified in step 2.

Step 5: Evaluation and selection of supply chain choices

Supply chain choices are evaluated and selected according to their impact on shareholder value and their ease of implementation. The academic background of the shareholder value approach as measurement of the financial impact of efficiency-related supply chain choices and of real option valuation methods as a measurement for flexibility-oriented supply chain choices was already discussed under P6 in section "Development of theoretical propositions". Ease of implementation takes into consideration current supply chain capabilities, the amount of effort required to achieve the targeted supply chain design and the willingness to change of supply chain stakeholders. The evaluation of the ease of implementation often prevents companies from the unfeasible "perfect solution", without taking into consideration their current and future limitations.

Step 6: Screening for synergies

Lastly, the resulting supply chain choices are screened for synergies before being released for implementation. This step arose from iteration of case studies back to design theory of Ayers and Odegaard (2008), according to which operations of different "spheres" or segments are merged or split, depending on the compatibility of the different supply chain segments. Screening for synergies enables further optimisation of shareholder value through identification of potential for economies of scale by conflating of supply chain operations and their facilities that share the same design solutions.

Conclusion

Our aim was to develop a truly practitioner-oriented approach for the redesign of demand-driven supply chains that targets to select the most suitable supply chain configurations ready to be implemented. The redesigned supply chain is supposed to deliver both, sustainable competitive advantage through delivery of customer value and shareholder value, while considering its inherent risks before being implemented. Our proposed 6-step redesign approach does not aim to create new theory but builds on existing ones. It combines them in a comprehensive way, enriched by empirical findings of this study, to form a unique approach that unifies the best of two worlds: state-of-the-art theories and empirically grounded results.

Reflecting the situation of practitioners, our suggested approach focuses on the redesign of supply chains, which means the reconstruction of existing supply chains that evolved over time,

opposing to from-scratch design of green-field supply chains that are purposefully designed by professional supply chain architects and engineers. In line with this, our proposed redesign approach leads the practitioner step-by-step through a guided process that applies real data analysis, compares the prevailing supply chain design with the targeted one and addresses this gap by the identification of supply chain design alternatives. These design choices are quantitatively evaluated, synthesized and assessed on the limitations of the company before being implemented.

Whereas most approaches start their design journey from company objectives or reviewed customer value propositions that involves supply chain managers into corporate strategizing, our approach keeps supply chain managers on the operational-tactical level they are more familiar with. Demand profiling tool provides a practical and quick means to define relevant demand segments by application of specific variables of single product items, Furthermore, we support practitioners in the most crucial step of the approach, the selection of the appropriate supply chain design decisions by the provision of a predefined list of generic design choices. This predefined list is available per each segment type and functional area of the supply chain and describes its drivers that fit to specific supply chain attributes. The practitioner merely needs to select the most appropriate choice out of this list and assign it to the respective supply chain segment in evaluation.

As to our knowledge, there are no other supply chain redesign approaches that considers an assessment of the supply side to identify its constraints. However, as demonstrated, supply constraints or weaknesses that impede or aggravate the provision of customer value require attention through selection of design decisions that effectively erase or minimize this level of uncertainty. The analysis of the supply side thus massively impacts on supply chain design decisions.

Our redesign approach includes a systematic financial evaluation of the design decisions selected. Depending on the type of choice, either shareholder value approach is considered for efficiency-oriented choices, or real option valuation methods for flexibility-oriented supply chain choices. If the choice does not lead to increased shareholder value, the respective choice is disregarded and replaced by another design decision. Screening for operational synergies further enhances shareholder value through utilization of potential for economies of scale. Depending on the complexity of the ultimate supply chain configuration, multiple and similar supply chain design choices may result. Their consistent segmentation across all operational entities and facilities may lead to unnecessary duplications.

Lastly, reflecting on practical evidence especially from small and medium size companies, the ultimate design decision may exceed a company's capabilities regarding professional skills required or the willingness to change. Even though disregarding the "perfect solution" might entail future limitations, supply chain managers may prefer a design choice that finds undivided support of their stakeholders.

Even though it is not possible to generalise from two case studies, we believe that the suggested redesign approach is robust and capable to provide a solid ground for a practitioner guideline to support them in their supply chain redesign process. The validation of this process against reality takes currently place in the course of a 10-month industry project.

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A STUDY OF THE ATTRACTIVENESS INDEX OF CHINA (SHANGHAI) FREE TRADE ZONE

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Introduction

In past few decades, China had reinforced its economy by its low labor cost and low Renminbi currency value. With elapse of time, China has been under a lot of pressure, such as the decreasing economic growth, declining export value, and the increasing RMB value as well as the signing of free trade agreements between neighbor countries (Lee, 2013). Consequently, China has established the China (Shanghai) Free Trade Pilot Zone to solve these dilemmas.

Free trade zones (FTZs; also known as commercial free zones) are fenced-in, duty-free areas, offering warehousing, storage, and distribution facilities for trade, transshipment, and re-export operations (World Bank, 2008). China (Shanghai) Pilot Free Trade Zone (SFTZ) includes seven sub-zones. Differing from just focusing on the favorable tax conditions, there are four new practices implemented in the Shanghai FTZ which are listed as follows: “creating an innovative system of investment management”, “reforming the financial system”, “making trade free to the public”, as well as “transformation of government's economic function”.

However, it’s worth noting that the operation of SFTZ would be suspended if its performance is under the Chinese government’s expectation. As a result, how to attract different enterprises to move into SFTZ and understand the key attractive factors of SFTZ to further support the development of Shanghai Free Trade Zone are both critical issues for the Chinese government.

This study mainly aims at investigating the attractiveness index from enterprises’ viewpoints by firstly reviewing literatures and then surveying enterprises that have already set up their operation offices in SFTZ and the potential SFTZ users. Finally, this study employs IPA technique to analyze critical factors which can then be defined as the SFTZ attractiveness indices.

Literature Review

The spirit of most Free Trade Zones is to operate “within national territory but outside customs territory”. Cargoes are generally allowed to be imported, exported, stored, packed, sorted and processed without being restricted to traditional customs procedures. Besides preferential tariffs, enterprises operate in the free economic zone have also enjoyed preferential policies in various aspects, such as taxation, land use, and the employment of workers, etc. Although free economic zone is not set up outside of the national customs territory, almost all of the economic activities are allowed to exist without tariff charge or custom duty (World Bank, 2008).

In terms of attractiveness, Mortensen’s (2012) research shows that attractions between buyers and sellers are effected by value, trust, commitment, satisfaction on services, privileges, and dependency. As for suppliers, financial, economic, performance management, science and technology, company culture, strategic factors will influence their attractiveness (Olsen & Ellram, 1997). Chandler and Hanks (1994) considered performance of new investment and market attractiveness are relevant to resource-based capabilities. Resource-based capabilities are highly related to enterprises’ future competitive strategies. Performances of investments affect the allocation of competitive strategies and resource-based capabilities. Privatization on port operation, degrees of port congestion, leverage production, the size of ships…etc. will affect shippers’ decision on choosing the port to unload cargo (Steven & Corsi, 2012).

Pantelidis & Nikolopoulos (2008) found the factors that impact Greece and other country to attract foreign direct investment (FDI) are general macroeconomic conditions of local market, political environment and governance, labor, energy, taxes or incentives, infrastructure for transport and telecommunications, and research and development expenditures. Economic activities, opportunities for real estate investment, the depth and intelligence of capital markets, investment protection and legal

structure, the burden of administrative supervision and restrictions on government management, culture of the society and political environment will affect the attractiveness of the investment in general real estate invest (Karsten et al., 2011). UNCTAD (1997) mentioned in the 2001 World Investment Report that growth market, scale of the local market and political stability…etc. will be the main factors for enterprises to consider investing. It's worth noticing that country risk is considered as a first concern when it comes to international investing (Solnik, 1999). International Labor Organization (ILO, 1998)'s research report shows that governments can attract manufacturers to invest in EPZ by financial incentives, infrastructures, and lower labor cost. Labor regulations will also impact the decision of international trading location (Kerstin, 2002).

Through scale of market, wages, education level, industrialization level…etc., the investing environment of each province in China can be examined (Xin & Ni, 1995). Huang (2001) conducted a survey of 600 Taiwanese companies that have invested in Central China and South China. Among 125 samples collected, lower labor cost, cheaper rent, local premium terms, and policy are the main reasons for Taiwanese enterprises to invest in China. Based on the oversea investing theory, Yang (2003) created an SEM model from the aspect of manufacturers to investigate factors influence enterprises to invest in the FTZ. Political stability, premium terms, efficiency of local government's administrating, labor cost and energy cost are the top five factors the enterprises valued most.

After summarizing relevant literatures of the Free Trade Zone, it was found that the functions of the free trade zone were no longer limited to loosen merely tax restriction, but the restrictions on investment, finance and transportation. Despite the considerable benefits generated to the country or region during the establishing of a free trade zone, it may also incur certain risks when setting up a free trade zone and providing relevant preferential tariff break and tax cut.

Setting up FTZ will reduce production cost and trading cost for manufactures, effectively boost the international flows by allocating global resources and production elements, increase consumers' welfare, replace bilateral and multilateral trade, gain local or national employment opportunities, and enhance regional economic diversity. Besides, there may be problems such as excessive trade, excessive consumption, deindustrialization, conflicts on capital and financial openness, destructive competition among enterprises in FTZ, waste of resource and clash against urban planning (Lu, 2014).

Via integrating literatures of attractive factors for enterprise, it could be divided into seven aspects and 27 factors. (See Table 1)

Important-Performance Analysis

Importance-Performance Analysis (IPA) was firstly proposed by Martilla and James (1997) which analyzes the degree of importance and degree of performance of each factor and each alternative from the customer's viewpoint. The pivotal point of the two-dimensional matrix is represented by the average degree of importance and average degree of performance to develop the matrix into four quadrants. Thereafter, enterprises can develop their marketing strategies to enhance their own competitiveness according to the location of the factors in the matrix.

The purpose of this study is to investigate whether there is a gap between the degree of importance and the degree of performance on each of the attractiveness indices perceived by the respondents. Afterwards, IPA analysis is applied to find out the indices with high degree of importance and low degree of performance to be improved in the Shanghai Free Trade Zone.

In this study, the average degree of importance and average degree of satisfaction will be the pivot of the matrix. Axis X is defined as the degree of importance, and axis Y is defined as the degree of satisfaction (see Figure 1). By means of sorting the factors, the importance and satisfaction of enterprises can be explored on the attractive factors of the Shanghai Free Trade Zone as well as can we understand the differences.

Aspect	Factor	Supporting Literatures
Political Status	Political Environment	Karsten et al.(2011)
	Political Stability	UNCTAD(1997)
	Governance	Pantelidis & Nikolopoulos(2008)
	Country Risk	Solnik(1999)
Corporate Strategy	Competitive Strategy	Chandler & Hanks(1994)
	Investment Strategy	Chandler & Hanks(1994)
	Performance Management	Olsen & Ellram(1997)
Soft Power	Value	Mortensen(2012)
	Commitment	Mortensen(2012)
	Privileges	Mortensen(2012)
	Satisfaction on Services	Mortensen(2012)
	Information System Integration and Resources	Chandler & Hanks(1994)
Physical Facility	The Size of Hinterland	Huang(2001)
	Geographical Location	ILO(1998)
	Availability of Infrastructures	ILO(1998)
	Transportation and Distribution Capability	Pantelidis & Nikolopoulos(2008)
Human Resource	Labor Regulation	Kerstin(2002)
Managerial Policy	Availability of Resources	Pantelidis & Nikolopoulos(2008)
	Local Premium Terms	Pantelidis & Nikolopoulos(2008)
	Budget on Innovating	Pantelidis & Nikolopoulos(2008)
	Privatization on Operation	Steven & Corsi(2012)
	Amicable Investing Regulations	Karsten et al.(2011)
	Efficiency of Government's Administrating	Yang(2003)
Current Market Situation	Scale of Market	UNTCAD(1997)
	The Depth and Width of Local Market	Karsten et al.(2011)
	Local Economic Activity	Karsten et al.(2011)
	Degree of Industrialization	Xin & Ni (1995)

Table 1 Literatures of Attractiveness Factors for Enterprises

The study started on April 13, 2015, and ended on May 15, 2015. The questionnaire has aimed at the enterprises in the Free Trade Zone and the potential enterprises in the Shanghai Free Trade Zone. 400 questionnaires were issued, and a total of 138 questionnaires were collected. The incomplete

questionnaires were excluded from the analysis, and 129 valid questionnaires were included in this research analysis. The overall effective questionnaire response rate is 32.25%.

Industrial Classification	Numbers of participate enterprise	Ratio
Real Estate Industry	1	0.78%
Public Administration and National Defense	7	5.43%
Supportive Service Industry	2	1.55%
Wholesalers and Retailers	6	4.65%
Other Service Industry	4	3.10%
Finance and Insurance	9	6.98%
Professional, Scientific, and Technical Service	9	6.98%
Educational Service	1	0.78%
Information and Communication Industry	1	0.78%
Agriculture, Forestry, Fishery and Husbandry	4	3.10%
Transportation and Warehousing	64	49.61%
Manufacturer	21	16.28%

Table 2. Questionnaire Respondent's Basic Information

Introduction of IPA Matrix

IPA Matrix contains four quadrants which classifies 27 factors from Table 1 into four Quadrants.

Quadrant I (High Importance/High Performance): Keep up the good work. Attributes fall into this quadrant are the strength and pillar of the enterprises, and they should try to maintain or improve the status in case other competitor step in.

Quadrant II (Low Importance/High Performance): Possible Overkill. It denotes attributes that are overly emphasized by the enterprises; therefore, enterprises should reflect on these attributes, instead of continuing to focus in this quadrant, they should allocate more resources to deal with attributes that reside in this quadrant.

Quadrant III (Low Importance/Low Performance): Low Priority. Any of the attributes that fall into this quadrant are not important and pose no threat to the enterprises.

Quadrant IV (High Importance/Low Performance): Concentrate Here. Attributes that fall into this quadrant represent key areas that need to be improved with top priority.

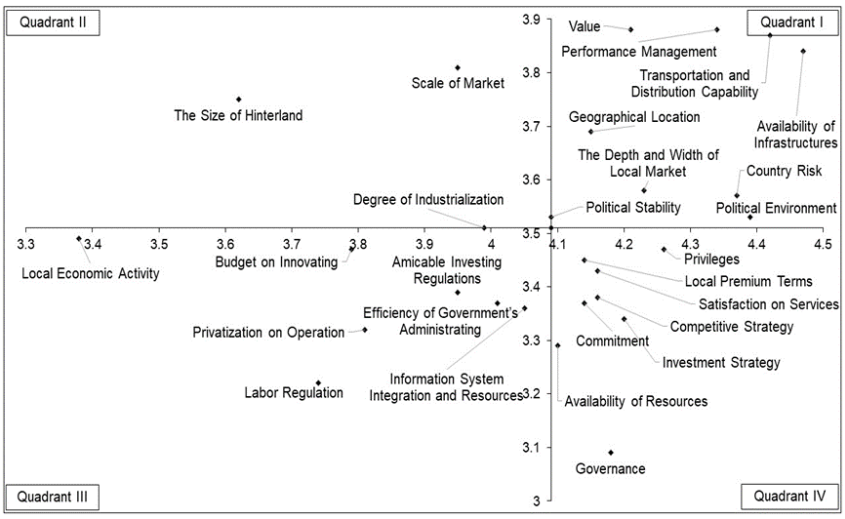

Figure 1. IPA Matrix

No.	**Factors**	**Importance**	**Satisfaction**	**IPA Matrix**
A1	Political Environment	4.39	3.53	Quadrant: I
A2	Political Stability	4.09	3.53	Quadrant: I
A3	Governance	4.18	3.09	Quadrant: IV
A4	Country Risk	4.37	3.57	Quadrant: I
B1	Competitive Strategy	4.16	3.38	Quadrant: IV
B2	Investment Strategy	4.20	3.34	Quadrant: IV
B4	Performance Management	4.34	3.88	Quadrant: I
C1	Value	4.21	3.88	Quadrant: I
C3	Commitment	4.14	3.37	Quadrant: IV
C4	Privileges	4.26	3.47	Quadrant: IV
C5	Satisfaction on Services	4.16	3.43	Quadrant: IV
C7	Information System Integration and Resources	4.05	3.36	Quadrant: III
D1	The Size of Hinterland	3.62	3.75	Quadrant: II
D2	Geographical Location	4.15	3.69	Quadrant: I
D3	Availability of Infrastructures	4.47	3.84	Quadrant: I
D6	Transportation and Distribution Capability	4.42	3.87	Quadrant: I
E1	Labor Regulation	3.74	3.22	Quadrant: III
F1	Availability of Resources	4.10	3.29	Quadrant: IV
F2	Local Premium Terms	4.14	3.45	Quadrant: IV
F3	Budget on Innovating	3.79	3.47	Quadrant: III
F4	Privatization on Operation	3.81	3.32	Quadrant: III
F5	Amicable Investing Regulations	3.95	3.39	Quadrant: III
F6	Efficiency of Government's Administrating	4.01	3.37	Quadrant: III
G1	Scale of Market	3.95	3.81	Quadrant: II
G2	The Depth and Width of Local Market	4.23	3.58	Quadrant: I
G3	Local Economic Activity	3.38	3.49	Quadrant: III
G4	Degree of Industrialization	3.99	3.51	Quadrant: III
	Average	**4.09**	**3.51**	

Table 3. The Importance and Satisfaction Figures to 27 Attractiveness Factors

Note: The overall average degree of satisfaction of the abovementioned factors is 4.09 and the overall degree of perceived importance of these factors is 3.51.

From Figure 1. we can see that “Political Environment”, “Political Stability”, “Country Risk”, “Performance Management”, “Value”, “Geographical Location”, “Availability of Infrastructures”, “Transportation and Distribution Capability”, and “The Depth and Width of Local Market” factors are situated in quadrant I. It means that enterprises were very satisfied with these important attractiveness factors.

Since "The Size of Hinterland" and "Scale of Market" are factors of low importance and high satisfaction of the enterprises, it is not necessary for Shanghai Free Trade Zone to make excessive invest in this quadrant.

From enterprises' viewpoint, "Information System Integration and Resources", “Labor Regulation”, “Budget on Innovating”, ”Privatization on Operation”, “Amicable Investing Regulations”,

“Efficiency of Government Administrating”, “Local Economic Activity” and “Degree of Industrialization” factors can be defined as satisfying and have no threat for enterprises.

However, “Governance”, “Competitive Strategy”, “Investment Strategy”, “Commitment”, “Privileges”, “Satisfaction on Services”, “Availability of Resources” and “Local Premium Terms” are the factors located in the quadrant IV which should be strongly emphasized but were not satisfied from enterprises’ viewpoints. This indicates that SFTZ should make an improvement for these factors.

Attractiveness Factors Analysis

First of all, the driving factor for enterprises to invest in Shanghai Free Trade Zone is the consideration of the international market strategy. Due to rapid rise of China's economy in recent years, China has gradually become an economic leader in the Asia-Pacific region. Shanghai's position in the Asia-Pacific region has turned step by step into the economic center of the Asia-Pacific region. Therefore, most companies choose to set up international branch even headquarters in Shanghai. The advantages of location in Shanghai is the main attractiveness for most companies to invest in the Asia-Pacific region. Therefore, for enterprises, the amount of Research and Development budget invested by the government, the size of the local market, the local economic activities, and investment in local industrialization are not the main factors of determining the entry for enterprises to the Shanghai Free Trade Zone. It’s worth noting that since the consumption power of the people in Shanghai ranks first place among the provinces in 2016 and the enterprises are satisfied with current market size in Shanghai.

Secondly, the industrial structure in Shanghai has gradually changed from a labor-intensive manufacturing industry into service industry. Therefore, the factors influenced the manufacturers such as the size of land and labor regulations are gradually weakened. Currently, the scope of the Shanghai Free Trade Zone has expanded from 28.78 square kilometers to 120.72 square kilometers. It appeals manufacturers who want more space to accommodate their new investment. By reason of the rise of labor awareness in China, the government has further protected labor rights in accordance with labor regulations. The limitations of labor regulations will cause the advantages of lower production cost to vanish, so enterprises have relatively lower satisfaction with labor regulations factors comparing with the overall general average score.

Thirdly, in order to improve administrative efficiency and anticorruption reform, the Chinese government has actively targeted the development of mixed ownership enterprises and the establishment of information sharing platforms and public credit information service platforms. However, it needs time for state-owned enterprises to transform themselves into mixed ownership enterprises. On the path of organizational restructuring, there must be an adjustment period. In addition, China has actively cracked down on corruption and has been looking forward to monitoring the overall administrative process through the establishment of a regulatory platform and a public credit information service platform. This anti-corruption approach seems to be helpful. However for some enterprises’ do not have ability to follow the implicit rules, this has inevitably hinder enterprises to move in and operate in SFTZ. Even if the degree of importance of the government's administrative efficiency is located in a low-priority area, but it’s importance is near the average degree of the overall importance. This means that the government's administrative efficiency factors will more or less affect the enterprises’ willing to invest in SFTZ.

Fourthly, Shanghai Free Trade Zone has liberalized the FDI scope by using the negative trading list. The advantage of negative trading list provide foreigners a large area of investment opportunity. Reviewing the contents of the negative list, it can be found that Shanghai Free Trade Zone still has restrictions and prohibitions for FDI on certain specific industries, which has not fully opened up for foreign investment. Thus, the performance of the friendly investment regulations in the Shanghai Free Trade Zone has not reached the average degree of satisfaction, and the degree of importance perceived by the responding manufacturers on the negative list is below the average degree of importance. This is because of the potential SFTZ investors have already understood some business scope have to be included in the negative list, which means that their perception on the degree of importance on the negative list factor is relatively low.

Finally, regarding to the information system integration and resource-based factors, due to the exclusive account for cross-border payment and financing functions of the trade has only been launched recently and the promotion on this factor is insufficient, which made the respondents unaware of these services and the degree of their satisfaction on these factors were below average.

Conclusion

This research target is to figure out the attractiveness factors of Shanghai Free Trade Zone. Through reviewing relevant literatures and distributing questionnaires to survey international enterprises, 27 SFTZ attractiveness factors were constructed. This study analyzes enterprises' perception on the factors influencing Shanghai Free Trade Zone's attractiveness via questionnaire survey and IPA technique.

IPA matrix analysis on various industries shows that different industries are basically have the similar perception on the degree of importance and performance of the SFTZ on these 27 factors in this study. For example, the enterprises in transportation and warehousing industry benefited less from the preferential measures introduced by the Shanghai Free Trade Zone, as the result, the degree of importance on the "Local Premium Terms" was lower than that perceived by the other industries.

As for financial industry, it focuses on the preferential measures proposed by the Shanghai Free Trade Zone. Factors such as: "The Size of Hinterland", "Labor Regulations", "Availability of Resources", "Budget on Innovating", and "Information System Integration and Resources" are perceived to have the lower degree of importance when comparing with the other industries.

There are two major contributions achieved from this research. Firstly, multifaceted literatures are reviewed to form Shanghai Free Trade Zone enterprises' attractiveness index. It provides not only a direction for SFTZ's future development as well as indices for FTZ in other countries. In addition, the development of unique enterprises' attractiveness indicators will enable SFTZ regulators a real-time adjustment and improvement opportunities during their starting-up stage.

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AN ANALYSIS OF THE INSTITUTIONAL PRESSURE AND COMPETITIVE VALUE IN THE ADOPTION OF GREEN LOGISTICS PRACTICE AND HOW ENVIRONMENTAL AND INFORMATION SHARING FACILITATE ENVIRONMENTAL SUSTAINABILITY: A THEORETICAL FRAMEWORK

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Introduction

The globalization of business has a significant impact on the way businesses operate. More than 90 percent of the trade volume is dominated by marine transportation. Ports play a part role in logistics chains and the location and efficiency of ports correspond significnatly to economic competitiveness, resulted in promoting the economic cohesion of different countries (UNCTAD, 2016). Although, container shipping acts as a key factor in the global supply chain which critics to the transportation networks and facilitating the economic development and international trade (Notteboom and Rodrigue, 2008), based on Eurostat, the transportation sector is responsible for 24% of CO2 emission in Europe (Oberhofer and Dieplinger, 2014). Generally, logistics system is claimed as one of the major contributors to overall greenhouse gas (GHG) emission and energy consumption in the world (Kim and Han, 2011; Oberhofer and Dieplinger, 2014; Murphy and Poist, 2003; He et al., 2017). According to Commission of the European Communities, by 2030, the goal for transport will be to mitigate GHG emissions to around 20% below their 2008 level. Given the substantial increase in transport emissions over the past two decades, this would still put them 8% above the 1990 level".

Environmental issues have attracted the significant attention of governments, nongovernment organizations (NGOs), business communities, and masses across the globe. These pressures led to the adoption of environmentally responsible behavior among nations to act pro-environmentally (Saeed et. al, 2018). Meeting such targets will only be possible by making intense efforts on balancing economic growth and reducing the ecological impact of shipping activity. As such, many organizations have to face with multiple competing pressures alongside the challenges to implement and optimize the green supply chain management integrating in their logistics solutions. Other than an intensive cut-throat competition, in this respect, many companies tend to survive and take a competitive advantage as they compete with their competitors by giving more attention to environmental awareness and adapting green practices into the supply chain process to secure their future existence of their resources and business. In fact, green supply chain strategy has become one of the most important initiatives for many organizations to achieve competitive advantages and corporate sustainable development (Cai et. al, 2008). The fundamental concept of green logistics is to integrate the environment thinking into supply chain activities, as such it required governments, policy makers, stakeholders along with firms and their supply chain partners involvement to reduce environmental risks and increase community goodwill (Darnall, 2006).

Sarkris (2003) illustrated further studies that a majority of firms engaged in adopting collaboration of environmental practice into their strategic plans and process. In general, focal company and supplier collaboration is the significant element of green logistics in facilitating supply chain activities and socially responsible activities which contributed to achieve sustainability's goal. Collaborative process toward sustainability have been attracted an increase interest among scholars, policy makers, business practitioners, and other environmental constituents (Hartman et al., 1999). The sustainability is no longer to be approached at the general firm's level, but rather, its attainment requires the involvement of supply chain participants. In this regard, several studies have indicated that the availability of a wide range of timely and relevant information also play a part role in environmental integration. The information has increasingly become the key determinants of supply chain sustainability in term of increasing interorganizational coordination and product quality to flow along the supply chain (Cheng, 2008). Generally speaking, information sharing is frequently considered as being the key

element in reducing supply chain cost, this exchange of information not only increase the service level but also reduces the cycle times in supply chain (Khan et. al, 2016). Yet few, if any, firms are able to respond definitively to the questions, “Which of your products, processes, services, and facilities are really sustainable? Is it a sustainable organization?” Answering these questions is requiring the ability to assess sustainability of economic and non-economic factors in a quantitative or at least qualitative method. The simple word sustainability, however, implies no presumption of economic development. In other word, sustainability refers to being "environmentally friendly. Therefore, measuring sustainability holistically differs from measuring other dimensions of business performance in several important respects. Sustainability performance can be regarded as the performance of a firm in all dimensions and for all drivers of corporate sustainability. It extends beyond the boundaries of a single company and typically addresses the performance of both upstream suppliers and downstream customers in the value chain (Sebhatu, 2008).

Specifically, this study provides a green logistics-oriented framework to explore what are the promoting factors influence LSPs to engage in green logistics practice and how green logistics practices can facilitate the environmental sustainability through environmental collaboration and information sharing among shippers and logistics service providers. The key motivation for the research is to examine the relationships between GSCM practices and sustainability performance (Eltayeb et al., 2011; Sang et al, 2012), there is a dearth of studies that have considered these relationships within the context of sustainability in term of logistics context. Besides, this article will be of an explorative nature. The paper subsequently demonstrates concepts of institutional theory and competitive advantages aspect, green supply chain management practice, environmental collaboration, information sharing and sustainability performance. Also, this study draws together a theoretical framework based on intensive review of the previous studies to portray relationship of each constructs with hypothesis and included with some managerial implications and suggestions for future research.

Institutional Pressure and Competitive Value

Several studies on GSCM have indicated a broad range of factors, convincing firms to take environmental management into account and practices to its supply chain partners. As such, it could be influenced by company’s stakeholder requirement leading to have full compliance with environmental regulation, or even promoted a good reputation as a green image, which is related to the opportunity to gain competitive advantage in the market. Institutional theory plays a part role in effecting companies to adopt GSCM, most companies embedded in social network perceive strong pressure in response to institutional requirements to attain social legitimacy and access to important and rare natural resources since violations may jeopardize company performance and long-term development (Dimaggio and Powell, 1983). Over last decades, Laari (2016) suggested that customer satisfication and environmental performance portrayed both of direct and indirect impact relationship on GSCM. Many researches adopt stakeholder and institutional theory to GSCM, for example, Sarkis (2011) said that both of stakeholder theory indicates a great environmental of institutional pressures and increase many organizations to implement GSCM practices concept (Bjorklund, 2011; Mohanty and Prakash, 2014) and customer demand is one of the most significant factors for many firms when it comes to implementing GSCM practices (Mohanty and Prakash, 2014). Moreover, many organizations take a proactive environment action as a significant weapon that influencing to gain competitive advantages, environment strategies can encourage firm’s performance with cost mitigating, reputation and legitimacy as well as future positioning in the global market (Porter, 2006).

Green Supply Chain Management Practice (GSCM)

As consumers become more aware of environmental issues and global warming issue, exporters and shippers will request logistics service providers for more environmentally-friendly shipping transportation. Container shipping companies can also anticipate to be questioned as to how green are their transportation processes and supply chains value chain. Green Supply Chain Management (GSCM) is gaining potentially importance in the container shipping industry owing to coercive pressure from international organizations and governments, normative pressures from professional groups, and mimetic pressures from competing organizations. Green supply chain management decreases the

ecological consequence of industrial activity, promotes energy utilization efficiency and synergy among business partners, and strengthens corporations. It also helps to enhance environmental performance, corporate green image, and minimize waste (Zhu and Sarkis, 2004). With a rising concern in environment and in order to achieving a competitive advantage, GSCM as a new innovative managerial strategy can be implemented as a strategic weapon to gain competitiveness and to promote the organization environmental and financial performance (Hajikhani, 2012).

Environmental Collaboration

Today it is widely accepted that sustainability cannot be achieved by firms in isolation but requires the collaboration of all supply chain players. Relationship is an essential element for achieving collaboration and one of the major notions of SCM is to manage raw materials and components flow smoothly from distant suppliers to manufacturing companies for the purposes of converting raw materials into finished goods and satisfying the value expectation of consumers. Roa (2006) stated that GSCM must involve collaboration with suppliers in designing green product, providing awareness seminars, and helping suppliers to create their own environmental program. Sarkis (2003) provided further evidence that an increasing number of firms are adopting collaboration of environmental practices into their strategic plans and processes. Collaboration in terms of environmental is a method that helps companies to develop and support the environmental process of their supply partners. According to Paulraj (2011), environmental collaboration includes cooperating with suppliers to achieve environmental objectives and improve waste reduction initiatives, providing suppliers with design specification that include environmental requirements for purchased items, encouraging suppliers to develop new source reduction strategies, working with suppliers for cleaner production and helping suppliers to provide materials, equipment, parts and services that support organizational target. Moreover, top management plays a significant role in influencing the scope of an organizational sustainability practices.

Information Sharing

In order to achieve a successful business performance, each partner have to not only be willing cooperate their activities and agree on an appropriate way of reconsidering their profit, but also sharing their information to mitigate uncertainty and smooth production along the supply chain (Huang et. al, 2017). Information exchanging is progressively seen as a significant contributing parameter to the success of business and can increase supply chain efficiency by resourcing inventories and smoothing production. In addition, the information sharing accounted for a basic to effective coordination in supply chain, many studies revealed that information sharing has a positive effect on business performance, especially in mitigating the bullwhip effect (Lotfi et al., 2013). Whilst information sharing is frequently cited as being the key to reducing cost, there has been little research to investigate its value in a sustainable supply chain although sustainability is acknowledged as a major competitive priority. Managers are always keen to identify ways to successfully meet social and environmental targets and develop relevant tools that are economically viable – Winter and Knemeyer (2013).The relationship with suppliers tends to encompass the concern for social and environmental issues and exchange of information related to day-to-day tactics and policies related to material flow – Vachon and Klassen (2006). Though Lee et al. (2000) clearly mentioned that information sharing has a great value for supply chains but their significance has yet to be explored for a sustainable supply chain.

Environmental Sustainability

GSCM should not only focus on environmental concerns, but at the same time it should concern on reaching and maintaining operational efficiency in a sustainable way, and focus on the economic, logistics, operational, and marketing objective. GSCM performance can be evaluated by both quantitative and qualitative approaches. Some organizations use financial measurements, such as increasing profitability, market share, and revenue, return on investment; others concentrate on operational measurements, such as customer service level and performance of the inventory management. The evaluation of performance may be specific to the firm, or the unit within a company, depending on the main aims and the environment

In 2015, the United Nations Climate Change Conference indicated that efforts must be taken to save Earth, and preventive measures certainly should not be restricted to manufacturing aspect alone, but rather should incorporate social, economic and organizational aspects as well (United Nations Framework Convention on Climate Change, 2015). At a broader level, organizational sustainability is compost of three components which are the economic performance, environmental performance, and social performance (Ahi & Searcy, 2013; Carter & Rogers, 2008; Seth, Shrivastava, & Shrivastava, 2016).

Theoretical Framework

The objective of this study is to develop research model and formulate the hypothesis based on the construct defined in pervious sections, conceptual framework has been established relating the relationship between GSCM practice, environment collaboration, information sharing and environmental sustainability. To understand the role of Green supply chain management practice on the provision of environmental collaboration, information sharing and environmental sustainability (Fig.1) as following.

A. Green supply chain management practice and environment collaboration

Firms in logistics sectors have been started to implement GSCM in response to governmental regulations of environmental and customer demand for products and services that are environmentally sustainability (Murry, 2000). Collaboration effort between focal company and supplier play a part role in facilitating supply-side environmentally and socially responsible activities along supply chain. Collaboration in terms of environmental is an approach that helps firms to develop and support the environmental prowess of their supply partners. Dangelico and Pontrandolfo (2013) concluded that the benefit of green collaboration includes improving market performance (by accessing new markets and strengthening competitive advantage), enhancing corporate image performance (in its reputation and regulatory compliance), increasing manufacturing performance (by increasing its efficiency of materials and energy usage), boosting financial performance (by increasing margins or market share due to customers' willingness to pay a premium price for products) and containing supply chain cost. Based on above discussion, we posit:

H1: Green supply chain management practice affects environmental collaboration positively

B. Green supply chain management practice and information sharing

A green supply chain management is a network made up of providers, producers, storage facilities and distributors who work together to turn their plans, activities and raw material into a finished goods. This supply chain must also include an environmental awareness across all chains (Marinagi, 2014). When it comes to adopting a green supply chain, the use of information sharing is important to try and improve the sustainability of the company's communication, provisioning and transport systems, all of which allows for customer and logistics service provider involvement. This coordination via exchanging information means that manufactures, products and communication through the network can be better integrated, whilst also reducing the cost and environmental impact. A successful implementation of ecological information also leads to the correct implementation of the green supply chain. Costs are decreased, relationships between members are increased, the flow of materials increases, deliveries are faster, consumer satisfaction improves and, what is most important, an environmentally-friendly image is reinforced across the entire supply chain (Mishra, 2017). We suggest the next hypothesis:

H2: Green supply chain management practice affects information sharing positively

C. Environment collaboration and information sharing

The main concern of supply chain management is how to link the independent partners, so that they work together as a unit, in the pursuit of the common target in a rapid change in market conditions. Thus, firms are often implementing green strategies for coordination (i.e. collaboration), between the players of their supply chain to make more efficient use of limited resources and to capture the

knowledge of suppliers and consumers, in an attempt to integrate and coordinate production and information flows through the whole supply chain (Caridi, Cigolini, & De Marco, 2005; Lejeune & Yakova, 2005; Verwaal & Hesselmans, 2004). The causal direction "information sharing results in collaboration" or collaboration results in information sharing" is subject to argument. It has been said that strong collaborative process relationships enhance the likelihood that firms will sharing more critical information required to further increase more collaborative supply chain strategies. In contrast to this, an intensive information sharing could encourage the firms involved to specify their collaboration in terms of a process in order to be able to more efficiently use the information exchanged (Derocher and Kilpatrick, 2000; Mentzeret al., 2000; Sandberg, 2007). We therefore postulate the following hypothesis:

H3: There is a positive correlation between environmental collaboration and information sharing

D. **Environment collaboration and environmental sustainability**

The benefits that can be acquired from environmental collaboration have been considered in the GSCM. Researchers have emphasized the direct relationship between GSCM practices and performance. Holt and Ghobadian (1991) used external GSCM to see the effect of environmental collaboration on firm performance. Paulraj (2011) stated about a relationship between sustainable supply management and sustainability performance. In contrast to these researches, environmental collaboration is illustrated as a moderator of the network between the GSCM practices and sustainability in term of the presence of the environmental collaboration could facilitate GSCM practices and firms which form collaborative relationships with suppliers would be easy to adopt GSCM practices. In this regard, environmental collaboration as a key relational capability could be advantageously positioned to facilitate the environmental sustainability and execution. Therefore, the following hypothesis is proposed:

H4: Environmental collaboration has a positive impact on environmental sustainability

E. **Information sharing and environmental sustainability**

Sharing of information between firms has long been recognized as a competitive weapon that enhances firm performance (Closs et al., 1997; Daugherty et al., 2005; Whipple and Russell, 2007). The type of information shared generally involve production planning, inventory levels or turns(e.g. in VMIs), fill rate, forecast accuracy, promotion performance, price levels and pricing, sales data, and on-time delivery (Sandberg, 2007; Whipple and Russell, 2007).Such information exchange increases operational efficiency in business performance and provides better supply chain visibility, which can in turn contribute to cut cost , improved in-stock performance, increased sales, and improved customer satisfaction of the returns turn around process. Information sharing has also been recognized as a significant prerequisite for effective collaboration (Yu et al.,2001; Sandberg, 2007). In line with above arguments, we develop the following proprosition that:

H5: There is a positive correlation between information sharing and environmental sustainability

F. **Green supply chain management practice and environmental sustainability**

Considering that sustainable consumption habits are growing, environmental responsibility will be required not only from companies, but from various tiers of productive chains, consequently, GSCM practices emerge as an opportunity to improve competitiveness and the environmental performance of organizations. GSCM is a strategy that manages the flow of materials along the value chain through different stages such as acquisition, production and distribution with the purpose of protecting the environment by safeguarding natural resources and reducing global warming and carbon emissions (Ageron, Gunasekaran, & Spalanzani, 2012). The GSCM interacts with each other and can hold an organization together for sustainability performance, where the interaction has found to lead significantly to firm performance (Green, 2012). Surprisingly, Laosirihongthong (2013) found that the pro-active (reverse logistics) practices do not have significant impact on GSCM performance. Thus, it is of interest

for this study to explicitly examine the differences of green logistics findings in greater details. The above discussions develop the basis of the following hypothesis:

H6: Green supply chain management practice affects environmental sustainability positive

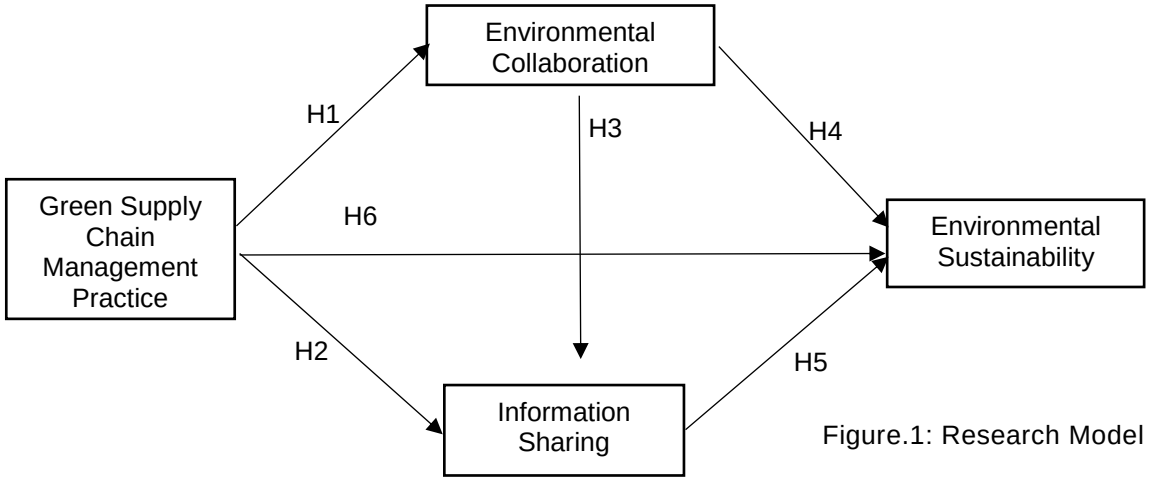

Figure.1: Research Model

Discussion and conclusion

In this paper aims to propose a theoretical framework among factors of green supply chain management practice, environmental collaboration, information sharing and environmental sustainability. As we could conclude from the extensive review carried out in this study, we then provide the set of testable propositions, derived from previous studies and conceptual articles to understand the significant role of green supply chain management practice in increasing environmental sustainability with mediation effect from environmental collaboration and information sharing. The research extends the framework in the earlier section based on variables identified from literature review are based on the conceptual framework, the derived hypotheses and have not been empirically measured. This study is a part of ongoing research, so this proposed conceptual framework will be empirically validated to prove this framework into accepted and validated model. In addition, the future research should be directed toward investigating the interrelations among these constructs.

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AN EMPIRICAL RESEARCH ON THE CHOICE OF INTERNATIONAL MULTIMODEL TRANSPORT ORGANIZATION FORMS – A CASE OF CHINA (CHONGQING) – SINGAPORE STRATEGIC INTERCONNECTION DEMONSTRATION PROJECT

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Introduction

Multimodal transport generally refers to the movement of cargo from origin to destination by several modes of transport but under a single contract or bill of lading and a single carrier during the whole journey. The same transport carrier is responsible for moving the shipment in all legs, in all modes. In simple terms, Multimodal is using various modes of transport but with one transport bill of lading. The key difference between multimodal transport and intermodal transport lies in the contract/ bill of lading and transport carrier responsibility/liability of the movement. In multimodal shipping, there would only be a single company bearing one contract that handles all legs of the journey. This means that the same company is going to responsible for moving your shipment in all legs, in all modes.

Depending on whether the shipment crosses different countries or geopolitical boundaries, multimodal shipping can be categorised into domestic multimodal transport or international multimodal transport. According to the provisions of the United Nations Convention on International Multimodal Transport of Goods, international multimodal shipment generally refers to the carriage of goods by the multimodal transport carriers from the place of takeover of a country to the designated place of delivery in the territory of another country by at least two different modes of transportation in a single international multimodal carriage contract. The effective use of integrating the various subcontractors in the multimodal transport network has the potential of increasing transport efficiency and service quality thus reducing overall transport costs.

The 'China-Singapore (Chongqing) Strategic Interconnection Demonstration Project' (hereinafter refers to as 'China-Singapore Project') is the third intergovernmental cooperation project between China and Singapore. Its goal and focus in logistics are to 'build comprehensive transportation network in the Southwest China region, inland international logistics hubs, and multimodal transport and logistics operations centres in Western China'. Therefore, multimodal transport plays an important role in the international cooperation of the "China-Singapore Project". It facilitates the trade and transport in China's Western region where the "Chongqing-Chengdu economic corridor" is the core. Using multimodal transport, cargo can be transported from Singapore and other ASEAN countries to China's Western region and vice versa. The project is a strategic development of the belt and road initiative, connecting Chongqing with Europe, western China and Southeast Asian countries through multimodal transport modes.

With the development of the China-Singapore logistics project and the Chinese government's focus on multimodal transport, international multimodal transport has achieved considerable growth in Chongqing. Several international multimodal transport lines have been opened since the initiation. These include Chongqing-Qinzhou-Southeast Asia, Chongqing-Ningbo-Northeast Asia that connects Chongqing to Europe and America, and Chongqing-Shenzhen-Europe/America rail-sea intermodal line, Chongqing-Shanghai-Europe/America river-sea intermodal line, Europe-Chongqing-Southeast Asia's rail-road intermodal channel, and finally YUXINOU railway that connects to all the respective intermodal networks.

Literature Review and Research Design

International multimodal transport involves a large group of actors: shipping lines, terminal operating companies, freight forwarders, hinterland transport companies, inland terminal operators, port authorities, etc. Coordination of these players is a key to form an integrated multimodal network. The different parties have to effectively organise themselves to complete the entire international multimodal shipment efficiently. Often, the total cost involved in such multimodal transport shipments includes not only the transaction costs, but also costs of communication and coordination within the organisation. Moreover, the different forms of organising the multimodal transport players will inevitably affect the quality and efficiency of the transport network. Therefore, a study on the possible organisation forms of multimodal transport market is expected to shed light on the appropriate approach of organising the large diverse group actors in the multimodal transport market to minimise organisation cost, improve service efficiency and service quality of the entire multimodal transport chain is a worthwhile research subject.

The term ‘‘transaction cost” is frequently considered to have been coined by Coase, who used it to develop a theoretical framework for predicting when products or services would be derived from market (classical contracting) or by firms (hierarchical coordination) [1]. Based on Coase’s work, Williamson (1985) further delimitated transaction costs in two categories: transaction costs arising from ex ante reasons (drafting, negotiating, and safeguarding agreements between the parties to a transaction) and ex post reasons (maladaptation, haggling, establishment, operational, and bonding costs). Further, transaction cost is characterised by three variables of the transactions: (1) asset specificity, (2) uncertainty surrounding the transactions and (3) frequency of the transactions [2].

Transaction cost economics has been applied in diverse fields to guide the selection of the appropriate corporate governing structure to facilitate the effective coordination of multimodal transport subcontractors that connects international boundaries. L. E. Henesey (2006) pointed out that in analysing the freight transportation systems and multimodal transport corridors, a key component to consider is the transaction cost [3]. Prior research in transaction costs and freight transportation systems includes both qualitative as well as quantitative, in which the measured variable is mostly based on surveys or interviews [4]. When assessing the governance structure of multimodal transport, besides considering transaction costs, production costs and strategic factors should also be considered. The evaluation of transaction costs will help to indicate which governance structure can lead to higher efficiency. Pierre Franc et al (2010) propose that there are three organizational forms of multimodal transport: market transactions, mixed forms, and companies; the mixed forms include two types, namely, long-term contracts and minority equity investments with risk sharing [5].

Prior studies on governance structures of multimodal transportation using transaction cost economics are mostly conceptual, lacking in specific measures of the transaction costs. There is sparse empirical research that make use of the operating multimodal transport subcontractors as the empirical context for the quantifying the empirical variables that might be indicative of the decisions on the appropriate organising form of the multimodal transportation.

This paper fills this gap by developing an analytical hierarchical process (AHP) framework by Saaty, 2008) [7] by decomposing complex and unstructured issue in the multimodal transport network into a set of components organized in a multi-level hierarchical form. The AHP framework is developed based on the earlier field observations and inputs on the local conditions by experienced multimodal practitioners. Based on these earlier inputs, we delimit that there can be four possible forms of organisation in the multimodal transport market. They are organised in the form of ① Own Subsidiary (when an actor invests more than 50% in another actor), ② Minority Investment (when an actor invests less than 50% in another actor), ③ Strategic Partnership in the forms of interfirm alliance and cooperation (e.g. Contracts with risk bearing commitments) and ④ Pure market transaction.

Based on the characteristics of multimodal transport and our review of prior literature, we established a set of corresponding decision criteria for the multi-criteria decision model. Panel of expert representatives from eight international multimodal transport companies and two industrial associations in Chongqing were invited to participate in the questionnaire survey and interviews. A total of 35

questionnaires were distributed, out of which 30 valid responses were achieved that were useful for our subsequent data analyses.

The Organizational Form of Multimodal Transport and Its Decision Factors

H A. Shelanski; P G. Klein (1995) proposed that enterprises have five governance structures: vertical integration, hybrid forms (long-term contracts, complex contracts with reciprocal agreements, contracts providing offsetting specific investments, equity linkages, exclusive transaction contracts), long-term business contracts, informal agreements and franchise contracts [6]. Pierre Franc et al. (2010) proposed that there are three cooperation forms between shipping lines and terminal operating companies in intermodal transport: own subsidiary, contract with risk-bearing commitment, minority investments [5].

A multimodal transport operator can own or operate the mode of transport or choose to arrange for these types of transport by subcontracting. They may also subcontract inland stevedoring, warehouse and other related logistics services. We term these parties whom the multimodal transport operators engage as service providers for related multimodal transport services as subcontractors in this study.

Considering above-mentioned research and based on our earlier field observations of relevant multimodal transport companies in Chongqing, we posit four possible forms of organising multimodal transport:

P1 - Own Subsidiary (when a multimodal transport operator owns more than 50% share of another multimodal transport subcontractor), which forms a vertical integration to multimodal transport subcontractors, is a hierarchical governance structure;

P2 - Minority Investment (when a multimodal transport operator owns less than 50% share of another multimodal transport subcontractor), which is an intermediate form between hierarchy and market;

P3 - Strategic Partnership (e.g., interfirm alliance and interfirm cooperation), an organization in the form of long-term partnership by signing an agreement for strategic cooperation with co-sharing of specific assets such as mutual investment. This is considered as another form of hybrid organisation;

P4 - Pure Market Transaction, an organization form that completely adopts contractual transactions to obtain multimodal services, which is a pure market governance structure.

Decision Criteria for Selecting the Organisation Form of Multimodal Transport

International multimodal transport operation involves activities that involve a large group of actors, including loading/unloading of cargo, different modes of carriages/ shipments, customs declaration and insurance, etc. Therefore, it is pivotal to ensure and maintain good communication and coordination to integrate different actors into one efficient transport network to achieve a speedy completion of the transport task at a reasonable cost.

By the time when this study was carried out, the multimodal transport network in Chongqing has become a relatively mature market. In the operations of multimodal transport, the direct costs involving in the various types of transport services are essentially non-variant. In other words, regardless of the choice of subcontractor that one engages to provide the desired multimodal transport service, the per-tonne-kilometre freight, the handling costs per ton of cargo, every bill of goods declaration and other direct costs are essentially the same.

However, the organizational cost (including transaction cost and interior coordinating costs) and corresponding service quality and efficiency might differ vastly depending on the forms of engagement among the different actors in the multimodal transport chain. In this study, we assumed the direct operations costs involved in the multimodal transport network is non-variant among all the multimodal transport subcontractors. Therefore, the main decision criteria for determining the total cost

and quality of multimodal transport can be summarized by three key determinants/ decision criteria: - *Organizational Cost (B1), Service Efficiency (B2) and Service Quality (B3)*.

Composition of Organizational cost (B1) Criteria

Based on prior research, there can be four forms of multimodal transport. These include vertical integration that result in the formation of own subsidiary, hybrid forms of organising as minority share investors and strategic partnership, and pure contractual arrangements. In this study, we assume the direct transportation cost is non-variant and therefore is excluded in our analysis. We focused on evaluating organisation Costs (including transaction costs and interior coordinating costs) involved in the multimodal transport network that is a key determinant in the multi-criteria decision-making framework for decision on organisation forms.

Transaction costs include the costs of selecting subcontractors and the costs of making an agreement and implementing it. Internal coordinating costs emerge in vertical integration. The various cost components considered in Organisation Cost (B1) are described as follows:

Subcontractor Selection Cost (B11): the costs of collecting subcontractor information and selecting the appropriate multimodal transport subcontractors. They include the costs of bidding, information dissemination, subcontractor's information collection and subcontractor identification.

Administration costs of agreement signing (B12): the cost arising from initiating the contractual agreement among the multimodal transport subcontractors. These activities include contract negotiation, pricing request, drafting of contractual terms and signing the final agreement document.

Contract Implementation Costs (B13): the costs arising from overseeing the proper executing and completion of service tasks in accordance to the agreement. These include the cost of supervision and oversight, cost of mediating any differences, coordinating costs, disputes handling and other litigation costs. These costs mainly arise from specific investments, market uncertainty and the opportunism of the parties to the transaction caused.

Internal Coordination Costs (B14): the internal coordination costs resulting from the vertical integration of the multimodal transport chain. The internal coordination costs are necessary to ensure the proper execution and completion of the required multimodal transport tasks, include the cost of coordinating various internal functional departments, internal supervision, control and internal communication.

Composition of Service Efficiency (B2) Criteria

The efficiency of multimodal transport service will affect the final cost to the customer bears and the overall customer experience. Therefore, all multimodal transport subcontractors attach great importance to providing efficient services. Through preliminary research, the service efficiency of multimodal transport can be measured by the following indicators:

Response speed (B21): speed of the multimodal transport subcontractor handling customer complaints, responding to the requirements from other departments within the organisation, responding to the requirements of the partners in the upstream and downstream, responding and interacting with the relevant government departments.

Adjustment speed (B22): speed of adjusting to the changes in customer demands, delays in cargo, any other unexpected events, and the ability to adjust swiftly to the meet the schedules of the shipping lines or transportation organization.

Information dissemination speed (B23): speed of information transmission among the different operators within the multimodal transportation network when operating the multimodal transport.

Composition of Service Quality (B3) Criteria

Based on prior research, service quality should be an important decision-making criterion for multimodal transport operators. From the customer's point of view, the quality of multimodal transport services is mainly determined by five aspects, namely transport reliability, the convenience of information inquiry, the convenience of compensation, service accuracy and service diversity. Their respective meanings are as follows:

Transportation Reliability (B31): the safety and punctuality of cargo transportation during multimodal transport

Convenience of information inquiry (B32): the ease of cargo information tracking and the convenience of inquiring the information involved in document delivery, customs clearance, and export tax rebates.

Convenience of compensation (B33): the support and assistance rendered to facilitate customers' claim to be processed when the goods are damaged. This helps the customers to quickly verify any loss and provide relevant evidence and information to facilitate customers to get fast and convenient claims services.

Service Accuracy (B34): the accuracy of information transmission and the accuracy of generating documents such as orders and bills of lading, etc. necessary in the multimodal transport process.

Service Diversity (B35): the ability of the multimodal transport network to provide a diverse range of value adding services leading to enhanced customer satisfaction. Such value adding services include assistance in payment collections, container loading/unloading, cargo inspection services, etc.

Methodology

The complexity of multi criteria decision-making process is handled by the AHP which is known for handling both qualitative and quantitative data [7]. The use of the AHP method is useful for this research as the number of relevant companies that represent the overall landscape of the multimodal transport market in Chongqing are not many at the time when this study is carried out. Moreover, AHP allows us to collect both qualitative and quantitative data for meaningful analysis. The panel of experts who had participated in the survey are authoritative in the respective multimodal transport companies and are well informed of multimodal transport landscape of the China-Singapore Project.

Research hypothesis

We made the following assumptions in developing the Analytical Hierarchical Process (AHP) Framework for the multi-criteria decision making of organisation form of the international multimodal transport network:

Assumption 1: Organizational cost refers only to the communication and coordination costs of the organization of international multimodal transport, including external transaction costs and internal coordination costs, excluding the direct operating costs of completing multimodal transport activities.

Assumption 2: In any organization form, direct transport handling and other operating costs are the same.

Assumption 3: The acquisition and shareholding relationship can be either a multimodal transport operator holding a stake in a subcontractor or a large subcontractor holding a stake in a multimodal transport operator.

Assumption 4: The goods being transported are container goods of relatively high value.

Analytical Hierarchical Process (AHP) Framework

Figure 3.1 shows the Analytical Hierarchical Process (AHP) Framework for the decision-making framework for International multimodal transport organizations.

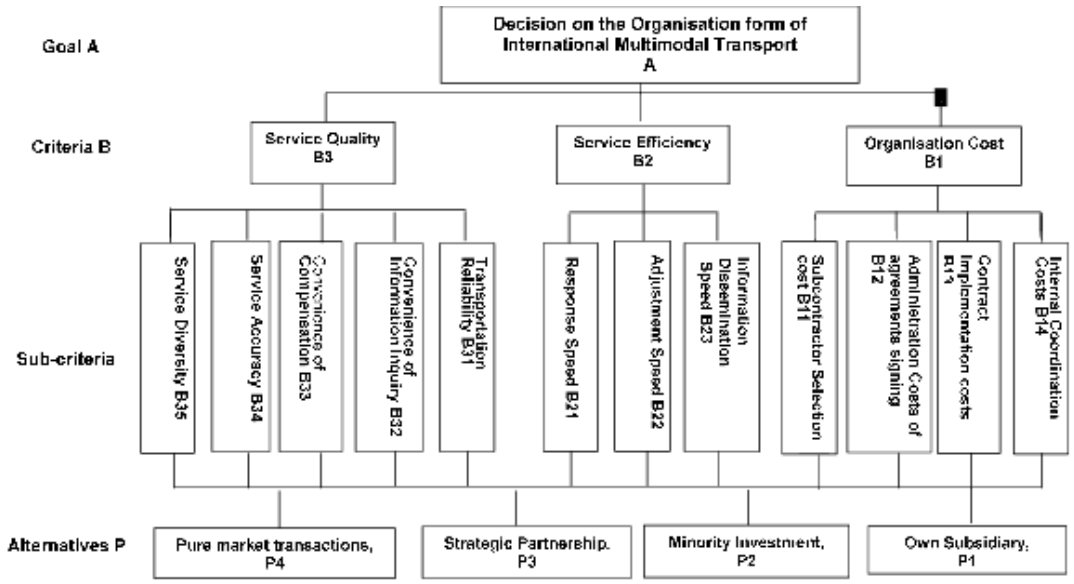

Figure 3.1 Analytical Hierarchy Framework for Decision on the organization form of International Multimodal Transport

Data collection

Experts from eight major international multimodal transport companies and two industry associations in Chongqing were invited to complete the survey questionnaire. In total, 35 copies of questionnaires were distributed, and 30 valid responses were collected. The first author visited the respective companies in person to explain objectives and scope of the study to ensure the validity of the responses.

Data Analysis

AHP data analysis and consistency checks of all the pairwise comparison matrices were carried out using excel spread sheet. Table 3.1 shows the pairwise comparison matrix for the first level decision criteria; B1, B2 and B3.

Table 3.1 Relative Importance of the first level decision criteria with respect to the Goal

A	Priority weight	Principal Eigen value, λmax	Consistency Ratio C.R
B1	0.411	3.054	0.046
B2	0.261		
B3	0.328		

Table 3.1 shows the most important factor influencing the decision on international multimodal transport organization is the organization cost (B1), followed by the service quality (B3) and the service efficiency (B2). Overall, the surveyed experts believe that if the organization costs are high, the corresponding service quality and service efficiency will be affected.

The higher priority weight given to organizational costs is mainly due to the higher transaction costs and internal coordinating costs arising from difficulties in communication and coordination among the multimodal actors when carrying out the required transport or logistics activities to ensure service quality and efficiency in the international multimodal transport network. Table 3.2 shows the pairwise comparison matrix for the Organization Cost Criteria (B1).

Table 3.2 Pairwise comparison matrix of each sub-criteria for Organization Cost Criteria (B1)

B1	Priority weight	Principal Eigen value, λmax	Consistency Ratio C.R
B11	0.238	4.261	0.097
B12	0.280		
B13	0.280		
B14	0.202		

The weights of each factor show no significant difference. The cost factors relating to agreement signing and implementation B12 and B13 are weighed slightly higher than the cost of subcontractor selection and internal coordination cost B11 and B14. This is because the multimodal transport market in Chongqing is relatively transparent by the time of this study. Therefore, subcontractor selection is not difficult. In general, the size of most multimodal transport firms in Chongqing is not large so internal coordination costs is not high. In comparison, the costs involved in agreement signing and implementation are relatively more important.

Table 3.3 shows the pairwise comparison matrix for Service Efficiency Criteria (B2). The most important factor affecting the efficiency of international multimodal transport service is response speed (B21), followed by adjustment speed (B22) and information dissemination speed (B23).

Table 3.3 Pairwise comparison matrix of each sub-criteria for Service Efficiency Criteria (B2)

B2	Priority weight	Principal Eigen value, λmax	Consistency Ratio C.R
B21	0.411	3.054	0.046
B22	0.328		
B23	0.261		

The ranking in Table 3.3 corresponds with our field observations. Through our conversations and interviews at site, experts related that the speed of response often determines the overall efficiency of the transport process. In contrast, the speed of adjusting to unexpected events and the speed of information dissemination are weighed lower as the experts consider the probability of unexpected events occurrence as low and they do not see information access as a barrier with the wide reach of internet connectivity.

Table 3.4 shows the pairwise comparison matrix of each sub-criteria under the service quality criteria.

Table 3.4 Pairwise comparison matrix of each sub-criteria for Service Quality Criteria (B3)

B3	Priority weight	Principal Eigen value, λmax	Consistency Ratio C.R
B31	0.262		
B32	0.320		
B33	0.141	5.378	0.086
B34	0.162		
B35	0.115		

The factors relating to the quality of international multimodal transport service are weighted with the convenience of information inquiry (B32) being the highest, followed by transport reliability (B31), while the other sub-criteria B33, B34, B35 are almost equally weighted. This result is slightly contradictory with our observations gathered from the earlier interviews when most experts believe transport reliability should be the most important driver what determines service quality. We reasoned that transport reliability (B31) is scored relatively lower since it is deemed as a basic service guarantee that should be fulfilled by transport subcontractor. In comparison, the convenience of information inquiry (B32) is more important as it is often critical to the customer to understand the status of the shipment within the complex network of connections and transhipment points in the multimodal system.

Among all the sub-criteria that are considered under service quality, the degree of service diversity or the ability to meet the diverse needs of customers is scored lowest. Service diversity is often viewed as additional value-added services that are provided to customer, usually without charge and this sub-criterion is not deemed as a key expectation on the multimodal transport subcontractors yet.

The final stage of our analysis is presented in the synthesized Table 3.5 on the optimal alternative selection for the organisation form of multimodal transport. The alternative with the highest value is, in fact, the most acceptable or optimal alternative. The last procedure of the AHP method application is presented in Table 3.5. All the pairwise comparison and AHP analysis were also checked for consistency by evaluating the consistency ratio. C.R. C.R ≤ 0.10, the calculation of relative criteria importance (weighted priority of alternatives) is considered acceptable by Saaty, 2008 [7].

Table 3.5 Ranking of the Weighted Alternatives with respect to the goal (P)

Alternatives	Weighted Priorities
P1	0.462
P2	0.266
P3	0.169
P4	0.101

As shown in Table 3.5, Alternative 1 (own subsidiary) is weighted highest at 0.462 as the most preferred option in deciding the multimodal transport organisation form in the China (Chongqing)-Singapore Strategic Interconnection Demonstration Project. The most preferred form is one that bears the lowest organizational costs, highest service quality and service efficiency. Alternative 2, organising as minority investment, is weighted the second highest with a score of 0.266. Alternatives 3 and 4, strategic partnership and pure contractual agreement, were weighted at 0.169 and 0.101 respectively.

Results and Discussion

To verify and corroborate the results of our AHP data analysis, we identified two companies that are involved in Chongqing multimodal transport business for in-depth case explanatory analysis. The two case companies are CCI Eurasia Land Bridge Logistics Development Co., Ltd. (CEL) and YUXINOU (Chongqing) Logistics Co., Ltd.

Case Study 1: The CCI Eurasia Land Bridge Logistics Development Co., Ltd. (CEL)

The CCI Eurasia Land Bridge Logistics Development Co., Ltd (hereinafter referred to as CEL) is a mature multimodal transport company in Chongqing. It offers a sea-rail combined transport line operating from Chongqing-Qinzhou-Southeast Asia in the form of a government platform. The company is jointly owned by four large state-owned enterprises - Guangxi Beibu Gulf International Port Group (hereinafter referred to as GBG, accounting for 41% of total shares), Chongqing Railway Port Logistics Development Co., Ltd. (hereinafter referred to as CRPL, accounting for 39% of total shares), Minsheng

Shipping Co., Ltd. (hereinafter referred to as MS, accounting for 10% of total shares), Sinotrans Chongqing Co., Ltd (hereinafter referred to as Sinotrans, accounting for 10% of total shares).

GBG and CRPL who held key monopolistic resources own majority shares and controlling position in the company. At present, CRPL is responsible for the railway transport segment from Chongqing and GBG oversees the port operations. The companies held less monopolistic resource in the maritime segment have no share of CEL. CEL has formed strategic partnership with 15 major global shipping companies by signing contractual agreements for services relating to container shipping and shipping agent. CEL engaged in an entirely market-oriented relationship with customs clearance and cargo handling operations.

Therefore, we postulate that in scenarios when there is a presence of a large international multimodal transport subcontractors with monopolistic power, the multimodal transport operators should engage with shareholding relationships to ensure the stability of the international multimodal transport. Moreover, when monopoly is absolute, there should be a controlling relationship with share between the international multimodal transport subcontractor and the operator. This is somewhat consistent with the results of our earlier AHP analysis. Reflecting our final synthesised results presented in Table 3.5, corresponds partially with the formation of CEL, where the two companies with an absolute monopoly of resources and services (Guangxi Beibu Gulf International Port Group and Chongqing railway crossings Logistics Development Co., Ltd.) both form the majority shareholding relationship in CEL while the other companies that do not have the resource monopoly of resources engage in the form of pure market pure market transactions. For instance, a pure contractual relationship was formed with 15 other shipping companies for activities relating to customs clearance and cargo inspection and handling operations.

Case Study 2: YUXINOU (Chongqing) Logistics Co., Ltd.

YUXINOU (Chongqing) Logistics Co., Ltd., a joint venture between 5 corporations - China Railway International Multimodal Transport Co., Ltd. (10% of total shares), Russian Railways Logistics Co., Ltd. (16.3% of total shares), D.B. Schenker (China) (accounting Shares of 16.3%), Kazakh Transport Services Co., Ltd. (16.3% of shares) and Chongqing Transportation Holdings (Group) Co., Ltd. (41.1% of shares). It mainly engaged in the two-way station-to-station railway freight transportation business along Chongqing and Europe. At the same time, it is expanding the rail and sea combined transport business from the Yangtze River to Shanghai Port.

YUXINOU is established with stakes in the respective monopolistic rail networks in various countries that connects Chongqing to the European Continent. In contrast, in the road transport and water transport segments where the market is traditionally more fragmented with no one monopolistic power, it has chosen to operate under the pure contractual or market transaction form. Therefore, this observation corroborates our AHP synthesised results presented in Table 3.5.

From the above two cases, the results of our AHP analysis are basically effective. Therefore, we postulate that multimodal operators should be cognizant of the degree of monopolistic power and the extent of competitiveness in the respective transport market segments that they are operating in to select the most appropriate mode of association with the other players.

Effects of monopolistic power and market competition on the organization form of international multimodal transport

Based on the survey responses and conversational exchanges with the experts, the multimodal transport operators should treat the organization form with multimodal transport subcontractors in different transport segments differently based on the market conditions.

If the services provided by the subcontractors are irreplaceable (monopoly), higher transaction costs will be incurred. To achieve better service efficiency and service quality, the multimodal transport operators should engage in a closer shareholding relationship. Because the subcontractors owning monopolistic resources often are large companies with substantial fixed assets, the multimodal transport operator integrating resources often has no ability to purchase or control them. Therefore, in such a

scenario, we postulate that the appropriate organization form is to have the large subcontractors owning monopolistic resources control or co-control the multimodal transport operator.
If the services provided by the subcontractors who do not have monopoly resources, the multimodal transport operators should choose the appropriate organizational form depending on their market position. For subcontractors with higher market power, they should form a relationship with minor investment or strategic cooperation to reduce transaction costs in the entire transportation chain and improve service efficiency and service quality. For perfect competition subcontractors with lower market power, multimodal transport operators can consider engaging in the form of pure market transaction.

The impact of Government Participation on international multimodal transport organisation form

The Chinese government has participated actively in the development of multimodal transport network systems that support the China (Chongqing) – Singapore project, which can be viewed as a part of the China's Belt Road Initiative. The main multimodal transport operators involved in this strategic project are essentially multimodal transport platform enterprises formed under the Chinese government's advocacy. As a result, situations relating to anti-holding arise in the multimodal transport market. The subcontractors conversely control the multimodal transport operator. The situation may be different, if there has not been active government participation from the onset and is completely market-oriented. For example, river-sea combined transportation from Chongqing to Shanghai has operating for many years in a relatively competitive market where most of the multimodal transport operators are free to choose the engagement forms with other relevant operators and decide on the right level of cooperation with their strategic partners. In such a market scenario, the advent of anti-holding issues is relatively unlikely.

Conclusion and Future Research

Based on the above analysis, the following conclusions can be drawn:

(1)The multimodal transport operator should treat the transport organization of different transport segments and different subcontractors differently and cannot be generalized.

(2)Monopoly resources and market position have a great influence on the choice of organizational form of international multimodal transport. Multimodal transport operator should be close cooperative relationship with subcontractors who have a monopoly of resources; forming a strategic partnership with subcontractors who have a higher position in the market; and forming a relatively pure market transaction relationship with subcontractors who have a lower position in the market and are full competitive.

(3)Government participation has a greater impact on the choice of organizational form of international multimodal transport.

This research is one of the first that examines the multimodal transport network organisation forms under the China-Singapore Project. However, our research suffered from several limitations, which can be enhanced by future research. First, this research did not consider the market shares and levels of competition among the multimodal transport subcontractors in the empirical context, which results in some difficulties in evaluating the relative importance of each factor. Future studies can include the level of interfirm competition in the market as a variable to enhance the findings we have presented on the multimodal transport network in Chongqing. Second, the impact of governmental participation in the macro environment of the China-Singapore Project may also be considered for future comparative research. Finally, further work can also be explored to understand how the group of diverse multimodal transport subcontractors can effectively coordinate among themselves in the different organizational forms (P1, P2, P3, and P4) to add on the learnings from this study.

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AN OUTLOOK ON TECHNOLOGICAL READINESS OF ASEAN PLUS THREE

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Introduction

ASEAN Plus Three (APT) is a cooperation between Southeast Asia and East Asia nations which consists of 13 countries, i.e., Brunei Darussalam, Cambodia, China, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, South Korea, Thailand, and Vietnam. Main focus of this forum is to strengthen development of energy, transportation, and information and communication technology. Its rapid economic growth is expected to play important roles in the world economy in the next decades (HV et al., 2014).

Technological readiness is a critical factor which facilitate sustainable growth, especially during the current waves of economic disruption. It is important for both investors and facilitators to analyse and assess overall potential of this element in order to efficiently prepare and strategize their business initiatives. Many technological readiness indexes are reported annually by international institutes. This paper attempts to study relevant facets of this aspect and summarize them accordingly. Four major indexes are chosen in this study based on their organizational creditability and citations. These includes the Global Information Technology Report (GITR) by the World Economic Forum, ICT Development Index (IDI) by the International Telecommunication Union, Internet Usage Statistics (IUS) by Miniwatts Marketing Group, Global Salary Survey (GSS) by Robert Walters, and Global Cities Report (GCR) by A.T.Kearney. It is also important to note that this study only attempt to identify trends of these countries as an overview of regional body, not as an absolute comparison.

The second section of this paper reviews various perspectives of technological readiness described by the aforementioned indexes. Then, general outlook towards technological readiness of ASEAN Plus Three is discussed in the third section. Overall rankings on each nation are proposed in the fourth section. Finally, the fifth section conclude this paper.

Technological Indexes

The latest version of four international technological indexes are represented in this paper. All of these international indexes can be freely accessed online for non-commercial purposes.

Global Information Technology Report (GITR)

Global Information Technology Report is created and distributed by the World Economic Forum (World Economic Forum, 2016). The latest update of this data is from 2016. This index has been previously recognized as Networked Readiness Index during 2004-2014. It classifies ten pillars of ICT readiness. This involve (1) political and regulatory environment, (2) business and innovation environment, (3) infrastructure and digital content, (4) affordability, (5) skills, (6) individual usage, (7) business usage, (8) government usage, (9) economic impacts, and (10) social impacts. In their latest report, 139 countries were surveyed. All of APT countries excepted Brunei Darussalam were included in the latest report. On the other hand, Lao PDR and Myanmar were just included only since 2014. It is remarked that the analysis in the subsequent section on all other APT countries are based on the 2016 data while the data of Brunei Darussalam is inevitably from the 2014 report.

Due to the fact that this index has the most completed perspective, it is used as the main structure of this paper. Table 1 illustrates the GITR score of APT countries during 2012 to 2016. The numbers in the brackets depict their annual ranking. It can be seen that there are no significant changes in the readiness scores and rankings of most APT countries. Singapore is ranked 1st in the world in this index. South Korea, Japan and Malaysia are also ranked in the top quartile of the list. Brunei

Darussalam, although with missing latest data, is still likely to be on the top of the second quartile. China still retains the fifth seat of APT countries. Thailand makes the biggest jump in APT cluster, that is, from 77th rank in 2012 to 62nd in 2016. Moreover, Indonesia, the Philippines and Vietnam are attempting to climb up to the middle of the second quartile. Cambodia, Lao PDR and Myanmar are still lagging in the last quartile.

Country	**GITR Score (Rank)**				
	2012	**2013**	**2014**	**2015**	**2016**
Brunei Darussalam	4.0 (54)	4.1 (57)	4.3 (45)	N/A	N/A
Cambodia	3.3 (108)	3.3 (106)	3.4 (108)	3.3 (110)	3.4 (109)
China	4.1 (51)	4.0 (58)	4.0 (62)	4.2 (62)	4.2 (59)
Indonesia	3.8 (80)	3.8 (76)	4.0 (64)	3.9 (79)	4.0 (73)
Japan	5.2 (18)	5.2 (21)	5.4 (16)	5.6 (10)	5.6 (10)
Lao PDR	N/A	N/A	3.3 (109)	3.6 (97)	3.4 (104)
Malaysia	4.8 (29)	4.8 (30)	4.8 (30)	4.9 (32)	4.9 (31)
Myanmar	N/A	N/A	2.4 (146)	2.5 (139)	2.7 (133)
The Philippines	3.6 (86)	3.7 (86)	3.9 (78)	4.0 (76)	4.0 (77)
Singapore	5.9 (2)	6.0 (2)	6.0 (2)	6.0 (1)	6.0 (1)
South Korea	5.5 (12)	5.5 (11)	5.5 (10)	5.5 (12)	5.6 (13)
Thailand	3.8 (77)	3.9 (74)	4.0 (67)	4.0 (67)	4.2 (62)
Vietnam	3.7 (83)	3.7 (84)	3.8 (84)	3.9 (85)	3.9 (79)
Surveyed Countries	**142**	**144**	**148**	**143**	**139**

Table 1: Global Information Technology Report of APT countries during 2012-2016
(World Economic Forum, 2012; World Economic Forum, 2013; World Economic Forum, 2014; World Economic Forum, 2015; World Economic Forum, 2016)

ICT Development Index (IDI)

The International Telecommunication Union is an agency supervised by the United Nations with a focus on information and communication technology aspects. Their latest ICT Development Index was published in 2017, involving 176 countries (International Telecommunication Union, 2017). This index highlights three major areas. The first area, ICT accessibility, comprises phone users, Internet bandwidth and percentage of household with Internet access. The second area, ICT users, designates ratio of Internet users and subscribers. The final area is the educational level of the population. All APT countries were included in the index.

As can be seen from Table 2, the rankings of APT nations during 2016 and 2017 are similar. South Koea, Japan and Singapore are in the top quartile. Brunei Darussalam, Malaysia, Thailand and China are ranked in the second quartile. Yet, although the rest of the APT cluster are located in the third quartile, there were noticeable increases in their raw scores. This suggests a promising sign of development in the regional overview.

Internet Usage Statistics (IUS)

A report on Internet Usage Statistics was annually published by Miniwatts Marketing Group. In the latest report, internet penetration rate of 242 countries were highlighted (Miniwatts Marketing Group, 2018). The report indicates that the average internet penetration rate of the world is 54.4% while Asia is slightly lower at 48.1% average. Number of Facebook users is also included but not used in this paper.

Table 3 displays the internet penetration rate of APT countries. It can be seen that almost all of APT countries have higher internet penetration rate than the average of Asia. In addition, more detailed data suggest that although the number of internet users are still low in several countries, their growth rate is exceptionally high. For example, Myanmar's internet penetration rate has been rapidly rising from

only 2.1% in 2014 to 33.4% in 2017. Likewise, this rate has been increasing from 14.3% in 2014 to 35.0% in 2017 in Lao PDR.

Country	IDI Score (Rank)	
	2016	2017
Brunei Darussalam	6.56 (54)	6.75 (53)
Cambodia	3.04 (128)	3.28 (128)
China	5.17 (83)	5.60 (80)
Indonesia	3.85 (114)	4.33 (111)
Japan	8.32 (11)	8.43 (10)
Lao PDR	2.43 (144)	2.91 (139)
Malaysia	6.22 (62)	6.38 (63)
Myanmar	2.59 (140)	3.00 (135)
The Philippines	4.52 (100)	4.67 (101)
Singapore	7.85 (20)	8.05 (18)
South Korea	8.78 (1)	8.85 (2)
Thailand	5.31 (79)	5.67 (78)
Vietnam	4.18 (108)	4.43 (108)
Surveyed Countries	**176**	**176**

Table 2: ICT Development Index 2017 of APT countries
(International Telecommunication Union, 2017)

Country	Population (Estimated)	Internet Penetration (Rank)
Brunei Darussalam	434,076	94.6% (19)
Cambodia	16,245,729	49.3% (153)
China	1,415,045,928	54.6% (134)
Indonesia	266,794,980	53.7% (139)
Japan	127,185,332	93.3% (24)
Lao PDR	6,961,210	35.0% (178)
Malaysia	32,042,458	78.3% (75)
Myanmar	53,855,735	33.4% (185)
The Philippines	106,512,074	62.9% (121)
Singapore	5,791,901	83.6% (60)
South Korea	51,164,435	92.6% (29)
Thailand	69,183,173	82.4% (63)
Vietnam	96,491,146	66.3% (110)
Surveyed Countries	**242**	**242**

Table 3: Internet Usage Statistics 2017 of APT countries (Miniwatts Marketing Group, 2018)

Global Salary Survey (GSS)

Robert Walters is an international recruitment consultancy. Their 2017 survey in salary involve 9 countries from APT region (Robert Walters, 2017). Although incomplete, it can be used as a guideline for the region. Table 4 lists approximate maximum annual salaries of positions equivalent to software developers in US Dollars in APT nations. It can be seen that the salary diversity is high amongst the region. Brunei Darussalam, is expectedly to be on par with Japan and Singapore. On the other hand, salary for software developer in Cambodia, Myanmar and Lao PDR are highly likely to be lower than all listed nations.

Country	Salary (USD)
Brunei Darussalam	N/A
Cambodia	N/A
China	22,000-58,000
Indonesia	15,000-34,000
Japan	54,000-90,000
Lao PDR	N/A
Malaysia	20,000-44,000
Myanmar	N/A
The Philippines	20,000-49,000
Singapore	51,000-110,000
South Korea	45,000-67,000
Thailand	27,000-49,000
Vietnam	20,000-30,000

Table 4 Global Salary Survey 2017 of APT countries (Robert Walters, 2017)

Global Cities Report (GCR)

Unlike other indexes, the Global Cities Report by A.T.Kearney focuses on major cities instead of the entire nations. The 2018 report includes 135 cities (A.T.Kearney, 2018). This involves cities from China, Indonesia, Japan, South Korea, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. The Global Cities Report has been in published for almost a decade. It observes major cities from 2 perspectives, i.e. current performance and future potential. The current performance of a city is determined by business activities, human activities, information exchange, cultural experience, and political engagement. On the other hand, the future potential illustrates personal well-being, economics, innovation, and governance. Since the report focuses on cities and is not directly related to technological readiness and the detailed scores are not revealed by this index, it is used only as a supplementary evidence. Furthermore, Brunei Darussalam, Cambodia and Lao PDR were not surveyed. Table 5 displays both current performance and future potential during 2016-2018 of major cities in APT nations. Only the top two cities are displayed here.

Country	City	Current Performance Rank (2016/2017/2018)	Future Potential Rank (2016/2017/2018)
China	Beijing	9 / 9 / 9	42 / 45 / 47
	Shanghai	20 / 19 / 19	63 / 61 / 64
Indonesia	Jakarta	56 / 56 / 59	110 / 109 / 114
	Surabaya	104 / 104 / 105	109 / 110 / 120
Japan	Osaka	52 / 51 / 50	33 / 41 / 39
	Tokyo	4 / 4 / 4	19 / 23 / 14
South Korea	Seoul	11 / 12 / 12	32 / 38 / 45
Malaysia	Kuala Lumpur	49 / 49 / 49	54 / 53 / 61
Myanmar	Yangon	118 / 120 / 127	115 / 108 / 112
The Philippines	Manila	59 / 66 / 64	74 / 75 / 85
Singapore	Singapore	8 / 6 / 7	17 / 11 / 5
Thailand	Bangkok	41 / 41 / 43	89 / 83 / 82
Vietnam	Ho Chi Minh	76 / 76 / 80	97 / 74 / 83
Surveyed Cities		**125 / 128 / 135**	**125 / 128 / 135**

Table 5: Global Cities Report 2018 of APT cities (A.T.Kearney, 2018)

Technological Readiness

Technological readiness can be defined by various items. This paper moderates and classifies all key information from the four reports into 4 main dimensions, i.e., regulatory, infrastructure, ecosystem and people.

1st Dimension: Regulatory

Regulatory involves the readiness in politics, regulations, taxes and supports from the government. In the Global Information Technology Report, information for this dimension is drawn from the first and second pillars which involves availability of ICT laws, effectiveness and efficiency of enforcement, intellectual property protections, software piracy and tax rate.

Data from related index suggest that there are laws and regulations for ICT and related issues in APT region (World Economic Forum 2014; World Economic Forum 2016). However, they might not be sufficient in some countries. According to GITR index, Singapore and Malaysia have the most appropriate set of laws and regulations and they are both ranked amongst the top ten world ranking. South Korea and Japan also have adequate regulatory. On the other hand, enforcement of the law can be an issue for most APT countries. Singapore, Japan, Malaysia and Brunei Darussalam have the most effective law enforcement system in the region. China, Lao PDR, Vietnam and Indonesia are reported to have moderately effective enforcement. However, there seems to be challenges in the effectiveness of law enforcement in the Philippines, Thailand, South Korea, Myanmar and Cambodia. This is similar to the intellectual property protections.

Software piracy rate is reported to be generally moderate to high throughout the region. Nations with the lowest problem of software piracy are Japan, Singapore and South Korea. Japan is actually the second best in the world on actions against piracy. It is important to note that there are missing data from several countries such as Cambodia, Lao PDR and Myanmar.

In contrast, despite of having reliable regulatory system, Japan and Malaysia's tax rate may be less appealing when compared to other APT nations. China, the Philippines and Vietnam are also reported to have comparatively higher tax rate. Cambodia, Lao PDR, Thailand and Indonesia provide more attractive tax structure that the aforementioned countries. Yet, although not significantly different from the previous group, Singapore and Brunei Darussalam are reported to be the most preferable destination in the region in term of taxation.

2nd Dimension: Infrastructure

Infrastructure is another critical factor which influence success on investment. Information discussed in this section are retrieved from the third pillars in the Global Information Technology Report and the Internet Usage Statistics.

It is unfortunate that more than half of the APT members seem to have lower electricity capability than the rest of the world. Only South Korea, Brunei Darussalam, Singapore and Japan are ranked amongst the world leaders. In contrast, the reliability of electricity in Vietnam, Indonesia, the Philippines, Myanmar and Cambodia seem to have a large room for improvement.

Overall international internet bandwidth per population in Singapore and Brunei are peerless. Thailand, Japan and South Korea are reported to offer above average of services. On the other hand, the international bandwidth in Vietnam, Cambodia, Indonesia, China and Lao PDR are lagging behind. Nevertheless, it needs to be noted that this index considers the entire population of a country therefore it is not surprising to see lower scores in larger countries.

The 2017 internet penetration rate exceeds 90% in Brunei Darussalam, Japan and South Korea. Singapore and Thailand also have satisfying penetration rate at more than 80%. On the other hand, more than 50% of the population do not have access to the Internet in Cambodia, Lao PDR, and Myanmar. Yet, the Global Cities Report suggests that in certain cities of these countries, it may be possible to find high quality infrastructure.

3rd Dimension: Ecosystem

Overall environment and ICT ecosystem discussed in this section is based on information from the eighth, ninth and tenth pillar in the Global Information Technology Report, the ICT Development Index and the Global Salary Survey. It discusses the support from the government, availability of knowledge-based job positions, salaries, usage of technologies and accessibility to technologies.

According to the Global Information Technology Report, there are excellent reception towards ICT business from the government in Singapore, Malaysia, Japan, South Korea and Brunei Darussalam. China, Indonesia and Vietnam also gain increasing support from the government. In contrast, the government of Thailand, Cambodia and Myanmar provide the least support on ICT industry in the region.

As for job positions, Singapore is currently one of the world leaders in knowledge-intensive jobs. Brunei Darussalam, Malaysia, Japan, the Philippines and South Korea are also reported to be in the top half of the world. On the other hand, the percentages of knowledge-based workforces in Cambodia, Indonesia, Vietnam and Thailand are still rather low. There is no report on this index from China, Lao PDR and Myanmar.

Salaries in more developed APT countries are significantly higher than the rest of the region. Singapore and Japan's high wage may not be attractive to the investors. However, most of other APT nations share similar salary structure while Vietnam and Indonesia's talents can be hired with the lowest budgets. Other countries which are not included in the Global Salary Survey, i.e. Lao PDR, Myanmar and Cambodia are expected to have the same, if not lower, rate of salary as well.

Singapore, Malaysia and South Korea are reported to be familiarized with the use of technology in the highest level. Japan, Brunei Darussalam and China score slightly lower than the three previous nations. In contrast, in Cambodia and Myanmar, ICT has been used in a substantial lower rate than other APT nations.

South Korea is ranked second in the world for overall development of technology-related issues based on ICT Development Index 2017. Japan and Singapore also offer high quality ecosystems for investors. Nevertheless, several APT countries, i.e. the Philippines, Vietnam, Indonesia, Cambodia, Myanmar and Lao PDR, are still in an early stage of ICT ecosystem development.

4th Dimension: People

People is the last dimension in this paper. It includes information from the fifth and seventh pillars of the Global Information Technology Report on the aspects of education system, adult literacy rate and capacity of innovation. Population from the Internet Usage Statistics is also discussed.

Singapore and Malaysia are reported to provide the highest overall quality of education systems in the region. Japan, the Philippines, Brunei Darussalam and Indonesia are also providing a competitive level of education. Thailand, Vietnam, Cambodia and Myanmar, on the other hand, need more improvement on their systems.

Regarding the populations, it is clear that China has the highest potential in this region with more than one billion residents. Indonesia, Japan, and the Philippines all host more than 100 million populations. In contrast, Lao PDR, Singapore and Brunei Darussalam

Adult literacy rate in APT nations are interestingly at the same level. Apart from Cambodia and Lao PDR which have almost 80% literacy rate, all other countries have exceeded 90% adult literacy. Although information from Japan and South Korea are not presented in the study, it is expectable that the literacy rate in both countries are on par with the majority.

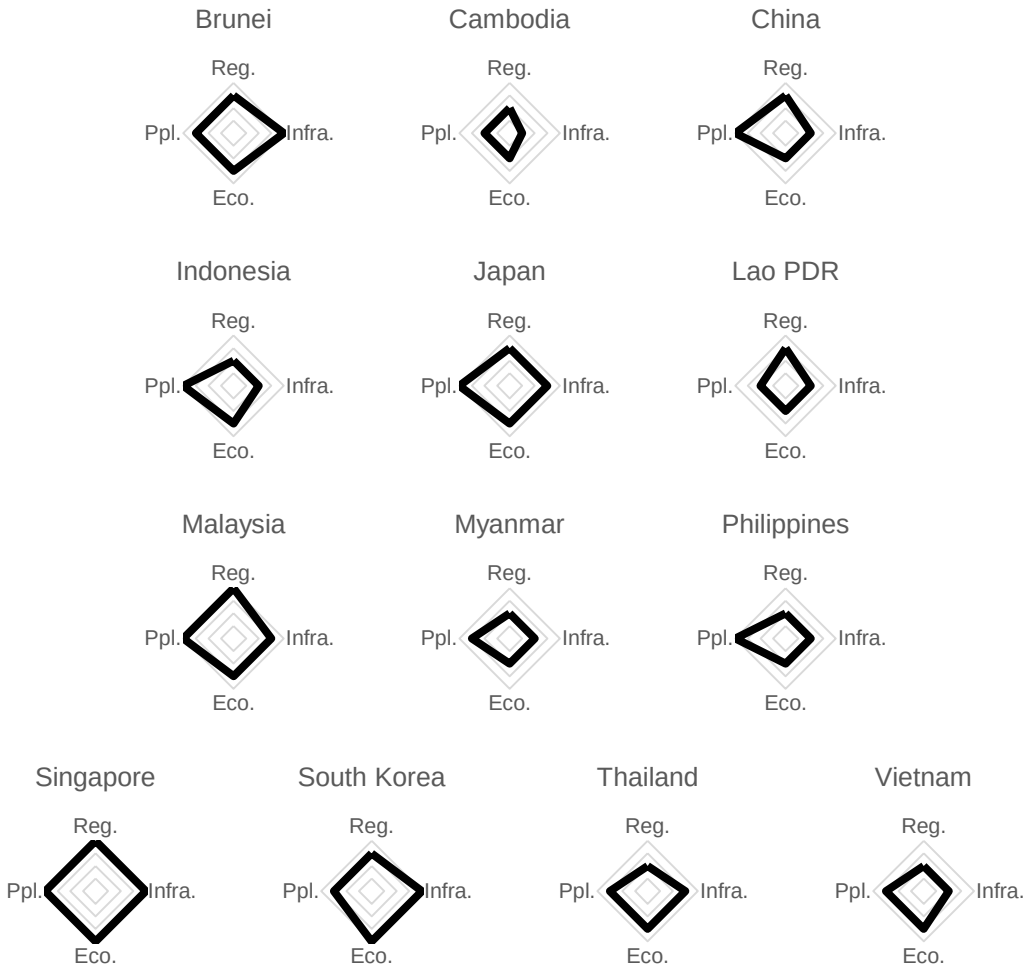
Malaysia is at the top of the region for the capacity of innovation, following by Japan, Singapore and South Korea, respectively. Indonesia and the Philippines leads the second tier of innovation. China, Thailand and Brunei Darussalam appear to be the upcoming contender. The rest of APT region is under development on this aspect.

Outlook on Nations

All four dimensions on technological readiness are summarized in Figure 1. Based on the criteria, it is obvious that Singapore is the current leader in technological readiness due to several aforementioned issues. Brunei Darussalam, Japan, Malaysia and South Korea are also the top tier of the region. Then, China, Indonesia, the Philippines, Thailand and Vietnam are developing their

competitiveness as an upcoming tier. On the other hand, Cambodia, Lao PDR and Myanmar, is a future tier which are still full of potential. They may require more time to develop their capacities to meet the average of the region.

Yet, it is obvious that, due to incompleteness of data as well as other business limitation, investors must realize that these information is relative. It does not necessarily mean that the top tier countries will always be the most preferable destination for all. For example, higher wage can be a sole reason to hold an investment. On the other hand, investing in a less ready country may yield higher and several facets of long-term benefits.



Note: Reg.=Regulatory; Infra.=Infrastructure; Eco.=Ecosystem; Ppl=People

Figure 1: Outlook on APT Nations

Conclusion

This paper surveys latest reports and suggests a technological readiness outlook of ASEAN Plus Three countries. The outlook consists of 4 main dimensions, i.e. regulatory, infrastructure, ecosystem and people. Advantages and disadvantages of each nation based on the dimensions are explained and discussed. As a result, three tiers of APT nations are summarized. Firstly, the top tier countries which have already established their readiness includes Singapore, Japan, South Korea, Brunei Darussalam and Malaysia. The second tier which still has challenges in certain aspects are China, Indonesia, the Philippines, Thailand and Vietnam. Finally, Cambodia, Lao PDR and Myanmar are found to be lagging at present. However, due to the rapid growth of technology, they may require a short period of time to move up their tier in the future.

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ANALYSIS OF THAI GOVERNMENTAL INFORMATION LOGISTICS OF EARLY WARNINGS

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Introduction

An Early Warning System (EWS) is the set of required capacities to generate and disseminate timely and useful warning information for those who are at risks (Kelman and Glantz, 2014). A good structure for an EWS constitutes risk knowledge, monitoring and warning services, dissemination and communication of warnings and response capability (Rogers and Tsirkunov, 2011). While disaster monitoring is extremely important, the significance of dissemination and communication of warnings are often underestimated. The 6.5 magnitude earthquake in Leyte, Phillipines, was an example of several natural disaster incidents struck without warning (Interaksyon, 2017).

Warning information must be simple, clear, recognizable, understandable, reliable, and timely (WMO, 2011). The supporting systems must allow needed information to be delivered effectively, efficiently, in the right format, to the right place and persons and at the right time (Michelberger *et al*., 2013). Information Logistics (IL) concerns about achieving those goals.

Research in IL involves information flow models, efficiency, and distribution of information based on user demand (Haftor and Kajtazi, 2009). Distribution of needed information in the right format to where and when it is needed is crucial. Information made available by EWS needs to be processed and transformed into the right form of useful and needed information and forward to those at risks in time to prevent disasters and reduce the impacts.

The main concern of IL is efficiently driving information flow from the source to destination. Various parts in information flows can be optimized to increase efficiency of delivery of warning information (Haftor and Kajtazi, 2009). The first part is a warning dissemination process. The second and third parts are information production time and flow time, and user-demand and information-supply chain, respectively.

For the first issue to be achieved, standardized warning dissemination mechanisms should be enforced through government policy. Once the policy is in place, procedures and protocols can be defined at local and national levels. Then, partners and their responsibilities can be identified. Multiple communication channels should be made available. Moreover, information provided on certain channels should be tailored for specific recipients. After an effective warning dissemination process is recognized, production, processing and transportation time of information should be shortened to allow critical information to be delivered as early as possible when every single minute is important to saving lives. However, ineffective information processing can lead to information overflow and lack of needed information. Consequently, not enough of important information can be passed through to the recipients. Warning dissemination, thus, should focus on providing the right content in the right form at the right place and at the right time.

The increasing popularity of the World Wide Web has been influencing private and public organizations all around the world to use websites as their public information outlets (Panopoulou *et al*., 2008) to reach a large audience. The innovation in information technologies not only allowing different types of information to be presented on websites, they can be customized to allow a variety of presentation styles. Different information presentation style affects the ability of audiences to receive information and how well they do so. In this paper, a further investigation was conducted to evaluate the quality of warning messages given via websites of Thai authorities responsible for early warning. Thereafter, the effectiveness of IL can be determined based on the quality of warning messages.

Warning dissemination

An architecture of EWS contains components such as monitoring, decision supporting and warning dissemination (Wächter *et al*., 2012). Information flow in EWS starts with acquisition of sensor data and transmitting them to related warning agents. Once information reaches the warning agents, the decision support component analyses and plans for dissemination. Warning information is then customized and disseminated to selected channels. In this study, warning information available on the selected channel, websites, are observed and analysed to evaluate the ability of the warning systems in production and dissemination warnings.

Warning dissemination encompasses transformation of warning information into forms, usually as warning messages and reports, that are understandable and useful to those who needs them. Recipients of warning information include authorities (local and national) and public.

Observation and Analysis

A warning dissemination part of EWS usually deals with a large amount of data that has to be processed in a limited time and notifies affected parties with information they need (Lendholt and Hammitzsch, 2011). To improve warning dissemination, the quality of warning information should be assessed. Then, the results can be analysed to identify problems and their roots.

The study began with an initial investigation of available warning information, in this case, warning messages on the selected websites. This is to survey on characteristics of warning information. Generally, warning messages are tailored for specific needs of recipients and types of hazards. For example, Tsunami related warning messages may include one of the followings: “Tsunami warning” or “All Clear” (Lendholt and Hammitzsch, 2011). If the recipient of those messages is the administrator of the local authority who are trained to recognize to the message and actions associated with it, he should be able to quickly take the appropriate action in response to the message received. On the other hand, if the recipient is a commoner who has never been trained to recognize the meaning of the message, he may not understand the message the way it should be understood. Consequently, the subsequent actions may not be taken.

Specific types of warning messages are formatted to aid in reduction of the time for recognition, interpretation and communication of messages. However, for a particular type of recipients, such as commoners, it is not possible to train all of them to recognize types and meanings of messages. For practical use, typical warning messages on the websites are appeared in natural language. While natural languages are easy to understand and require no additional training, there are limits to how it can be used in communication (Erikksson, 2018). Natural language is ambiguous, hence, may not be consistently understood. On the other hand, language is linear. If the important message is placed later in the page, the delay in receiving and interpreting is greater. Besides, in many cases, it is hard for machine to get a good translation.

The preliminary findings suggested that available warning information is usually given in forms of textual representation combining with graphics such as image, illustration, chart, map, etc. Interactive media contents are offered with limitations. Remarkably, no contextual Information is provided along with the warning messages. By giving information on current environments (i.e. resources, surroundings and locations), otherwise stated as contextual information (Haseloff, 2005), warning systems can adjust information processing and information representation to deliver information that is useful to the those in needs.

Next, the requirements of warning dissemination were identified from guidelines (Rogers and Tsirkunov, 2011)(WMO, 2011) and generic requirements of IL for EWS (Lendholt and Hammitzsch, 2011). They were used as the base references for assessing the quality of warning messages. Accordingly, the requirements of warning dissemination include (1) independency of hazard types and dissemination channels, (2) increasing reception of warning messages with sufficient information (text, picture, instruction), (3) provision of message type filtering, (4) delivery of context-aware information via appropriate dissemination channels and (5) usability of the system.

1. Hazards types

Warning messages should be independent to hazard types. In other words, warnings must not be limited to specific sets of messages. While there are specific terms to be used for certain types of hazards, the structure of messages should remain the same or similar across different scenarios. This is to increase reception of warning messages across different groups of recipients. If different types of messages are provided for different types of hazards, it could easily lead to confusion and increasing learning curve.

2. Dissemination channels

Warning messages for different channels must be provided by EWS in suitable forms. They should be delivered to a wide range of dissemination channels. The most efficient channels for the specific situation must be chosen for distribution of messages. Messages must be delivered to the dissemination channels which are not just ones that fits for a situation, but they must also be the ones that recipients want to be notified. For example, while websites are perceived to be easily accessible via any devices with web browsers installed, they are not the best choice of receiving warning messages for certain environment, such as in areas with low Internet reception, overcrowded locations or panic situations.

3. Information adequacy

Information comes with a cost. Poor information can lead to a higher cost. Therefore, messages must be adequate in terms of content, forms of content, instruction, context and situations, risk, priority and needed information. Adequacy can be justified by user role, area of interest, spatial reference, situation, direction, granularity and existence of necessary components.

4. Context-awareness

Context can be any piece of information used to describe the situation of an object based on a set of attributes. Each attribute is typed and holds values (Haseloff, 2005). Contexts are important in communication. By providing circumstantial information, meaning can be uniquely shaped and miscommunication can be reduced. Contexts are important in communication among humans as well as humans and computers. Context awareness is a crucial feature of IL (Haseloff, 2005) that allows computers to alter their execution and deliver only needed information.

5. Usability

Adequate information should be formatted in such a way that recipients can easily receive and make informed decisions. Moreover, they should be simple, clear, consistent, recognizable, understandable and authentic. Messages in natural languages are linear. Information appears at the beginning or at the top of the contents is recognized before the later. Important information should, therefore, appear at the site landing. Formatting is another important factor to make message more usable.

Findings and Implications

Five Thai public authorities' websites are used as the main case study in this research (referred as A, B, C, D and E). They were systematically analysed based on the requirements listed above. Table 1 presents the analysis results of warning messages based on the three requirements; hazard/message types dependence, wide range of dissemination channel and context-awareness. Messages from each of the selected website were examined in terms of dissemination channels, dependency to hazard or message types and provision of contextual information.

All of the five surveyed EWS support warning dissemination across a variety of communication channels including Mobile application, Webpage, Online inquiry and Social Media Network. Facebook is used by all cases. Twitter and YouTube are the second most popular Social Media Networks. All of them used E-mail and Online inquiry to provide alternatives for those who would like to contact the system in writing. As Email and Online inquiry are both seen as writing tools that can be used interchangeably, some system omits the use of Email and offers only Online inquiry. Another reason

might be that not everyone uses Email. YouTube and Radio broadcasting are similar tools but yield different coverage. Anyone with smartphone and Internet connection can access YouTube videos. However, not everyone has smartphone. Hence, it is a good idea to provide an alternative to information broadcasting. Radio, although traditional, is in fact a great alternative as it can be efficiently broadcasted to remote locations where Internet connection may not be available. Moreover, the number of people in rural areas who can access radio are far greater than those who can access smartphone. Hotline is another good channel to provide an alternative for spreading warning messages.

Table 1. The analysis of information logistics of five selected Thai authorities based on hazard types, dissemination channel and context-awareness.

Authority	Dissemination Channel	Hazard / Message types dependence information	Context-awareness
A	- Mobile application Webpage - Online inquiry - Web board - Facebook - Hotline call - Radio broadcast	- Hazard type - Period - Situation, overall - Affected area, Division - Impact / Casualty - Recovery area - Current situation, overall and subdivisions - Relief information	- Location information - No tailored message
B	- Mobile application - Webpage - Web board - Online inquiry - Email (dead link) - Hotline Fax - YouTube - Facebook, Twitter, Instagram	- Period - Message type - Situation - Affected area, Region - Affected area, Division - Instruction / Recommendation	
C	- Mobile application - Webpage - Email - YouTube - Facebook, Twitter, Instagram - Hotline call - Radio broadcast	- Hazard type - Period - Affected area, Region - Situation - Instruction / Recommendation - Affected area, Division	
D	- Mobile application - Webpage - Online inquiry - Email - YouTube - Facebook, Twitter - Hotline call	- Hazard type - Period - Situation - Instruction Recommendation - Affected area, Division - Forecast	
E	- Mobile application - Webpage - Web board - Online inquiry - Email - YouTube - Facebook, Twitter	- Hazard type - Period - Message type - Affected area, Division - Situation - Forecast - Instruction Recommendation	

It is found that all websites that offer warning do provide warning messages of similar structure with slight differences in terms of components in the messages, order of the components and granularity of details. Although, most of them include hazard type, period, affected area and situation information, only some of them specify message type, impact, instruction/recommendation, current situation and forecast. In addition, some website does provide warning messages using only textual information with no other types of information presentation, neither situational picture nor any kind of images. Surprisingly, some of them provide no contextual information in the messages. Consequently, people who read the warning messages need to spend extra time extracting information related to them. All websites appear to provide all available information in bulk without any selective options. Therefore, the information supplied are not likely to match the actual demand. This results in inefficiency of information flow in IL.

Table 2 shows an attempt to classify types of media presenting in the warning messages provided by the five websites studied. Images showing situations are important to reception of warnings. Some images are shown as maps. Geographical and weather maps are useful to represent affected areas and their situations. Yet, layered information posed on top of the map can create confusion due to complexity of information posed. Consistent format of those images provided across different websites containing warning messages could help readers to receive information faster and enable them to response faster as well. Maps are useful for representing geographical related information, but as previously noted that layered information posed on top of the maps could delay information delivery. Remarkably, only one website does provide illustrations to symbolize the situation information in such the way that readers can easily understand and make informed decisions without having to look at the tables full of numbers. This proves that simplification of messages is very important to acceptance of the messages.

Table 2: Types of media used by the five selected Thai authorities

Authority	Text		Graphic					
	Para-graph	Table	Image	Map (Geo-graph-ical)	Map (We-ather)	Map (Inter-active)	Illust-ration	Color code
A	✓	✓	✓		✓	✓		✓
B	✓		✓	✓				✓
C	✓		✓	✓	✓	✓		
D	✓	✓	✓		✓	✓		✓
E	✓	✓	✓	✓	✓		✓	✓

Figure 2. Symbols representing different kinds of disasters shown on the the National Disaster Database provided by Website A.

Figure 1 gives an example of another usability problem found on some of the websites. Indeed, consistency is the key to message delivery and acceptance. However, inconsistency is found from the icons used to represent types of disasters. These icons are not used elsewhere in other public authorities' websites. That means people who use these websites would have to remember different

pictures for the same meaning. This is not a recommended practice for channelling information to the public when time is one of the most important factor in preventing and reducing damage caused by disasters.

Conclusion

The main goal of Information Logistics (IL) is enabling effective and efficient delivery of needed information, in the right format, to the right place and persons and at the right time (Michelberger *et al*., 2013). In order to meet the goal, EWS or systems supporting early warnings must fulfil the following requirements; (1) delivering warning messages independent of hazard and message types, (2) providing sufficient information in warning messages to increase reception, 3) Disseminating and messages through a wide range of communication channels, 4) filtering information to allow only needed and useful information to get to the recipient, and 5) usability to ensure that everyone can efficiently access and understand the information in a timely manner.

Based on the results of this study, and the recommendation made by other related work, needed information that should be included in warning messages include nature of threats and their impacts, risk information, contextual information, suggestion on how to respond to different types of hazards after an early warning message is received, follow-up actions, provision of simple information on hazards, risks and how to reduce disaster impacts, also information to let the recipients know that the threats have ended. Warning information should also have the following quality attributes to enable high quality IL: Clear, Timely, Reliable, Understandable, Authentic, Recognizable, Simple.

Research Limitations and Future Research

There are other public authorities that can be used in the next study to find similarities or differences. In fact, expanded analysis to regional or international level can also be beneficial. This is due to many other influencing factors such as culture. Nevertheless, the findings can be used to create guidelines for creating useful and effective warning information for all authorities involves in warning dissemination. An experiment to verify this framework can also provide informative feedbacks for further development.

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CONTEMPORARY ISSUES IN MANAGING GLOBAL LOGISTICS AND SUPPLY CHAIN

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Introduction

Nowadays, there are many factors which impact to changing pattern of global logistics and supply chain management. Especially, accelerating to open trade liberalization between nations and disruptive technology. The global chain becomes shorter and more complex. Global trade and business transaction also disclose opportunities and complexity. Countries support and protect their importers and exporters by increasingly using non-tariff barriers. As a result, these barriers increase unnecessary costs and complexity, including extending longer lead time.

The objective of this study is to examine current status of global logistics and supply chain players and their changing roles. It also identifies future trends and problematic issues of the players in global perspective. Finally, it designs a new conceptual model to effectively contribute Thailand's changing international trade. To achieve the objectives, it reviews related literature and collects primary data through in-depth interviews and questionnaire survey. It concentrates only manufacturing and agricultural goods as a representative. It interviews five companies in each section. Validity and reliability are carefully examined.

Literature review

Global logistics and supply chain are a rather modernized topic in an academic research, especially in Thailand The paper reviews definitions of global logistics and supply chain, factors influencing to global trade, contemporary issues in global logistics. Authors (Dornier, P, Ernst, R., Fender, M, 1998; Schary, B. & Skjott-Larsen, T. 2001; Theppitak T, 2008) define logistics and supply chain in global perspective. Dornier et al. (1998) define global logistics as the design and management of a system that directs and controls the flows of materials into, through and out of the firm across national boundaries to achieve its corporate objectives at a minimum total cost. Schary and Skjott-Larsen (2001) support the mentioned definition but they include managing information flow with responsiveness in their definition. Theppitak (2008) defines as operations and management of physical and information flow across nations to achieve common objectives of supply chain members. The review shows that authors quite agree on management of physical flow through national boundary, but some of them ignore importance of information flow and occurring barriers from international operations, particularly non-tariff barriers.

When considering to managing supply chain in global contexts, *Shapiro (2001*) defines as a coordination of a company's activities)both internal and external), with objective is to develop and improve long-term performance of the company and its partners through the chain. As *Christopher (1998)* explains as the management of upstream and downstream relationship with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole. Cooper & Ellram (1993) state as an integrative approach to manage the total flow of a distribution channel from the supplier to the ultimate user. Authors point out to importance on building relationship among members, but many definitions lack insights on global perspective like cultures or complexity.

Global players are different, they depend on pattern and scope of trade cooperation and complexity of mutual agreement. Traditionally, they consist of exporter, freight forwarding companies, container freight station or inland container depot, warehouse, port or air port to another country. The importer side has players as similar as export side, but it may additionally increase some players for example distributor, wholesaler or retailer. As transporters or carriers play a role to link part of supply chain together. However, under a new model of global perspective, the chain would be shorter and leaner. Some members may be cut or reduced to achieve cost and value advantage.

Authors (Schary, B. & Skjott-Larsen, T. 2001; Theppitak T, 2008) identify that tariffs and non-tariff barriers (i.e. charging other fees and custom procedure and evaluation are increasingly becoming

future complex and complicate issues for global logistics in term of cost and time management. When reviewing problematic issues often occurred in global supply chain, it shows that nature of conducting a business has been changing. Driving forces (i.e. globalization, information technology and advanced transportation) have pressured to SC members to change the way of doing business. Trend of countries attempts to open trade liberalization or establishing economic cooperation to reduce or eliminate tariff barriers. As a result, invisible barriers like non-tariff measures (TBT and SPS) are becoming serious problem and affecting to supply chain as a whole. To compete in global market, cost advantage and responsiveness will become a key success in global perspective.

Research methodology

Global logistics and disruptive technology are a rather modernized topic in an academic research, especially in Thailand. Its importance is recognized to help concerned importer-exporters to plan, work and control their business transactions. A review of literature is conducted on sources related to global logistics management, and disruptive technology and international business from texts, and international journals. The paper has two major objectives. *First,* related literature has developed and rapidly changed overtime. Therefore, a historical review (traces the development of an issue related to global supply chain over periods, (*Newman, 1997, p. 90*), and an integrative review (summarizes what is known related to issues of global supply chain at a point in time) will be conducted (*Zikmund, 1997, p. 203*). *Second,* it is to refine a research idea to facilitate further research (Kervin, 1992). The information gathering stage can be viewed as a preliminary investigation, identified by *Emory and Cooper (1991),* as a core method of conducting exploratory case study research.

The paper presents globally contemporary issues to facilitate Thai firms for managing their businesses in global context. The paper was used for generating insights to investigate and answer the research questions as follows:

- What is definition of global logistics and supply chain?
- What are factors impacting to global trade?
- What are problematic issues and barriers of Thai importers and exporters in global context?
- What is new conceptual model of managing global logistics and enhancing competitiveness to Thai firms as global players?

The paper uses an *exploratory study* in order to explore pattern of global players and their operations under pressures from trade liberalization and global competition. A questionnaire survey was used to 210 Thai importers and exporters. The 210 questionnaires were distributed and 168 samplings were returned, with 0.80 percent of response rate.

This sampling would be appropriate representative of population, which is accepted and reliable *(Sekaran, 2000).* It additionally conducted interviews 25 the samplings in Thai language. The semi-structured questions were developed based on research questions and repeatedly asked the same questions to all respondents. Data were be manually used to categories, cluster and analyses the interview data *(Miles & Huberman, 1984; Neuman, 1994; Zikmund, 1997; Sekaran, 2000).*

Finding results and discussions

The survey shows kinds of businesses, numbers of employees, type of goods and services, problematic issues of respondents when importing and exporting to other countries. The proportions of sampling size are significantly dispersed as representative to all segments of Thai firms. The KMO and Bartlett's test is used to examine appropriation of data for using factor analysis. The result shows that the factorability is accepted, and there are significantly positive relationships between the variables which could group variables within a dimension. The results show that samplings are normal distribution, and it is significantly used as representative of the population.

Table 1 Type of business

Type of business	Percent
.1Importers	27
.2Exporters	45
.3Others (e.g. investors and LSPs)	28
Total	100

The result of survey on kinds of respondents is shown in Table 1. Frequency distributions are classified in three major groups: importers, exporters and investors. It shows that 27, 45 and 28 percent respectively. The result shows that samplings are normal distribution. As China, Japan, Singapore and United Stated of America are destination countries.

Table 2 Number of employees in respondents

No of employees	Percent
.1Less than 50 persons	13
200-51 .2persons	46
20 .31 500-persons	25
.4more than 501 persons	16
Total	100

Table 2 show profiles for number of employees in respondents' organization. It reveals that 46 percent had 51 – 200 employees, 25 percent had 201-500 employees, 16 percent more than 501 employees, and 13 percent had less than 50 employees respectively.

Table 3 Type of goods and services

Type of Business	Percent
.1Agriculture	32
.2Manufacturing	21
.3Hi-Tech infrastructure investment and related business	12
.4Mineral industry	11
.5Energy	9
.6Information Technology and Communications	5
7 .Others	10
Total	100

Table 3 shows type of sectors of respondents. The greatest number of respondents or 32 percent is in agricultural sector. As 21 percent is manufacturing, 12 percent is Hi-Tech infrastructure investment and related businesses respectively. The questionnaires are distributed to other sectors, but there are few questionnaires to be returned in some sectors for example information technology and Communications firms.

Table 4 Issues related to custom rules and procedures

Issues	Percent
.1Tariffs	29
.2Fees	22
.3Custom procedure and evaluation	20
.4Import license	17

.5Country of Origin	12
Total	100

Table 4 shows problematic issues of Thai firms when import or export to-from countries. The greatest number of respondents or 29 percent is tariff barriers. As 22 and 20 percent of respondents that charging other fees and custom procedure and evaluation. Non-tariff barriers are increasing becoming a serious problem that caused increasing operational costs.

Table 5 Barriers when exporting to partner countries of Thai respondents

Issues	Percent
.1Non-Tariff Barriers within importing countries i.e. label, additional tests.	36
.2Issuing of license, permissions	26
.3Limitation of using raw materials,	15
.4Requirement of VISA and work permit	12
5. Tariff Barriers	11
Total	100

Table 5 shows barriers when exporting to partner countries of Thai respondents. The study shows that importing-exporting firms or 36 percent faced with non-tariff barriers when imported-exported their goods to foreign customers. 26 percent has problem related to issuing of license and permissions, 15 percent is limitation of using raw materials and 12 percent is requirement of VISA and work permit and 11 percent is tariff barriers respectively.

Table 6 Average number of global trade players in each import or export transaction

Issues	Percent
.1Less than 4 players	16
.25-6 players	21
.37-8 players	13
.49-10 players	9
5. More than 10	7
6. Not sure	34
Total	100

Table 5 shows average number of global trade players in each import or export transaction. The study asks the respondents to number of players in each transaction of importing-exporting. The greatest number or 34 percent shows that they are not sure to number of players because of using outsourcing (i.e. freight forwarder). Some respondents or 16 percent identifies that there are less than 4 players (i.e. freight forwarding companies, customer brokers, transporters). Others or 21, 13 and 9 percent identify that there are 5-6 players, 7-8 players and 9-10 players respectively.

Table 5 Contemporary issues in managing global logistics

Issues	Percent
.1Complexity of import-export documents	24
.2Costs of import-export operations	21
.3Uncertainty of delivery time	17
.4Reliability of global players	15
5. Managing global outsourcing	13
6. Consistency of information technology, infrastructure, and facilities	10

Total	100

Table 5 shows contemporary issues in managing global logistics. The respondents reveal interesting results in managing global logistics. The greatest number of respondents or 24 percent identifies complexity of import-export documentation. Some respondents reveal that costs of operations and uncertainty of delivery time and reliability of global players are problematic issues, including managing global outsourcing and information technology.

Discussions and Implications

The study shows that importing-exporting firms identified that global trade and investment increasingly become more difficult and complex. The difficulty comes from members in global supply chain trying to reduce their costs and increase responsiveness. As complexity occurred from advance technology like the internet, artificial intelligence (AI), robots or using of RFID and modern transportation. It needs firm to adapt and flex to dynamic changing.

The survey reveals that firms lack global knowledge and skills to deal with foreign competitors, especially competitors from developed countries. Thai players in sectors for example agriculture and manufacturing were medium enterprises with loosen cooperation among global supply chain members. Global supply chain players are shorter and professional. Non-tariff barriers (i.e. charging other fees and custom procedure and evaluation are increasingly becoming future problematic issues for global trade in term of cost and time management.

When considering to contemporary issues in managing global logistics, the study reveals interesting issues, for example complexity of import-export documentation, costs of operations and uncertainty of delivery time and reliability of global players including managing global outsourcing and information technology, infrastructure and facilities to support transportation system and cargo operations.

When considering major players in global supply chain, traditional model is not sufficient to respond to dynamic environments. Traditional model in exporting country consists of exporter, freight forwarder, inland container depot, transporter, warehouse, port or air port. On the other hand, importing country covers port or air port, customer broker, freight forwarder, distributor, wholesaler, retailer and importer. However, a new model would be created with more shorter and leaner. Members of a global supply chain would be less than competitors and work professionally.

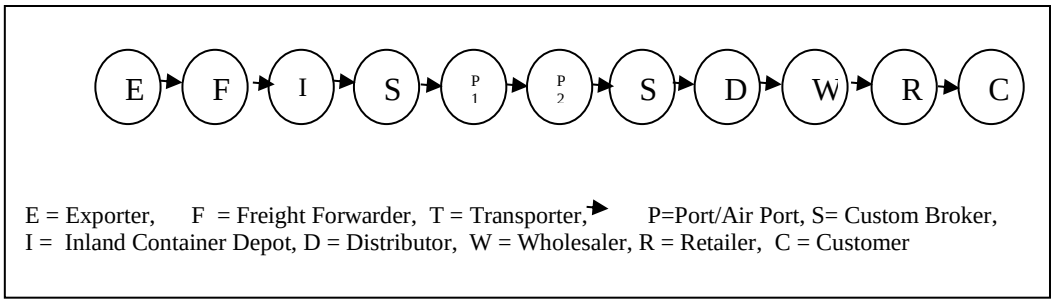

Figure 1 Traditional model of international logistics and supply chain

Figure 1 shows traditional model of international supply chain. Traditionally, exporters deliver their products through intermediates until arrival to importers. The processes took several weeks with many problems and barriers. The barriers include tariff and non-tariff measures. As tariff measures have been decreasing due to opening of trade liberalization and economic cooperation, but non-tariff measures are becoming serious issues for players. They increase long lead time with higher total costs through global supply chain.

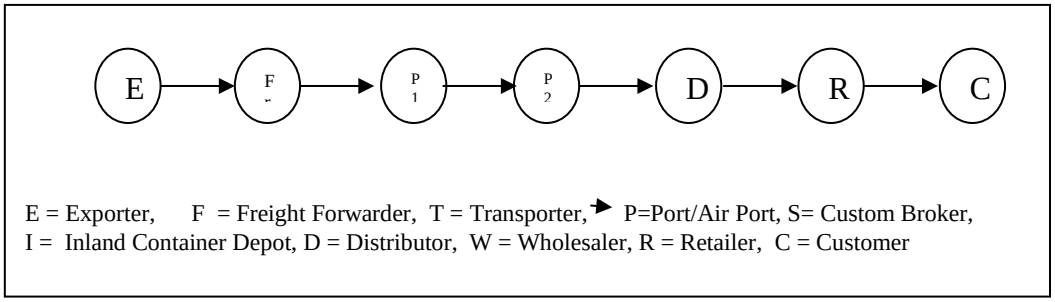

Figure 2 Modified model of global supply chain

Figure 2 shows modified model of global supply chain. To respond to dynamic changing, members become professional and manageable players. In this model, exporters can outsource professional freight forwarding company who can deliver a product with shorter chain and wide-network to importer. Inventory would be stocked at distributor before delivering to customers. As transporter and information technology (IT) professionals will link supply chain members through physically and electronically. Achievement of time and cost advantage, responsiveness and flexibility would be a major objective of the model.

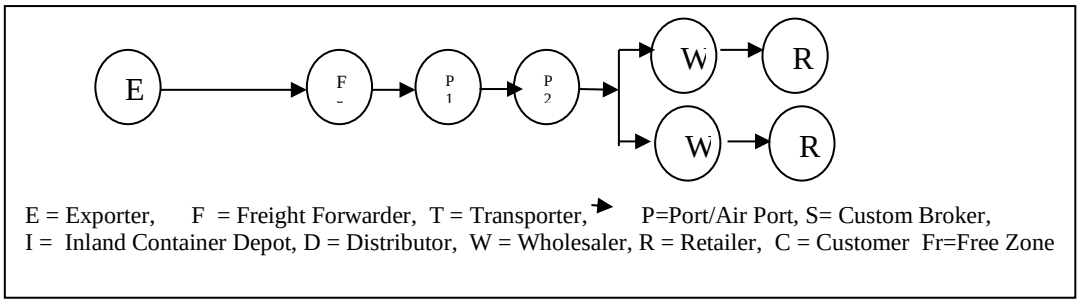

Figure 3 Alternative model of global supply chain

Figure 3 Alternative model of global supply chain. In this model, export side, especially freight forwarding companies need to be a professional player. They have accurate demand forecast and hold inventory to import side. Inventory will be stocked at freight forwarding companies and delivering to wholesalers and customers. As modern transporter and information technology (IT) professionals would be a critical success factor. Also achievement of cost advantage, responsiveness and flexibility would be a main purpose.

Outsourcing management is a new way of managing global logistics and supply chain. Cost and time management would be a pressured drive to firms. The firms identified that they are interested to hire external transporters or warehouses. Many firms are worried the issue of coordination and controlling to outsourcing companies. The firms state that effectively working with members in global supply chain, it needs to understand culture and value of partner countries. Understanding culture and values of partners build closer and positive relationship among members. Under trade liberalization and economic cooperation between Thailand and other countries, tariff barriers are reduced or eliminated. However, non-tariff barriers are becoming serious and complex problems. Operating in global supply chain, cost, responsiveness and flexibility are critical success factor. Members would design and develop their effective supply mapping with more shorter and leaner. To achieve the global objectives, lower costs with high responsive and flexibility would be a desired output.

Conclusion

The study concludes that players would change their new and innovative way of conducting global business in a new direction and system thinking, consistent with dynamic changing of world trade and investment. The contemporary issues in managing global logistics would be trained to firms in topics of how to manage complexity of import-export documentation, costs reduction of operations and

managing uncertainty of delivery time and reliability to global players, in particular managing global outsourcing and applying information technology to global trade activities.

The result concludes that importers and exporters need to learn more on aspect of global knowledge and flexibility to changing global trade. They cannot operate their business in old way. Under current government policy which accelerates to open trade liberalization to partner countries. As a result, then tariff barriers would be reduced or eliminated, but non-tariff barriers (i.e. charging other fees and custom procedure and evaluation are increasingly becoming future problematic issues for global trade in term of cost and time management. Therefore, importers and exporters are confronting to serious barriers when trading with partners. Even though tariff rate has been annually decreasing until zero percent, but non-tariff barriers (TBT, SPS, national treatment, and standards) are increasingly becoming big problems. Players, in particular Thai side, need to be more professional in term of global knowledge and understanding, including readiness to adapt and flex to changes. New global chain would be shorter and leaner in term of total costs and time.

The study leads to a conclusion that before managing global logistics and supply chain, it needs to examine status of global players, including identifying current and future problematic issues associated with changing trade patterns and future policy making of partner countries. Then defining a framework and developing a new model. Further research would be conducted by focusing on changing role and responsibility of specific logistics activities (i.e. freight forwarding, customs broker, ICD/CFS, Shipping lines and ports).

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DATA CHAIN MANAGEMENT ON CROP MAINTENANCE IN PRECISION AGRICULTURE

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Introduction

Agriculture or Agricultural Activities is the farm practices and activities of crops production including the soil's tillage, crops' planting, fruit trees' growing, and harvesting of any agricultural and horticultural commodities, and operated by a farmer on a farm excepting the processing or manufacturing of farm products [1][2]. The cycle of crops production consists of the sowing of seeds, the maintenance of crops during growth and development, harvesting, storage, and distribution [3] as shown in Figure 1.

Previously, farmers cultivate and maintain their crop using indigenous knowledge, natural resources, and cultural beliefs of the farmers. The number of world population in the next 40 years was predicted by the Food and Agriculture Organization (FAO) that will increase around 1.5 thousand million people [4]. Additional, the unpredictable environment, for example climate change; drought; etc., is the major problem of crop's cultivation which affects to crop maintenance process and yields. Therefore, farmers have to more emphasize on the significance for increasing the quality awareness of productivity and foods' sufficiency for the world population.

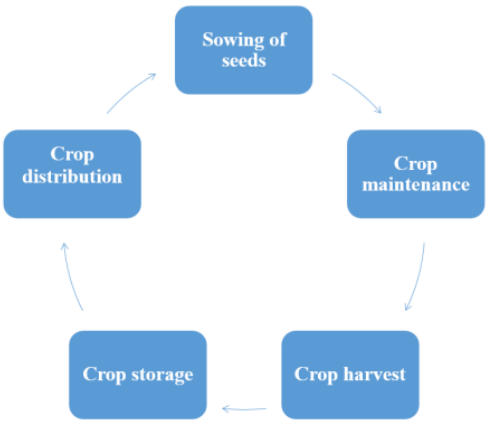

Figure 1: Lifecycle of growing crops

Consequently, the limited amount of crops grown is the negative results from these impacts. To reduce the risk from highly damages of farming operation is to adopt the concept of Precision Agriculture (PA) for farms management by following the conditions of farm situation. The Precision Agronomics or Precision Agriculture (PA) is adopted to enhance crop maintenance process and to improve quality of productivity. According to the concept of Smart Farming from European Network Mainstreaming Smart Farming Technologies among the European farmer community (Smart AKIS Network), PA is one of the three pillars of modern information and communication technologies (ICT) application which is a concept of farm management to observe and measure variance in cultivation using smart technology and decision support system (DDS) for managing whole farm including fertilizing, irrigation, pesticides, etc., and enhancing quality of productivity [5]. PA techniques use data obtained by closely monitoring related variables using smart technologies like sensors and remote sensing technology [6]. PA has developed and applied in many countries such as Canada, USA, European, Japan, etc. For example, vineyard adopts precision agriculture by installing sensors on farm and using smart technologies and sensing technologies for monitoring farm's environment (comprising air temperature, soil moisture, air humidity, rainfall, wind speed and direction) via smartphone or tablet that helps farmers for farm management

effectively and grapes' quality controlling [7]. Another example is proposed by [8] which is tractor's tracking in large farm areas using Global Positioning System (GPS) technology for tracking and ZigBee wireless network for communicating so that tractors will be tracked when it is running on the farm field. In PA, the data is very significant. Numerous data are relevant for crop maintenance which the management of data chain is necessary. Consequently, this paper proposes the approach to manage data chain for crop maintenance. The paper is structured as follows: starting from Concept of crop Maintenance, Data relevance crop maintenance, Data chain management approach, and ending with the Conclusion and future work.

Crop Maintenance

Crop management is the process to manage the crop cultivation in whole life cycle of crop production consisting of beginning of life, middle of life and end of life. It is one of the processes on crop production to protect the crop cultivation against issues which affect to yields such as weather, diseases and insect, etc. A variety of cultural treatments also may be required to meet the purpose of the crop cultivation. On the crop maintenance, the factors affecting to crop growth consists of growth regulator and hormone, soil, nutrient, water, climatic, diseases, insect pests, and weeds [9]. Additional, there are six main methods of crop maintenance [10]. Firstly, irrigation is one of important methods of crop maintenance that crops need water for growth, dissolving nutrients into the soil, keeping moisture and cool, and carrying nutrients through the crop. Secondly, fertilizing is the method to maintain crop to healthy conditions and to increase their resistance to harm from diseases and pests. Thirdly, pruning is the method for improving structure of crop, controlling size of crop, or removal of diseased, dying, or dead branches. Fourthly, disease control is the method to protect crop by interfering crop as little as possible so that forecasting and avoidance the occurrence of diseases, pests, and weeds are the most reliable way to deal with them. Fifthly, insect pests control is the methods to avoid the insect pest attack to crop including to care crop after attacked. Finally, weeds control is the method to avoid weed occurrence which affect to soil properties, he habitat of poisonous animals like snacks.

Crop maintenance is relevant lifecycle of growing crop to care the crop from the beginning to the end of crop's life. Generally, the lifecycle of growing crop includes sowing the seeds into soil, young crop, mature crop, flowering, ripening, dormancy, and death [11][12][13] as illustrated in Figure 2. Some crops like grain, rice, the lifecycle is always starting from sowing the seed and ending with the death of crops. On the other hand, the lifecycle of some crops like horticulture is starting from sowing the seeds at the first time of planting, but it is ending at the dormancy stage, and it will start its next growing with mature crop stage.

In each stage of crop's lifecycle, the process to maintain crop (including irrigation, fertilizing, pruning, diseases control, insect pests control, and weeds control) is different depending on the needs of crop and environment. For example, crop in the flowering stage needs less water than other stages because it helps to stimulate the sprout of flowers.

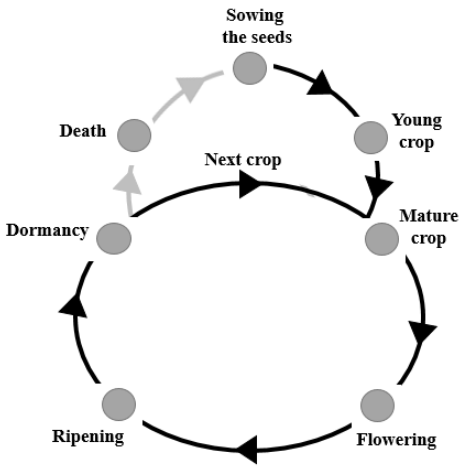

Figure 2: Lifecycle of growing crops

Data Relevance Crop Maintenance

Data is information or raw data collected using particular methods for a particular purpose of analyzing and/or studying. In crop maintenance, numerous data are relevant that are classified based on the sources of data comprising on-farm data, off-farm data, and expert's knowledge as shown in Table 1.

Table 1: Classification of crop maintenance data [14-32]

Method	On-farm data	Off-farm data	Knowledge
Irrigation	- Air temperature - Air humidity - Canopy temperature - Rainfall - wind speed - solar radiation - vapor pressure - evapotranspiration (ET0) - day length - soil moisture - soil temperature - Drainage - electrical conductivity - leaf wetness - Crop canopy -Trunk diameter	- Weather forecast, - Daily climatic datasets, - Daily ET0	- Crop coefficient (Kc), - water requirement of crop, - irrigation method, - timing of irrigation water application, - days of irrigation during cultivation
Fertilizing	- leaf area - Crop canopy - soil PH - soil salinity - rainfall - temperature	- Harvest index, - Grain weight, - type of soil, - soil diagnostic, - farm location, - weather forecast	- timing of fertilizer application, - nutrient requirement of crop
Pruning	- Image of crop canopy		- crop architecture, - methods of pruning
Diseases Control	- Air temperature - humidity - rainfall - day length - wind speed and direction - evapotranspiration - air pressure - canopy temperature - leaf wetness - soil moisture - soil PH	- historical climatic data, - historical diseases occurrence data, - soil diagnose data, - particular field of a geographical area information, - weather forecast	- Method to control diseases
Insect pests Control	- Air temperature - humidity - solar radiation - rainfall	- Historical of insect pests occurrence	- the life cycle of the insect pests, - methods to control insect pests
Weeds Control	- Air temperature - humidity - rainfall - soil temperature - soil moisture - soil PH	- Historical of weed occurrence, - Weed species density data,	- Methods to control weed occurrence, - irrigation method

Data Chain Management Approach

Data chain is data chain is a combination of two or more data elements in a prescribed sequence to yield meaningful information. Nowadays, there has the gap between the raw data collection and decision-making process in terms of data management so that the data chain will be help to close this gap. [33]. Therefore, we propose the approach of data chain management for crop maintenance in precision agriculture. This approach is aggregate the data from heterogeneous data sources including on-farm data, off-farm data, and experts' knowledge before using these data for decision-making. The chain of our data starts from data collection, data processing, data storage, and data analysis as illustrated in Figure 3.

Figure 3: Data chain management in context of crop maintenance in precision agriculture

In figure 3, the chain of data start from data collection which is process to collect data relevant crop maintenance from data sources as a raw data of the chain. The next step of data chain is data processing and integration comprising data processing and data storage. Data processing is the stage of collected data processing that has two methods which are used for capturing experts' knowledge and transforming knowledge base in human language to machine language for analyzing. Data storage is the stage to store processed data and distribute data to analysis stage. The last step of data chain is data analysis which is the stage to process data for making decision on crop maintenance. In this paper, we will focus on the chain of data from data collection stage until data dissemination to analysis stage.

In this approach, the expert's knowledge or knowledge base will be captured by interviewing experts and transformed from human language to machine language by using Natural Language Processing (NLP) so that machine will understand the data captured from experts. And, on-farm and off-farm data that are collected by installing smart sensors on farm and accessing other data sources respectively, will be integrated to be the inputs data of decision model. The combination data processing from heterogynous data sources into a unified view, making it more meaningful and valuable information is the concept of data integration that users, organizations and applications can merge different types of data (such as tables, data sets, and documents) for using as business or personal functions and/or processes.

Natural Language Processing (NLP)

The format of knowledge is categorized into two sources including structured and unstructured knowledge. The structured knowledge includes XML file and relational database and the unstructured knowledge includes image, document, and text file. The creation of both knowledge sources is the concept of knowledge extraction. The expert's knowledge is captured or extracted by interviewing experts. After that It will be converted from human language to machine language for machine-readable in decision-making process.

For capturing and transforming knowledge, the artificial intelligence (AI) technique is necessary. One AI's branch is NLP that is the combination between computational linguistics and computer science to fill the gap between the communication of human and the understanding of computer [34]. NPL is the method helping computer to understand, interpret, and manipulate the language of human. The function of NLP is transformation information in human language to machine language that is the useful and smart way helping computer to analyze and to understand the meaning of human language. The steps of data processing in NLP consists of Lexical analysis, Syntactic analysis, Semantic analysis, Disclosure integration, and Pragmatic analysis [35].

Extract, Transform and Load (ETL)

ETL is data integration process for transforming raw data from diversities databases and then preparing the information for downstream uses [36][37]. The step of ETL consists of three steps comprising extract, transform, and load. First step, the data reading from database is called extract step that data will be collected from numerous and heterogeneous types of data sources. Then, extracted data will be converted into the user need form called transform stage so that it can be placed into another database. Final step, the data will be writing into the target database that is called load step.

Relational Database management system (RDBMS)

To store the set of data, the database is significant. Generally, there are two main types of data comprising structured and unstructured data which most of data is structured data for easily accessible. Several types of database are used to store set of data. However, the most used of database is relational database which is organized into table and allows users to access and to identify the relationship of data in database. To manage the relational database, the RDBMS is applied that is the program allowing administrators to create, to update, manipulate the relational database [38]. Most of RDBMS uses the Structured Query Language (SQL) for database accessing [39][40]. The function of SQL is for data communication that are stored in relational database to manage the storing and disseminating data in database for analyzing.

Conclusions and Future Work

This paper proposes the approach of data chain management on crop maintenance in precision agriculture. This benefit of this approach is helping to manage the chain of numerous data that collected from heterogeneous data sources including on-farm data, off-farm data, and expert's knowledge. The chain of crop maintenance data starting from data collection, data processing, data storage, and data analysis. Natural Language Processing (NLP) will be used to capture and to transform knowledge base captured from experts in human language to machine language for machine-readable data. Extract, Load and Transform (ETL) is the method to integrate on-farm and off-farm data to be the inputs data of decision system. And, Relational Database management system (RDBMS) based on the Structured Query Language (SQL) language will be used to create database and to manage data for storing and disseminating to/from database.

For the future work, the data will be collected and processed based on the proposed approach. Additional, the method for data analyzing in decision model is not proposed yet in this paper. Therefore, the appropriate method of data analyzing in decision model on crop maintenance processing will be proposed in the future work.

Acknowledgement

The authors would like to acknowledge the support of Decision and Information Systems for Production System (DISP), Université Lumiere Lyon 2 (France), College of Arts Media and Technology, Chiang Mai University (Thailand), and Qatar University (Qatar). We also would like to acknowledge all of our colleagues who worked together and provided encouragement to the authors.

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DRIVING SUPPLY CHAIN INNOVATIONS IN SMALL AND MEDIUM COFFEE ENTERPRISES IN NORTHERN THAILAND

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Introduction

Coffee has been a popular agricultural product in Thailand for over ten years. Coffee has been grown mostly in the Southern and Northern of Thailand. According to Angkasith (2002), coffee has mostly grown in the south where around 16,800 tons are produced annually from the total of 70,796 Acre (Office of Agricultural Economics, 2018). Whereas, in the north region of Thailand, the office of Agricultural Economics of Thailand (2018) reported that only 8,879 tons of coffee bean has been produced from around 28,308 Acre, which is primarily the provinces of Chiang Mai and Chiang Rai. Thailand has exported approximately 550 tons of coffee products for over the last 5 years (Office of Agricultural Economics, 2018). There are two main types of coffee that have been grown in Thailand, Robusta coffee is primarily grown in the south while Arabica coffee is grown in the north. Thailand mainly exports 70% of Robusta coffee products, while another 30% are used for soluble, roasted ground and canned coffee in the domestic market. On the other hand, Arabica coffee is mainly used for roasted and ground coffee in Thailand Marketplace.

Focusing on Arabica coffee, it has become more popular with Thai farmers due to the support from the Royal project (Angkasith, 2002). Arabica coffee is mainly grown in the highlands located approximately 800 meters or more above sea level. This landscape is suitable to give a high-quality coffee bean. Growing Arabica coffee provides a greater income to the farmers and reduces the problems of traditional slash-and-burn shifting agriculture (Angkasith, 2002). Because of the policy of natural resource conservation, as well as the limitation of land in Northern Thailand, the highland and the hill—tribe farmers grow coffee not only to support their livelihoods but also able to sustain the local's natural resources on the highland. There is also a high demand for coffee beans because many coffee shops have been opened all over Thailand, especially in tourist destination cities such as Bangkok, Phuket and Chiang Mai. There are over 2,000 Coffee shops across Thailand according to TripAdvisor.com in early 2018.

There are large numbers of coffee shops and coffee producers in Chiang Mai. In the coffee's supply chain, coffee shops are defined as downstream and coffee producers are defined as upstream. After conducting the 1st research phase, the interviewing of 30 target samples, the research team found out that there are significant problems regarding communication and the sharing of information among the stakeholders in Thailand's coffee supply chain. The success of supply chain management could increase the greater business operation and give competitive advantages in a highly competitive environment.

This research project was funded from the Industrial Promotion Center Region 1, Department of Industrial Promotion of Thailand. They focus only industrial promotion for the northern region of Thailand. Hence, this research targets the coffee industry and discusses the coffee supply chain in the northern region by using Chiang Mai as a case study. Even though Thailand has a large number of coffee shops and coffee producers, it is rarely a strong relationship created between the stakeholders in coffee's supply chain in order to develop a business relationship. Most of the individual stakeholder has never been concerned to manage the value chain in their business, especially the small and medium businesses. Therefore, this study aims to develop a web application to illustrate the coffee supply chains' cluster in the north of Thailand. It also purposes to introduce the webpage which might deliver value activities into the chain. This new webpage developing purposes to develop business relationships and alliances, as well as to improve the overall management of the supply chain for small and medium coffee entrepreneurs.

Literature Review

Value Chain

Every organization makes decisions that affect the competitive position and profitability. Strategic planning helps the firm position itself in the marketplace against its opponents in the pursuit of competitive advantage. According to Porter (2001), value chain analysis can be a useful approach in developing business strategy and gain a more competitive advantage to all firms. The value chain can be used to formulate competitive strategies by understanding the sources of competitive advantage and identify or develop the linkages and interrelationships among each activity that create value.

Value Chain activities can be grouped into 2 main different activity groups, which are the primary activity and support activity. The primary activity group covers inbound logistics, operations, outbound logistics, marketing and sales, and customer service activity. The support activity group includes a firm structure, human resource management, technology development, and procurement, as illustrated in Figure 1. Value creation creates added value which leads to a competitive advantage. The firm may earn a higher profitability when it considers applying and analyzing the value chain of their business operation for each activity performance.

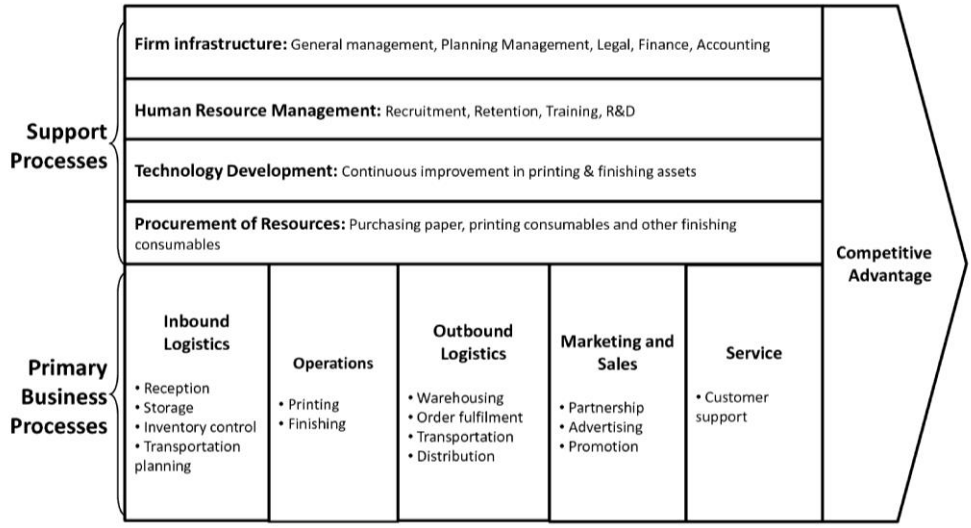

Figure 1: Porter's Value Chain
Source: Poter (2001)

Additionally, Horvath (2001) explained that in an effect of global markets, competition no longer takes place between individual businesses, but between entire value chains. A collaboration through business networks will provide the competitive edge that enables all the alliances in a value chain to prevail and grow together.

Supply Chain Management

In today's competitive environment, most business management has entered the era of internetwork competition. Moreover, the ultimate success of the single business will depend on management's ability to integrate the company's intricate network of business relationships. Lambert and Cooper (2000) explained that the management of multiple relationships across the supply chain is being referred to as supply chain management (SCM). They also mentioned that the supply chain is neither a chain of businesses with one-to-one nor relationships between business-to-business, but a network of various relationships and businesses. It can be explained that Supply Chain Management (SCM) is the integration of main business processes from end users through original suppliers that deliver products, services, and information that add value for customers and other stakeholders in the chain. (Lambert & Cooper, 2000).

Additionally, SCM offers an opportunity to capture the synergy of intra- and intercompany integration and management, which allows the members under the same chain exchange some

resources or information among themselves as a business alliance (Bowersox,1997). Furthermore, Lambert, Cooper, and Pagh, (1997) explained that SCM deals with all business process excellence and represents a new way of managing the business and relationships with other members of the supply chain. All the activities of SCM aim to satisfy customers which include 4 main stakeholders; suppliers, manufacturers, distribution centers and retailers or customers (Chan and Paulraj, 2004). The success of SCM needs to manage not only in the logistics activities of materials financial and information flows but also the planning and controlling activities for both internally within a company or externally between companies (Chan and Paulraj, 2003).

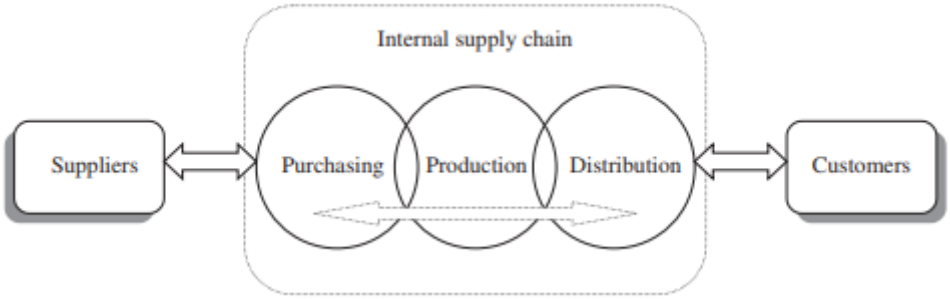

Figure 2. Supply chain management
Source: Chen and Paulraj (2004)

Furthermore, there are many strategies in SCM to increasing business's competitive advantages. The two different processes in manage supply chain to develop a great relationship and satisfied customers are a pull model and push model. In the pull model, it is related to the just-in-time school of inventory management that minimizes stock on hand, focusing on last-second deliveries. Under these strategies, products enter the supply chain when customer demand justifies it. With a pull strategy, firms should concern about the cost of carrying inventory that may not sell or they might not have enough inventory to meet demand (Wong, Arlbjørn and Johansen, 2005). For a push strategy, Wong et al., (2005) explained that a push model in the supply chain management is projected or forecasted customer's demand. Under a push model, all firms are allowed to plan production to meet their needs and gives them time to prepare a place to store the stock they receive. Moreover, the competitive advantages from SCM need a success of business relationships which will be developed from a great trust from all alliances and a long-term mutually beneficial to all chain's members.

Research Methodology

This study follows the advantages of qualitative research techniques by focusing on the small and medium of the coffee industry in Chiang Mai, one of the well-known destinations for all coffee lovers in Thailand. The research project was divided into 2 different phases and was conducted from August to October 2018. The 1st phase of this research adopted a focus group for brainstorming and discussing the strong and weak points in the supply chain of coffee businesses. 30 target samples were selected by following a convenient sampling technique, divided as 10 coffee shops (Upstream), 10 roasted shops (Midstream) and another 10 from coffee producers or coffee farmers (Downstream). The step aims to explore the ideas and analyze the data of the coffee business's supply chain management.

For the 2nd phase, this study was conducted by interviewing 400 potential samples in order to collect data regarding their supply chain, three most popular menus, contact detail as well as their location. All the collected samples were placed into the web application in order to increase the business relationship within the coffee industry and to improve their overall performance. The web database shows all stakeholders in the supply chain. They are mainly producers, roasters and coffee shop owners. The database is accessible via a webpage, which was developed based on the waterfall model which is one of the techniques of the Software Development Life Cycle (SDLC). The waterfall model is a sequential design process and it is mostly used in software development processes, in which progress is seen as flowing steadily downwards through the phases (Balaji & Murugaiyan, 2012).

There are 6 steps in the waterfall model, as is presented in Figure 2. The process begins with analyzing the users' requirements, then designing the website based on their requirements. After that, the system or webpage is developed following the requirements and then testing the system or webpage with the users. Then, listening to the feedback from the users and the developers will solve all errors in the system and adjust them until the systems or webpage satisfy users' requirements. Implementing the systems to public and lastly, keep maintaining the systems.

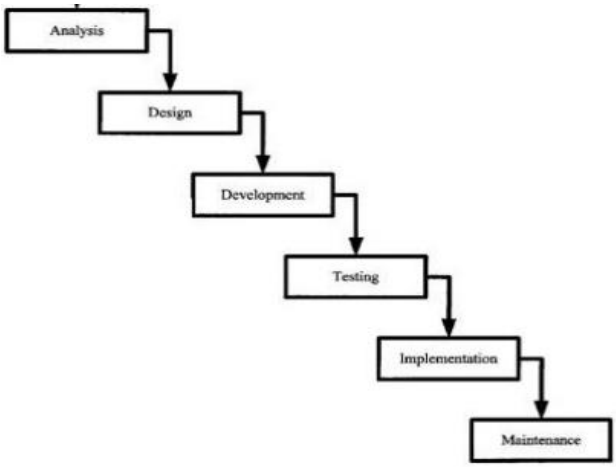

Figure 2: Waterfall model life cycle

Source: Balaji & Murugaiyan (2012)

However, in the testing process, the research team tested the system with 50 sample group which included the coffee producers, coffee roasters and coffee shop, owners. After step 5th, the implementation, every participant will be informed about the information the webpage and the manual book of the system.

Research Findings and Discussion

From the study in phase one, the research team found out that more than 80% of participants agreed that the coffee industry in Chiang Mai has come to the maturity of its life cycle. Even though, there are many strengths and opportunities to keep the business growth; such as the unique menu, location (close to the coffee farm), beautiful decoration, there were some weak points and threats from the marketplace (e.g. lack of digital marketing knowledge and supply chain relationship management, a highly competitive environment and standardize of its teste).

After analyzing the value chain of the coffee supply chain, the findings are evaluated and summarised based on the primary and support activities of each stakeholder, as explained in Figure 3. Furthermore, the findings exposed that the shortage of information among members in the chain is significantly concerned from 22 out of 30 participants.

"*Even there are more than 300 coffee shops in Chiang Mai, we don't know each other. Our marketing distribution is still shortage and did not reach the target market. I think ICTs and digital marketing is necessary as a useful tool to sales and promote. It might create awareness of our brand to the target customers."* Midstream #2

"I think a clustering group of people in coffee industry is very helpful. We will know who are existed in the market and can do business together." Upstream #5

"*I also want to reduce the cost of logistic. At the same time, I need a roasted coffee bean with great quality. Therefore, I have been searching for the supplier who will roast coffee for and match with my standard because it leads to my customer satisfaction*." Downstream #6

"*I think if we have a web or application that provide the information about all members in the coffee chain should be nice. Everyone will search for the information and contact each other easier. We also have more opportunity to develop business relationship and partnership*." Downstream #1

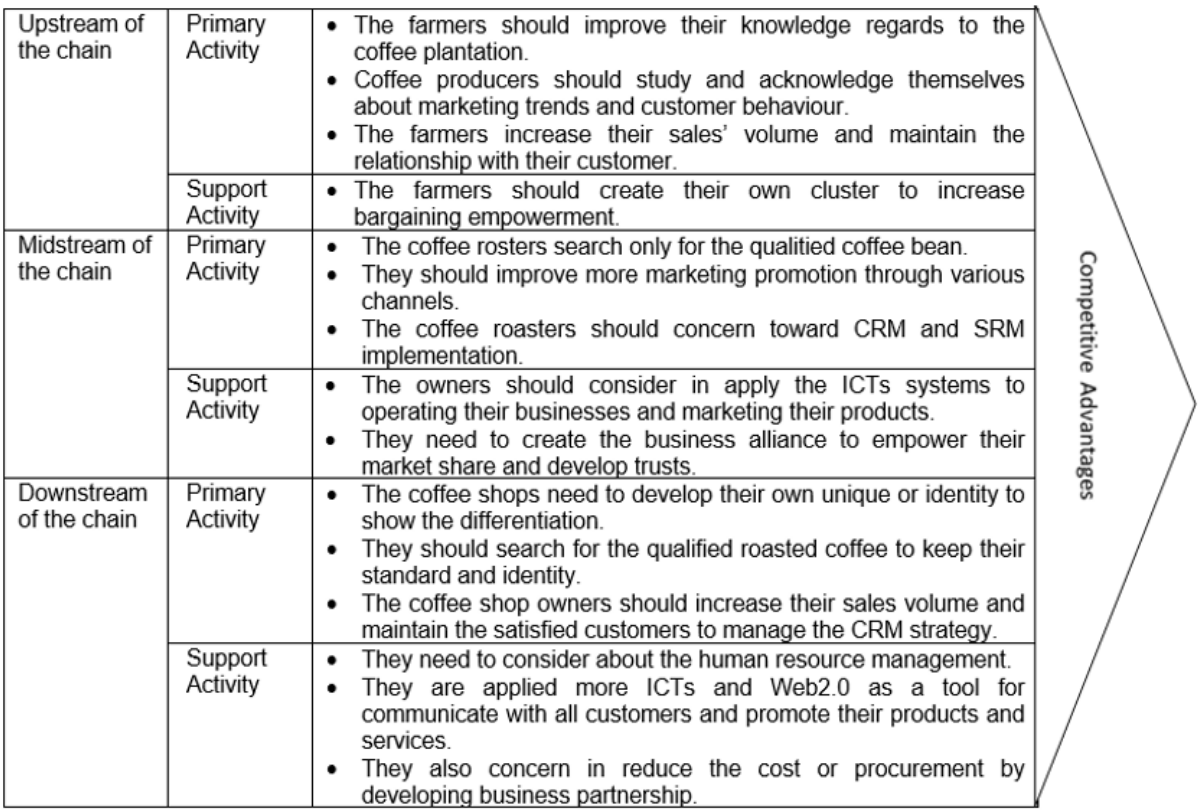

Figure 3: Value chain analysis for coffee industry to develop a competitive advantage.

From the findings of the 1st phase, it shows that most stakeholders in the coffee supply chain of Chiang Mai agree that the innovative Information and Communication Technology and business partnerships are influenced to develop a strong competitive advantage. At the same time, these two issues can add value to the whole chain because it could improve the operational management and control all budgets and expenses. Furthermore, the benefits of the Internet and Web 2.0 could offer an alternative marketing channel to every player in the supply chain to contact and promote its products and services.

Therefore, in the second stage of this project, the researchers developed the web-based technology in order to illustrate the coffee business cluster in Chiang Mai, Thailand. In this webpage, the users will be informed about the business profile, the location and map, contact information, the best-recommended menu and images of the products and/or services, which presents in Figure 4, and 5. Additionally, this webpage shows the supply chain information of each coffee shop which is might use for the users or customers who interest to track the origin or type of coffee bean. Nonetheless, the web 2.0 technology provides as an online cluster for all stakeholders in coffee business, where allows them to contact and develop their business relationship. They also will be acknowledged about suppliers and demanders from upstream to downstream of this business chain.

The URL of this webpage is https://chiangmaicoffeehub.com/. In figure 4, it presents the 1st page of this website where illustrates the location of all coffee chain's stakeholders in Chiang Mai, Thailand. The red points are represented the coffee shop, the yellow points are represented the roasted shop and

the green points are represented the coffee producers. Additionally, Chiang Mai Coffee Hub webpage will present the information and detail of each member, that includes a brief business profile, location, contact address, images, the top 3 popular menus and the chain of its coffee bean, as shown in figure 5. This webpage presents the information of 415 small and medium coffee businesses in Chiang Mai, which include coffee producers, coffee roasters and coffee shops.

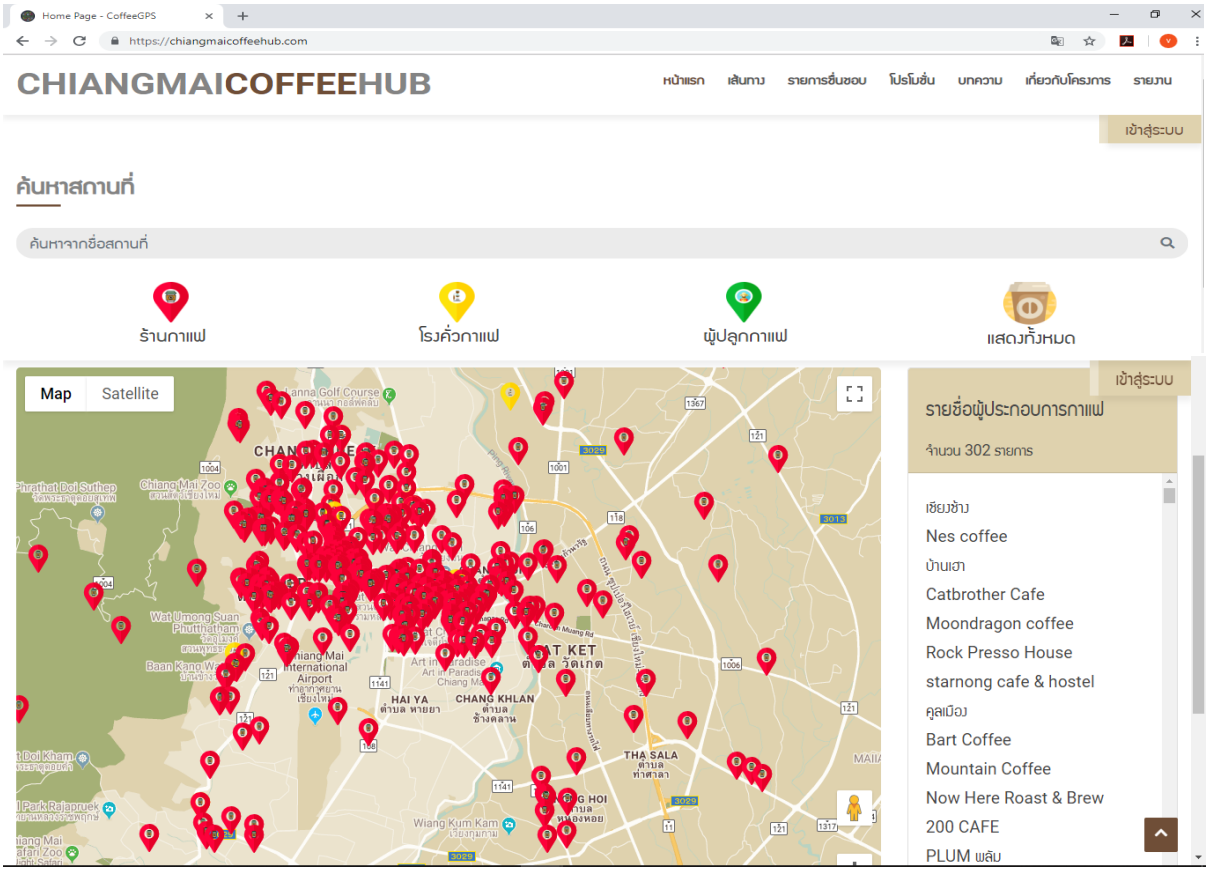

Figure 4: The 1st page of www.chiangmaicoffeehub.com

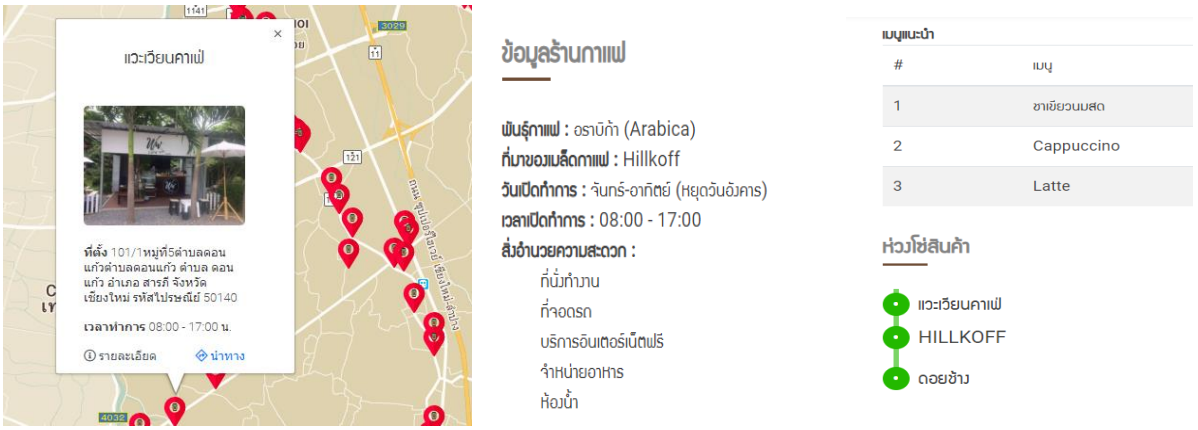

Figure 5: An example information of each member

After testing with 50 samples, the results show that 40 from 50 testers (80%) are satisfied with this webpage. Also, 42 samples or 84% said this webpage is user-friendly with a clear design and organized, however, they suggested to insert more image of the menu and atmosphere, as well as their

logo. Likewise, a majority of the testers with 86% agree that this webpage provides a useful information about the suppliers and customers in the market and should help them to develop a greater business relationship with their suppliers and customers, which could be lead to stronger competitive advantages in today's highly competitive market environment. Nonetheless, this webpage is available for the public. Even the main target users are the coffee business owners, all customers also can be access to the information.

Conclusion

To conclude, this research project develops a new platform for small and medium coffee enterprises' cluster in order to present their business information. Also, this webpage should provide more information to all coffee businesses in Chiang Mai to develop their relationship with their prospect supplier and customers. All coffee entrepreneurs who are the members in this webpage are covered from the upstream to downstream of the coffee business. The total of 415 coffee business members is included 386 of coffee shops, 18 of roasted shops and 11 of coffee producers. Additionally, the majority of users who tested the system with 85% satisfy with this webpage and agree that it should increase the opportunity for them to increase a greater relationship in their supply chain management by offering as an alternative channel to communication and offering basic information for the suppliers and customers.

This research not only provides a benefit to the business side but also useful for the academies who interested in this study area. However, this study has some limitation due to the time and budgeting. The study conducted with only coffee business in Chiang Mai province. Therefore, to increase the validity of the research outcome the study should be extended to wider geographic as should be aimed for further research.

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FRESH GARLIC SUPPLY CHAIN IN THE NORTH THAILAND

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Introduction

Garlic is one of Thailand economic plant .In the year 2017, total of 65,695 rai was planted across the country) 1 rai =0.16 acre(and made 69,504 tons of production, according to the data from the Office of Agricultural Economics . Most of all is in the northern part including 24,967 rai in Chiang Mai, 17,176 rai in Mae Hong Son, Phayao 6,939 rai, Lampang 4,865 rai, Tak 4,131 rai and Lamphun 3,272 rai .

In 2016, Thailand ranked as the 16th garlic producer of the world lead by China as the first productive of 12,750 million tons a year . The second garlic producer was India of 645 million tons, followed by South Korea as 375 million tons)Department of Agriculture, 2016 .(Most of garlic produced in Thailand was consumed within the country for households and food processing industry such as paste and sauces factories .80 percent of produced garlic was used as fresh product while the other 20 percent was used as processed garlic, for example, pickled garlic, fried garlic, powdered garlic, and extracted garlic .Thailand exports garlic and its products of 500 -1,000 tons per year, however, 20,000 – 50,000 tons of garlic were imported to fulfill the consumption in the country.

As an economic plant, garlic price was highly sensitive with uncertainty change .In 2014, garlic price downed to the lowest point .When the price of fresh garlic was not high enough, farmers would not sell the garlic right after the harvest time .They held the product until the price raised .But some farmer had to split their stocks to sell just enough to cover their daily expenses . Some had to loan money and wish the increasing price would cover the interest their owed .

The structure of garlic prices in Thailand was also interrupted by the imported garlic from the neighbor countries, both legal and illegal . Since the cost of garlic plantation in Thailand was higher almost one half than the competitors such as China, India, Korea, there were illegal smuggled into the country border . Therefore, even the demand of garlic in the country was increased, the price of Thai garlic would not get higher .

To stay in the competitive market, the improvement of garlic supply chain is considered to be a suitable way to lower the garlic production cost . The study of the garlic supply chain structure since plantation until deliver to the factory were studied in this survey .

Research Methodology

Four garlic cultivation areas in the north part of Thailand were selected to study : A. Pai, Mae Hong Son; A. Li, Lamphun; A. Mae Wang, Chiang Mai; A. Samoeng, Chaing Mai. Field study included depth interview and questionnaire related cultivation were implemented .

A questionnaire was developed to use as a tool to gather the information from the farmer in the four selected area .The principle of supply chain operations reference :SCOR model is used as a guide to develop the content of the questionnaire .The gathering information included the farmer's activities in planning, preparation, production, delivery and repatriation .Production cost, logistics cost and total cost were investigated as well. Following was some examples of questionnaire's contents .

Operation cost: details and expenses

1 .Cost of production

-Fixed cost -rent, agricultural equipment depreciation cost

- Variable costs - materials and tools using in plantation process, wage and other expenses such as electricity, tap water phone bills and agricultural tools repairing cost, etc.

2 .Logistics costs

-Transportation cost -cost of transportation equipment

-Insurance fee for transportation equipment

-Interests from purchase the equipment

-Cost of equipment maintenance
-Cost of import transportation
-Cost of export transportation
-Cost of reverse transportation
-Cost of wage for transportation
-Costs related to keeping product -cost of keeping space
-Cost of inventory services
-Cost of risks of inventory
-Cost of wage to keep and take care of inventory

3 .Total Costs -total cost of production and logistics

Farmer, middle man and company survey

Farmer

- 10 Garlic agriculturists, Pai district, Mae Hong Son province, 10 Garlic agriculturists, Lee district, Lamphun province, 10 Garlic agriculturists, Mae Wang district, Chiang Mai province, 10 Garlic agriculturists, Sa Moeang district, Chiang Mai province

Middleman

- 2 middlemen, Pai district, Mae Hong Son province, 2 middlemen, Lee district, Lamphun province, 2 middlemen, Mae Wang district, Chiang Mai province, 2 middlemen, Sa Moeang district, Chiang Mai province

Company's representative

- 1 representative from transportation company, Pai district, Mae Hong Son province, 1 representative from transportation company, Lee district, Lamphun province, 1 representative from transportation company, Mae Wang district, Chiang Mai province, 1 representative from transportation company, Sa Moeang district, Chiang Mai province

Research result

Structure of garlic supply chain

1. When start at farmer, we found the connection to various levels of the chain .Farmer played the role since plant, maintain, harvest, keep and sell .There were two methods of selling .1 .Contact farming : the farmer made the sell contract with the local middle man before the plantation or sometime between plantation time . Most of it, between the plantation time because the local middle man could monitor and predict both the quantity and quality of the product then evaluation for price . After the harvest, the local middle man came to take the product at the field .2 The selling after the harvest, after harvest the farmer sold directly to the middle man if it was the best price .If not, the farmer kept the garlic for another 2-3 days by hanging drying then sold out if the price matched .To sell out this way, the product would be mixed quality .However, if the price still could not be accepted the farmer which did not have financial problem would hold the product for a while until the price increased .
2. the local middle man collected the garlic from the farmer then hanging drying and keep in the inventory and sold out if the price was acceptable .
3. Merchant bought the fresh garlic from farmer or local middle man then hung drying in their inventory .They would split sold lot by lot after the garlic were decorated by root cut and grading and mixed in many forms such as binding as a bundle, cut each seed, separated to split-seed . The different style of product will be delivered to whole sale market which the biggest one was in Bangkok .Then the product would be sent to the other parts of the country .
4. Retailer in Bangkok and any other parts of the country separated the garlic bundle then re-packaging and sold to the consumer.
    a. Food factories bought the garlic from retailer .The price was considered from the quality of the garlic at the trading time.
    b. Supermarket received garlic from retailer and sold to the customer by re-packaging.

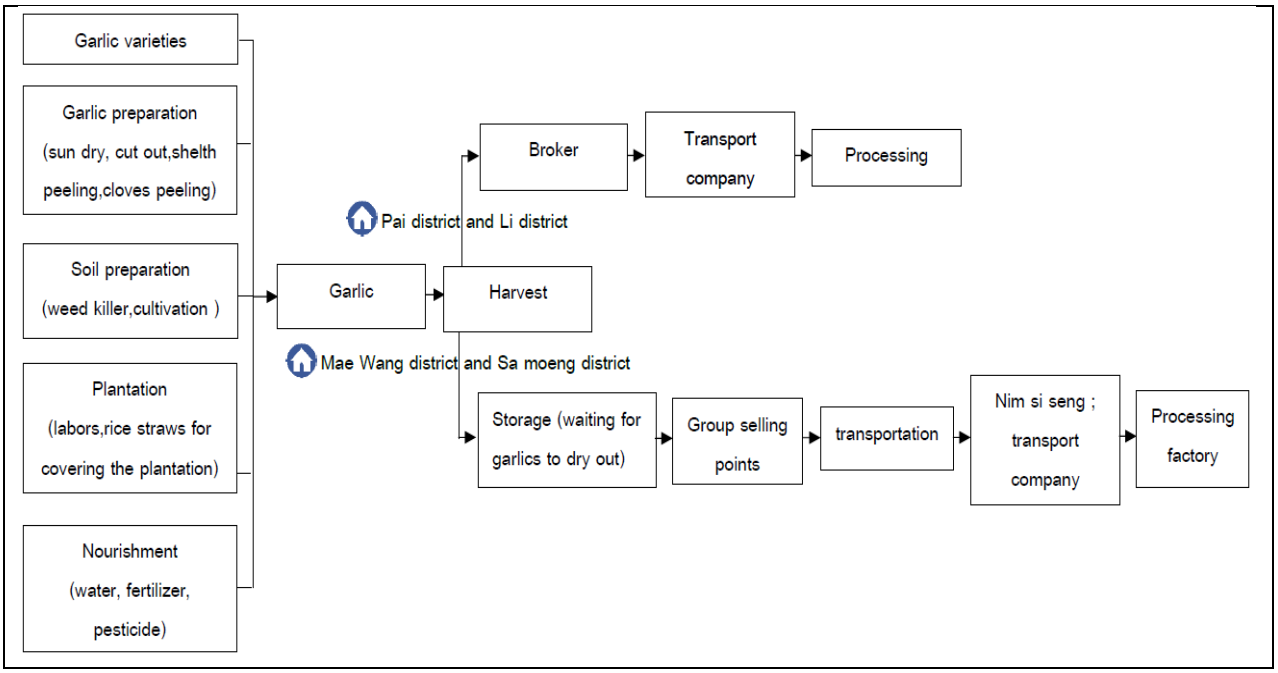

Figure 1 .Supply Chain Structure

Supply chain of the survey areas

The study found that the overall of fresh garlic supply chain in the survey areas were quite similar .Only a small different could divided the structure in to two groups as in figure 1 .

The first group was farmer in Pai and Li .These two places sold their product to the middle man)broker .(After harvest, the product was delivered by the transportation company by the expense of the middle man.

The second group was farmer in Mae Wang and Sa Moeang .Their activities were similar .After harvest, garlic would be hung drying first .After that, the representative of the group would take all product to the transportation company and delivered to the factory .This side, the delivery cost was paid by the factory .

Supply chain cost in the survey area

It was found from the interview with the farmer as following;

Farmers from Pai, Li, Mae Wag and Samoeng had experienced from garlic plantation in the average of 25 years, 11 years, 10 years and 7 years, respectively .Most of the farmers had their own field but rent some more field from their cousin or neighbors .Farmers in Pai, Samoeng, Li, and Mae Wang had the average of plantation field as 10.4 rai, 4 rai, 3.5rai and 1.5 rai, respectively .The garlic are well growth in sandy loam .Farmer in Pai used their local breed 70 %as 100-120 kilograms per rai .All farmers use organic fertilizers such as bat dung, cow dung, but they put these fertilizers at only the beginning of the plant process .The garlic could be harvested at the age of 100-120 days .The experienced farmer could make fresh garlic as 2,000-5,000 kilograms per rai .the average costs of farmers in Pai district, Li district, Mae Wang district, Samoeng district are as follows; 23,848, 28,133, 26,092, and 27,106 baht per rai respectively, These equal to 7.95, 9.38, 15.65, 12.55 baht per kilogram respectively.

Table 1 .Yields and average cost

	A.Pai	A.Li	A.Mae Wang	A.Samoeng
Average cost(Baht/rai)	23,848	28,133	26,092	27,106
Average yield (Kg / rai)	3,000	3,000	1,667	2,160
Cost (Baht/ Kg)	7.95	9.38	15.65	12.55

Table 2. The production and logistics cost

Production and Logistics Cost (Baht/ Kg)		A.Pai	A.Li	A.Mae Wang	A.Samoeng
Production Cost	Fixed cost	0.2	0.5	0.5	0.4
	Variable cost	7.5	8.43	15.05	11.95
Total		7.7	8.93	15.55	12.35
Logistics Cost		0.25	0.45	0.1	0.2
Total Costs		7.95	9.38	15.65	12.55

Acknowledgement

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IMPROVEMENT OF DOORFRAME PRODUCTION PROCESS IN WOOD FACTORY USING LEAN TECHNIQUE

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Introduction

In the manufacturing industry, competition is high in terms of price, quality, product delivery time, and customer satisfaction. It is necessary to improve the performance and to reduce waste in the process. Lean techniques are important techniques that are used to improve processes to increase productivity in small, medium and large industries, to reduce waste, to respond customer requirements and to increase competitiveness advantage. This research studied the working production process in wood factory. Main products are doorframes divided into standard and customized according to customers' orders. The demand for standard doorframes is 66.46%. There are 7 sizes of all sizes all in the same length but with different widths. The highest demand for standard doorframes is 0.80 x 2.00 meters. The demand for standard doorframes are an average of 3,018 pieces per month, with an average of 116 pieces per day from 16 employees. But they can produce only 80 pieces per day. When the demand for a product exceeds the capacity of the process. Therefore, employees need to work overtime. Including hiring more workers. The cost of labor increased. In the year 2018, this plant was planned to increase production to accommodate the increasing demand of customers. If the production process does not meet the needs of the customer. The production will need to recruit more staff or more machines. As a result, the cost of production increased. In the process of manufacturing labor from people with machines. There are no clear operational steps within the production process and time limits for production. It is not defined as a large industry. There are delays in the production process. The production line is not balanced. Each stage of the survey found that the unemployment of people and machines did not work. Affect the delivery of the product to delay the customer. The objectives of this study are to reduce the time and unnecessary steps, to balance the production line in the production process and to reduce the problem of delayed delivery which identifies the actual process improvement using lean technique.

Literature Review

This independent study concepts, theories, and research related to improving the efficiency and effectiveness of business processes. Variety of types and sizes, which brings a variety of tools are also applied such as Lean Techniques.

Analysis of waste in the process.

In the production process, there is often a hidden waste, which is the efficiency and effectiveness of the process is lower than it should be. Therefore, it is necessary to constantly explore and analyse the process so as not to overlook the waste that occurs. This is an important first step in seeing the current state of the process so that visibility and identification of wastes can lead to many ways to eliminate or reduce these losses. (Oliveira, et al., 2017), analysed the current status of the overall the production process with value stream mapping (VSM) to detect several wastes and to appropriately select lean tools for improvement. This VSM showed a high level of stock and several workplaces which may have emerged because there are a large number of unplanned breakdowns due to malfunctions, which could be reduced through the implementation of the total productive maintenance. (Coffey Jr., et al., 2018), used process maps to identify outpatient pre-operative holding area processes before and after implementation of lean interventions. Waste and root causes were categorized and workgroups

were created using the 5 Why's, and future state design, to redesign the existing workflow for first cases of the day. (Sutari, 2015), Production did not meet customer specification that rework defect. The 7QC Tools include the Pareto Chart to identify defects that need to be addressed. Then analyse the cause of the defect with the Ishikawa Diagrams. And the tools to improve the production time and reduce the loss of repetition, resulting in inadequate product value. Kaizen is primarily used to help reduce repetitive problems. Reduce work time. Reduce waste due to non-compliance with customer requirements. This results in improved production processes in terms of time. Including cost effective production.

So, the researcher studied the process of doorframe producing then used VSM, flow process chart and flow diagrams to analyse the current waste in the factory case study. This is used as a guideline to select lean tools and methods to eliminate wastes appropriately to increase productivity in the process.

Using of lean techniques in industrial plants.

Lean technique is a systematic process improvement tool by identifying and eliminating the waste. It has been used extensively in various businesses to increase the ability to produce quality products and more effective. (Lam, et al., 2016), used the line balancing tool to reduce imbalances workers and workloads and to solve bottleneck problems on production lines using Takt time vs. work cycle times of each assembly station. The line balancing analyses the ability to respond to customer needs of each station. The electronic assembly line can meet the needs of customers. But, there are also losses due to the unemployment of employees. ECRS has been used to combine work stations from 4 to 3 as a result, the ratio of balance and efficiency increase the balance. (Antosz & Stadnicka, 2017), showed that small and medium enterprises (SMEs) in Poland are keen on adopting lean manufacturing philosophy to use in the organization in order to improve the operation, 81% of them are aware of the need to eliminate waste. The major wastes were waiting for materials, 49% of unnecessary movements, 41% of damaged goods and 39% of damaged machines, which also increased the competitiveness. Lean companies use the basic principles of 5s. (Garrea, et al., 2016), the improvement of the productivity about the pressure vessel manufacturing unit which reduced the motions and waits and also provided a better working environment. They remove the scrap and other unnecessary raw materials. An additional worker was employed at the full welding station to perform the pre-weld jobs. The re-layout reduced the transport time and promoted the continuous flow. The generalized fixture was replaced by a modular fixture which reduced the time spent on indexing and clamping. Work standards were defined to improve the efficiency of the manufacturing process by creating a standard operating procedure. All these implementations led to the increase in productivity of full welding process and child parts assembly station and also decreased its total operating cycle time. (Nguyen & Do, 2016), applied lean techniques in reengineering an electronics assembly line. Reengineering focuses on some aspects such as reducing wastes, standardizing works, internal logistics, workplace designing and changing layout. After improvement in throughput time from 7.5 days from 3 days for the same order. The number of operators decrease 40%. Average cycle time decreases 40% and saves 30% space.

In doorframe production process is a person's work with the machine. It consists of several steps. When seeing the process that produces waste, there is no need for production. The researcher will eliminate or consider what steps can be combined without increasing the workload for people and machines and the sequence of production steps to reduce unnecessary movement, production is faster. And improve the work easier and more convenient to reduce the time and process of production more efficiently.

Using of lean techniques in wood and furniture factory.

(Sujováa & Marcinekováb, 2015), said that in view of business processes the fierce competition in the timber and furniture market in Slovakia. In addition to the quality of the product. Also consider the quality and efficiency of internal business processes. Focus on improving production processes to add value to products and organizations. By exploring different wood processing plants that management tools have been adopted to the organization to promote business processes in terms of optimization. Increase productivity and quality, reduce hidden costs in the process. Most of the wood processing plants in Slovakia are small with 11-20 employees. Produce a few times. It does not give importance to

improving internal processes. Lean management, TPM, and Kaizen have resulted in a number of operational wastes. But Zimbabwe's furniture factories have adopted lean techniques to improve the production of wooden beds for export. (Nyembaa & Mohawk, 2017), started from a work study to explore non-value-added activities, the plant layout is complex. The process was analysed by process chart and flow diagrams this plant layout is complex. There are the cross flow of process routes and old machinery often results in product quality and delays in fulfilling customer orders. As well as the location of the machine is exposed to dust, resulting in some lost products. The spray station is also located near other work stations which are not properly controlled. Affect the safety of work. Lean techniques have been used to improve the distance between stations that need to interact. Reduce waste from transportation and improve production time efficiently. A furniture manufacturing company in Southern Brazil (Guimarães, et al., 2015), improved both ergonomic and production outcomes by a cellular teamwork model. Work enlargement and enrichment, and the improvements in workstation design and process flow increased worker satisfaction and reduced postural risk, fatigue, body pain and production waste. Workload was reduced by 42% and productivity increased by 46%.

This research will observe the positioning of work stations or machines in accordance with the production plan. Starting from the survey, the station alignment of the factory is currently in line with the workflow which high frequencies of interaction are nearby or combine work stations by a cellular teamwork model to improve ergonomic and reduce transportation distances, which reduce waste from non-value-added activities for improvement production time efficiently.

Research Methodology

The research focused on the improvement of doorframe production process and product delivery. Researchers have made a framework for research approach that it is divided into 4 steps to the following steps as show in

Study Production process and related research

Study process and current problems by studying the method and collecting data from the actual location. Then write and analyse the process as a whole, using the current stream of values that provides an overview of the process from a customer perspective. This makes it possible to identify the activities needed to eliminate waste. Study papers and theories related to process improvement include 7 wastes, Lean, and Line Balancing.

Analysis of current production process

The flow process chart of doorframe production process is drawn to realize as-is process. The value added (VA), non-value added (NVA) and necessary but non-value added (NNVA) activities could be identified from this stage. The flow diagram shows the flow direction and the distance of production from the first stage to the final stage of process. And analysis balance of production lines was calculated from productivity per day Eq (1), Line Balance Ratio from Eq (2), Target manpower from Eq (3) and Line Balance Efficiency from Eq (4), as in:

Productivity per day	= OT / CT	(1)
Line Balance Ratio	= Tw/ N* CT	(2)
Target manpower	= Tw / TT	(3)
Line Balance Efficiency	= Tw/ Target manpower*TT	(4)

Where those variables are defined as follows:

OT = production time per day
CT = the most time-consuming workstation.
Tw = total time of workstations
N = total number of workstations
TT = Takt time

Data collection on process & product delivery

Collects information about current work processes, manpower, machinery used, transport distance between work stations position and placement of machines or stations. Transport time, components, and waiting time between work stations.

Improve production process & product delivery

The improvement started with the use of the ECRS principles to eliminate NVA and NNVA activities that occurred in each of the investigated work steps. Then use the line balancing tool to minimize imbalance between workloads in order to achieve required the continuous flow under the conditions of customer requirements. And use the fishbone diagram identifies many possible causes for an effect or problem about delayed delivery of products using brainstorming. Interviews with relevant staff. Results are analysed by comparing number of processes, times, line balance efficiency and problem of delayed delivery before and after improvement.

Results

Analysis of current production process

1. The doorframe production process was studied using VSM by examining the working process. The primary data was collected to draw the overview of doorframe production process in current state VSM. It consisted of 11 workstations which the lead time at 1378.68 sec. NVA activities were found waiting work in process until 100 pieces before to be taken out from planing and grooving, NNVA activities were found transport and inspection. VA activities were found, which equivalent to 72.60 % of the total time as in Figure 1.

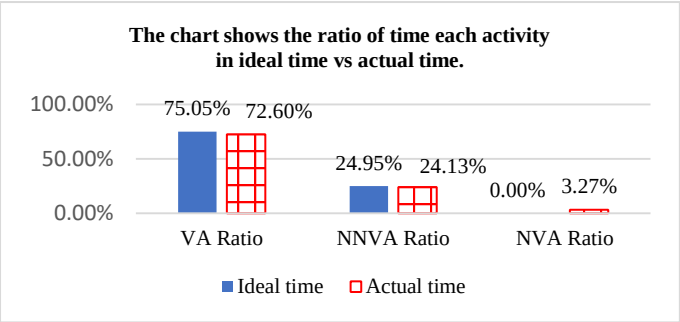

Figure 1: The chart shows the ratio of time each activity in ideal time vs actual time

2. After the current state VSM was sketched, overall doorframe production processes are more comprehensible. The wastes can be detected from each stage. The flow process chart identified 12 VA were carried out, 2 NVA and 4 NNVA.
3. Flow diagram from the planing stage to the assembly stage showing the distance to move from the planing station to the cutting station is 12 meters, and from the grooving station to the punching station is 7.80 meters. As a result, transportations take a long time.
4. Problem Delivery to the Customer, the factory and the researcher collect the product delivery information. As shown in Table 1.

Month 2017-2018	**The ratio of deliveries**	
	On time	***Delay***
October	38.52%	61.48%
November	23.29%	76.71%
December	37.76%	62.24%
January	31.98%	68.02%
February	29.04%	70.96%

Average	32.12%	67.88%

Table 1: The problem of product delivery

The average delivery delay of 67.88% reflects the problems of production processes that cannot respond to customer requirements. Therefore, use a fishbone diagram to identify several possible causes for delayed delivery results or problems. There are 3 main reasons:
a) The wastes in the production process.
b) No ongoing order tracking.
c) Lack of continuous communication and information sharing among departments

Improve production process & product delivery

1. Improvement processes using of ECRS principles

- Reduce the number of work in process before moving from planing B station and grooving B station. Can reduce the waiting time before removing from the work station. It also makes transportation easy and shorter time.
- Combination of work stations: planing A and planing B. Reduce time down to 32.25 seconds or equivalent to 13.52% show in Fig 2.

Figure 2: Planning station after improvement

- Integrate operation and inspection together in grooving A station. Reduce time down to 5.23 seconds or equivalent to 8.35% show in Fig 3.

Figure 3: Grooving A station after improvement

- Making jig for perforating station. Reduce time down to 13.25 seconds or equivalent to 18.07% show in Fig 4.

Figure 4: Perforating station after improvement

- Prepare equipment and assembly to be available. Reduce time down to 35.29 seconds or equivalent to 12.96% show in Fig 5.

Figure 5: Assembly station after improvement

From the results of the improvement of doorframe production process, the size of 0.80 x 2.00 meters can be reduced unnecessarily stage as shown in Figure 6.

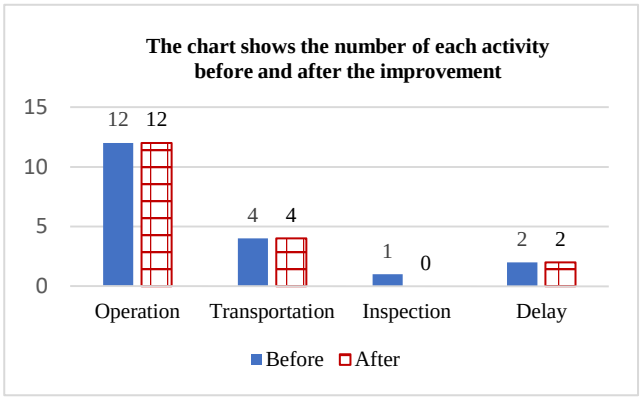

Figure 6: The chart shows the number of each activity.

Can reduce 1 inspection but transportation and delay cannot be reduced due to the obstacles in the process layout. Show the time changes for each activity from Figure 7.

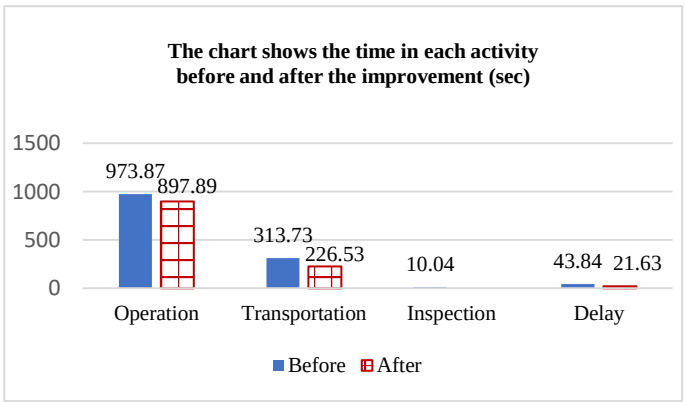

Figure 7: The chart shows the time in each activity.

The time in each activity after improvement was reduced, which corresponds to the ratio of time in each activity is based lean technique, as reflected in Figure 8.

The VA ratio is higher. This is consistent with the NNVA and the NVA have a reduced ratio because Integrate operation and inspection together in grooving A station and reduce the number of work in process before moving, making transportation easy and shorter time.

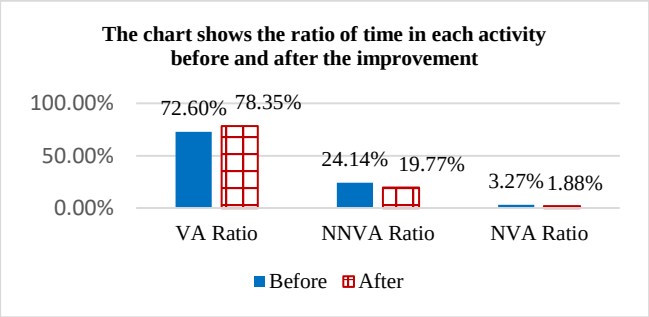

Figure 8: The chart shows the ratio of time each activity is based on lean technique.

2. Combine workstations using the line balancing.

Before the improvement, there are 11 workstations. Each workstation has a different production time which the balance ratio of the production line is 32.52% and line balance efficiency is 37.35%. Thus, combine workstations are 4 major workstations under customer requirements, include: planing, cutting, perforating and assembly. As show in Figure 9.

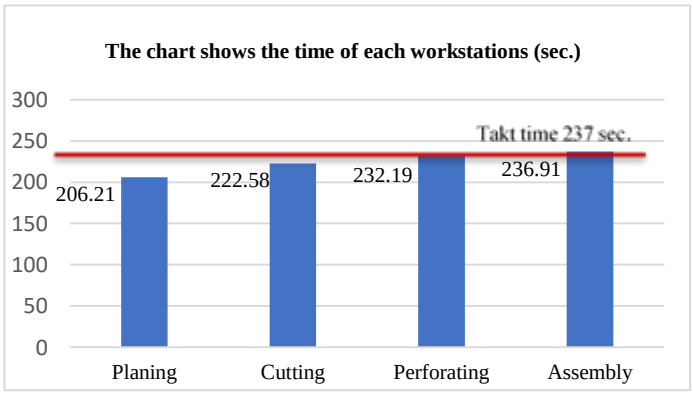

Figure 9: The chart shows the ratio of time each activity is based on lean technique.

3. Improvement of product delivery to customers.

From the fishbone diagram to the cause analysis. Lead to the following improvements.

- Improve the production process. As mentioned in section Improvement of production process.
- Increased tracking of order status on both the real and the system.
- Inter-departmental meetings “Delayed Delivery” to share information between each other. It shows the current production status regularly.

The delayed product delivery was 54.34%, as show in Figure 10.

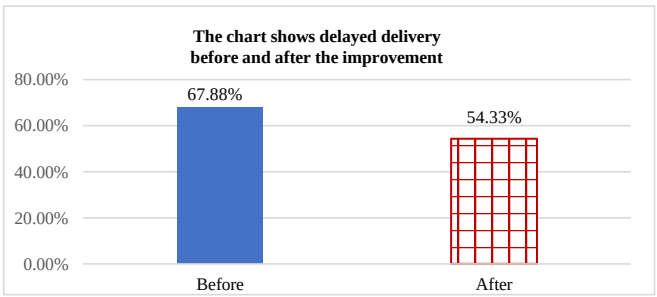

Figure 10: The chart shows the ratio of the delayed delivery.

Improvements from both production and delivery resulted in a 13.55% drop in deliveries.

Conclusion

This study investigates the doorframe production process. Lean techniques were used to reduce the waste which occurred in the production process.

Reduce unnecessary stage and time.

Using the ECRS principle to improve the sub-processes that have hidden wastes in the process, it is possible to reduce the production cycle time from 1,341.48 seconds per piece to 1,146.05 seconds per piece, or 14.57% of the total production cycle time. The three types of lean techniques can be classified as follows:

- NNVA, this reduces the inspection and reducing the number of work in process Reduce the number of work in process before moving from planing stage and grooving B stage from 100 to 50 pieces. The duration of the activity was reduced from 323.77 seconds per piece to 226.53 seconds per piece, which was reduced to 30.03% of necessary but non-value-added activities.
- NVA, reducing the number of work in process Reduce the number of work in process before moving from planing stage and grooving B stage from 100 to 50 pieces that reduced the waiting time from 43.48 seconds per piece to 21.63 seconds per piece down to 50.25% of non-value-added activities.
- VA, apply ECRS principles to eliminate latent wastes in the work process, such as planning A and planning B, grooving A, perforating and assembly. As mentioned above. The duration of the activity was reduced from 973.87 seconds per piece to 897.89 seconds per piece, which decreased to 7.80% of value-added activities.

Improvement of doorframe production process using ECRS can be summarized in Table 2.

Description	Before (sec)	After (sec)	Decrease (sec)	Percentage Reduction (%)
- VA	973.83	897.89	75.94	7.80%
- NVA	43.48	21.63	21.85	50.25%
- NNVA	323.77	226.53	97.24	30.03%
- Cycle Time	1,341.48	1,146.05	195.43	14.57%

Table 2: Value analysis of doorframe production process before and after improvement

Balance of production line.

Combine workstations from the 11 workstations to 4 major workstations under customer requirements, include: planing, cutting, perforating and assembly. Every work station can achieve required the continuous flow under the conditions of customer requirements. The balance ratio of the production line increased by 62.23% and line balance efficiency increased by 57.40%.

Reduce delays in delivery of products.

Improvements in production and delivery can reduce delays in delivery of products by 13.55%.

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LEVEL OF INFORMATION TECHNOLOGY USAGE IN MANAGING LOGISTICS AND SUPPLY CHAIN OF THAI INDUSTRY

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Introduction

Thailand is an industrialized, developing economy. As the world's 21th strongest economy with GDP of 437.8 USD billion, Thailand is now trying to overcome the middle-income trap. Thailand is positioning toward a value-added economy, following the national policy of Thailand 4.0, with key agendas of creativity, innovation and digitalization. Of interest of this paper is the information and Information Technology (IT) usage in managing logistics and supply chain of Thai industry. Bywhich are the critical keys of these transformation [1,2].

It shall be highlighted at first that the level of Information Technology (IT) usage in managing logistics and supply chain of Thai industry is still questionable. Whilst each industry shall require different objectives of logistics and supply chain management, e.g., cost, responsiveness, agility, level of IT usage can be varied. In addition, as many as 96% of Thai enterprise are small and medium (SMEs), their investment can be low, and the level of technology sophistication and IT usage can be such conditional [3]. However, without data, information and IT, it is so difficult to create anything. Therefore, it can be a big obstacle for any industry if their level of IT usage is limited [4, 5].

In overview, Thailand logistics system is debatably improving [6]. Thailand's logistics performance dropped from 35th rank in 2014 to 45th rank in 2016 out of 160 countries based on World Bank LPI report [7]. In terms of IT, Thailand is ranked low at 78 out of 176 countries on ITU's ICT Development Index (IDI) 2017 [8]. Thailand is also ranked 62 out of 139 countries on the World Economic Forum's (WEF's) Networked Readiness Index (NRI) 2016 [9]. These are only some reflections to the logistics of Thai industry and their IT ecosystem.

The paper is therefore exploring the level of IT usage of Thai industries, based on database of Logistics/ Supply Chain Scorecard (LSC) by Ministry of Industry.

Survey on Logistics Potential of Thai Industry

Ministry of Industry of Thailand by Division of Logistics is the main responsible for industrial logistics improvement of Thai industry. For years, thousands of industries in Thailand have been supported to increase their capability and competitiveness [10]. The survey on logistics potential of Thai industry was also a highlight project aims at exploring and understanding the logistics potential of Thai industry. The survey uses Logistics/ Supply Chain Scorecard (LSC) as an assessment tool to identify the potential of the participating company.

Logistics/ Supply Chain Scorecard (LSC)

LSC is a self-assessment tool for industry to review their logistics potential. LSC allows participated company to compare their logistics potential against the peers in the database collection. The scorecard is based on original work by Tokyo Institute of Technology in collaboration with the Japan Institute of Logistics System (JILS) [11, 12] and further developed by Ministry of Industry of Thailand in order to assess and support Thai industry [13].

LSC is constructed of 5 areas and 23 items. Each item was defined and each five level for the assessment is described to quantify the potential of interest. This is to reduce the biasness of the assessor. In general, the 5th level (score 5) indicates as the best practice. On the other hand, the 1st level (score 1) indicates the least preferable practice in terms of logistics and supply chain management.

5 areas of LSC includes (Area 1) Corporate strategy and inter-organization alignment, (Area 2) Planning and execution capability, (Area 3) Logistics performance, (Area 4) IT methods and implementation and (Area 5) External collaboration. This paper focuses on Area 4 which encompasses 3 items, i.e., (1) data interchange coverage, (2) open standards and unique identification codes and (3) logistics and supply chain IT capacity building.

Whereas these items are identified, and their level is defined as shown in Tables 1-3.

Table 1: Description of Index: Item 1 Data interchange coverage

Level 1	Company is not electronically linked to any customer or supplier.
Level 2	EDI links are set up with some customers or suppliers at their request.
Level 3	EDI is used with over 50% of customers or suppliers. Proprietary EDI standards are used in most cases.
Level 4	In addition to Level 3, EDI is integrated with the company's internal systems so that manual re-entry of data is not necessary in most cases.
Level 5	EDI is used for nearly all transactions and is integrated with internal systems. Open standards for EDI are adopted or in-process of adoption.

Table 2: Description of Index: Item 2 Open standards and unique identification codes

Level 1	Company has no awareness of open standards and unique identification codes.
Level 2	Company understands the importance of open standards and unique identification codes for improving the efficiency of logistics processes.
Level 3	To exploit the potential of IT, unique identification codes are used within the company and process simplification is also carried out.
Level 4	In addition to Level 3, usage of unique identifiers is extended to suppliers and/or customers. Open standards for EDI and other IT applications are adopted or under consideration.
Level 5	In addition to Level 4, unique identification codes are extended to both suppliers and customers. Company is actively working towards adoption of open standards for EDI and other IT applications

Table 3: Description of Index: Item 3 Logistics and supply chain IT capacity building

Level 1	Company has no awareness of logistics and supply chain IT capacity building
Level 2	Company understands the importance of logistics and supply chain IT capacity building
Level 3	In addition to Level 2, there are human resource management plan, such as training
Level 4	In addition to Level 3, the activities are delivered as plan partially
Level 5	In addition to Level 4, the activities are delivered as plan. The plan is evaluated continuously.

Database of LSC

In 2017, 100 companies in Thailand have been participated in the logistics potential survey project. Only 9 ISIC [14] have greater than 5 samples and therefore are used in this consideration. There are ISIC 10 Manufacture of food products, ISIC 15 Manufacture of leather and related products, ISIC 20 Manufacture of chemicals and chemical products, ISIC 21 Manufacture of pharmaceuticals, medicinal chemical and botanical products, ISIC 22 Manufacture of rubber and plastics products, ISIC 25 Manufacture of fabricated metal products, except machinery and equipment, ISIC 27 Manufacture of electrical equipment, ISIC 28 Manufacture of machinery and equipment n.e.c. and ISIC 29 Manufacture of motor vehicles, trailers and semi-trailer.

It shall be highlighted here that the database is small. Therefore, the discussion in this paper will not be statistically conclusive. It is only the preliminary reflection of the findings.

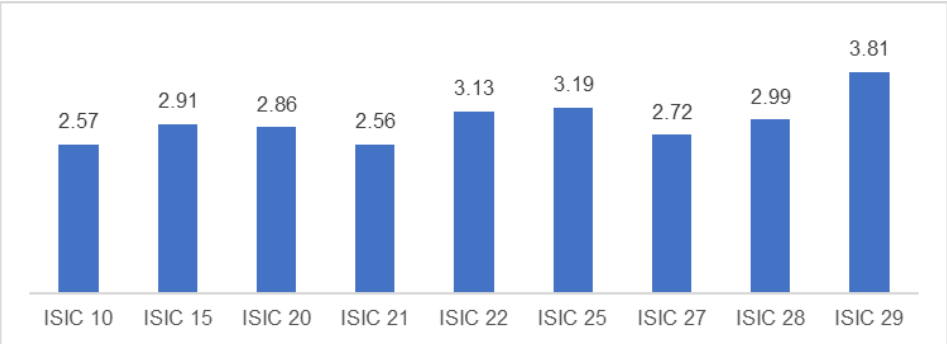

Figure 1: Average LSC Score of 9 ISIC

Before investigating the IT area, Figure 1 illustrates the overview logistics potential of all 9 industry types. It can be seen that ISIC29 is outstanding at the average score of 3.81. Whereas, ISIC

10 and 21 are, on the other hand, possessing as low score as 2.5x. This is only the observation prior to the IT usage investigation as follow.

Result Presentation

Focusing on Information Technology (IT) usage in managing logistics and supply chain of Thai industry, 3 items are of interest. The area comprises of (1) data interchange coverage, (2) open standards and unique identification codes and (3) logistics and supply chain IT capacity building.

Item 1 Data Interchage coverage

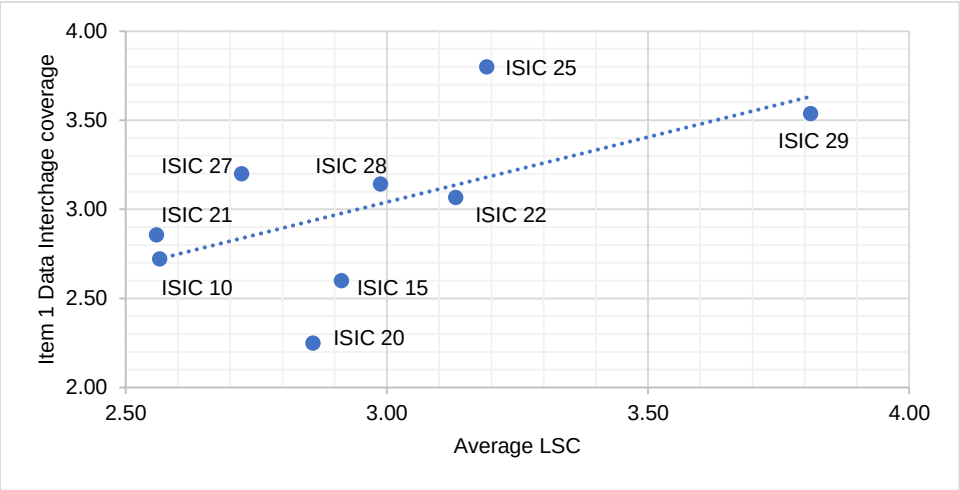

Figure 2: Item 1 Data Interchage coverage vs average LSC

Out of the assessment, ISIC 29 is the most advanced in term of data interchange coverage. ISIC 29 scores at 3.80 which means EDI is used and almost integrated within the company's internal systems. On the other hand, other ISIC mostly lies at levels 2-3. This means that EDI are implemented within their supply chains. Yet, it is partially used in most cases.

Anyhow, it is not fair to directly compare each ISIC by its absolute score as each ISIC possesses their poteltial differently as seen and discussed in Figure 1. Therefore, in order to reflect their logistics potential, here, the score in each item (items 1-3) is crossed with average LSC score. Linear (dot) line in Figure 2 represents average trend line of Item 1 versuses average LSC score.

Here, it can be seen that ISIC 21, 25, 27 and 28 are above trend line. ISIC 25 is at the most preferrable position. Whilst its LSC score suggest that its item 1 score of ISIC 25 shall lies at 3.2x, its score is up to 3.80. This is satisfiable. On the other hand, ISIC 15, 20, 22 and 29 are below its suggested score. ISIC 20 is somehow much below than what it should be. Moreover, data interchange coverage of ISIC 29, which is before discusses as the most advaced, is then questionable.

Item 2 Open standards and unique identification codes

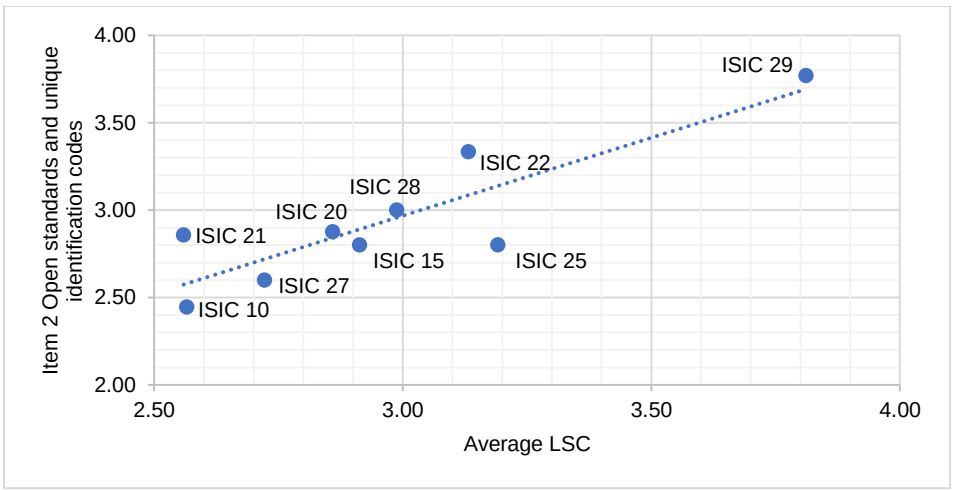

Figure 3: Item 2 Open standards and unique identification codes vs average LSC

From Figure 3, it is again suggestive that ISIC29 is the most advanced with the score of 3.77. It is indicated that most of ISIC29 companies uses unique identification code within the company and partially extended to its supply chains. However, it is somehow slightly above the average trend line. It is also the cases with ISIC 20 and 28 that are marginally above the trend line. ISIC 21 and 22 are somehow possessing better potential. ISIC 10, 15, 25 and 27 on the other hand are considerably lower than expectation, especially ISIC 25.

Item 3 Logistics and supply chain IT capacity building

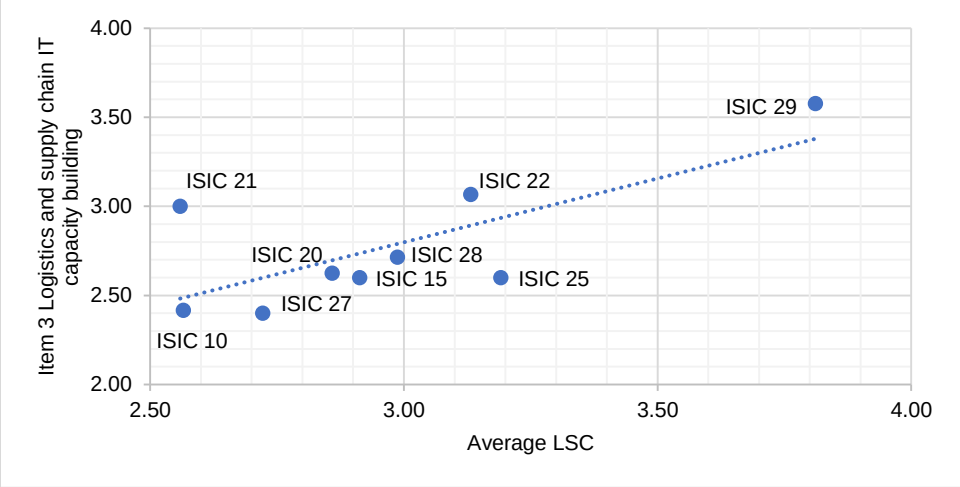

Figure 4: Item 3 Logistics and supply chain IT capacity building vs average LSC

In terms of logistics and supply chain IT capacity building (Item 3), ISIC 29 is again outperforming. Their IT personnel are developed through human resource management program and some activities are implemented as plan. However, the rest of the companies in other ISIC are below 3.50 bar. This means they do not pay much attention in IT capacity building as they should.

Figure 4 is suggestive that only ISIC 20, 21, 22 and 29 are above average. ISIC 21 is by far the most advanced in term of margin to the average trend line. It scores at 3.0 which is 0.5 higher than expectation. On the other hand, ISIC 10, 15, 20, 25, 27 and 28 are below what is expected.

Conclusion and Discussion

The paper focusing on potential of Thai industry based on 3 IT perspectives of Logistics/ Supply Chain Scorecard (LSC) database of Thai industry, i.e., (1) data interchange coverage, (2) open standards and unique identification codes and (3) logistics and supply chain IT capacity building. The data from LSC database is rather small. Therefore, the result is not conclusive, however suggestive in terms of basic understanding.

The investigation uses not only score from direct assessment on 3 items of interest but also crossing with the average LSC to reflect the potential if they are above or below what is expectation, indicated by the linear average line.

The result is suggestive that ISIC 29 Manufacture of motor vehicles, trailers and semi-trailer, which is generally the most advanced ISIC in terms of logistics potential, is somehow questionable in terms of data interchange coverage. ISIC 10 Manufacture of food products and 21 Manufacture of pharmaceuticals, medicinal chemical and botanical products, which are the two lowest potential industries in LSC, are somehow not as bad. For example, ISIC 21 possesses better potential in terms of open standard and unique identification codes and logistics and supply chain IT capacity building.

Many points are also suggestive from the investigation. For example, ISIC 22 Manufacture of rubber and plastics products is also better than expectation in terms of open standard and unique identification codes and logistics and supply chain IT capacity building. ISIC 15 Manufacture of leather and related products and ISIC 20 Manufacture of chemicals and chemical products have room of improvement in data interchange coverage. ISIC 25 Manufacture of fabricated metal products, except machinery and equipment is satisfiable in data interchange coverage but need improvement in open standards and unique identification codes.

The information here is suggestive for the policy makers as well as the industries themselves if any measurement must be delivered to improve logistics potential of Thai industry as a whole or to any company in specific.

Acknowledgement

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LOGISTICS SITUATION IN MYANMAR

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Background

The Republic of the Union of Myanmar, commonly called Myanmar, is a country in South-East Asia formerly known as Burma (BBC, 2007). The country has a population of a little over 55 million (World Factbook, 2018), which is expected to grow to at least 57.8 million (Karasawa, 2018) or even 73.9 million by 2030 (Shibata, 2014). Myanmar is bordering India, Bangladesh, Thailand, Laos and China. It started transitioning from a military government to democracy in 2011 and has seen sanctions by the US and other countries lifted in 2016 (World Factbook, 2018). The lifting of sanctions has allowed foreign companies to engage in business with Myanma companies and also to invest in the country (figure 1). This led to economic growth (figure 2), and growth in turn leads to an increase in cargo movements and logistics requirements.

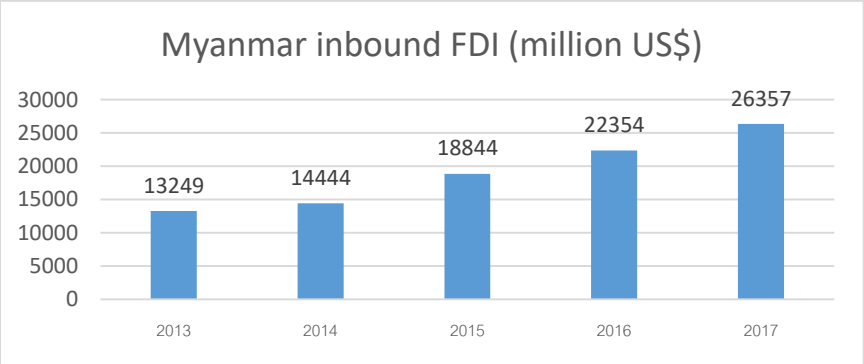

Figure 1: Myanmar Inbound FDI
Source: Adapted from DICA (2018a)

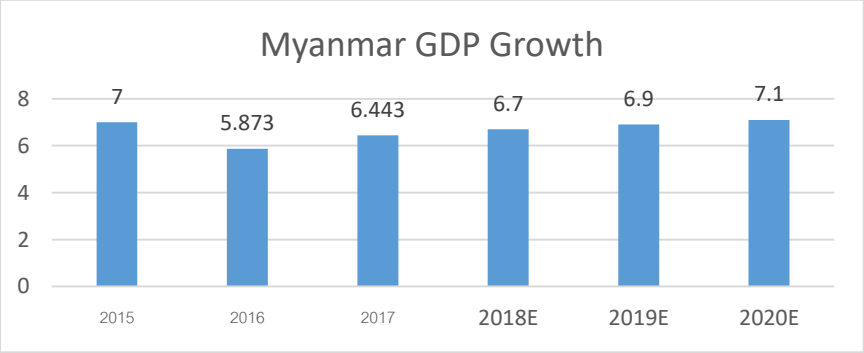

Figure 2: Myanmar GDP Growth
Source: Adapted from World Bank (2018a)

Myanmar is classified as a Least Developed Country (LDC) by the UN (2018). It has a Logistics Performance Index (LPI) of 2.3 and ranks 137 of 160 in the world (World Bank, 2018b). The logistics requirements on the country are increasing due to the rapid growth, but doubts may arise from the low LPI for any company considering to invest in the country.

Logistics requirements in Myanmar are expected to grow by 9.3% on average per year up to 2030, resulting in a total growth of 3.8 times in the period from 2015 to 2030, according to the National Logistics Master Plan (table 1). The main growth is expected in air transport (11.3%), followed by rail transport (10.5%). This will make the possible investor ask whether his logistics needs can be met.

Myanmar has a National Transport Master Plan (MYT) and National Logistics Master Plan (MYL) in place (Karasawa, 2018; Hytike, 2017). The MYT proposes investment of 29,271 billion Kyat, and the MYL for 24,909 billion Kyat (US$ 18,207 million) until 2030 (Karasawa, 2018).

This paper aims to provide a snapshot of the current situation by each mode of transport as well as customs and the introduction of Special Economic Zones. Furthermore, some planned improvements are highlighted to facilitate decision making.

Demand Forecast of Logistics Corridor with Transport Mode

Logistics Corridor	Major Link/terminal	Year	Total	Road	Railway	Port (Local)	IWT	Air
Myanmar-India Corridor	Tamu-Mandalay	2015	3,800	500			3,300	
		2030	12,400	4,400			8,000	
North-South Corridor	Yangon-Bago	2015	19,900	14,100	5,800			
		2030	80,500	53,200	27,300			
	Bago-Mandalay	2015	12,900	8,400	4,500			
		2030	55,300	37,000	18,300			
Main River Corridor	Yangon-Mandalay	2015	7,700				7,700	
		2030	19,600				19,600	
Trans Myanmar Corridor	Kyauphyu-Magway	2015	7,000	7,000				
		2030	10,800	10,800				
	Magway-Mon Lah	2015	2,400	2,400				
		2030	4,100	4,100				
South-East Corridor	Bago-Mawlamyaing	2015	13,800	10,300	3,500			
		2030	67,300	58,000	9,300			
	Mawlamyaing-Myawaddy	2015	8,500	8,500				
		2030	21,000	21,000				
	Mawlamyaing-Thanbyuzayat	2015	4,900	2,800	2,100			
		2030	37,100	21,100	16,000			
	Thanbyuzayat-Dawei	2015	4,000	2,900	1,100			
		2030	18,100	13,000	5,100			
Coastal Marine Corridor	Sittwe-Yangon-Kawthaung	2015	4,200			4,200		
		2030	12,000			12,000		
Aviation	Total Air Cargo	2015	50					50
		2030	250					250
Total		2015	89,150	56,900	17,000	4,200	11,000	50
		2030	338,450	222,600	76,000	12,000	27,600	250
	Change in Times	2030 / 2015	3.8	3.9	4.5	2.9	2.5	5.0
Change of Share by Transport Mode		2015	100%	63.8%	19.1%	4.7%	12.3%	0.1%
		2030	100%	65.8%	22.5%	3.5%	8.2%	0.1%
Average Annual Growth Rate		2015 / 2030	9.3%	9.5%	10.5%	7.2%	6.3%	11.3%

Table 1: Demand Forecast by transport mode
Source: Htike (2017)

Logistics Activities and Modes of Transport

The authors summarise the publications according to modes of transport, customs clearance and Special Economic Zones.

Customs

Myanmar is a member of ASEAN (ASEAN, n.d.). This means that, according to the ASEAN Trade in Goods Agreement (ATIGA), import of goods originating in other ASEAN countries is free of import duties for almost all goods (ASEAN, 2012). This facilitates international trade, which means that import and export customs clearances need to be smooth and efficient.

Myanmar implemented the Myanmar Automated Cargo Clearance Systems (MACCS) on 06 January 2017 (JICA, 2017). MACCS is a computer system for customs clearance and links into the National Single Window (NSW). In the NSW, all organisations involved in international cargo movements will be connected. As of 2016, 11 sea ports, 1 special economic zone and 1 airport are connected, with

the Food and Drug Administration, Animal Quarantine, Plant Quarantine, Fishery Department, Economic Bank, Ministry of Commerce, and Myanmar Port Authority to follow (ASEAN, 2016). The National Single Window is part of the ASEAN-wide ASEAN Single Window (ASW), to which the NSWs of all ASEAN member countries will be connected. This is to facilitate movements of goods among the ASEAN member countries**.**

Road Network

The Asian Development Bank (ADB) introduced the Economic Corridors in the Great Mekong Subregion (GMS) in 1998, which includes Myanmar. In the original plan, the Myanmar section of the East-West Economic Corridor (EWEC) would stretch from Myawaddy at the Thai-Myanmar border to Mawlamyine. However, the latest proposal issued in 2016 shows not only an extension to Yangon now included, but also a possible extension to the port city of Panthein (figure 3). This new proposal connects Yangon, the main commercial area of Myanmar, to the EWEC and hence improves the connectivity from there via Thailand and Laos to Danang in Vietnam.

Furthermore, Myanmar's main highway from Yangon via Nay Pyi Taw to Mandalay is now proposed to be fully included in the North-South Economic Corridor (NSEC) in order to improve connectivity from central Myanmar and not only the northern parts of the country to China via Mandalay and Lashio to the border town of Muse. Before this new proposal, there was a gap between Meiktila and Mandalay in the plan.

Figure 3: Proposed Realignment and/or Extension of the Greater Mekong Subregion Economic Corridors
Source: ADB (2016)

To refine the ADB's economic corridor approach, the Ministry of Transport and Communications plans 10 corridors in their National Master Plan (Htike, 2017). The main national growth corridor is the Central North-South Corridor along the Yangon – Nay Pyi Taw – Mandalay – Mitkyina axis, with the major regional growth corridors being the East-West Corridor (Dawei – Mawlamyine – Yangon), The Northern Corridor (Yunnan – Muse – Mandalay) and the Western North-South Corridor.

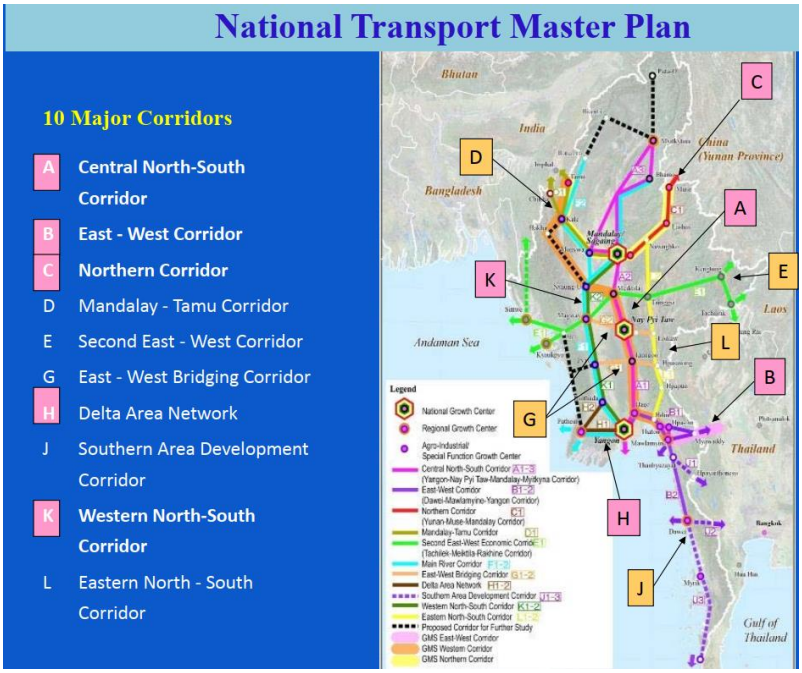

Figure 4: National Transport Master Plan
Source: Htike (2017)

Myanmar is also part of the ASEAN Highway Road Network, which connects ASEAN and other Asian countries (JICA, 2014). JICA proposes upgrades on several of these roads (figure 5).

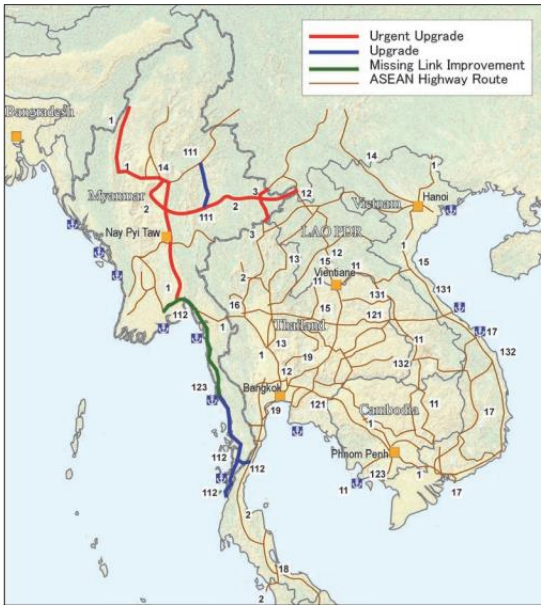

Figure 5: ASEAN Highway Road Network and proposed upgrades in Myanmar
Source: JICA (2014)

Rail Network

Myanmar has an extensive rail network which they claim to be the longest rail transport network in ASEAN, with 5,405.285 km single track and 705.196 km double track lines totalling 6,110.481 km over 12,103 bridges and through 12 tunnels, serving 960 stations, as of 2016 (Htike, 2017). The World Bank puts Myanmar's rail lines (total route-km) at 3,185 km and Thailand at 3,735 km (World Bank, 2018c), citing the International Union of Railways, of which Myanmar Railways is not a member. The World Factbook (2018) shows 5,031 km as of 2008 – at rank 39 indeed the highest-ranking ASEAN member, with Thailand listed as the second-largest rail network in ASEAN at rank 45 in the world with 4,127 km as of 2017.

Myanmar Railways is a state-owned company under the Ministry of Rail Transportation and the only rail operator in the country. It uses a meter gauge, which is the same gauge as in the other contiguous ASEAN countries. Neighbouring China uses the standard gauge and neighbouring Bangladesh using both the meter gauge and the broad gauge, according to the World Factbook (2018).

Myanmar Railways (former known as Burma Railways) was founded in 1877 by the British colonialists. Much of the track system is in need of upgrade, and 13 lines have been identified for modernisation (Thiha, 2018). The main author of this paper took a train from Mandalay to Yangon in 2016, a distance of 620.5 km (JICA, 2018), which should take 12 hours according to the schedule. It actually took 17 hours, resulting in an average speed of 36.5 km/h. This railway line should be upgraded within the year 2023 to accommodate train speeds of 100 km/h (ebd.), which will result in a reliable railways network.

Water Transport

Myanmar has international seaports, river ports along the two main rivers, and dry ports. This section will separate the literature accordingly.

Seafreight

According to Logistics Cluster (2018), the main ports of Myanmar can be found in 9 cities: Sittwe, Thandwe, Kyuak Phyu (Rakkhine State), Pathein (Ayeyarwaddy Division), Yangon (Yangon Division), Mawlamyine (Mon State), Dawei, Myeik and Kawthaung (Tanintharyi Division)., with Yangon being the main port (Htike, 2017). Yangon port is divided into two ports, the bigger being at Thilawa, 16 km outside of Yangon, with two main terminals, Myanmar International Terminal Thilawa (MITT) and Myanmar Integrated Port Limited (MIPL).

Road access between Yangon and Thilawa (both the port and the Special Economic Zone, see below) are being improved with loands from JICA (Karasawa, 2018).

The other Yangon port is in downtown Yangon, consisting of four terminals and 15 wharfs, including Asia World Port Terminal (AWPT) and Myanmar Industrial Port (MIP), which are the biggest (Logistics Cluster, 2018) Yangon faces a lot of vehicular traffic, so that trucks were banned from driving in the city from 6am to 9pm, which attracted criticism from the industry (Paing, 2016), as it led to congestion for trucks trying to leave the port. The regulations have since been relaxed again from 11am to 3pm, except on nine main roads (Nilar, 2017), including Strand Road, which is the major road at the ports but also a major downtown road for private vehicular traffic.

Inland Waterway

The two main rivers of Myanmar, the Ayeyarwaddy (also spelled Irrawaddy) and the Chindwin River, are both used for transport. Ports along the Ayeyarwaddy are Sinkham Port, Mandalay Port, Pakakku Port and Magway Port and along the Chindwin River there are Monywa Port and Kalewa Port (Htike, 2017). The National Logistics Master Plan includes 33 projects for sustainable transport along the inland waterways within 2030, so improvements can be expected.

Dry Ports

There are currently two projects under way to establish dry ports in Myanmar, Ywathargyi at Yangon

and Mitinge at Mandalay and are expected to be operational in April 2019 (Swe, 2017). A total of eight Dry Ports are planned, in Tamu, Muse, Monywa, Mandalay, Yangon,. Bago and Mawlamyine.

Air Transport

Myanmar has three international airports (Yangon, Nay Pyi Taw and Mandalay) and 30 operational domestic airports according to Htike (2017), The World Factbook (2018) puts the figure at 36 airports, 28 of which unpaved. Yangon Mingaladon International Airport is the largest airport. Freighter aircraft to this airport are operated by Qatar Airways (Livingston, 2017; Qatar Cargo, 2018).

Hanthawaddy International Airport, a new airport in Bago Region, 80km north of Yangon, is being planned. A framework agreement had been signed with a Singapore-based consortium (Yong, 2016), but the negotiations fell apart and the government is now negotiating with Japan (Thu, 2018).

Special Economic Zones

Currently, there are three Special Economic Zones (SEZ) in development: Kyauk Phyu in Rakhine State, Dawei in the Thanintharyi Region and the Thilawa in Yangon Region (DICA, 2018b), of which Thilawa SEZ has been operational since 2015 as the first SEZ in Myanmar (Thilawa SEZ Management Committee, 2015). Three more SEZs have been approved along the China border at Kanpiketi town, in Kachin State's Special Region 1, under the control of the New Democratic Army-Kachin militia; Chinshwehaw, in Shan State's Laukkai Township, part of the Kokang Self-Administered Zone; and in Shan State's Muse Township (Lwin, 2018).

In Myanmar, there are two types of Special Economic Zones: Free Zones and Promotions Zones. These two types come with different privileges for the investors (DICA, 2018b).

Discussion and Conclusion

The Republic of the Union of Myanmar is still a Least Developed Country, but it is growing fast. This creates logistics challenges.

The literature research has shown that the government is actively working on in cooperation with international ODA organisations, including JICA and ASEAN. For each of the modes of transport and other logistics activities covered in this paper, development projects are under way within a fixed time frame, and have been identified as important and leading to increased efficacy of logistics. This includes the master plans that are in place up to the years 2025 and 2030 respectively.

In conclusion, Myanmar is a country that is actively and rapidly developing, and the researchers are confident that the improvements proposed or planned will greatly benefit investors and bring prosperity to the country.

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MEASURING PERFORMANCE OF LOGISTICS SERVICE PROVIDERS: A PROPOSED CONCEPTUAL FRAMEWORK

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Introduction

Performance measurement of logistics service provider (LSP) is an important element in the logistics outsourcing process. Logistics activities are considered to be the activities that do not need to be managed by firms themselves, as they can be outsourced to a professional external party (Ho *et al*., 2012; Ciravegna *et al*., 2013). Firms seek to outsource logistics activities in order to avoid high fixed costs and heavy investment requirements associated with logistics and to focus more on their own basic activities. Logistics outsourcing has proven to be an effective strategy helping logistics services users to achieve competitive advantages, improve customers' service-levels, and reduce overall logistics costs (Boyson *et al*., 1999).

The performance measurement systems are an instrument for assessing the success of LSP's and identifying corrective actions in respond to service failures (van Hoek, 2001; Wilding and Juriado, 2004). The establishment and continuous monitoring of key performance indicators (KPIs) related to logistics services allow users to compare their achievements with expected service levels. LSP performance measurement can be classified into two perspectives: 1) Logistics Users (LU), which are suppliers, manufacturers, and distributors; 2) LSPs which is third-party LSPs such as logistics companies, couriers, transporters (Fernie, 1999; Parasuraman *et al*., 1985; Gunasekaran and Ngai, 2003).

However, the literature on LSPs has focused mainly on LSP performance measurement in the perspective of logistics users (Chen, 2007; Kunadhamraks and Hanaoka, 2007; Rafiq and Jaafar, 2007; Bhatti *et al*., 2009; Qureshi *et al*., 2009; Banomyong and Supatn, 2011; Kumar and Singh, 2012; Sahu *et al*, 2013; Alkhatib *et al*., 2015; Lan *et al*., 2015; Govindan *et al*., 2015). There is lack of study and assessment standard that could directly address LSPs in the perspective of non-users (e.g., third-party LSPs). Howerver, there are three notable exceptions. Firstly, the study by Min and Jo (2006) adopted Data Envelopment Ananlysis to measure the competitiveness of the major third-party LSPs in the US... The second examined the performance of LSPs and provides using financial statement analysis and potentially benefits to logistics executives, analysts and researchers (Hofmann and Lampe, 2012). The last presented a content analysis of corporate social responsibility reports published by 350 international LSPs, and analysed factors influencing the level and scope of reporting (Piecyk and Björklund, 2014).

This study proposes a framework to assist researchers in analysis of LSP's performance and provides the decision-making supporting tool to meet logistics industry's needs. It proposes an advanced comprehensive LSPs' evaluation framework based on the comparative literature outcomes. The literature review is derived by consolidating knowledge on logistics performance measurement systems perceived from and developed by the perspective of LSPs. There are threefold contributions made by this study. First, it presents a systematic literature review of LSP performance measurement by studying the existing articles related to LSPs evaluation dated back to the first article published in 1978. Second, it proposes the conceptual framework identifying any possible shift regarding to how LSPs are evaluated and measured. Finally, research agendas are presented to guide future studies on LSP performance measurement system and KPIs.

Literature review

Theoretical foundation

In this section, existing theory and frameworks on performance measurement found in literature are explored and reviewed. . There appears to be three commonly used approaches to measure LSP performance: transaction cost economics (TCE), resource-based theory (RBT) and agency theory. The

differences between these are summarised as follows.

TCE, the most frequently used theory, suggests that operations should be viewed as the sum of productions and transaction costs at minimised level (Williamson, 1975, 2008; Riordan and Williamson, 1985). Transaction costs represent the costs of physical and human resources incurred in order to complete the exchange of goods and services between parties. Meanwhile, RBT views firms as a bundle of resources (Penrose, 1959; Rumelt, 1984; Wernerfelt, 1984) and competencies that represent the basis for their competitive advantages (Barney, 1991; Conner, 1991). Outsourcing is the way that a firm can secure resources from its environment in order to survive and improve its operational performance (Olavarrieta and Ellinger, 1997; Rungtusanatham *et al*., 2003). Lastly, the agency theory provides a justification for the establishment of alliances between organisations and their service providers (Blancero and Ellram, 1997; Stock, 1997; Logan, 2000). It refers to the methods by which one party (the principal) ensures the development and maintenance/monitoring of beneficial relationships with another party, i.e., service providers and vendors (the agent) (Stump and Heide, 1996).

In summary, TCE is generally accepted as a useful framework for analyzing logistics and outsourcing decisions. RBT concerns of resource utilisation in order to sustain a firm's competitiveness. The agency theory focuses on the costs and benefits of supply chain relationships. As the purpose of this study aims at proposing the measurement framework for LSPs performance as to maintain their competitive advantages, the appropriate theory should provide the LSPs sustainable competitive advantages gained from an appropriate access to a bundle of valuable, rare, non-imitable and non-substitutable resources (Penrose, 1959; Wernerfelt, 1984; Barney, 1991). Some LSPs are asset-heavy focus (property-based) but some are asset-light and knowledge-based (Das and Teng, 2000). Such phenomena can be explained by the RBT. RBT thus provides a key theoretical foundation for the LSPs' competitive advantages and is the theory adopted in this study.

Summary of the authors' previous literature review works

One objective of this study is to review the literature and identify research domains and evolutions of performance measurement in the LSPs' context. Thus, the systematic approach was selected as the review methodology. The main strength of a systematic literature review from other styles of literature review is that it provides a standard research methodology. This method also provides a rapid comprehensive identification of main research themes and clusters regarding to the logistics service provider performance domain.

The first stage of the review process involves the identification of papers and reports studying LSP performance measurement spanning from the year the first article was published in 1978 to recently ones in 2017. In order to cover all the relevant articles, ProQuest and Scopus were selected as the main database for this systematic literature review. Since these databases have the coverage for potential databases and websites which are searched namely Emerald, Science Direct, Taylor & Francis, Springer and Wiley Online Library. In total, 209 articles published in 112 journals were read over through abstracts and keywords. Finally, 93 articles from 45 journals were selected and deemed suitable for inclusion in the systematic literature review.

The next step was the analysis and interpretation of the selected articles according to the guidelines provided by De Nooye *et al.* (2005) who used the social network analysis (SNA) as the key linking articles with Pajek software 4.01. The SNA approach can offer a more objective analysis than the authors' judgment (Colicchia & Strozzi 2012). The initial finding suggests that LSP performance measurement can be classified into five categories: efficiency and effectiveness (47 articles), service quality (21 articles), inter-organisation relationship (16 articles), socio-environmental performance (5 articles) and financial performance (4 articles).

Furthermore, the authors drew a map of knowledge structure by conducting a Main Path Analysis of articles within each research domain. The first path is efficiency and effectiveness which includes Beamon (1999), Gunasekaran *et al.* (2001), Mentzer *et al.* (2001), Lieb and Miller (2002), Lai *et al*. (2002), Neely (2005) and Jharkharia and Shankar (2007).

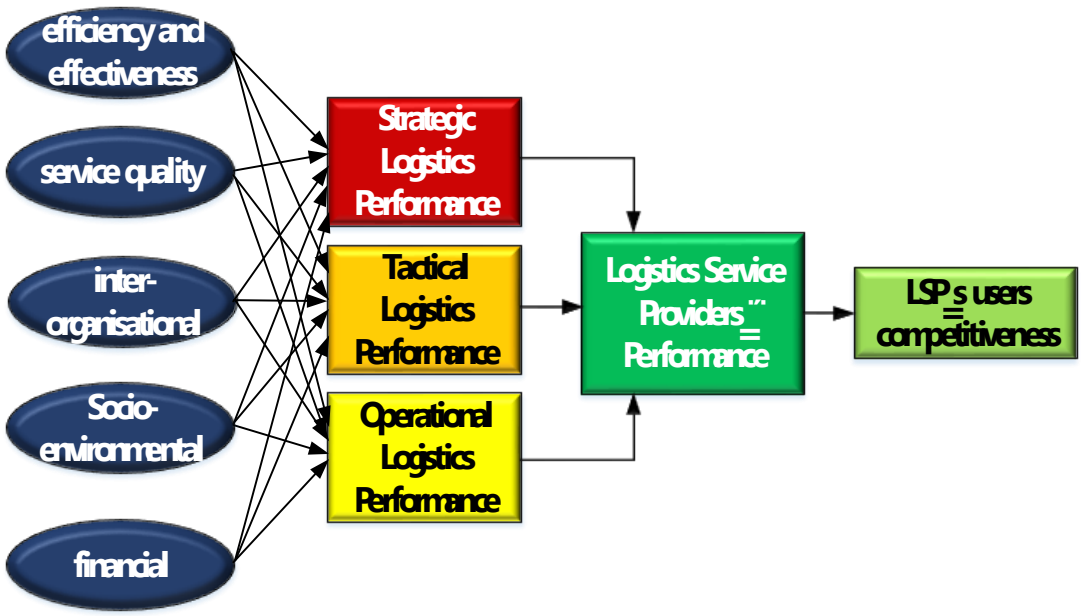
This path concerns on the status of logistics performance measurement in corporations and provides a benchmark for organisations to assess the quality of their logistics performance measurement

practices and identify opportunities for significant improvement. Secondly, the service quality path consists of six articles: Parasuraman *et al.* (1988), Bienstock *et al.* (1997), Mentzer *et al.* (1999), Lai (2004), Grant (2003) and Seth *et al.* (2006). It is related to the assessment on customer perceptions of service quality in LSP's organisation. The next path is inter-organisation relationship which is related to the measure of LSP performance across the supply chain and networks rather than within an organisation, especially between an LSP and its clients. This path includes articles by Neely *et al.* (1995), Beamon (1999), Chan and Qi (2003), Gunasekaran *et al.* (2004) and Bhagwat and Sharma (2007). Besides, the environmental and social perspectives are also taken into account. The last two paths are then the performance measurement concerning on financial (Beamon, 1999; D'Avanzo *et al.*, 2003; Hofmann and Lampe, 2013) and socio-environmental (Gunasekaran *et al*, 2004; Hervani and Helms, 2005; Bjorklund *et al.*, 2012) perspectives. In sum, there is lack of theoretical foundation and unbalanced approaches in adopting theoretical views in order to provide an appropriate, holistic and balanced tool to measure LSPs performance. There is lack of analysis on the causal relationships between KPIs and how they might affect each other. However, it should be noted that these research domains are not exclusive and are based on published peer-reviewed articles in academic journals.

Conceptual framework

Framework evaluation

Figure 1 presents the general scheme of the proposed framework. The framework is developed by adapting the models proposed by Fugate *et al*. (2010) and the framework developed by Töyli *et al*. (2008). According to Fugate and Töyli's frameworks, it is assumed that logistics performance is influenced by 8 factors: effectiveness, efficiency, differentiation, responsiveness, quality, operational metrics, and service level and logistics costs. This can be inferred that these factors affect logistics performance and the performance at the organisational level. These factors must be considered independently in order to understand their relationships with logistics performance.



Source: Adapted from Fugate *et al*. (2010) and Töyli *et al*. (2008)

Figure 1: A proposed framework for this study

The conceptual framework consists of three axes of analyses. First, "LSP performance" defines as the degree of efficiency and effectiveness, service quality, inter-organisation relationship and socio-environmental and financial aspects at the different levels of organisational activities (i.e., strategic, tactical and operational). This should provide a clearer guideline on which measures/metrics should be used at the different levels of an organisation. Second, "Firm performance", in addition to represent an organisation's efficiency and effectiveness, represents a company's profitability and wealth of its

stakeholders. Finally, “Competitive Advantage” is the perception of logistics value compared with other companies in the market.

Meanwhile the authors consider different points of view, a system approach, on a company’s performance. Its concept views an organisation as a closed or opened system considering interactions of the organisational environment by means of input, output, process, throughput and outcome (De Leeuw, 1990). The combined use of output, outcome and throughput measurements enables the performance assessment of public organisations in a sense of multi-task fields. The input and output indicators are defined at the starting and ending points of production process which finally generate the outcome, while the throughput indicators are defined somewhere in the production process. For example, the study by Hanman (1997) proposed the methodology for defining the best practice called the Leaders-Laggers Analysis. The outcome of the analysis plotted an organisation’s logistics performance compared to the other organisations separately regarding to logistics inputs and outputs.

Based on the idea that the appropriate LSP should have a superior competitive position, the proposed framework aggregates the most relevant and critical indicators that are found to be fragmentally in logistics studies. The RBT serves as a dominant theory as to distinguish logistics resources and capabilities. Moreover, the authors investigated the importance of LSP factors using the alternative performance measure (the Leaders-Laggers Analysis) which refers to the firm’s success in terms of producing maximum output from a given set of inputs measured relatively to a set of firms (Farrell, 1957). To the best of the authors’ knowledge, this measure is very rarely used in RBT research.

At last, 32 indicators were included in the development of LSP performance measurement system. Each indicator was explicitly frequently mentioned in the literature. Beyond the indicators themselves, one of the key features of this proposed measurement system is its structure. Illustrated in Figure 2, the indicators were firstly grouped into five key themes. The five key themes were then divided into fifteen key dimensions. These dimensions provide the framing which is necessary for an initial constructing of measurement system. A group of linked indicators organised by a hierarchical approach that tied to the firm’s competitiveness is created for each of the fifteen key dimensions. For example, 3 individual indicators were created for the key dimension named as “Cost”. Furthermore, the relationship between the input and output indicators are explicitly highlighted.

Finally, the groups of indicators for each key dimension provide the basis for subsequent levels of structuring. Figure 2 illustrates that three tiers of aggregated measures were created. The first tier of aggregations involves the creation of one sub-index for each of the fifteen key dimensions called “Key dimensions Sub-indices”. The second tier focuses on the development of the sub-index for each of the five key themes called “Key Themes Sub-indices”. In the third tier, a composite index for the transmission system of the firm’s competitiveness was created. In every LSP, the indicators were normalised so that the greater areas covered in the sub-index plot of the “Leaders-Laggers Analysis” could correspond to the greater progress towards the competitiveness goals.

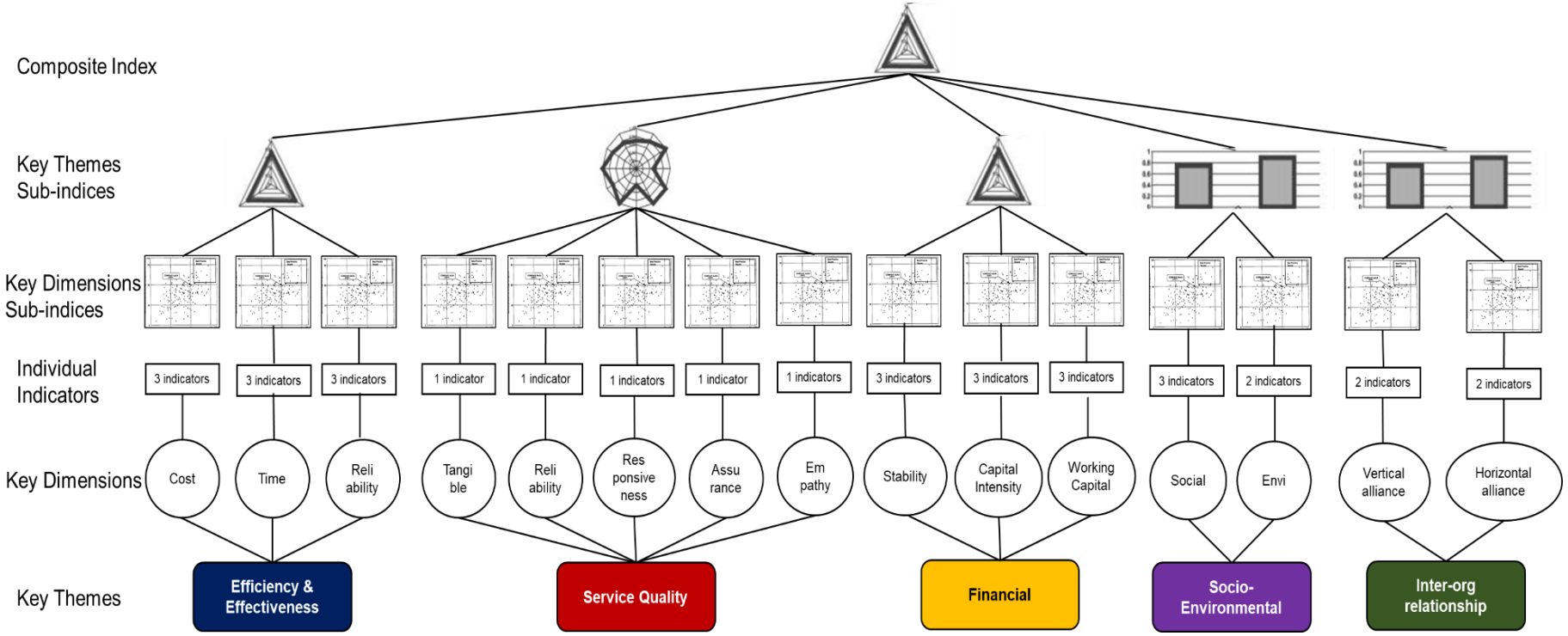


Figure 2: Structure of performance measurement system relevant for LSPs

Performance measurement indicators

To study the performance measurement of the LSPs, table 1 illustrates the 32 indicators that were proposed in five key themes, which are efficiency and effectiveness, service quality, financial, socio-environmental and inter-organisation relationship. The listed indicators have been implemented by several researchers studying LSP performance (e.g., Boyson *et al*., 1999; Gunasekaran and Ngai, 2003; Chen, 2007; Hofmann and Lampe, 2012). However, due to some limitations, the authors could only present the relationship between input and output indicators. The proposed LSP performance measurement framework focused on the activity of LSP firm offers a clear guide for computing and organising the indicators with user-friendly interface.

Dimensions	Outputs	Inputs
Efficiency & Effectiveness		
Costs	Transportation cost	The expense of of shipping goods from suppliers to plants, plants to warehouses and warehouses to customers
	Warehousing cost	the expense of storage place for products. Principal warehouse activities include receipt of product, storage, shipment, and order picking
	Inventory carrying cost	the expense of opportunity cost, shrinkage, insurance and taxes and obsolescence of holding inventory
Time	Average order cycle time	the average cycle time between order placement by the customer and order delivery to the customer
	Average transportation time	the average time between order out of factory and order delivery to the customer
	Cash conversion cycle	lays inventory outstanding lays sales outstanding lays payable outstanding
Reliability	Delivery in-full and on-time	- total items/shipments - number of items/shipments delivery in-full - number of items/shipments delivery on-time
	Order accuracy rate	- total shipment - wrong and substitute items
	Damage rate	- total items shipped - number of damage items
Service Quality		
Tangible	Appearance of physical facilities and personnel	- Appearance of physical facilities - Availability of resource - Utilization of resource - Staff sufficiency
Reliability	Performing services right the first time	- document - time - safety
Responsiveness	Willingness and ability to provide prompt service	- Provide enough information to customers - Fast and easy ordering process - Fast document processing - Quick respond to customer claims
Assurance	Trustworthiness of customer-contact personnel	- Clear policy on warranty, security - Staff competency - Staff professionalism
Empathy	Friendliness of customer-contact	- Understanding specific customers' needs - Ability to accommodate special needs

Dimensions	Outputs	Inputs
	personnel	- Personal attention
		- Assessing customers' future needs
Financial		
Stability	Return on Asset (ROA)	- net Income
		- total Assets
	Return on Equity (ROE)	- net Income
		- total equity
	Operating Profit Margin	- **operating** earnings
		- revenue
Equipment and staffs availability	Non-Current Asset Turnover	- revenue
		- gross fixed assets
		- accumulated depreciation
	Total Assets Turnover	- revenue
		- total Assets
	Capital Intensity Ratio	- revenue
		- total Assets
Working capital	Current Ratio	- current Assets
		- current Liabilities
	Cash Ratio	- cash
		- marketable securities
		- current liabilities
	Inventory Turnover	- a**verage inventory**
		- c**ost of goods sold**
Socio-environmental		
Environmental	Utilisation	- fuel efficiency
		- electricity consumption
		- water consumption
		- waste recycled
	Emission	- total CO2 emissions
		- other emissions (SOx, NOx)
Social	Labour practices and decent work	- education and training
		- accidents
	Human rights	- training on policies and procedures concerning human rights relevant to operations
	Society	- number of community projects supported
		- sponsorships and donations to community projects
Inter-organisation relationship		
Horizontal alliance	Alliance size	- resource utilization within the alliance
	Task complexity	- exchange of valuable information
		- facilitates continuous alliance improvement
		- high level of joint decision making
Vertical alliance	Operational fit	- highly complementary geographical networks and customer portfolios
	Relational fit	- the degree of corporate culture similarity and rivalry between the partners

Table 1: List of clustered performance indicators for LSPs

Implication

As demonstrated, the conceptual framework of LSP performance measurement would encompass all five domains. This proposed framework can be employed to spur future research .The adoption of the proposed framework should provide an agreement on starting point and accepted structural framework for additional development and empirical testing of LSP performance measurement

concepts, principles and methods. This could further aid the identification and resolution of LSP. Given this framework, the development of performance measurement approach will facilitate LSPs to measure and evaluate their day-to-day business operations. A considerable number of publications have been recognised as the importance of LSP management in order to develop a performance measurement system. Although the relationship between logistic outsourcing function and organizational performance has been studied in a scenario regarding large enterprises and supply chain management, there are few studies focusing on this direct relationship.

There are two main implications for both academic and business sectors. For academia, this study moves logistics research towards the performance measurement framework of LSP and provides an opportunity for future research to validate the framework with empirical evidence. The studies of LSP have many hierarchical levels and each level differs in the scope that is represented in the proposed structure. On the other hand, this proposed framework might have implications for business operations. It might allow managers to visualise and consider a wide range of indicators of their outsourcing activities. The framework is also aim to assist practitioners in developing the more structural and understandable performance measurement system which is vital for creating and sustaining competitiveness and profitability in today's business environment.

Conclusion

The contribution of this paper has twofold. Firstly, the authors presented the literature review on the concept of performance measurement in logistics service provider (LSP). Secondly, the authors presented the framework that captures the dynamics of performance indicators for LSPs and consists of an extensive list of LSP performance indicators. The literature suggested a number of studies on LSP performance measurement. However, these studies mainly focus on particular areas or cases and concern on external and quantitative indicators. In a more holistic view, the literature review therefore considered the areas which are efficiency and effectiveness, service quality, inter-organisation relationship, socio-environmental and financial indicators. The framework presented is a first step towards a long-term aim to use performance indicators ex-ante rather than post-ante. The model considered indicators regarding two main dimensions. On the one hand, the authors looked at the perspective level: operational, tactical and strategic. On the other hand, the authors classified the indicators into inputs and outputs. These two dimensions were encompassed with the Resource-Based Theory.

Since LSP is developing and evolving continuously, an optimal performance measurement framework might not be previously determined. However, the authors believe that the proposed framework could capture LSP performance measurement better than those proposed in previous published because it includes the views of both academic and practitioners. Furthermore, the proposed framework encompasses five themes; efficiency and effectiveness, service quality, inter-organisation relationship, socio-environmental performance and financial performance. These themes have been widely agreed in LSP literature and classified into different levels of organisational activities (strategic, tactical and operational) .While the field of LSP is developing, these core themes are a vital part of LSP and continuously growing and developing .Based on the proposed framework, there are a great number of implications for academic and practitioners.

References

Can be furnished upon request

RESEARCH IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT IN AN ERA OF DIGITAL TECHNOLOGY: A FORECASTING STUDY

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Introduction

There has been considerable development in literature on logistics and supply chain management (L/SCM) (Sachan and Datta, 2005; Christopher, 2016). Supply chain management (SCM) can be defined as an integrative activity linking key tasks and processes to various levels to form a coherent, high-performance business model that takes into account the strategic dimension of process-integration designed to satisfy customers (Roussat and Fabbe-Costes, 2008). According to Charvet et al (2008), who carried out bibliometric research on the subject, SCM is studied in a cross-disciplinary way. It is distinct from logistics insofar as the latter is "the technology of mastering flows of goods and materials that a firm sends its customers, transfers between or within its production units, and receives from its suppliers." (Fulconis and Paché, 2011, p. 172).

SCM and logistics take into consideration issues in oversight and optimisation of flows and stock, coordination of stakeholders within a chain, incorporation of these players, decision-making, the governance and structuring of multi-stakeholder chains, and sustainable development (Sachan and Datta, 2005; Charvet et al, 2008; Georgi et al, 2013). Considered key factors in firms' competitiveness (Porter, 1980; Christopher, 2016), the fields of L/SCM have been the focus of reflection in innovation in digital technology for several years (Kim, 2000). Nevertheless, it is difficult to determine which direction innovations should take to support the workings of L/SCM, especially in an era of digital technology when innovative solutions develop rapidly and the economic climate requires market players to weigh up opportunities to invest in one digital innovation or another (Clausen et al, 2016).

To begin with, a review of published writings underlines a wide range of digital innovations that could support L/SCM in relation to digital development. Yet the vagueness of this proliferation of innovation in digital technology highlights the need for a forecasting study that could improve understanding of L/SCM issues regarding digital innovation. The question that our research puts forward is as follows: What challenges can we imagine in tomorrow's logistics and supply chain management in the light of innovation in digital technology? To answer this question, we used an original forecasting method. The procedure was divided into four rounds. Its results and related discussions are presented in this paper.

Innovation in logistics and supply chain management

For several decades, interest in logistics and supply chain management (L/SCM) as fields of research has grown prolifically (Sachan and Datta, 2005; Charvet et al, 2008; Georgi et al, 2013). Alongside it there have been reflections on external conditions that affect firms and prompt them to become more agile to meet different customer requirements (Georgi, 2013). In a highly competitive, globalised world, innovation is a means by which firms adjust to changes in their environment (D'Aveni, 2010; Hitt et al, 2012). Innovation refers to new products, procedures or systems that change markets or create new ones. The drive to innovate is not new, but gaps between theory and practice have been observed: "Today, logistics sees itself as a dynamic procedure of just-in-time production. But in practice it manages immobility: parcels waiting to be collected in warehouses" (Ballot, 2016). Against this backdrop, the diversity of digital innovations creates research opportunities. Blockchains, the internet of things, artificial intelligence and so forth support the development of tomorrow's L/SCM (Hazen et al, 2014; Wang et al, 2016) but also tend to bring about obscurity for researchers and firms: What direction should be taken? What challenges underpin tomorrow's L/SCM? Moreover, it is difficult to discuss what a firm seeks to achieve strategically without knowing what it could accomplish objectively, given its capabilities and environment. We share the idea according to which a strategic vision can only be

decided upon in the light of a panorama of possibilities (Ansoff, 1965; Gozé-Bardin, 2008; Seraidarian, 2008). So while innovation can set a firm apart from its competitors and keep it competitive, it can only be effective and differentiating through foresight and openness regarding the future possibilities that interest a firm the most. This approach based on forecasting and openness requires an overview of current possibilities: a starting point from which speculation on the future becomes possible (Roussat and Fabbe-Costes, 2008; Gozé-Bardin, 2008).

Forecasting Approaches

Gaston Berger coined the term *prospective*, meaning forecasting, to refer to approaches through which possible future scenarios can be identified. Forecasting aims to discern future challenges in an exploratory way. There are several forecasting methods in management studies: the Delphi method, the Prodin method and profession-forecasting (*prospective métier*) (Scouarnec, 2008). Since the profession-forecasting method generally focuses on a particular line of work, we used the Delphi and Prodin methods in this study.

The Delphi method is "a method of enquiry that [...] seeks to reach a consensus by asking questions individually to members of a group, using a series of questionnaires that incorporates the members' opinions gradually and summatively. […] Through this repetitive procedure, each group member can reassess their own opinion in the light of other group members' opinions, but without feeling pressured to do so" (Rousseau, 1996, p. 28). The method assesses experts' intuition and knowledge (Oble, 1992) in order to "know the future" (Rousseau, 1996) by picking out and ranking priorities or factors discerned, by casting light upon any areas of uncertainty, by clarifying cutting-edge trends, by discussing theoretical change in a given environment and by weighing up chances of risk (Rousseau, 1996; Schmidt et al, 2001). Inspired by the Vatican method, it aims for a consensus in the face of divergence among expert opinions through three general principles: anonymity, feedback and data extraction (Oble, 1992). The approach is mainly applied through successive questionnaires in a repetitive procedure that includes questions that are generally open-ended in an initial phase, then, in a second phase, closed questions based on quantitative measurement scales (such as a Likert scale). It requires considerable time and effort, generally spread over several months, so can be considered "the precise opposite of an expeditious method" (Rousseau, 1996, p.42). Given how onerous this empirical procedure can become, the mini-Delphi method emerged as a way to reduce the number of repetitions. Devised in the 1970s, it abolishes the partitioning of experts and puts forward anonymous voting with live vote-counting alongside the entire panel in the same location and with short-lasting debates between participants, especially in regard to extreme positions (Oble, 1992). In the same perspective aiming for group dialogue, the Delphi method with Régnier's Abacus takes into account a focus group, this time incorporating a qualitative dimension in the voting process, where qualitative scales (generally a coloured scale of attitude with a midpoint) are used instead of quantitative scales (Oble, 1992). These two variations of the Delphi method tend to incorporate dialogue between experts in a repetitive process (Oble, 1992), partly in line with another forecasting method: the Prodin method. The Prodin method is a highly interesting approach but remains little-examined in published writings. It is a dynamic forecasting method focussing on the analysis of change. Bergadaà and Coraux (2008) uses it to identify the skills that sellers may need in coming years, or a concept (management of risk perceived by consumers in purchasing situations), in the light of a customer-salesperson-manager dialectic (Bergadaà and Coraux, 2008). In relation to the traditional Delphi method, there are three especially interesting points in this approach that can be underlined: first, the use of separate focus groups; second, the benefit of using different groups according to forecasting stages; and third, impetus for sharing the results with a readership of researchers (science conferences) and practitioners (report for firms).

Whatever the forecasting method used, a panel of experts should be put together. This panel should be made up of competent participants specialising in the emerging topic to get closer to the truth of the matter. The panel should be composed of a diverse range of experts bringing a wealth of viewpoints and distinctive contributions (Rousseau, 1996). Each of these methods offer different advantages but a combination of them all that keeps the strengths of each one could bring further benefits. Such a methodology would be original. It would therefore be both relevant and inventive to

apply this methodology to tomorrow's L/SCM: a forecasting method that combines several tried-and-tested procedures.

Methodology

To respond to the research issues, an exploratory approach can be adopted, for which our forecasting method should prove relevant. Through discussions with recognised experts, our forecasting study can identify issues and scenarios that are currently unknown. This applies to tomorrow's L/SCM: the field needs to clearly identify developments likely to affect its stakeholders so it can better adjust to future challenges. To begin with, we reviewed published writings concerning innovation and the future of L/SCM to carry out the forecasting study. Focussing on academic and professional journals, our review brought 350 articles together. We identified nine main topics, which together made up a panorama of current reflections on the future[1].

This initial work formed the starting point for carrying out our forecasting study. After acquiring a database of logistics stakeholders held by institutional organisations, a committee was put together to select, from this list, 128 L/SCM experts (researchers and practitioners) potentially interested in tomorrow's logistics. Through a questionnaire of open-ended questions, these experts are asked about nine topics identified in the review of published writings. The following chart (**Figure 1**), based on four phases, or rounds, summarises the method used.

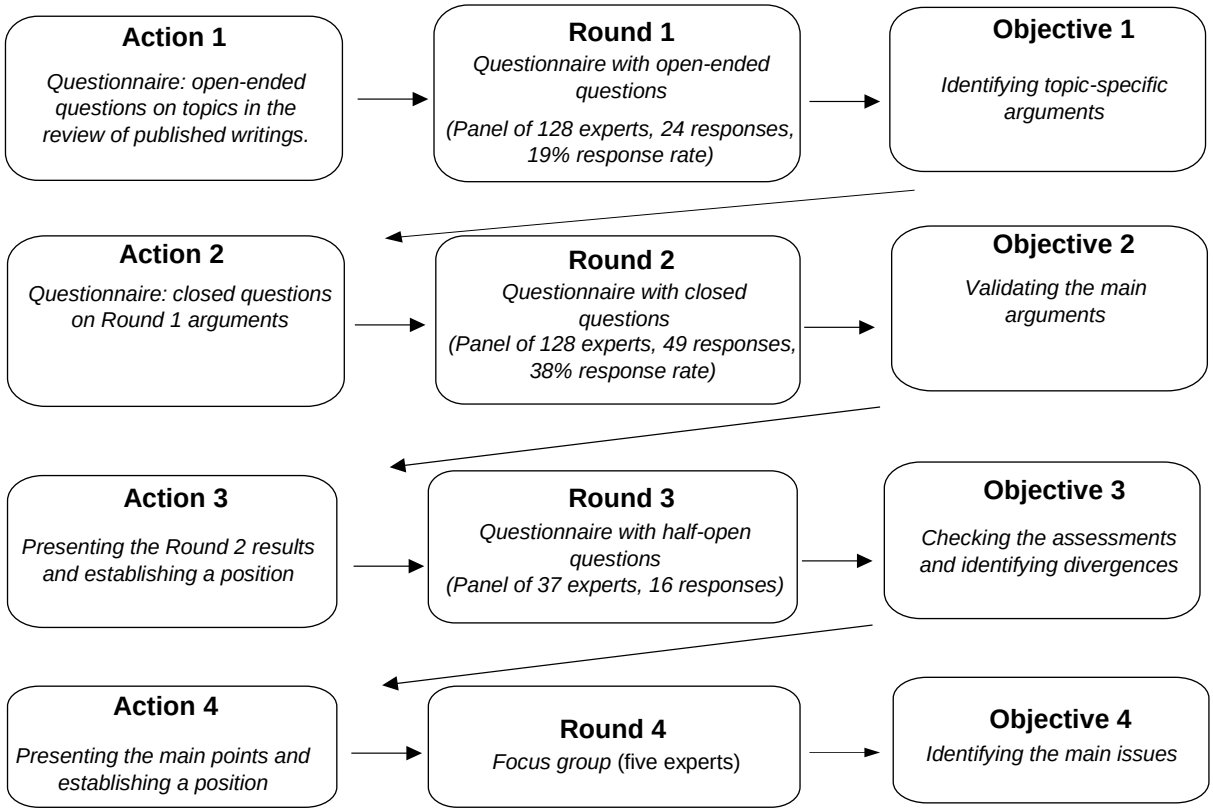

Figure 1. Chart summarising the forecasting method used.

The first round, a qualitative enquiry, is the longest. With this initial phase, a panorama of arguments required for drawing up a closed-question questionnaire[2] (Round 2) can be pieced together. This is

[1] 241 articles and reports from professional journals and publications by official bodies, appearing between 2015 and 2017, and 103 articles from academic papers, published between 2012 and 2017, were brought together, with research time having been considered longer than the monitoring of professional journals. The key words used were as follows: (logist* OR supply chain*) AND (futur* OR à venir OR demain OR 4.0 OR innov*), with their English-language equivalents for searches for articles in professional journals.

[2] The questionnaire of closed questions is based on Round 1. It is made up of three blocks: the importance of tools (Block 1) and procedures (Block 2) in tomorrow's logistics, and a measure of agreement with a series of statements

followed by the sharing of feedback, a phase in which the respondents can confirm or revise their assessments, especially in the event of divergence of opinion among the respondents (Round 3). The main issues can then be identified, particularly if they bring about polarity in regard to which the experts will establish a position (Round 4).

Results and Discussions

Following Phase 1, an analysis of the questionnaires, retranscribed in NVivo 11 (24 open-question questionnaires received from 17 practitioner-experts and seven researcher-experts) was used to identify a list of arguments, transformed into subject matters in a closed-question questionnaire for Round 2 of the forecasting method. This was distributed to the 128 members on the panel, with 49 responses received, and was followed by feedback shared to let the respondents revise, if need be, their assessments (16 responses received) in light of the group's median. Some divergences stood out. These were the subject of discussions in a focus group in Round 4, which brought together four experts (two researchers and two practitioners) in order to explore the points that brought about polarity over the two previous rounds. An overview of the entire procedure is displayed in the table below. This table identifies a number of issues relating to tomorrow's L/SCM from a perspective of three paradoxes, which can each be divided into two poles, of which the level of significance depends on the situation observed in each criterion in these paradoxes.

	Pole A	**Pole B**
Paradox of human-machine COOPETITION	***Pressured coopetition***	***Balanced coopetition***
	Degree of crobotisation	
	Degree of training	
	Degree of specialisation of human/robot tasks	
	Speed of innovation	
Paradox of stakeholder GOVERNANCE	***Brutal transformation without stakeholder involvement***	***Light transformation with stakeholder involvement***
	Governmental vision	
	Social vision*	
	Chain vision	
	Managers vision	
Paradox of SYSTEMS in making logistics operational	***Conventional method by incremental adaptation***	***Complexification of L/SCM***
	Degree of strategisation (supplychainisation)	
	Degree of personalisation (persondardisation)	
	Degree of growth of performance criteria	
	Degree of integration	
	Degree of flexibility	

Table 1. Main issues in L/SCM from a perspective of paradoxes

The first paradox is a collaborative paradox concerning human-machine relations. The study highlights a form of coopetition (Bengtsson and Kock, 2000) between humans and machines in L/SCM. The verbatim responses that were analysed show that this paradox can be divided into several criteria: degree of crobotisation, which refers to the level of integration of robots and cobots in firms; degree of training, which refers to humans' capacity to work alongside machines (early adapters, acceptability, skills, etc.); degree of specialisation of tasks, which refers to the question of whether humans and crobots are performing similar or complementary tasks; and speed of innovation, which refers to firms' tendency to look for technological innovation. Based on these criteria, the level of conflict between

on subjects identified following Round 1 (Block 3). Each block is made up of a range of subject matters on which the respondents give an opinion on a scale of 1 to 7.

humans and machines depends on whether this relationship focusses more on cooperation or competition. In the published writings, coopetition refers to inter-personal or inter-organisational relations (Leroy and Yami, 2007), but human-machine coopetition is not addressed. The study shows that human-machine coopetition is an especially relevant topic as relationships with machines are set to develop in our era of digital technology. 'There will necessarily be both distrust in human-machine relations, or, rather, in humans' attitude to machines, and a need to work together, depending on a firm's corporate culture,' said one respondent. The following verbatim response illustrates the complementarity of human-machine relations, where cooperation is promoted: *'Humans will be more respected if they do more respectable work and if they cannot be replaced by robots: if their role can only be for them!"* Respondents were generally unanimous regarding the presence of humans and machines in tomorrow's L/SCM. Humans will always have a role to play. *'We've always tried to eliminate humans on the pretext that they're too expensive and prone to error and so forth, but it's a good job they're here to resolve problems daily, make decisions and be creative!'* One respondent said: 'In logistics, people have always been both a problem and a solution'. Are machines the subject of such speculations?

The second paradox concerns governance. Governance is set to develop in the coordination of firms in L/SCM as part of a desire to take into account all stakeholders concerned (Freeman and Reed, 1983) and will relate to the speed at which values in L/SCM are transformed. This paradox represents *in fine* the level of education of stakeholders in tomorrow's L/SCM. With many cooperating stakeholders, it is easier to apply L/SCM but relational issues are added to governance. Fewer, partitioned stakeholders make it easier for the workings of governance to run smoothly but make it more difficult for L/SCM to be integrated. The analysis shows that an increase in sources of governance creates ambiguity in the daily application of L/SCM: if everyone is managing it, who is at the helm? 'Everyone talks about ecosystems but we don't really know what it refers to. Yet we know it will be taken into consideration in the future,' said a respondent. In the respondents' view, the intensity of the paradox seems to go hand in hand with: the governmental vision in the organisation's environment; the social vision conveyed by customers, consumers and associations; the vision of the chain (ethics regarding suppliers, etc.); and the vision of the directors themselves, which is critical. One respondent said: *'The answer lies in directors' code of practice, not in customers' expectations. In my view, the director, or the governing body, is fully responsible for the limits a firm sets itself in meeting a customer's request.'* These issues are likely to form part of a behaviourist approach to tomorrow's L/SCM, which observes the behaviour of a group seeking consensus in addition to decisions made by senior management, allowing the entire ecosystem to operate through leeway enjoyed by different stakeholders other than managers (Cyert and March, 1963).

Lastly, and in relation to the previous paradox, complexification in L/SCM at different levels makes up the third paradox identified, which is systemic. Indeed, models oriented towards greater integration (of stakeholders, data, etc.), more performance indicators (increase in criteria), a vision of supply chains that is 'supplychainist' ('supplychainisation' being a degree of strategisation that potentially shifts logistics towards supply chain management) and personalised ('persondardisation' being a method whereby specific logistics is plugged into standardised logistics), as well as the desired degree of flexibility between lean management and agility, make up the criteria related to this paradox. Yet this complexification should differ according to context, shifting trends in one way or another. Regarding the modularity of specific and comprehensive logistics chains, respondents said: 'There'll be several levels of logistics: one rooted locally, up to the last kilometre, and specialised; and one plugged into international trends', and 'international standards and norms will apply to a national scale like a best practice. *There's the case of GS1, which has slightly different beginnings, but it will be like GS1 on a much larger scale, with standardised, exemplary norms.'* The debate on supplychainisation did not reach a conclusion, while the respondents were also hesitant to confuse logistics and supply chain management in a form of Larson's re-labelling (2007). The complexification of L/SCM will be more or less radical. For some, 'it is often complementary rather than a full shift in model. *Take RFID for example: this solution was supposed to revolutionise logistics 15 years ago, but today it still hasn't done so.* In terms of lean management, logistics remains a 'muda' (uselessness) in the deep sense, even if we add a form of service', while another respondent said, 'we will adapt ... and change in accordance with systemic changes, which will break from the models we've known'. This systemic vision is a continuation

of the writings of Wren (1967), Lemoigne (1977) and Lobre-Lebraty (2015). As part of L/SCM, the issue of complexification in making L/SCM operational reflects a deeper interconnection of interfaces in play, requiring subsystems that are autonomous yet interdependent to cooperate to reach common objectives. Lastly, through the paradoxes (Lewis, 2000), several theoretical approaches can mix in tomorrow's L/SCM, from the coopetitive vision in strategic management to a systemic vision of L/SCM, which reveals interfaces to manage, and a behaviourist approach to governance.

Conclusion

The research offers a forecasting study on how digital innovations affect issues in logistics and supply chain management. It uses an original methodology combining the Delphi method and the strengths of the Prodin method and underlines three 'paradoxes' to take into consideration in understanding tomorrow's L/SCM in light of theoretical issues: the paradox of human-machine coopetition in a collaborative vision of strategic management; the paradox of stakeholder governance in a more behaviourist approach to collective conduct; and a systemic paradox that highlights the complexification of making L/SCM operational. These are the directions that future research could follow regarding the role played by digital technology in L/SCM. In terms of management, the research carried out identifies the nodal points that are likely to cause divides in L/SCM in our digital era. By understanding these divides, stakeholders can be placed in one dynamic or another in L/SCM and, in this way, it can be easier to find solutions to any difficulties encountered.

Nevertheless, the research has limits. First, although the preliminary review of published writings identifying nine main topics to explore sought to include the concerns of practitioners according to professional journals, it led to less importance being accorded to current theoretical issues in L/SCM. Moreover, the list of experts, who were chosen carefully, remains relatively restrictive and cannot guarantee complete independence of expert knowledge on such a specialist topic. Four experts took part in the focus group, which would have benefited from support from a complementary focus group. Lastly, although the rate of feedback is interesting, each round inexorably loses a certain number of respondents, who, despite being interested in the approach, are more inclined to support research by taking part in questionnaires with closed questions rather than questionnaires with open-ended questions, notably due to their limited availability. To minimise risk, the researcher carrying out a forecasting study should use a low number of repetitions and preferably closed-question questionnaires from Round 2. In the case of focus groups, the starting panel should be as large as possible, and the presence of a nucleus of respondents for the focus group should be ensured from the outset. As part of this, exchange platforms offer the advantage of giving respondents anonymity and prevents them from having to take trips that are expensive or impractical.

Currently, the main themes of the research agenda have been put forward, putting research in the shadow of the paradoxes to manage. There are many perspectives and a non-exhaustive list of them could not be drawn up. As regards paradoxes, are we heading towards more paradoxes to manage as the environment becomes more oriented towards digital technology? Or towards a refocus on certain criteria associated with these paradoxes? Furthermore, while coopetition was studied from an inter-personal and inter-organisational point of view, how can human-machine coopetition be categorised given the different nature of the aspects concerned? Should not certain approaches to strategic management be adjusted to this version of coopetition? Or do we find the same features of conventional research in coopetition? To what extent can theoretical approaches in IT systems provide food for thought on an interdisciplinary approach? Regarding the governmental paradox, what are the visions that will prevail in governmental choices, according to the contexts of each system? Depending on the country, a sector's culture and so forth, a certain form of governance could be considered more appropriate to oversee tomorrow's L/SCM. Concerning the systemic paradox, it would be interesting to study the conditions required for producing poles (supplychainisation, persondardisation, etc.). Lastly, if digital technology in tomorrow's L/SCM means a shift towards reflections on interface management, what would be the most relevant interfaces to use in each form of paradox identified? Likewise, it would be interesting to make each criterion associated with the three paradoxes operational in order to

determine the conditions leading to one pole or another in the paradox, as well as the interest of remaining in a pole or seeking to reach another one according to the system's conditions.

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ROBOTICS PROCESS AUTOMATION THROUGH LEAN ENGINEERING

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Introduction

Most countries have a need to receive, store, and distribute blood for safe and adequate use in hospitals or simply to ensure that the blood bank is responsive to emergencies. Indeed, securing the nation's blood supply by ensuring a safe and adequate blood supply and providing specialist transfusion medicine services is a national blood service undertaken mostly at the public sector level. In Singapore, the Blood Services Group (BSG) is no exception.

The BSG is responsible for collecting, processing, and distributing blood and the blood components to all public and private hospitals in Singapore. The blood components of plasma, Red Blood Cells (RBC), white cells, and platelets, used in different healthcare settings, are typically processed in the Components Processing Inventory (CPI) lab of the BSG. The CPI lab processes the entire blood collected in the form of blood bags into the component products, and the patients may be treated with the whole blood (A, B, O, AB, Rh), or the specific blood components required for the various medical conditions.

The handling process in the CPI lab involves blood collection (either done on site or from the various blood donation sites located all over the island), blood processing, blood testing, and blood inventory. The whole blood is collected daily from the central blood bank and another three satellite blood banks located strategically at blood donation points (BloodBanks) sited in the CBD, shopping mall in the West, and a civic centre in the north of the island. The whole blood collected will be inspected and further processed after arriving in CPI lab within 24 hours. The component products will be stocked as inventory before distribution centrally to the demand points, which are usually the 26 hospitals and specialty centres. In this paper on robotic process automation using lean engineering, the focus will be on the processing and inventory of blood components.

The intent of this study will be divided into two stages. The first stage is to map the current handling process of blood in the CPI. It starts with collecting the process information, mapping the current state (“as-is”) including the entire material and information flows, followed by analysing both the value-adding and non-value-adding activities, and eventually identifying the hidden waste and sources of waste. In this stage, the detailed value stream workflow of the blood handling process and inventory in the CPI lab will be described. The information on each activity such as labour, location, time, objective, target output, and procedures will be meticulously captured. The successor-precedence relationships between the different activities also need to be understood. After developing the current state map with the information collected, a thorough process analysis is performed to find opportunities for removing the non-value added activities. Considering the large amount of manual labour involved in the current workflow, the opportunities for process automation so as to reduce labour costs will be identified using a discounted cash flow cost-benefit analysis. Upon completing the current handling process map, the second stage is on the future process improvement. In short, the study will show how through lean engineering, robotic process automation can be deployed operationally and meaningfully using design thinking. The goal is to improve the overall efficiency of the BSG workflow in the CPI lab.

This paper is structured as follows. Section 1 has introduced the background and context of the problem. Section 2 provides the necessary literature review under the various streams of work. Section 3 details the research method. Section 4 shows the effort at the current state VSM, in particular the blood processing steps. Section 5 presents the future state map. Section 6 highlights the results of the cost-benefit analysis. Section 7 concludes with some suggestions for future research.

Literature review

Lean Manufacturing

The modern concept of lean manufacturing dates back to the early 1900's, Henry Ford implemented the continuous assembly line and flow in the Model T automobile manufacturing at the Ford Motor Company**.** From the 1940's through the 1970's, the Japanese automotive industry had been inspired by this concept and the revolution first occurred with the Toyoda family who formulated the Toyota Production System (TPS). The TPS, focused on reducing the cycle time, cost, defects, and waste. It aims to achieve the same output with less input, such as less time, less space, less human effort, less machinery, less material, and less cost. The TPS system enabled Toyota to survive and even remain profitable during the oil crisis in 1974 (Womack et al. 2007).

The TPS has defined seven forms of wastes ("muda") in the manufacturing process. The first form of waste is overproduction, which means producing more, sooner, faster than necessary or required by the customer. The second waste is defect which can lead to a waste of money, production time as well as the effort spent for rework or correction. The third waste is inventory which brings inventory carrying cost including storage cost and operating cost, and for perishable goods there is also risk of depreciation. The fourth waste is transportation; the excessive movement is non-value adding. The fifth waste is waiting, which also leads to a waste of money and time. The sixth waste is over-processing, which is excessive processing work than needed, using more resources than required. The seventh waste is unnecessary motion, or the extra movement of people which slows down the production flow (Rampersad & El-Homsi, 2007). Lean manufacturing is usually applied to identify and minimize all these wastes, creating a more efficient work flow.

In the mid-1990's, the lean manufacturing concept was introduced to the American industries, and over time, it was applied not only in the production environment but also the entire supply chain even including the office administrative processes. Lean manufacturers have now turned into lean enterprises, involving all parties and roles in the value chain, focusing on obtaining the best possible value from the collective efforts of all the stakeholders (Keyte & Locher 2016). Today, lean thinking is a popular mantra.

Value Stream Mapping (VSM)

The most commonly used lean tools today include the 5S workplace organization and standardization, overall equipment effectiveness, mistake proofing, Kanban, and VSM (Voehl et al. 2013). VSM is a powerful visual management and communication tool. It is a lean-management method for analyzing the current state and designing a future state for a series of events that takes a product or service from its beginning through to the customer (Rother & Shook 2003). It is useful for identifying waste, reducing processing cycle times, and implementing process improvement. As it is applied visually, VSM helps to see the big picture and improve the entire flow. To do this, VSM uses a system of symbols to describe the activities and information flows, and the items are mapped as either adding value or not from a customer's perspective. The core of VSM is to seek out waste in any process and produce the most value in the most efficient way.

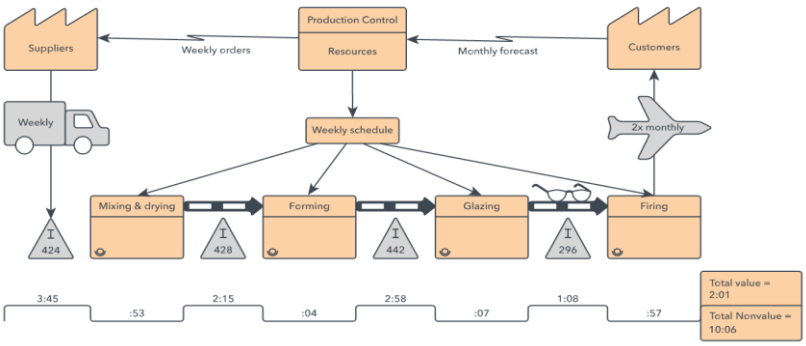

Figure 3: VSM example

Generally, a VSM tool contains a current state map and one or more future state maps that represent improvement to the current state. Generically, the steps to conducting a value stream analysis are set as follows:

1. Define the product family - Define and scope problem, Pick product family, Determine VSM objective and benefits, and Create VSM charter.
2. Document current state - Map current state value stream, Document each significant step in process, Collect process data and quantify current state value stream performance in terms of inventory type and size, cycle time, process time, number of workers, available working hours, Add process data to data boxes in VSM, Create a timeline to map process time and lead times through process steps, and Analyze and identify improvement opportunities.
3. Design future state - Develop future state VSM, use “kaizen burst” symbol on current state VSM to clearly communicate new improvements, and Prioritize improvement projects.
4. Create implementation plan - Develop implementation plan, Seek management approval, and Implement plan and monitor progress.

There are many software tools available for VSM; some allow the user to draw current state/future state with process variables such as material, employee, cycle time, and lead time. More complex tools allow for model building and simulation.

Lean management practices in healthcare industry

Lean management principles is also successfully applied to the healthcare sector. There are examples of healthcare organizations successfully using lean thinking to streamline their processes, reduce cost, and improve the quality of their products and services. The interested reader can refer to Nelson-Peterson and Leppa (2007) who reported on how a mid-sized medical centre adopted lean management principles since 2002. By working to eliminate waste, the centre created more capacity in the existing programs and practices to save significant capital expenses: $1 million for an additional hyperbaric chamber that was no longer needed; $1 to $3 million for endoscopy suites that no longer needed to be relocated; $6 million for new surgery suites that were no longer necessary. Using lean principles, the staff, providers, and patients have continuously improved or redesigned processes to eliminate waste, requiring fewer staff and less rework, and resulting in better quality. In another case study, Barnas (2011) reports on a health delivery system involving three hospitals, 27 physician clinics, and a 300,000-member health plan, based in a state in the US. The initiative for them to think lean in 2004 is that the leaders recognized that waste is the result of time the staff spent in “putting out fires,”. As a result, they believe that designing processes that work better will reduce waste and enable staff to better meet the needs of patients. The emphasis is this case is on reducing waste and the non value-added work. Through this focus, they managed to save $3.3 million in 2004, $154,000 in the catheterization lab supply procurement processes, reduced the accounts receivable from 56 to 44 days equivalent to $12 million. Both these studies highlight the financial and operational impacts of lean thinking on reducing waste in healthcare.

Research method

The methods used on the case study include drafting the general workflow after understanding the physical process, filling in the detailed process description, data collection, VSM current state analysis, and future state development. A mix of quantitative and qualitative methods was used for data collection and analysis (Williamson,2002).

The qualitative methods such as interviews and discussion with the officers and operators in the CPI lab, were adopted to create the general workflow of the blood handling process. It is regarded as the start point of the project, providing a structure to make further measurements. Based on the general workflow drafted, we then went on to improve the process descriptions for each activity.

The quantitative methods include time, labour, dimension, cost measurements are conducted for filling the data in value stream maps. The data was collected during visits to the CPI lab over four months. Much of the data collection involved the measurement of time. Each step of the process was observed and the cycle time was manually clocked. The cycle time is defined as the duration from the

time one component starts to be processed until the next component is placed. The cycle time is divided into two parts: machine time and labour time. Machine time refers to the time that a component is handled by an equipment. Labour time refers to the time the operator uses to prepare or wrap up an activity, i.e. bring materials to station, packing, cleaning the tools, moving the finished components from the equipment, etc. The reason to measure machine/labour time separately is to compute the machine/labour cost later in our study. While recording the cycle time, we also recorded other observations such as the number of staff involved in the activities. All the measurements collected were put onto an Excel file to be further analysed in the VSM analysis. A path map by product was then drawn with the VSM tool, eVSM to better visualize the movement of the components.

The workflow, detailed process descriptions, and the data collection serve as the foundation for creating the VSM current state. The map drawn with eVSM aids in understanding the processing activities and the various component flows. From the current state VSM, process inefficiencies are identified visually. Next, the future state VSM is created and measures of capacity, time, labor efficiency are tabulated. A discounted cash flow, cost-benefit analysis done on Excel is used to evaluate the feasibility of improvement.

Current state

To understand the entire process of CPI lab, we need to outline the blood collection and processing stages.

Generally, blood is processed after collection to yield the different products for specific treatments, and the handling process includes blood collection, blood processing, blood testing, and blood inventory. Blood collection is the start of the entire flow and carried in the four blood banks. The whole blood collected at the satellite blood banks is sent to the CPI lab twice daily at 3 pm and 9 pm respectively. Each bag of blood has a barcode and a record of the time of donation. The whole blood bag is then sent for processing. A random sample of blood is taken at the incoming inspection to scan the temperature, ensuring the blood components are in the active range of 20 to 24^{o}C. Next, the whole blood is centrifuged. The centrifuge can handle 6 x 2 units of blood bags each time, spinning for 15 minutes and then decelerating to rest within 30 minutes. The blood is now put into a semi-automated extractor for 3-5 minutes. For some special products required by blood and marrow transplant (BMT) patients, the white cells are removed, and the blood undergoes filtration. The filtered blood can now be handled for component pooling to get the specific components of blood, of which 60% is the supply of platelets. The next step is blood testing. Six test tubes are prepared for the six different types of mandatory tests. The turnover time for each test varies from ½ to 6 hours, and all the test results of the samples are released by noon of the next day. The test results are recorded in the IT system, and only blood bags which passed will be labelled to produce the final product. The blood test runs simultaneously while the samples are being processed. During the testing process, when the blood samples are centrifuged, the top layer is pipetted to test for HIV, hepatitis, Zika, malaria, antibodies, and syphilis. Finally, the handled blood is stocked for inventory. The labelled RBC's which are ready for distribution as well as the quarantined products that await labelling by noon of the next day are kept in a cold room.

Having an overview of the blood processing helps to identify and locate each individual procedure, especially for the component processing (including separation and pooling) and inventory. By adopting the 5W1H (Who, What, When, Where, Why, and How) approach, we were able to investigate what happens at each stage and gather the information needed for the VSM. The data/information is collected from the standard operation procedures, actual process observation, and interviews with the lab manager and senior lab officer.

Time usage was recorded using a stopwatch in terms of the machine time, labour time as well as the waiting time. The average time data is taken based on at least 2 sets of raw data. For example, for the procedure of whole blood centrifugation, we recorded the time for the breakdown of the activities, e.g. preparation work such as arranging samples, weighing and balancing the samples, travelling from the preparation work station to the centrifugation work station, as well as centrifugation by the machine. Batch size is also recorded in order to understand the efficiency per batch or per bag (see Table 1).

Table 1: Sample table of time motion study

Final product	Procedure	Activity breakdown	Avg time	Batch size
RBC+(BC)+Plasma	Centrifugation	Arrange samples	3 min	12 bags
		Weigh and balance samples	1 min	12 bags
		Travel	45 sec	12 bags
		Centrifugation	30 min	12 bags

Another key consideration is the human footprint in the process. We obtained the floor layout of the CPI lab, followed by identifying the functional areas of the lab. The major functional areas are: Incoming Receipt & Inspections, Separation, Component Pooling, Labelling Station, Storage rooms (pending and final product storage for RBC, plasma and pooled platelet), and Inventory & Distribution. To analyse the footprint, we observed during our visits to the CPI lab how the operators travelled between these functional areas. The data on the travel distance point to much human movement in the lab between the different stages of the process, as shown in Table 2.

Table 2: Current human footprint in RBC process line

From	To	Distance (m)
Door entrance	Receipt of satellite samples	2.55
Receipt of satellite samples	Incoming inspection station	6.84
Incoming inspection station	Centrifuge	3.52
Centrifuge	Extractor	1.93
Extractor	RBC filtration rack	2.43
RBC filtration rack	Inventorising station	9.07
Inventorising station	RBC pending cold room	15.47
RBC pending cold room	Labelling station	2.60
Labelling station	RBC FG cold room	26.13
RBC FG cold room	Temp storage for RBC dispatch	25.03
Temp storage for RBC dispatch	Dispatch window	3.20

Based on the process information collected, the current state VSM is obtained through the Standard Work Wizard in eVSM. Three major products, namely, RBC, plasma, and pooled platelets are included in the VSM, and the procedures are described as activity centres with the machine, labour, and waiting times indicated.

Muda Identification

Over-production waste: Due to the nature of the blood component services, all fresh whole blood have to be processed (at least to the RBC and plasma level), regardless how much the actual demand is. Thus, over-production waste is not a concern.

Processing waste: The production procedures cannot be changed as any change would potentially affect the quality of the product. Thus, no steps are identified to contribute to the excess quality which customer (hospital in this case) does not require.

Transport waste: During the site visits, it is observed that there are unnecessary movements of people and materials from one location to another. This suggests that the design of the layout can be improved with some automation of transport within the processing lab. The current layout of the CPI lab is rectangular with its length 3.2 times its width. Figure 2 shows that the sample receipt entrance point (Point A) and the finished goods distribution window (Point B) are very close to each other. The temporary and finished goods storage room/area are dispersed in the layout (yellow shaded area).

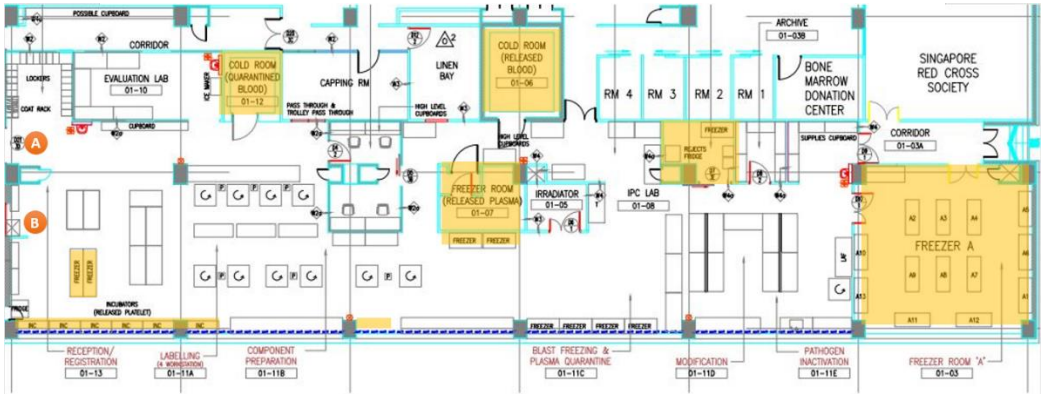

Figure 2: Storage area in current layout

Such a design results in inefficient travel routes in the processing activities. For example, from Figure 3, when the labelling of the RBC's is complete, the RBC bags are transferred from the labelling station to RBC (finished goods) cold room for storage (Red route below). The distance of the route from the labelling station to the RBC (finished goods) cold room is almost half of the length of the lab. When the RBC is needed for distribution, it has to be transferred from the cold room to the dispatch storage area which is nearer to the distribution window, as shown in the green route.

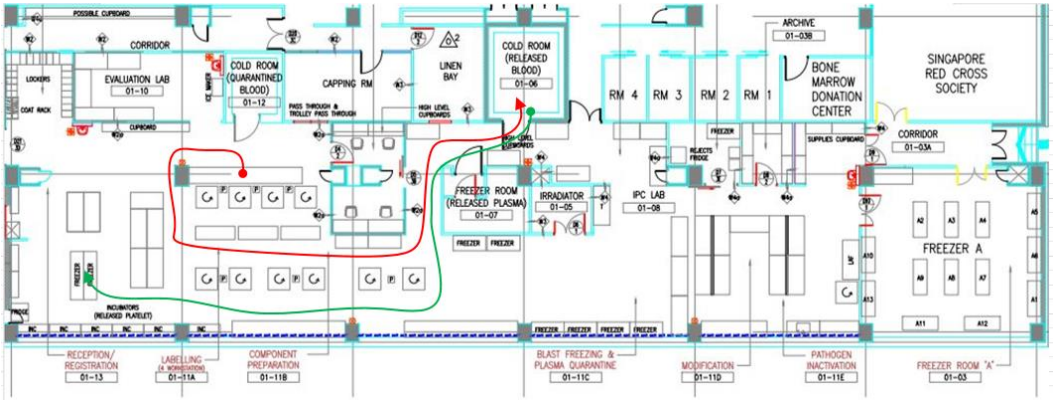

Figure 3 Example of travel routes in RBC processing

If we "straighten" the red and green travel routes and sum them, it transverses the entire length of the lab. In addition, the travel in the lab is currently done manually, which means the staff has to push a trolley with samples from one station to another; the travel speed is now slower than normal walking speed. Clearly, visual observation suggests a potential for automating the transport system.

Waiting Time Waste: During line visit, it is observed that the unexpected down-time of blood component extractor occurs at a noticeable frequency. The extractor machine pauses when such machine errors occur; the staff has to manually adjust the blood bag and tubing. This requires the staff to pay extra attention and monitors the machine running status and immediately adjusts to avoid process delays. Hence, waiting time is incurred.

Inventory Waste and Defects: Again, due to the nature of the blood component services, over-production is allowed, and hence inventory is maintained at a more-than-sufficient level. Defect is not the focus of the process optimisation as well.

Future state VSM

The future CPI lab can be re-designed for better flow and less interruptions, and robotic process automation can be introduced to reduce the need for manpower, lift productivity, and ensure consistency of work speed. We now look at each aspect.

The design of the future floor layout assumes that the floor area of the future CPI lab is unchanged. This provides for a better comparison between the current and future travel distances. The functional areas are rearranged in the sequence of component processing steps which allow materials to move in a “U-shape” path from the receipt entrance to the finished goods distribution window (exit). Figure 4 shows an example of the future movement path in RBC processing. The functional activities which are shared across components, such as incoming inspection, centrifuge, and extraction, are located next to the receipt entrance. Those functional areas which process specific components are moved to the back of the lab. The storage rooms for the pending and released products are moved to the side facing the distribution window; there are two purpose of such a design. First, it reduces the travel distance from the storage to dispatch stations and avoids any path intersection of the components. Second, the cold room placed next to the distribution window blocks any outside views, lending privacy to the internal operations. In general, such a design reduces the redundant travel distance to the greatest extent by ensuring that the component does not move back and minimizes route intersections. A reduced travel distance indicates time savings.

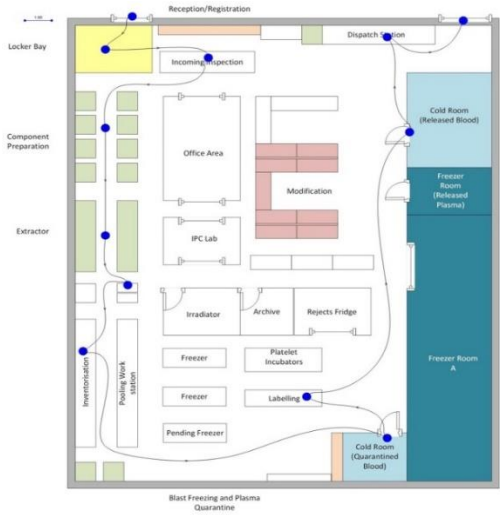

Figure 4: Example of future travel path in RBC processing

The paths of the three components, RBC, plasma and pooled platelets are plotted with eVSM and the distance between the functional areas are measured. Figure 5 shows the distance savings for each functional activity. Based on the data collected, by finding the total travel distance of each component, the new floor layout would yield a 37% distance savings for the RBC, and 45% for the plasma. The travel distance in the pooled platelets is found to be comparable with the current design. Again, time can be saved.

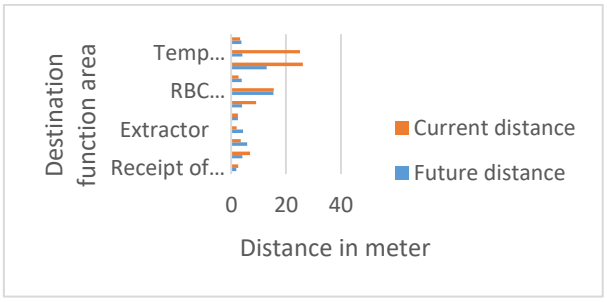

Figure 5: Example of RBC travel distance by functional area comparison

Currently, in the lab, the materials, e.g. blood bags are transferred manually or by trolleys. Automating the transport system will free the lab officers from the manual task of transferring the

samples and assigning them to more value-added tasks. Implementing a simple to use conveyor system which can be customized with a maximum width of 60 cm, maximum load of 91 kg can help to achieve robotic process automation and is sufficient for the transfer of the lab samples. In fact, robotic process automation in blood handling not only helps to enhance the efficiency, but also enables the process to proceed in a safer environment. In the blood components processing, automated devices can reduce the amount of manual operations such as centrifugation, component separation, and so on. Semiautomatic equipment is also available for the separation of plasma, RBC, platelets, which greatly enhances the efficiency of processing the leuko reduced products (Pasqualetti et al. 2004). Automation eliminates manual errors, reduces manpower, and provides uniform performance (Gupte 2015), which also plays an important role in testing.

In a possible future layout with process automation introduced, the storage area can be grouped and arranged in sequence along one side of the lab. The conveyor system can be installed along the wall of the storage rooms as demonstrated in Figure 6 in the orange patterned area. It will offer minimum disruption to the lab officer's normal workflow.

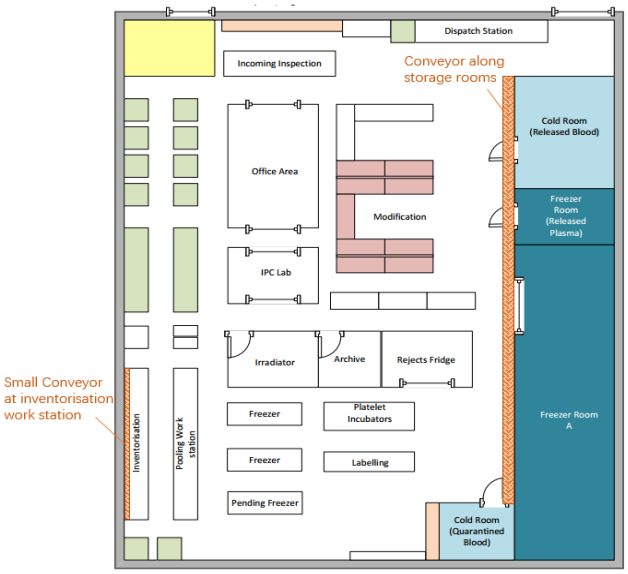

Figure 6: Conveyor in proposed future layout

A lift gate for the conveyor will be installed in front of the entrance of each storage room so that it can be easily lifted for access through the conveyor line. The conveyor system is designed with an automatic stop/start control. When the gate is lifted, the conveyor will stop automatically. When gate is returned to its original position, the conveyor will resume.

The labelling (inventorisation) station can also be automated. Inventorisation is a key step used to record the newly processed/extracted blood components into the IT system. Upon inventorisation, the qualified products will be labelled with a printed label. This currently requires a PC, a handheld barcode scanner and a labelling machine. The staff picks up a component bag, scans the barcode on the existing bag label to enter the bag ID into the IT system, and apply a new label generated by the labelling machine onto the bag.

This work process can be automated by using a barcode scanner robotic arm, a small conveyor, and a labelling placement robot. Figure 7 shows a simple demonstration of an existing laboratory application by Microscan. The barcode scanner is installed on the robotic arm. with a slight modification of the robotic hand so that the soft gripper can pick up the blood bags instead of the test tubes. The scan speed of such a scanner is 1000 scans/second. Installing this equipment can reduce the work time at the scanning station.

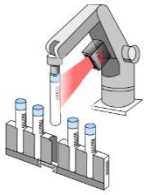

Figure 7: Barcode scanner robotic arm
Source: files.microscan.com/case-studies/cs_lab-auto_ms-3.pdf

Ideally, the blood bags are to be placed on the small-scale conveyor which can be integrated into the inventorisation work station. When the barcode scanning is complete, the blood bags are transferred by conveyor to the next step for labelling placement. As the distance between these two steps is short, the small conveyor is optional. Staff who is assigned at the component pooling workstation can help in this transferring process.

Next, we consider using a robotic precision labelling applicator for the labelling placement (Figure 8). As the robotic arm lifts each sample to the labelling machine, apply the label on the sample, and return the sample back to the tray.

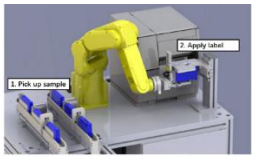

Figure 8: Label placement robot
Source: http://www.inventekengineering.com/services/robotic-precision-label-applicator/

The advantages of the automated storage and retrieval system (ASRS) for storing the blood bags can help to eliminate human errors, increase safety during dispensing and better use of the storage area. Automating the storage removes the need for static shelving. Instead there will be a robotic replacement for the vertical carousel. The lab officer will no longer need to locate, pick, and verify the blood bags in a very low temperature environment. The lab officers only needs to key in the required retrieval instructions on a PC, and the ASRS will retrieve the items accordingly.

Figure 9: Swisslog storage and retrieval system
Source:http://www.swisslog.com/en/Products/HCS/Medication-Management-Systems/BoxPicker-Automated-Pharmacy-Storage-System

We now propose, through design thinking and applying lean engineering principles, two options for the future state VSM. The first option is without automation while the second option incorporates robotic process automation where possible.

VSM for future layout without automation

Based on the proposed future layout, we developed the future state VSM. As the RBC processes cannot be modified, the focus of the future state will be on the optimisation of the movements between the production processes, e.g. travel time. For instance, the original movement from the labelling station to RBC finished goods cold room takes a minute. In the proposed future layout, the

distance is shortened, allowing for a 30 second transit instead, assuming the walking speed of the staff remains constant (see Figure 10).

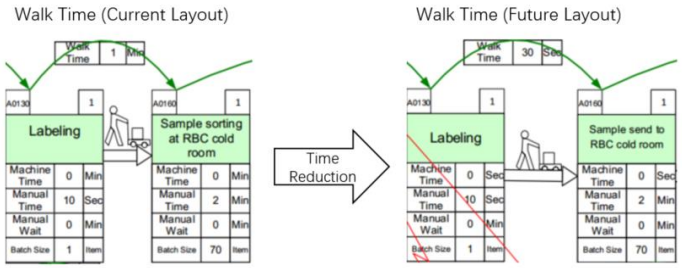

Figure 10: Walk time reduction of future layout vs. current layout (w/o automation)

VSM for future layout with automation

Automation will further enhance productivity by reducing the walk time, storage, and retrieval times as well as the time spent on inventorisation/labelling. For example, the lab officer will no longer need to push the trolley to transfer the samples manually. Instead, samples will be delivered on conveyor belt so that manual walking time is significantly reduced. By adopting an automated system of labelling, storage, and retrieval, physical walking and waiting is reduced. Figure 11 shows that the walk time by a staff is now 0.

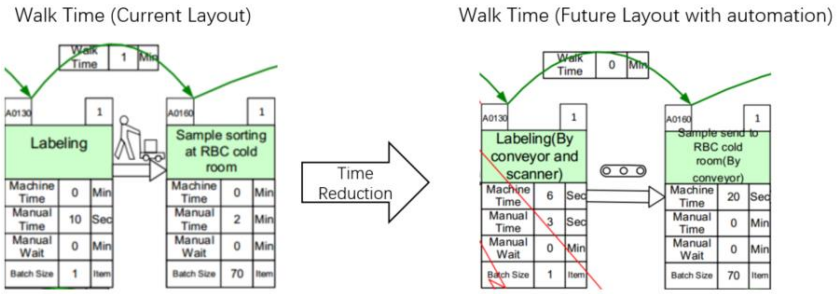

Figure 11: Walk time reduction of future layout vs. current layout (with automation)

Cost Benefit Analysis

To decide which of the two future VMS states to adopt, we now need to undertake a cost-benefits analysis to determine the impact of the capital cost of purchasing, installing and maintaining the automation equipment. The costs of the automation equipment were collected from suppliers or from Alibaba based on the current throughput and floor space data. The cost calculation includes the set-up cost, operating cost, and a straight line depreciation. The set-up cost for the ASRS, for example, includes the cost for the grid structure, the work stations, robots, necessary control software, and equipment installation. Suppose the automation equipment depreciates to a half of its original price within 5 years, and the annual operating costs are estimated to be 10% of the original cost, there would be an additional cost of $141,146.50 each year under robotic process automation, as shown in Table 3.

Table 3: Cost-benefit analysis

Cost Benefit Analysis for Automation					
Costs					
Category	**Item**	**Qty**	**Cost (S$)**	**Depreciation period**	**Cost**
Transport system	Conveyor belt	15	$ 350.00	5 years	$ 5,250.00
	Conveyor lift gate	4	$ 200.00	5 years	$ 800.00
Inventorization automation	Barcode scanner robotic arm	3	$ 3,200.00	5 years	$ 9,600.00
	Label placement robot	3	$ 7,000.00	5 years	$ 21,000.00
ASRS	ASRS system	1	$ 80,000.00	5 years	$ 80,000.00
Operating cost					$ 11,665.00
				Total Cost	$ 141,146.50
Benefits(estimated per annum)					
Increase in productivity per FTE					5993
Reduction in labour cost	$				(122,592.00)
Non-monetary benefits					
Reduction of human error					
Improvement in employee safety					
Optimized space utilization					

The main benefits brought about by process automation is the increase in productivity and reduction in labour cost. Before automation, the daily productivity of a full time staff is 101.57 blood bags; with automation, this value increases to 117.99. Hence, with automation, labour productivity increases by 16%. This effectively reduces the number of staff from 3.45 to 2.97 for each weekday and from 5.51 to 4.75 for each weekend, respectively. Assume 261 weekdays and 104 weekends in a year, and an average labour cost of $40/hour, the saving in manpower cost is found to be $122,592.

Besides the annual cost increase of $18,554.50, there are also other non-monetary benefits. In the current manual process, human error in the picking and labelling is inevitable, using robotic process automation would increase the operation accuracy significantly. Further, automation also offers a higher level of employee safety. For example, using the ASRS, staff would not have to enter the plasma storage cold room of under -30°C. It reduces the probability that an operator could experience physical harm. Deploying an ASRS will also optimize the space utilization by allowing for more products to be stored in the same space.

Our future layout design was predicated on a constrained floor space. This limits the choice of the automation system. In reality, with more floor space available, a more elaborate transport system other than a conveyor belt could be considered (i.e., AIV robot).

Conclusion

In this study, the current state of the blood handling process and inventory in the CPI lab was documented. All the waste and non-value-added activities were identified, as well as the opportunities for floor layout improvement and automation, using simple principles of lean engineering. The new floor layout design aims at re-allocating the functional activities and areas to optimize space utilization and minimize the transport time. Later, through design thinking, automation was proposed in the transport, inventorisation and labelling, as well as the storage and retrieval of the blood components. A future VSM was developed in two scenarios under a redesigned floor layout with/without the adoption of automation. Under automation, labour productivity improved by 16%. A cost-benefit analysis was also conducted to evaluate the economic feasibility of automation. Last but not least, this study can help other time sensitive and perishable service firms to consider using the traditional VSM redesign as part of the design thinking and lean engineering to improve their workflow, reduce waste in travel and waiting, and lift the productivity of existing operations.

References

Due to the constraint in space, the references are available from the authors on request.

SALES FORECASTING OF BOW SAW BLADE USING ARTIFICIAL NEURAL NETWORKS IN INDUSTRIAL BLADE FACTORY IN THAILAND

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Introduction

Forecasting is very important in many types of organizations since predictions of future events must be incorporated into decision-making process. Business firms, in particular, require forecast in many events and conditions in all phases of their operations. For example, total demand for products, demand in each product line, the numbers of workers required in different jobs must be forecasted in order to plan total management effort (Bowerman et al, 2005).

There are many ways to forecast the future. Many firms (especially smaller ones), the entire process is subjective, intuition, and years of experience. There are also many quantitative forecasting models, such as moving average (MA), exponential smoothing (ES), seasonality analysis and regression analysis (Render et al (2003). Furthermore, some advanced forecasting techniques are developed and used in academic institutions and many organizations. For example, there are artificial neural network (ANN), autoregressive integrated moving average (ARIMA) (Samarasinghe, 2007) etc.
A blade manufacturing factory, which is located in northern region of Thailand, is selected. The factory is established more than 30 years. Seventy workers are employed. Industrial blades and saws are their main products. Production planning policy of each product is different. Industrial blade production is used a make-to-order policy. On the other hand, saw blade production is used a make-to-stock policy. They sell their products in Thailand and neighbor countries such as Myanmar, Laos People's Democratic Republic, and Cambodia. Total sales volumes of the factory is more than 100 million baht per year.

Management of this factory has never been used any kinds of quantitative forecasting technique in order to forecast their sales volumes. They are interested to use forecasting techniques in sales forecasting. Saw blade is focused because management would like to determine production amounts more precisely. Question may arise which forecasting techniques should be selected for the factory. This study is deployed and compared three classical forecasting techniques with artificial neural network (ANN).

Research Methodology

Moving Average

Moving average is a simple and useful forecasting technique if we can assume the item we are trying to forecast will stay fairy steady over time. The moving average for the preceding *k* periods (where *k* can be any integer >= 2) serves as the forecast for the following period. Mathematically, the k-period moving average can be expressed as

$$\text{k-period moving average} = \sum(\text{Actual value in previous k periods})/k \quad (1)$$

Exponential Smoothing

Let F_t denote the forecast in period t and A_t denote the actual value in period t. The basic exponential smoothing formula is also follows:

Forecast for period (t+1) = forecast for period t + α (actual value in period t – forecast for period t)

$$F_{t+1} = F_t + \alpha(A_t - F_t) \quad (2)$$

Where α is a weight (called a smoothing constant) that has a value between 0 and 1.

Holt-Winter's Additive Exponential Smoothing

Let Y_{t+n} denote the forecast in period t+n. E_t denote the level of expected value in t period. *St* denote the seasonality factor in t period. *p* denote a number of time periods of a season.

$$Y_{t+n} = E_t + nT_t + S_{t+n-p} \quad (3)$$

$$E_t = \alpha(Y_t - S_{t-p}) + (1 - \alpha)(E_{t-1} + T_{t-1}) \quad (4)$$

$$T_t = \beta(E_t - E_{t-1}) + (1- \beta)T_{t-1} \quad (5)$$

$$S_t = \gamma (Y_t - E_t) + (1- \gamma)S_{t-p} \quad (6)$$

Where $0 \le \alpha \le 1$, $0 \le \beta \le 1$, and $0 \le \gamma \le 1$

Artificial Neural Network

The artificial neural networks (ANN), has shown great potential to be an effective tool to handle complex non-linear problems. The ANN method is a biologically inspired computational technique that imitates the behavior and learning process of human brain. It can update itself through learning from training samples. The ANN is widely used in many areas such as pharmaceutical research (Agatonovic-Kustrin and Beresford, 2000), combustion research (Xing et al, (2018). Figure 1 shows the schematic diagram of the topological structure of the ANN model.

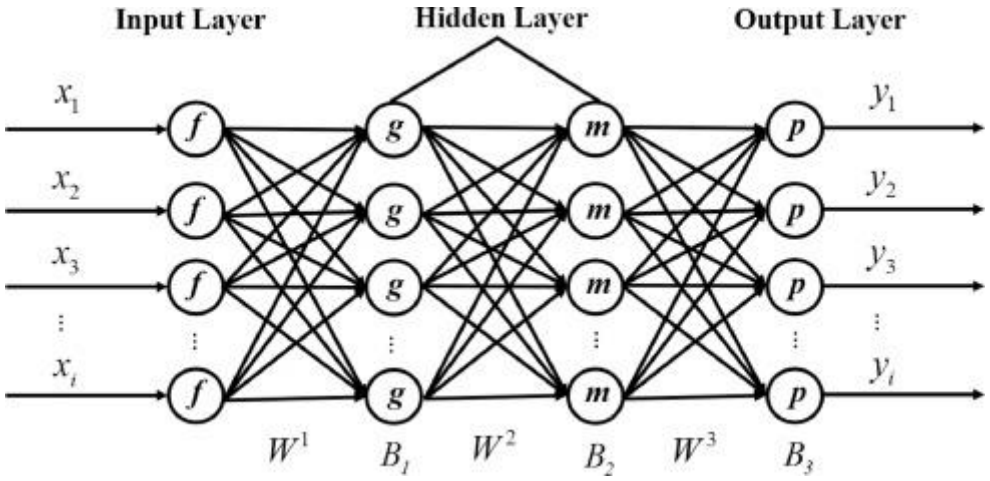

Figure 1 Topological structure of the ANN model

The ANN is composed of three kinds of layer, including input layer, hidden layer and output layer. The input data always flow from the input layer, and then are transferred to the output layer to obtain predictions with the help of activation functions, weight and bias vectors between neurons in the hidden layer. The final output for the ANN with two hidden layers can be expressed as:

$$y = p\{m[g(f(x)W1+B1)W2+B2]W3+B3\} \quad (7)$$

where *x* and *y* are the scaled input variables and output target vector respectively. W^i and B_i are the *i*th weight and biases vector for the *i*th neuron layer, respectively.

Measuring Forecast Error

Mean squared error (MSE) is computed as the average of the squared values of the individual forecast errors. If we have forecasted and actual values for T periods, the MSE is calculated as

$$MSE = \sum (A_t - F_t)^2 / T \quad (9)$$

There are four sizes of bow saw blade in the factory. There are 12-inch, 21 –inch, 24-inch and 30-inch. Sales data is collected for five years. 24–inch bow saw blade is selected because sales volume of this size is the highest volume. Figure 2 shows sales volumes of each size in five years.

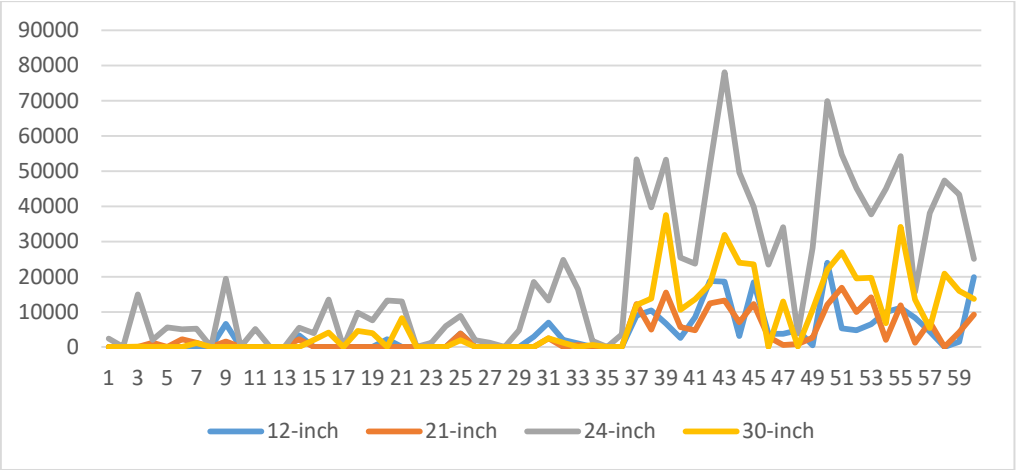

Figure 2 sales volumes of each size of bow saw blade in five years (pieces/month)

Research Results

The following forecasting models are used in this study. There are Moving Average, Exponential Smoothing, Holt-Winter's Additive Exponential Smoothing and Artificial Neural Network, respectively. Figure 3, 4, 5 and 6 show forecasting results of each forecasting model. Furthermore, table 1 also shows the MSE of each forecasting model.

The first three conventional methods are forecasted by using Microsoft Excel. The ANN model is a back-propagation network model using the R statistical program.

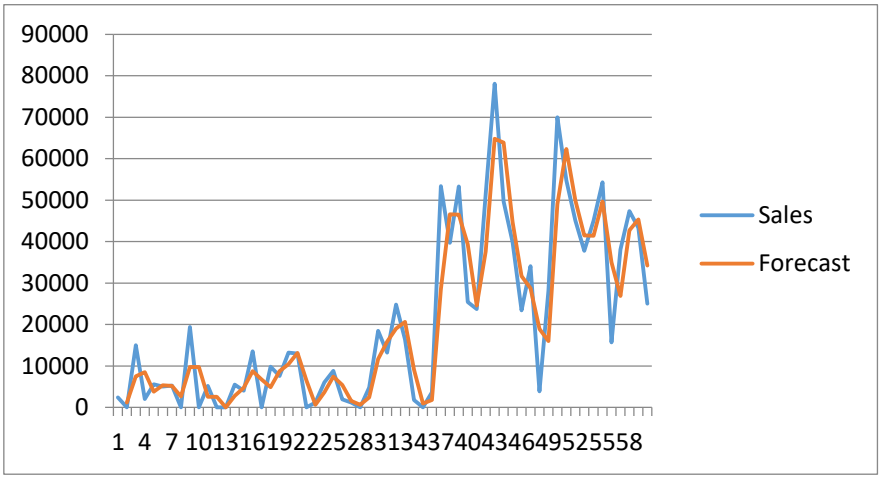

Figure 3 Moving Average forecasting model (2 months)

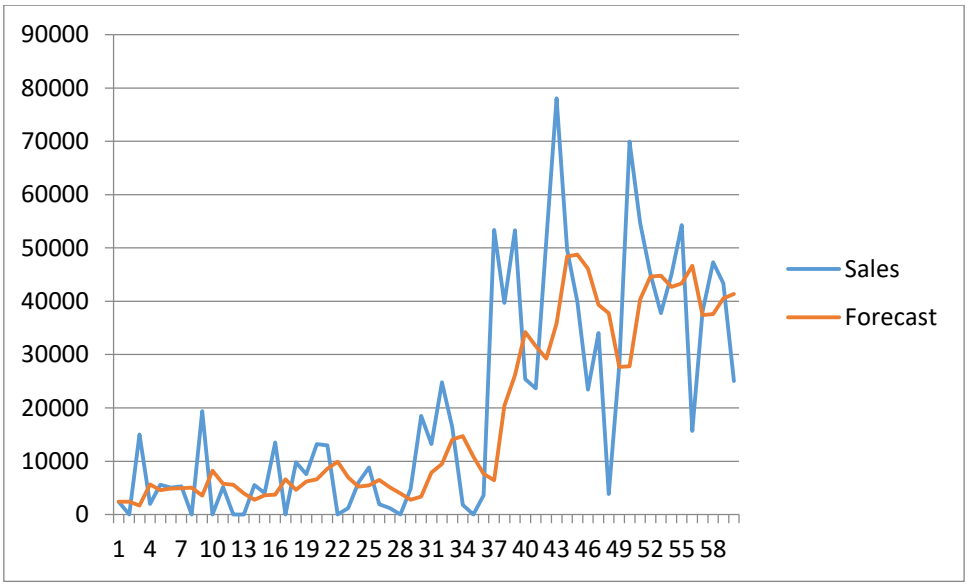

Figure 4 Exponential Smoothing forecasting model (α = 0.2976)

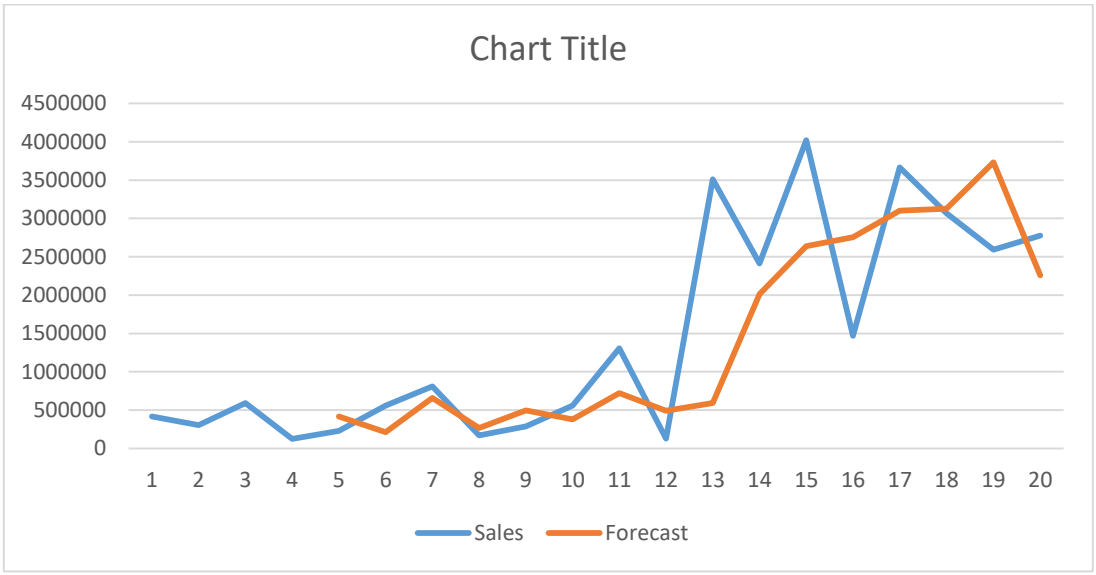

Figure 5 Holt-Winter's Additive Exponential Smoothing forecasting model (α = 0.4348, β = 0.0792, γ = 0.2847)

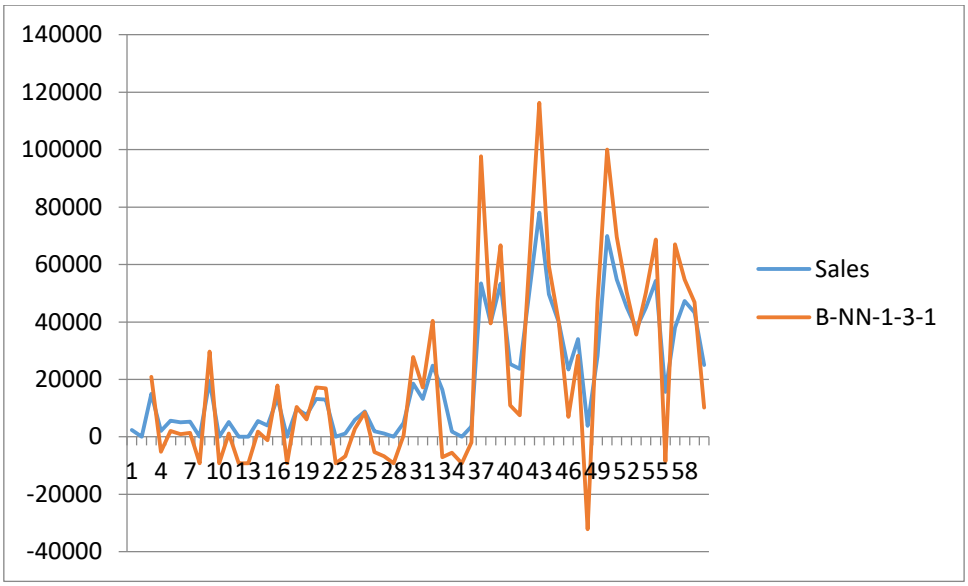

Figure 6 Artificial Neural Network forecasting model

Table 1 The MSE of each forecasting model of bow saw blade

Forecasting model	MSE
1. Moving Average	6.44×10^{7}
2. Exponential Smoothing	2.17×10^{8}
3. Holt-Winter's Additive Exponential Smoothing	9.29×10^{11}
4. Artificial Neural Network	1.99×10^{8}

Table 1 is shown that the MSE of Moving average forecasting model is the lowest value. On the other hand, the MSE of Holt-Winter's Additive Exponential Smoothing forecasting model is the highest value. Therefore, Moving average forecasting model should be chosen to forecast sales volume of bow saw blade.

Conclusion and Discussion

This study is focused to choose a forecasting model which appropriate with the sales volume of bow saw blade. Four forecasting models are studied. Conventional models require basic knowledge. On the other hand, advance models require advance knowledge. According to the results, a conventional model should be chosen.

The ANN model in this study may not fit to the data. Actually, there are many ANN forecasting models. Of course, they are complicated ones. Neural network may not work with some problems. In other words, some problems maybe well suited for the pattern recognition capabilities of a neural network model. Other problems may be best solved with other conventional methods (Tam, 2007).

Management (especially smaller firms) may select a forecasting model by using many criteria e.g. forecast error value, how easy to use, a ready-to-use computer program.

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SMART TRAVEL PLANNING FOR CHIANG MAI'S ECOTOURISM

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Introduction

While Thailand benefits from being one prime tourism destinations on earth, Chiang Mai has traditionally been top five most popular cities for tourists in the country. Welcoming over 10 million visitors in 2017, Northern Thailand in general and Chiang Mai in particular, is presented with significant challenges regarding the maintenance of its innate natural beauty, abundant resources and enriching cultural heritage. Chiang Mai's most notable natural resources are its lush flora, timber covered mountains and its many lakes, walking and hiking trails. Because of its breathtaking beauty, natural resources and the seemingly endless number of places to discover, the city has been recognized as a top destination for ecotourism. With all of this in mind, It would be a good idea for tourists to have access to a platform which provides up to date information about the variety of destinations available to visit in Chiang Mai along with predetermined plans about ecotourism excursions in Chiang Mai. It has been determined from a recent survey, that at present, there are no applications yet under development which offers these conveniences.

The magnitude of information communication technologies in tourist understanding and experience has been confirmed by past studied (Neuhofer et al., 2014) as well as in transforming the meaning of travel (Wang et al., 2012). Information communication technologies, particularly mobile technologies, increasingly influence the formation, facilitation and co-creation of tourist experience (Neuhofer et al., 2014). Consumers use IT extensively to evaluate alternative travel opportunities and to compare and contrast offerings (Law et al, 2009). Using meta search engines, potential travelers can identify and evaluate products according to their preferences, filters, and requirements (Buhalis & O'Connor, 2005). On-site information search through the website also enhances travel experience and influences how tourists view a destination (Wang et al., 2012).

In this study, we develop a web-based application providing updated destinations and suggested plan about ecotourism in Chiang Mai. As a pilot study, the most popular 10 ecotourism destinations in the city were collected from the secondary data observation through website. The classical method of travelling salesman problem (TSP) is applied to create the suggested travel plans for ecotourism routes starting from the city center. We consider the different time constrains between 3 and 48 hours for tourists to offer each trip plan and travel itinerary.

Literature review

Traveling salesman problem

Traveling Salesman Problem (TSP) is one of the most classical and famous problem in the field of operations research and computer science. It is a mathematical optimization problem which better solutions often means a solution that is cheaper. The problem can simply be stated as: if a traveling salesman wishes to visit exactly once each of a list of *m* cities (where the cost of traveling from city *i* to city *j* is *cij*) and then return to the home city, what is the least costly route the traveling salesman can take? Arithmetically, the traveling salesman problem can be depicted in graph form, showing places of interest as the points and the edges (or arcs) represent direct routes between the points of interest. The importance of each edge is the distance between the points. The goal is to find the path with the least amount of time constraints and obstacles.

An extensive examination of every possible route would be sure to reveal the fastest course possible. Unfortunately, it is mathematically recalcitrant to manage a large number of locations at the same time. For greater problems, techniques are needed in order to logically research the problems and find near-optimal solutions. A comprehensive study of this and related problems can be found in Hoffman and Wolfe. (1985), Applegate et al. (2006), and Cook (2011). Recently, TSP has been applied to offer a trip plan of tourist destinations problem. Those aimed to generate itineraries that maximize the

total value of the attractions visited and minimize the total travel cost involved. (Fatthi et al., 2018; da Silva et al., 2018; Hashim and Ismail, 2017; Barrena et al., 2016)

Ecotourism

Ecotourism is a form of tourist travel which involves visiting relatively natural and undisturbed areas. It is meant to be a way of traveling which has low impact on the natural environment conserving the environment and improving the well-being of the local people. Since the focus of ecotourism is primarily on socially responsible travel and environmental sustainability, people and organizations who develop and execute ecotourism programs and similar projects should adhere to the following sustaining principles (TIES, 2015):

- Minimize human impact on the natural environment socially and behaviorally
- Foster awareness of the environment and respect for culture
- Encourage mutually enjoyable experiences for both hosts and visitors
- Finance the costs of conservation.
- Create income for the local community and private businesses.
- Offer experiences which are memorable to visitors that help raise sensitivity to a host of environmental problems.
- Operate environmentally friendly businesses which have a low-impact on the environment.

Be mindful of the beliefs and rights and of the Indigenous and help to empower the community.

Method study

This section presents our ways of doing work to develop a smart travel planning for Chiang Mai's Ecotourism as follows:

1) An initial survey of ecotourism attractions in Chiang Mai

Because of its breath-taking beauty, natural resources and the seemingly endless number of places to discover, the city has been recognized as a top destination for ecotourism. Anyhow, as a pilot study, the most popular ten ecotourism destinations were collected from the secondary data observation or the internet search. The top ten attractions from several websites can be shown in figure 1.

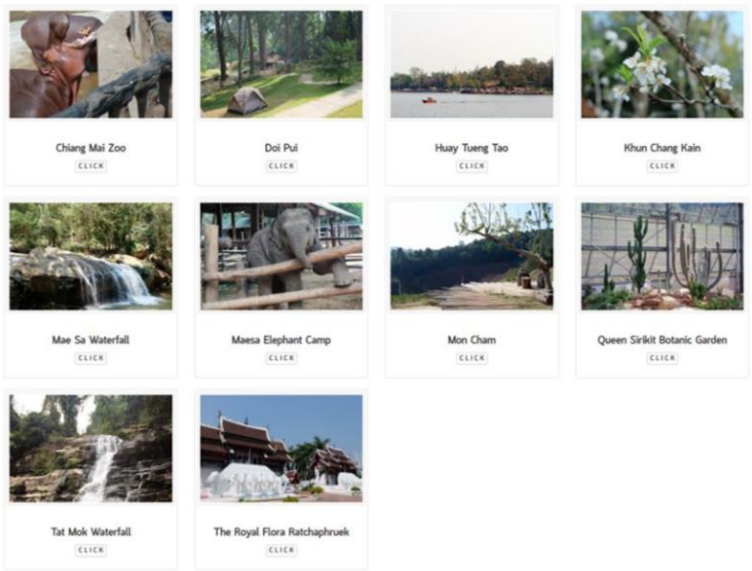

Figure 1: Selected ten ecotourism attractions in Chiang Mai

2) TSP for selected ten ecotourism attractions

We create the TSP matrix for the most popular ten ecotourism destinations by using the Google Maps Distance Matrix API. This can also help calculate distances between attractions as well as create the distance matrix from the results. The code shown below creates the data for the problem: the attractions and the distance matrix, whose entry in row i and column j is the distance from city i to city j in kilometres and travel time by car in hours.

```
# Attraction
Attraction_names = ["Chiang Mai Zoo", "Doi Pui National Park", "Huay Tueng Tao Lake", "Ban Khun Chang Khian
Christendom", " Maesa Waterfall", "Maesa Elephant Camp", "Mon Chaem", "Queen Sirikit Botanic Garden", "Tad Mok
Waterfall", "Royal Park Rajapruek"]
# Distance matrix
distance_matrix =
 [   0,  22/44,  11.3/22,  24.8/54,  22.1/32,  25.5/34,  36.5/53,  28.9/43,  28.5/41,  12.7/24 ], # Chiang Mai Zoo
 [ 22/4,    0,  13.4/61,  2.8/10,  43.2/73,  47/78,  58/97,  50.4/87,  50/83,  33/63 ], # Doi Pui National Park
 [ 11.3/22,  13.4/61,    0,  11.7/55,  16.6/22, 20/25, 31.1/44, 23.4/34, 23.2/32, 19.2/29 ], # Huay Tuen Tao Lake
 [ 24.8/54,  2.8/10,  11.7/55,    0,  28.3/78,  31.8/81,  42.8/100,  33.6/84,  34.8/87,  35.7/82 ], # Ban Khun Chang Khian
 [ 22.1/32,  43.2/73,  16.6/22,  28.3/78,    0,  4.7/8,  15.8/28,  6.5/11,  11.6/19,  30.4/40 ], # Maesa Waterfall
 [ 25.5/34,  47/78,  20/25,  31.8/81,  4.7/8,    0,  11/19,  1.8/3,  15/22,  33.8/43 ], # Maesa Elephant Camp
 [ 36.5/53,  58/97,  31.1/44,  42.8/100,  15.8/28,  11/19,    0,  11/22,  12.4/28,  44.8/63 ], # Mon Chaem
 [ 28.9/43,  50.4/87,  23.4/34,  33.6/84,  6.5/11,  1.8/3,  11/22,    0,  16.8/24,  35.6/46 ], # Queen Sirikit Garden
 [ 28.5/41,  50/83,  23.2/32,  34.8/87,  11.6/19,  15/22,  12.4/28,  16.8/24,    0,  36.8/50 ], # Tad Mok Waterfall
 [ 22/12.7,  33/63,  19.2/29,  35.7/82,  30.4/40,  33.8/43,  44.8/63,  35.6/46,  36.8/50,    0 ], # Royal Park Rajapruek
```

Figure 2: Distance matrix of ecotourism attractions in Chiang Mai

3) Development of web-based application

Designing the web application involves the graphic user interface, the content on the website, and showing the way of development. Our work aimed to develop a web application that presents a smart travel planning for Chiang Mai's Ecotourism. In this step, analysis of the ecotourism attractions and categorization are considered. Databases were created to record the following information: 1. Ecotourism Destinations 2. Distance 3. Activity Information 4. Time Tour 5. VDO 6. Picture

Secondly, the designed database also contained the file: (i) Design database structure (entity relational) (ii) Normalization (iii) Development database

Third, the web structure design contained the directory of the website:

(i) Title page (the home page showing a picture of Chiang Mai Ecotourism)
(ii) Ecotourism attractions (the menu showing information of each top ecotourism attractions)
(iii) Recommended routes (the menu suggesting a smart travel planning under time constraints)
(iv) Searching (the text box which accept keywords to search for ecotourism attractions)
(v) About the project (information on this project)

Fourth, the Graphic User Interface (GUI) was designed, which provides access by and interaction between users and the system and the exchange of information. Graphical multimedia was also used displaying Chiang Mai Ecotourism photography.

4) Development and Implementation

The development of the web application for smart travel planning also used SQL and an available program for developing the website using a responsive web site pattern. A requirement of the web application for smart travel planning was the need to create a trip plan and travel itinerary. We installed this requirement through social media plug-in code for support interaction, collaboration, and knowledge sharing. Figures 3 presents the example showing each panel displaying top ecotourism attractions and information.

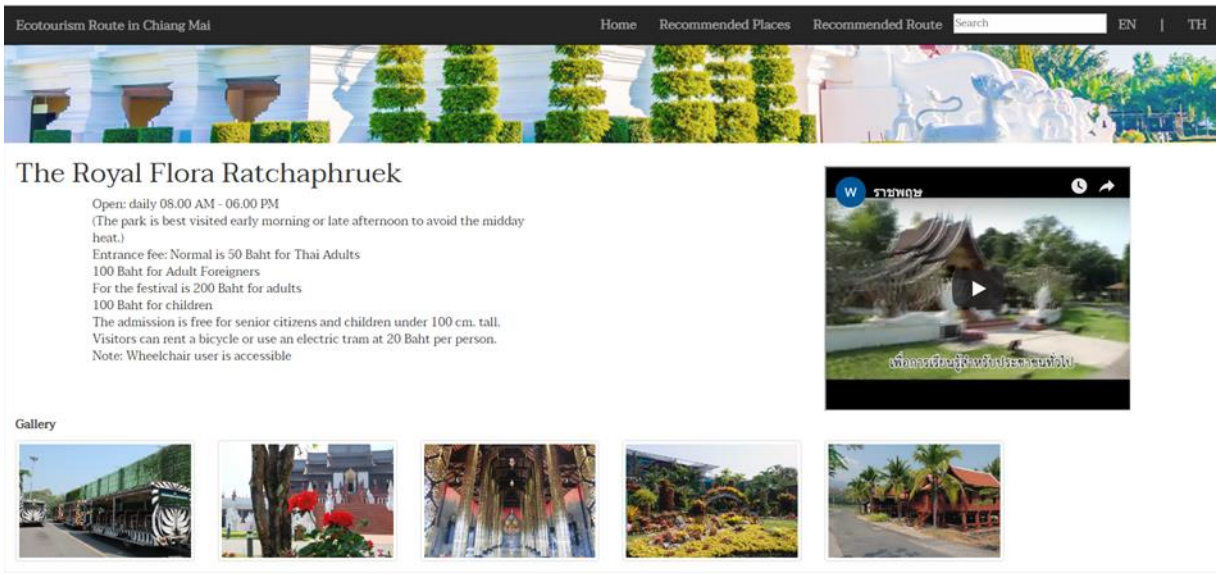

Figure 3: Information display of Royal Flora Ratchaphruek

The study purposes the plan based on the length of traveling duration between 3 hours and 48 hours for tourists to manage their traveling time as shown in figure 4. An example of created trip plan and travel itinerary by TSP algorithm for ecotourism route in Chiang Mai starting from the center shown in Figure 5 and 6.

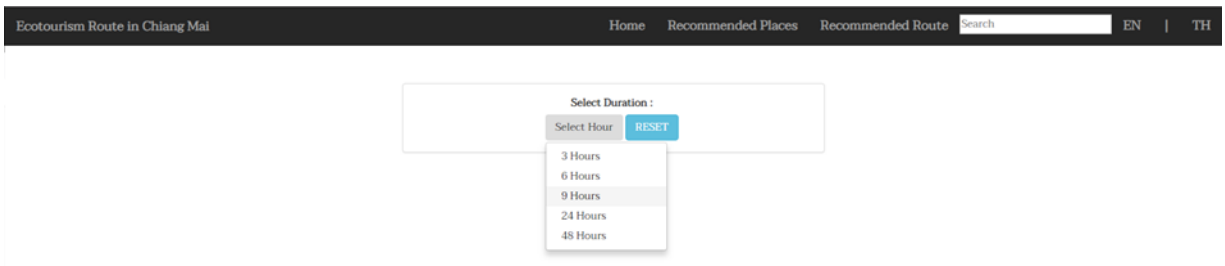

Figure 4: Options for traveling duration

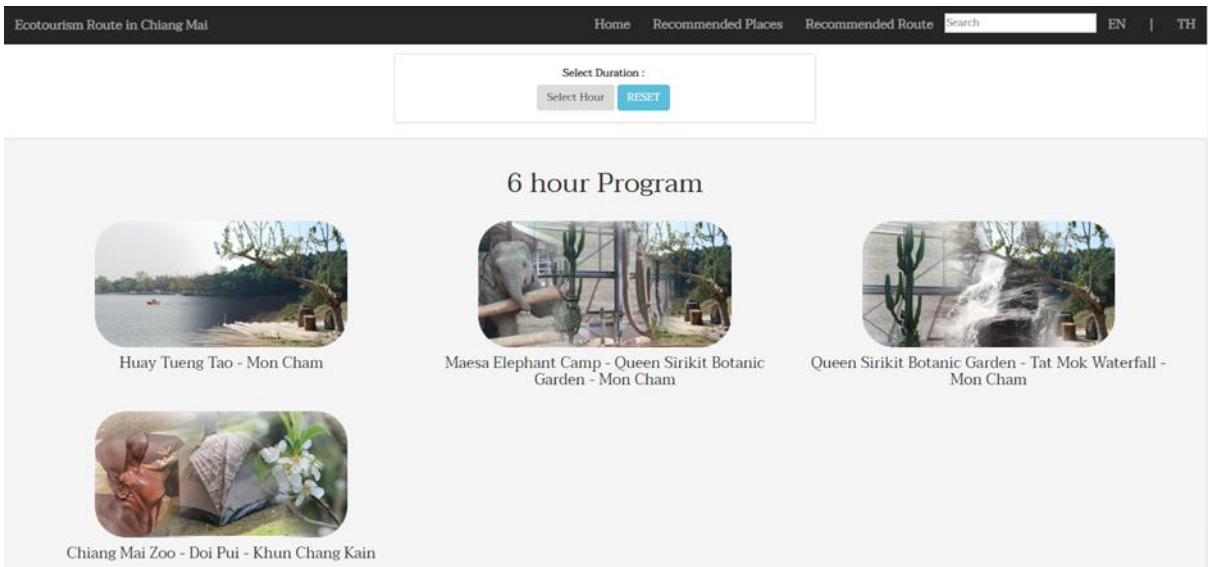

Figure 5: Offered programs for 6 hours traveling duration

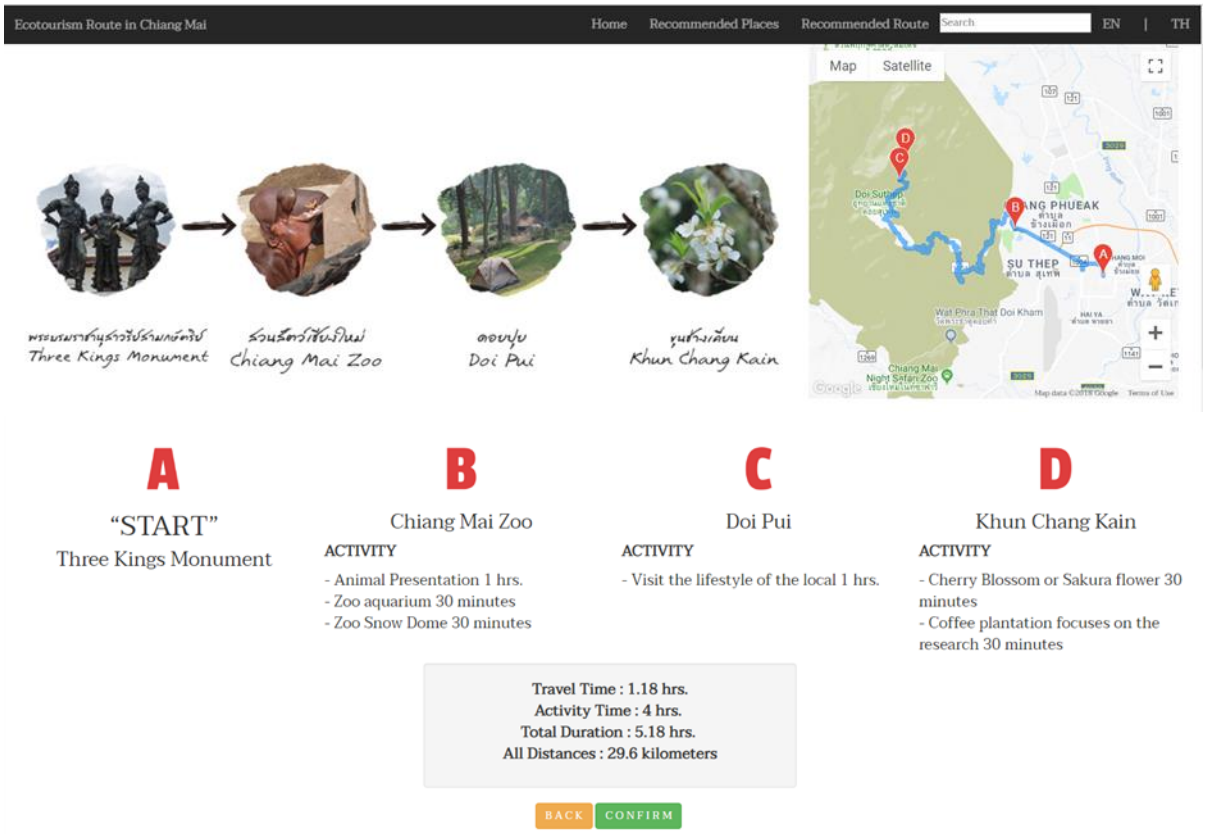

Figure 6: Selected trip plan and travel itinerary

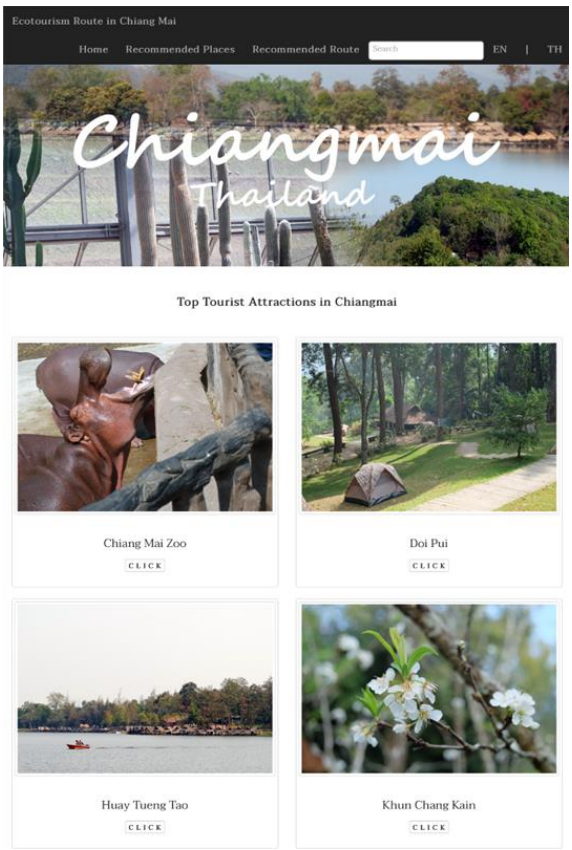

Figure 7: The display of home menu on smartphone

The responsive retrofitting web pattern provided an appropriate display for many devices such as a desktop computer, a tablet computer, and a smart phone. Our development can handle the resolution problem and display in an appropriate size on the screen. Figure 7 shows the appropriate size for display on a smartphone which is how the majority of people access web applications. After the development and implementation testing, the web application was uploaded to the internet, which could then be accessed using different devices. The outcome of the development contributed to a smart travel planning for Chiang Mai's Ecotourism.

Discussion and conclusion

With economic development, people have more and more free time and become more leisure-oriented. However, because of the time and physical constraints, most of the people are prone to taking short vacations. Well planning in advance is the foremost task that must be done in order to have a pleasant trip. A good travel plan not only allows a visitor gain the maximum enjoyment during the trip, but also satisfies his/her needs within the time and budget constraints. This study employs the advantages of traveling salesman problem to the tourism context. The outcomes of this research are presented and available for the target tourists as the web technology platform which could increase tourists' satisfaction level when they are looking for a travel itinerary planning for ecotourism destinations in Chiang Mai. We use modern computer-based technology, which is not new but is an appropriate development. Our development produced a web application which has been uploaded to the domain name at www.ecotourismchiangmai.com. The design and development accommodate user needs looking for a smart travel plan.

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STRUCTURAL CHARACTERISTICS OF HUMANITARIAN SUPPLY NETWORK

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Introduction

In disaster relief operations, The humanitarian supply network (HSN) consists of various actors involved such as donors, aid agencies, NGOs, governments, military, and logistics service providers, and suppliers (Kovács and Spens, 2008), community-based organizations, beneficiaries (Oloruntoba and Gray, 2006), media (Van Wassenhove, 2006). The collection of organizations that deliver humanitarian assistance can be understood as a complex open system, consisting of specialized units that are loosely coupled, socially connected, and highly dependent on external resources (Seybolt, 2009).

These actors differ in local presence, size, and mandate. Typically, no single actor has sufficient resources to respond effectively to a major disaster (Balcik et al., 2010). This difference in organizational structure affects the response times of these organizations (Kovács and Spens, 2009). The effective and efficient distribution of relief goods is a key challenge in disaster management. Typically, humanitarian supply network need to be built, in which various actors with different interests collaborate.

The collaboration occurs when different actors work together to address problems through joint effort, resources, decision-making (Zhao et al., 2012). Through collaboration, organizations negotiate and agree on the goals of their shared efforts and on the amount of contribution each partner must bring to execute the collaboration; in addition, organizations must align their actions to achieve the specified goals (Gulati et al., 2012). Collaboration efforts between actors in humanitarian supply network have been challenged due to characteristics of humanitarian aid environment as it is large, highly complex, differentiate, unstable, and moderate connectivity (Seybolt, 2009). Moreover, extreme demand and supply uncertainty is another obvious barrier to build relationship with other actors in the particular field (Van Wassenhove, 2006). Thereby, collaboration is considered as critical success factor of strategic plan in order to enhance the delivery performance (Pettit and Beresford, 2009). The purpose of this paper is to investigate structural characteristics of humanitarian supply network of disaster relief operations in Khon Kaen province by using social network analysis.

Literature review

Humanitarian Supply networks

The humanitarian supply network can also be called inter-organizational collaboration network (Zhao et al., 2012). Evaluating humanitarian supply network effectiveness is critical for understanding whether networks are effective in meeting the goals of the network as a whole, those of the individual network members and more importantly, the extent to which the needs of the affected people have been met (Ngamassi et al., 2014). Establishing the level of network effectiveness is also important for actors in the network and those whose policies and funding support the network. Ideally an effective humanitarian supply network would enhance the quality of service provided to its beneficiaries; optimize use of resource by reducing redundancies; however at a minimum it should achieve its own goals.

While coordination mechanisms within the domain of commercial supply chain management have been well studied, coordination in humanitarian relief chains is still in early stage (Balcik et al., 2010). Inter-organizational networks are believed to be a way to improve collaboration among humanitarian organizations. Although researchers have devoted a considerable amount of time exploring the influence of network structure on network performance and effectiveness, little work has

been done in the humanitarian relief field (Ngamassi et al., 2014). Therefore, it is increasingly important to analyse the network structure of humanitarian supply network.

Social network analysis (SNA)

Social network analysis (SNA) has recently gained acceptance among scholars for its potential to integrate the operations and supply management field with other branches of management science (Autry and Griffis, 2008; Borgatti and Li, 2009a, 2009b; Carter et al., 2007). SNA is an approach for examining the patterns of relationships that arise among interacting entities in supply chain operations. Specifically, SNA provides researchers a descriptive and statistical method to understand how supply network components are positioned, connected, and embedded within the supply network (Bellamy and Basole, 2013).

SNA provides both node- and network-level measures (Wasserman and Faust, 1994). SNA has proven to be a valuable lens and mechanism to compute and analyse salient structural and relational properties in numerous disciplines, including organizational theory and behaviour, strategic management, business studies, sociology, computer science, physics, psychology, joint ventures, interfirm alliances, knowledge transfer, and innovation (Provan et al., 2007). Surprisingly, there is comparatively little work that uses SNA in supply chain management. (Borgatti and Li, 2009b) provide an initial overview of SNA and its potential network mechanisms and properties that can be implemented by SCM researchers.

SNA is both an approach and an analytical method, allows for an in-depth investigation of the structural characteristics and the inherent relationships of such networks that would not be easily understood if investigated by traditional research approaches (Carter et al., 2007; Dempwolf and Lyles, 2012; Hollenbeck and Jamieson, 2015)

A network is made up of nodes and ties that connect these nodes. In a social network, the nodes (i.e., persons or firms) have agency in that they have an ability to make choices. With its computational foundation in graph theory (Cook, 1998; Kirchherr, 1992; Li and Vitanyi, 1991). Social network scholars (Everett and Borgatti, 1999; Freeman, 1978, 1977; Krackhardt, 1990; Marsden, 2002) have developed a range of network metrics at the node-level and network-level to characterize the dynamics inside a social network.

Social network analysis metrics

Node-level metrics

Node-level metrics measure how an individual node is embedded in a network from that individual node's perspective. Identifying the key actors in a social network is one of the primary uses of SNA (Wasserman and Faust, 1994). The concept of centrality is fundamental to node-level network metrics (Borgatti and Li, 2009a; Everett and Borgatti, 1999). Centrality reflects the relative importance of individual nodes in a network. There are different types of centrality metrics and they identify nodes that are important, in different aspects. Most prominent are as follows:

Node-level metrics	Definition	Supply network context	Calculation
Degree centrality	The number of direct ties to a node.	The extent to which the firm influences other firms on their operations or decisions as the firm has more direct contacts with others (Cachon and Lariviere, 2005; Ferguson et al., 2005).	$C_D(n_i) = \sum_j x_{ij} = \sum_j x_{ji}$
Closeness Centrality	Measures how many steps is required to access every	The extent to which a firm can act autonomously and	$C_C(n_i) = \left[\sum_{j=1}^{g} d(n_i, n_j)\right]^{-1}$

	other node from a given node.	navigate freely across the network to access resources in a timely manner (Kim et al., 2011).	
Betweenness Centrality	Measures how often a node lies on the shortest path between all combinations of pairs of other nodes.	The extent to which a firm can affect the interactions among others in the same supply network (Kim et al., 2011).	$C_B(n_i) = \sum_{j<k} \frac{g_{jk}(n_i)}{g_{jk}}$

Table 1: Node-level metrics

Network-level metrics

Social Network Analysis also yields metrics concerning the structure of the overall network, such as network density, network centralization, and network complexity. Network level metrics compute how the overall network ties are organized from the perspective of an observer that has the bird's eye view of the network.

Network topologies

Network topology is the structure of the network as a whole. The network topology can reveal characteristics of the network and behaviours (McCulloh et al., 2013). Moreover, the network topologies characterize the overall structure or configuration of a network. This can help researchers and managers in understanding how supply network function.

Developing supply network topologies will help advance existing theories on supply network structure (Borgatti and Li, 2009c; Kim et al., 2011). Random, small-world, and scale free network topologies are commonly used to represent real life supply network (Nair and Vidal, 2011). The measures can be characterized by values such as clustering coefficient, average shortest path and degree distribution of the network.

Research Methodology

This study focus on the case study of humanitarian supply network in disaster relief operations in Khon Kaen province. The province is divided into 26 districts. The 198 sub-districts and 2,139 villages. The province has local administration organizations comprise of 1 Provincial Administration Organization, City Municipality, Town municipality, Sub-district municipality and Sub-district Administration Organization. Khon Kaen province faces challenges caused by various disasters such as flood, storm, drought, fire, cold spell, forest fire and smoke and infectious disease (KKDPMPO, 2015).

Data source and Network construction

This study utilizes multiple data sources from the qualitative study such as documents and semi-structured interviews to create the structure of humanitarian supply network in disaster relief operations in Khon Kaen province. The related actors in disaster relief operations are assigned as nodes in the network. The links between actors are derived from collaboration relationship. This study used reciprocated collaborative links, meaning that both actors indicated that they collaborated. The collaboration occurs when different actors work together to address problems through joint effort, resources, decision-making (Zhao et al., 2012). The collaboration relationship among actors can be denoted by an inter-organizational collaboration network. In such a collaboration network, a node represents an actors and a link that connects two nodes means that the two actors are collaborators.

Each actor is constructed as a binary adjacency matrix, with cell entries is 1 if there is any relationship between two actors and 0 otherwise. As collaborative relationships are considered to be bi-directional, the humanitarian supply network resulted in an undirected graph (Newman et al., 2001).

Data analysis

In this study, *R programming language* and *igrapg package* which is a library collection for creating and manipulating graphs and analysing networks (Csardi and Nepusz, 2006) is used to visualizing the network, compute node-level metrics and network-level metrics.

Results and Interpretation of results

Real Structure of the humanitarian supply

A network visualization technique is used to depict the humanitarian supply network structure. R programming language and igrapg package is used to visualize the humanitarian supply network. The Reingold-Tilford layout (Reingold and Tilford, 1981) is used to create visually appealing and insightful the humanitarian supply network representation. Fruchterman-Reingold is one of the popular force-directed layout algorithms (Ognyanova, 2015). Force-directed layouts try to get a nice-looking graph where edges are similar in length and cross each other as little as possible. The links act as springs that attract connected nodes closer together. As a result, nodes are evenly distributed through the chart area, and the layout is intuitive in that nodes which share more connections are closer to each other. The real structure of the humanitarian supply is shown in Figure 1. The nodes colours in the network reflect the groups of the actors.

Networks are often most easily viewed using familiar visual forms such as circles (Cherven, 2015). Concentric layouts allow us to take advantage of this. Nodes are arranged in series of concentric circles base on the distance from the focal node. So, nodes with direct connections are arranged in the first circle followed by nodes that are at distance of two nodes away from the centre and so on. By arranging nodes in this concentric fashion, viewers are able to more easily navigate small network structures and see the closeness of relationships to a single node, and to each other. This study is also used the concentric layout approach to visualize the humanitarian supply network. The focal node is placed at the centre of the visualization while nodes k steps away from the focal node are placed on the k^{th} circle.

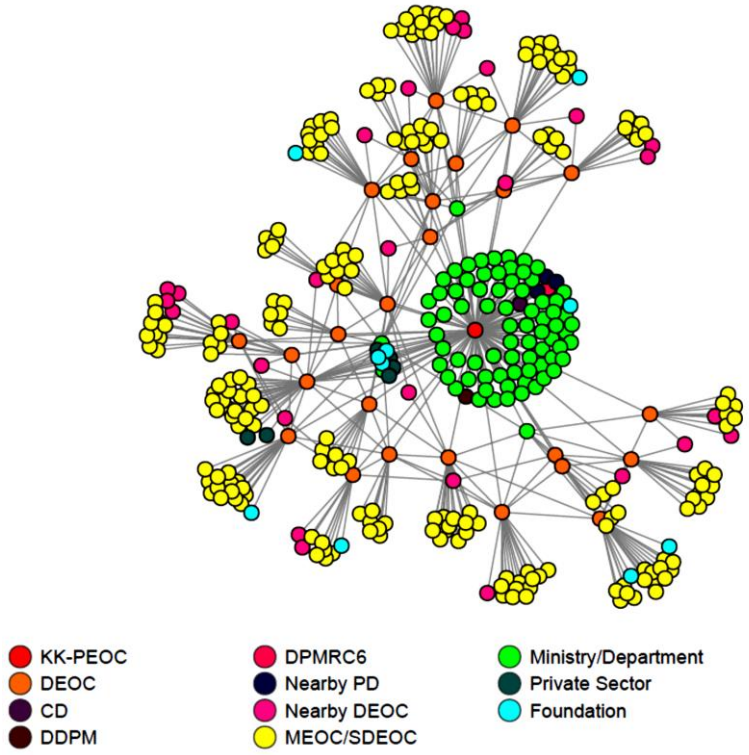

Figure 1: Visualization of humanitarian supply network in disaster relief operations in Khon Kaen province.

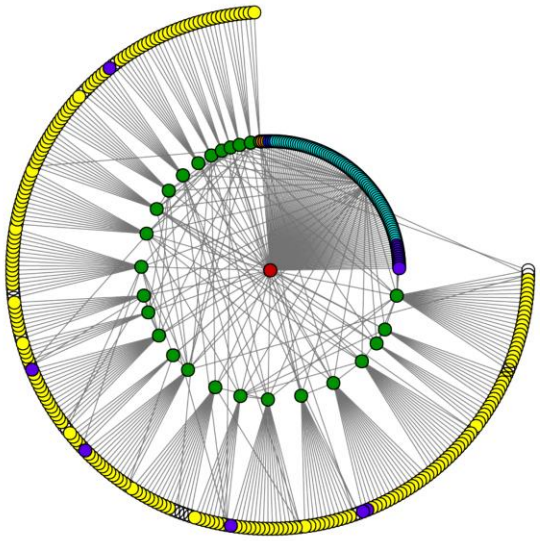

Figure 2: Visualization of humanitarian supply network by using concentric layouts.

Node-level results

The node-level metrics described in previous section include three centrality measures namely degree centrality, closeness centrality, betweenness centrality were calculated for each actors in the humanitarian supply network, the results of which are summarized in Table 1.

Rank	Degree centrality	Closeness centrality	Betweenness centrality
1	KK-PEOC (31.03)	KK-PEOC (59.18)	KK-PEOC (83.50)
2	DD1 (10.34)	DDPM1 (42.94)	DD1 (11.26)
3	DD5 (6.37)	DDPM2 (40.41)	DD5 (9.30)
4	DD15 (6.37)	DDPM3 (40.36)	DD15 (8.77)
5	DD7 (6.10)	DD5 (39.77)	DD7 (7.94)
6	DD12 (6.10)	DD1 (39.35)	DD12 (7.78)
7	DD10 (5.84)	DD16 (39.23)	DD9 (7.69)
8	DD4 (5.57)	DD4 (39.03)	DD4 (7.00)
9	DD16 (5.57)	DD6 (38.95)	DD16 (6.94)
10	DD9 (5.31)	DD12 (38.91)	DD10 (6.69)

Table 1: Node-level metrics results.

From the results, Khon Kaen Provincial Emergency Operation Centre (KK-PEOC) is prominent on all centrality metrics in the humanitarian supply network. The KK-PEOC has the highest degree centrality, closeness centrality, betweenness centrality scores. In term of degree centrality, the role of KK-PEOC is coordinator reconcile differences of network members and align their opinions with the greater supply network goals. In term of closeness centrality, the KK-PEOC acts as navigator who can explore, access, and collect various information with greater autonomy in the supply network. Finally, for closeness centrality, the KK-PEOC is a broker who mediate dealings between network members and turn them into its own advantage.

Network-level results

The results of the application of the network metrics introduced in section 2.6.2 are summarized in Table 2.

Network measures	Values
Number of nodes (actors)	378
Number of links	934
Network diameter	4

Network density	0.01310822
Average degree	1.310822
Average closeness	30.95272
Average betweenness	0.6015784
Degree centralization	0.2972366
Closeness centralization	0.5504267
Betweenness centralization	0.7545068
Clustering coefficient	0.21294
Average shortest path length	3.203949

Table 2: Network-level results

From Table 2 The network density of 0.01310822 mean that the network is sparse, with the number of links between nodes being only a small percentage of possible total number of links if all node were linked to all other nodes. This means that flow through the links will be limited to only those connections that exist, and in this case the number of links is small.

Recall that diameter of a network measures how many steps it takes to walk across the network from one side to another. This measure will assist us in determining how long it will take for nodes on the outer edges of the network to receive information and flows when compared to nodes closer to the center of the network. As a rule of thumb, a diameter less than or equal to 3 has ready access to all organizational resources (McCulloh et al., 2013). From the results, the network diameter is 4. This means it takes 4 steps to reach from one side of the network to the other. This value is a little larger than rule of thumb. This can show significant distance from one end of the organization to the other. Hence, it takes longer for information to travel to the outer parts of the network. Managers might be able to develop relationships between distant ends of an organization to reduce the diameter and thus increase the ability of agents to access organizational resources.

The average degree, betweenness, closeness centrality for nodes are determined provide a piece of the overall puzzle that reflects the network characteristics. The average degree centrality is a measure of network density which is a measure of the number of links present compared to the total number of links possible. The average closeness centrality measures the average length of geodesics within the network. Finally, Average betweenness centrality is the average number of nodes per geodesic. From the results, average degree and average betweenness are relatively low. The average closeness centrality

Regarding average betweenness, the supply network shows relatively low score (0.6015784), indicating that this network needs a smaller number of channels to get things done (Kim et al., 2011). Therefore, this supply network appears as more efficient, for instance, in managing such issues as supply disruptions because communications at the network level can be comparatively faster and more organized. However, the supply network shows the high average closeness score (30.95272). This implies that the actors in the supply network are more readily reachable from each other, indicating that information can travel faster across the network (Kim et al., 2011).

The centralization measures for the humanitarian supply network are between those for the star and ring networks, which are the two extremes in centralization. The degree centralization is 0.2972366, which indicates that there are very few nodes that are high in degree centrality when compared to the other nodes in the network. Betweenness centralization is 0.7545068, indicating that there is one node that acts as a boundary spanner or gatekeeper controlling access to all other nodes in the network. Closeness centralization is 0.5504267, again indicating that there is evidence of few dominant node: there is few nodes that is only one step away from every other node.

Network topologies

From the results, the humanitarian supply network has low clustering coefficient (0.21294) and medium average shortest path length (3.203949). The distribution of the number of connections per actor, or degree distribution, is widely used as a primary summary of the topology of complex networks.

A result, shown in Figure 3 and 4, reveals that degree distributions of the humanitarian supply network are not random but rather follow a power-law distribution.

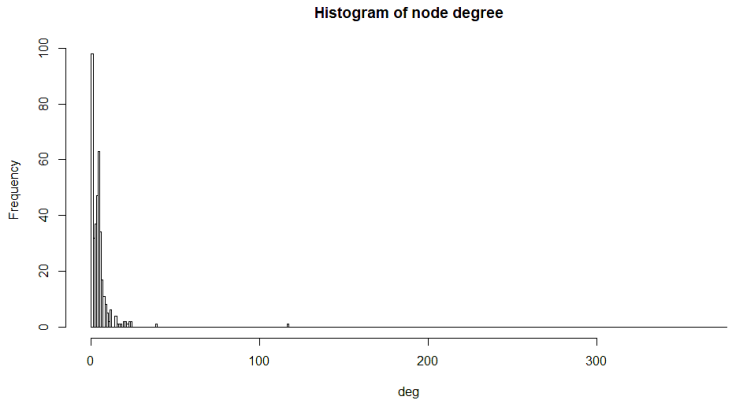

Figure 3: Histogram of node degree

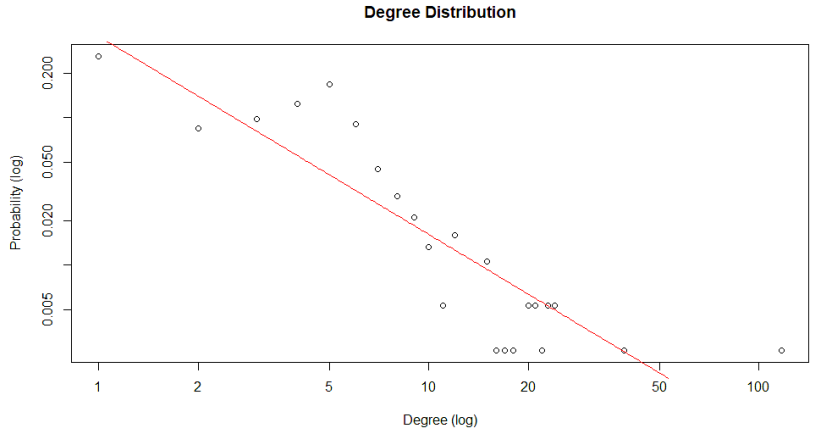

Figure 4: Fitting the degree distributions

A power law (PL), also known as a scaling law, is the form taken by a remarkable number of phenomena in the natural, social, and engineered systems. It is a relation of the type $Y=kX^{\alpha}$, where Y and X are variables of interest, α is called the power law exponent, and k is a typically unremarkable constant. A power-law implies that small occurrences are extremely common, whereas large instances are extremely rare. In other words, the humanitarian supply network is comprised of few actors with many and a majority of actors with only a few links, respectively.

A network whose distribution of connections among the nodes that follows a power law is known as a "scale-free" network (Barabási and Albert, 1999). The degree distribution of the humanitarian network follows a power law. This characteristic imply that the humanitarian network is a scale-free networks. The scale-free networks is more promising to represents efficient supply network and very resilient against random disturbances (Hearnshaw and Wilson, 2013).

Conclusions

We apply social network analysis to real supply network data derived from the key legal document governing disaster management in Thailand, Disaster Prevention and Mitigation Act, B. E. 2550 and related government documents. We use different social network analysis metrics at the node- or firm-level. The metrics are linked to specific roles in the humanitarian supply network and their implication performance. The humanitarian supply network consists of 378 actors and 934 links. Khon Kaen Provincial Emergency Operation Centre (KK-PEOC) is prominent on all centrality metrics in the humanitarian supply network. The degree distribution of the humanitarian network follows a power law. This characteristic imply that the humanitarian network is a scale-free networks.

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THE IMPACT OF DIGITAL TECHNOLOGY IN INTERORGANIZATIONAL SUPPLY NETWORKS

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Introduction

The pace of technological development is increasing. Previously shifts in technological paradigms were separated by centuries, now they occur within a single lifetime and the adoption of new technologies over the past century (EEA 2015). These large-scale changes can also be referred to as *megatrends* to describe significant technological movements in global economy (Naisbitt 1982). In fact, megatrends can provide clues and signals of the near future and aid in assessing the future business environment (Guemes-Castorena 2009). Although recent attention has focused on discussing the digital revolution, academic contributions on the impacts of digital revolution remain scarce (Glas & Kleemann 2016).

Although megatrends have potential to provide possible clues of the likely future, some scholars argue that megatrends can be perceived as *empty signifiers*. It is suggested that that megatrends do not transport clear information of the phenomena itself; instead they act as a bracket for social changes (von Goeddeck et al. 2013). Moreover, their impacts should be individually assessed rather than taken as an inevitable future (von Goeddeck et al. 2013), which may lead to over interpretation of the phenomenon. In particular, working with such large-scale changes in an interorganizational supply network context can complicate understanding these changes as every company should assess the impacts themselves and in case assessments differ, it can inflict misunderstandings in the supply network.

Companies respond to these technology-related changes differently. Uncertainty created by these changes is perceived differently and in some cases, perception of a change does no correlate with measurable probabilities of a potential risk (Botterill & Mazur 2004). *Risk perception* can have an impact on how risks are perceived based on the memories, personal experiences and cultural context of an individual (Garvin 2001). Thus, based on the perception of an individual, impacts of technological change can be perceived differently: a threat, an opportunity or both. In fact, risks tend to have speculative characteristics and how an individual perceives this uncertainty, can enable the individual to see a risk provoking loss, downside risk, or risk provoking a possible profit, upside risk (Verbano et al. 2013).

An essential impact of technology-driven change is *uncertainty*. Although, it is possible to list potential impacts of technology-driven change, it is uncertain which impacts materialize (Waters 2007). Still, companies may need to require adapt to these unpredictable changes (Mittelstaedt 2014; Retief et al. 2016), although it is not certain which impacts technology driven change has. In fact, risks occur due to uncertain future and due to uncertainty, unexpected risks may occur (Waters 2007).

Academic literature on digital technology impacts is scarce (Glas & Kleemann 2016), although the pace of technological development is accelerating. It is crucial for a company to understand what impacts technological megatrends can have and therefore, this study aims to instigate scientific discussion on technology-driven change impacts and their perception on an organizational level. More precisely, we illustrate how these impacts create uncertainty, affect in supply networks and how they have affected on the value creation roles of network actors.

Theoretical background

Increased pace of technology driven change is complicating the business environment of companies and supply chains. These changes cause uncertainty for companies, which could present both threats and opportunities. A common view among scholars is that the pace of technological change is increasing, however there is a lack of consensus which technological innovations will be most revolutionary to companies. Technological megatrends could provide clues of potential threats and opportunities for companies.

Technology driven change

Academic literature on megatrends and their impacts for companies is at its infancy (Retief et al. 2016; Glas & Kleemann 2016). However, in recent years large and growing body of practitioner literature has investigated different megatrends. Although lacking peer-reviews, they can offer insights on what megatrends are considered significant by global consulting and accounting and management companies. In particular, digital technologies are suggested to be the fundamental driving force of the next technological revolution affecting individually and in fusion with each other (Guoping et al. 2017). Therefore, the search for digital technology megatrends focused mainly on internet search engines instead of academic data bases. In order to find consensus among different megatrends, a matrix was created based on the identified technological megatrends of following practitioners: EY (2017), PwC (2016), OECD (2016), Sitra (2017) and European Environment Agency (2015). Variety of different technological megatrends were expressed with little consensus. However, a common view among these practitioners was that the development of technologies is rapid and this megatrend seems to act as an umbrella concept for several different technologies. Therefore, technologies mentioned by these authorities were examined in detail to establish an understanding, which are the most applicable and prominent digital technologies to inflict technology-driven change.

Identified digital technologies include 1) big data & analytics, 2) industrial internet, 3) digital platforms and 4) augmented reality. Big data and analytics are used to analyse, predict and control business processes based on high-volume, high-velocity, high variety and complex data and is suggested to become an essential requirement for business (Coleman et al. 2016; PwC 2016). Industrial internet was originally coined by General Electric (2012) to describe connected machines, advanced analytics and people by communications technologies to monitor, collect, analyse and deliver insights to decision-making process (General Electric 2018). Digital platforms are suggested to offer new ways to consume goods and services by decreasing the transaction and friction costs (Guoping et al. 2017). Rapid development of digital technologies have enabled to experience new perspectives of reality through augmented reality (AR) having significant deployment possibilities for both consumers and enterprises (European Commission 2017).

Perception of uncertainty

It is suggested that *risk perception* mandates how uncertainty caused by these digital technologies are perceived. More precisely, it is suggested that the socially constructed perception is closely related to individual's cognitive framework developed by individual's experiences to mandate how reality is perceived and how individuals act in their environment (Abelson 1981; Fiske & Taylor 2008). Furthermore, these cognitive frameworks are stored in the memory of individuals and aid in anticipating other's behaviour, coping with the environment and represent reality (Fiske & Taylor 2008). Thus, identifying local implications can be based on subjective evaluations of an individual contributing to subjective risk perception (Herbane 2010).

On a company level, top management is usually in charge of creating cognitive frameworks and organizational outcomes can represent the top management's perceptions of the environment (Hambrick et al. 1984). Consequently, risk perception of individuals can contribute to organizational outcomes depending how technology related change impacts are perceived once they are identified. Altogether, these actions form a decision tree on how local implications are identified and perceived, which is visualized in Figure 1.

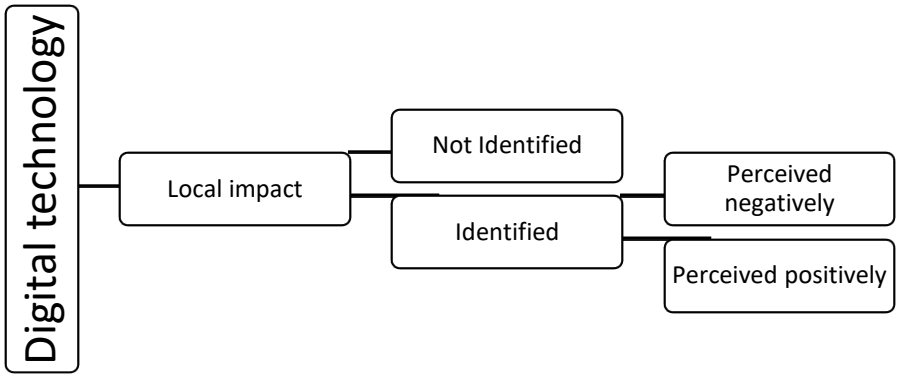

Figure 4: Digital technology perception decision tree

Digital technologies cause uncertainty and existing literature suggests that there are different dimensions of uncertainty varying from complete certainty to radical uncertainty depending on the amount of knowledge an individual has of a certain phenomenon (Vilko et al. 2014). It is suggested that it is certain that digital technologies change business, however its actual impacts are not known (Glas & Kleeman 2016), thus there is some knowledge of the future. Literature suggests that there are three different types of uncertainty when there is some knowledge of the future: 1) Parametric uncertainty, 2) structural uncertainty and 3) procedural uncertainty. In parametric uncertainty the structure of the future is known, however there is uncertainty of the parameters (Vilko et al. 2014), as in this case it is known that digital technologies will impact the future, however the parameters to which extent the digital technologies will affect are unknown. When the knowledge of the future decreases and no objective beliefs of the future can be stated, the uncertainty is referred to as structural uncertainty (Langlois 1984). Thus, it is uncertain how the future is and only subjective projections can be made what impacts digital technologies have. Procedural uncertainty describes the lack of skills and competence of computational and cognitive capabilities of an individual, which constrain understanding of potential risky events as a whole (Dosi & Egidi 1991; Vilko et al. 2014).

Methodology

Qualitative and explorative research design is applied to establish an understanding of technological change perception, technological innovation implications and its impacts to interorganizational supply chains. Case study approach was considered suitable for the explanatory nature of the study and provided an efficient means to examine a contemporary phenomenon in depth in its operational context (Yin 2009).

Empirical data was collected by semi-constructed interviews and stakeholder analyses. Interviews were mainly conducted with entrepreneurs and few managerial level. Informants as they were seen as experts in their industry and being able to provide insights. The process to identify stakeholders begun by employing value mapping tool prepared by the procedure of Bocken et al. (2013) which offered a means to establish an understanding of stakeholders and their relation to the firm. Next, the same stakeholders were categorized with a stakeholder analysis tool, which was prepared according to the procedure by Eden and Ackermann (1998). With this tool the identified stakeholders were assorted on a two-by-two matrix based on the commitment and influence of the stakeholders. Together these tools contributed to gain an overall understanding of stakeholder networks and their role to the case companies.

Case selection was based on information-oriented selection to maximize the empirical data (Flyvberg 2011). The cases offer insights to a variety of SMEs operation in different industries. Detailed respondent information and length of interviews is listed in Table 1.

Company	Company size	Industry	Sales 2016 (€)	Position of informant	Interview length (min)
Company A	Micro (1)	Wellbeing services, dietary supplement retailing	30 000	Entrepreneur	95
Company B	Micro (2)	Entertainment and activity services	-	CEO	70
Company C	Micro (5)	Restaurant and catering services	650 000	Entrepreneur	76
Company D	Micro (7)	Machining and metal product design and development	720 000	Entrepreneur	47
Company E	Micro (9)	Bakery and cafeteria services	850 000	Entrepreneur	54
Company F	Small (10)	Bakery and cafeteria services	700 000	Entrepreneur	45
Company G	Small (40)	Sports equipment and small machine retailing	14 000 000	Business controller Marketing manager	82 113
Company H	Small (47)	Transport and logistics services, wood chipping processing	4 800 000	Director of development	73
Company I	Medium (50)	Sports entertainment business	5 200 000	CEO	34
Company J	Medium (65)	Vehicle sales and maintenance	45 000 000	Marketing manager	142

Table 1: Respondent information

The interviews were personal face-to-face interviews conducted in Finland during fall 2017 and spring 2018 consisting of two or three interview rounds. During each round the studied themes were explored in more detail giving an opportunity for the respondents to become familiar with the terminology of the studied themes and to provide well-thought answers as well as to supplement their previous answers. The empirical data of the last interview is utilized in this study. The average length of the interviews was 75 minutes varying between 34 minutes to 2 hours and 20 minutes. During the interviews participants were asked to evaluate the impacts of certain megatrends.

Content analysis process was prepared according to the procedure by Tuomi & Sarajärvi (2018) which begun by listening and transcribing the interviews. Next, the transcribed data was uploaded to qualitative data analysis software Nvivo to enable coding the data into relevant nodes from which some partially arose from the data and some from the theoretical background. Then the nodes were categorized into 2nd order themes and further into aggregate dimensions according to the data structure suggested by Gioia et al. (2012).

Analyses and results

Perception of digital technologies and their impacts varied significantly among informants. The perception reflected a variety of positive, negative and both approaches to digital technologies and their impacts. The identified local impacts and their perception is visualized in Figure 2. In most cases, the entrepreneurs were in charge or identifying and perceiving these changes, however in some small and medium companies also top management and some employees took part in the process. Once local impacts of a digital technology were identified, the impacts were mainly perceived based on the previous experiences of the individual aiding to assess the nature of the impact. Furthermore, also supply networks provided information and clues on what impacts these digital technologies might have.

Augmented reality and industrial internet were perceived as rather unknown technologies for informants and received scarcity of identified impacts, which were mainly projections of how these technologies might affect in the future. More precisely, this technology seemed distant for the informants and how it might affect in the organizational context and as perceiving implications for their own company was challenging, identifying the impacts for the supply networks was even challenging.

Differences in perception and identification of megatrends begin on the definition of the megatrend itself, which was an unanticipated finding. In some cases, the informant was not familiar with the megatrend or considered the megatrend to have a different definition. One example of this is perceiving the digital technology of *big data and analytics*. Big data was understood as data collected from web sites and social media sites from customer behaviour, which was further utilized for marketing, planning and business activities. Furthermore, in some cases big data was perceived as evidence of customer preferences. Together, these findings indicate that big data and analytics offer a tool for companies to evaluate customer behaviour and it was perceived as an opportunity for companies.

Digital platforms received a variety of identified impacts. Digital platforms were used for purchasing and for reporting to their suppliers. Usage of digital platforms had increased expenses and workload for companies as well as decreased product selections and sales. More precisely, usage of digital platforms had brought expenses of purchasing software and equipment to use digital platforms. Furthermore, usage of digital platforms had increased the workload as the usage was challenging for employees, top management supervised the reporting and same information was needed to report on several supplier platforms due to compatibility issues. Digital platforms had also an impact on purchasing by transforming purchasing into e-procurement and decreasing the available product selection and products could not be seen before purchase. Furthermore, one informant noted that due to the growing amount of other digital platforms for second hand clothes and products, their sales had deceased. Altogether, the aforementioned implications of digital platforms were perceived as negative and complicating business. In contrast, the same informants who recognized negative impacts, were also able to recognize positive impacts of digital platforms. Usage of digital platforms brought transparency and ease to business activities. More precisely, digital platforms created automatically information that was seen useful and time-saving. Furthermore, digital platforms offer useful features such as tracking system and worktime monitoring.

Altogether, the findings seem to indicate of two different types of uncertainties: 1) Procedural uncertainty and 2) structural uncertainty. Concerning augmented reality, industrial internet and big data and analytics, it was challenging for the informants to describe the possible implications of these technologies due to their limited knowledge of the technologies. Consequently, limiting the understanding of potential future events caused by them and thus, indicating of procedural uncertainty. In contrast, local impacts of digital platforms received a variety of responses indicating that there is more knowledge of the future related to this technology. However, identified impacts were recognized in own business activities and presented as subjective statements, indicating of structural uncertainty.

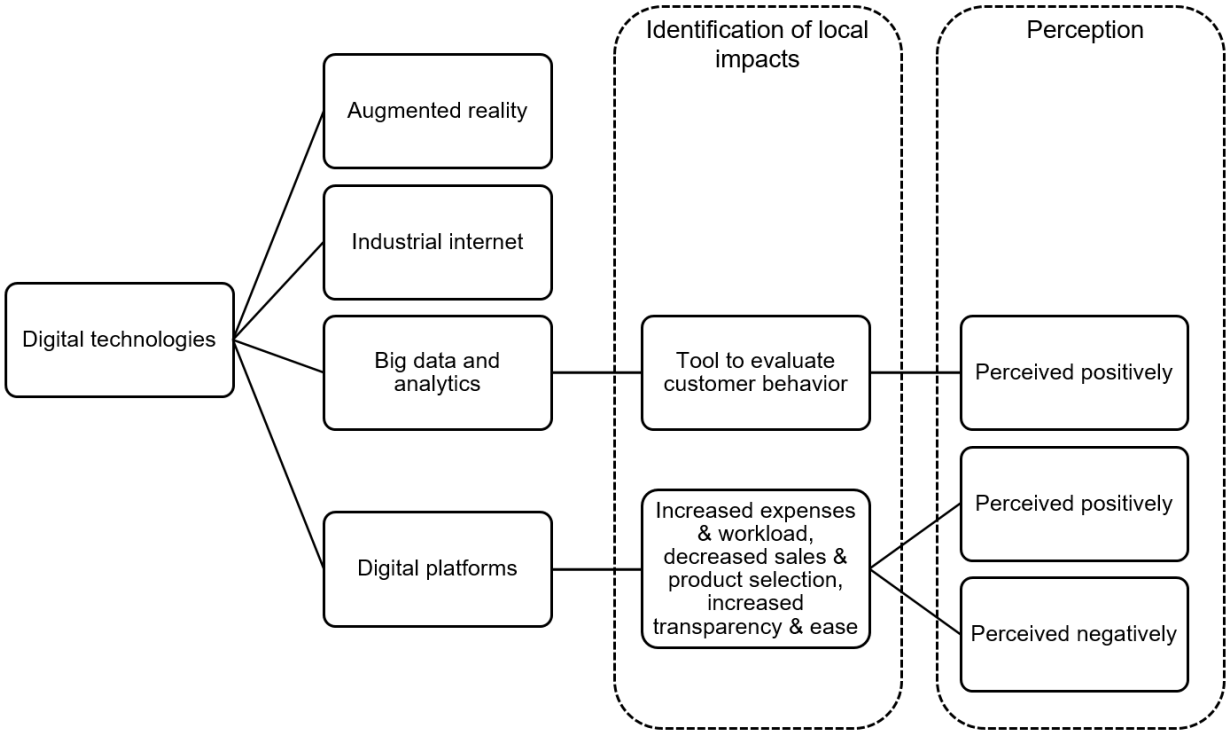

Figure 2: Digital technology perception

Conclusions

There is significant uncertainty related to digital technologies and their possible impacts. More precisely, uncertainty created by digital technologies can present opportunities as well as threats to companies and altogether, the findings seem to indicate that digital technologies are perceived as unpredictable and rapidly evolving technologies. Digital platforms received variety of different implications, which can indicate that currently this digital technology is identified as most influential among informants. Furthermore, the findings seem to indicate that the more identified local implications an individual identifies, the larger the perspective of perception is and both negative and positive impacts can be identified.

Besides having an impact on the activities of a firm, digital technologies seem to have more far reaching impacts and affecting in the supply network as well. Information of perception and impacts of digital technologies were exchanged within the supply networks, which can indicate that actors might become aware of how their suppliers perceive certain changes and decreased the amount of misunderstandings regarding the impacts of these technologies. Furthermore, digital technologies have transformed communication and business activities within the supply network. In particular, digital platforms have transferred certain tasks from one actor to another such as by enabling e-procurement, which alters the actor's role in the procurement process in a more independent way and the actor purchases through a digital platform. Furthermore, emergence of digital platforms have reduced sales by offering a new way to purchase products for consumers contributing to make an actor redundant in the supply chain as customers buy directly through the platform instead of making their purchasing at the actor.

This study makes several noteworthy *scientific implications* enhancing our knowledge of digital technologies' impacts to companies and supply network joining the discussion by Glas & Kleeman (2016). Furthermore, this study sheds light on the procedural and structural uncertainty caused by different digital technologies visualizing that the more distant a technology is for a company, the more uncertainty it causes. This was the case of augmented reality, industrial internet and big data and analytics and as the knowledge of these technologies was imperfect, their individual impacts could not be assessed. Consequently, without individual assessment, their impacts were unclear corroborating the idea of empty signifiers by von Goeddeck et al. (2013). Furthermore, identification of local implications was based on subjective evaluations and experiences of an individual, which further

supports the idea of Herbane (2010) of personalized risk perception. More precisely, in case the experiences of the individual were negative, the impact was perceived negative and vice versa, indicating that the experiences of the individual dominated how the change was perceived.

These findings also offer *managerial implications* by visualizing how uncertainty is constructed. By understanding different types of uncertainties, it is possible to mitigate uncertainty related to digital technologies. More precisely, searching knowledge of different sources of digital technologies and their potential impacts, can help establish an objective understanding of the impacts and contributing to establish a perception of these impacts that is not solely based on subjective evaluations of an individual.

The generalizability of the findings is limited in terms of research approach, small number of cases and geographical area.

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TOWARDS AN IMPLEMENTATION OF SUSTAINABLE SUPPLY CHAIN MANAGEMENT (SSCM) ASSESSMENT FRAMEWORK AND FUTURE RESEARCH DIRECTION

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Introduction

Sustainable development is of growing importance to the industrial sector because the current exploitation and lacking affection of resources use, together with the pollution generated cannot continue at present rates. Moreover, the negative social impacts are increasing because of the industrial operations. The development of sustainability performance measurement demonstrates a significant contribution to enhance and implement sustainable development and exhibits a way to manage sustainability in supply chain.

An effective of method for sustainable performance assessment with emphasis on sSCM subjects has been developed in the previous work (Santiteerakul et al., 2015). Managers related industries can use the purpose model to construct the sustainability measurement model. Based on the implementation of a sustainable supplier evaluation, companies identify and prioritize opportunities for improvement which may lead to the reduction of impacts of environmental and social impacts that are associated with their activities. Furthermore, the results from proposed approach can be used for benchmarking, to improve sustainability performance and to develop better sustainable processes. In order to implement the proposed conceptual framework and the model construction method in a practical situation. This work implements the sSCM assessment framework to develop the sustainability performance measurement model into 3 case studies, i.e. one case in the electronics industry and two cases in the agriculture industry.

Literature Review on sSCM Performance Measurement Model

While the social and the environmental are clearly associated in the sustainable development context, there is very little research addressing the social dimension. A comprehensive literature review on SSCM identified that out of 191 papers, 140 addressed the environmental dimension while only 20 addressed the social dimension (Seuring, 2008). Hence, the literatures which consider at least two sustainability dimensions will be reviewed in this section.

Similarly, with the classification criteria from traditional supply chain, two aspects which are component of measures and component in supply chain are adopted for analyzing sustainability metrics. In traditional SCM, the component of measures focus only economic dimension. Meanwhile component of measures in sSCM has extended to environmental and social dimension. Most of literatures use the TBL developed by Elkington, (1999) to classified sustainability criteria, as shown in , (Hassini et al., 2012; Veleva and Ellenbecker, 2001; Veleva et al., 2001; Zhu and Sarkis, 2004; Zhu et al., 2012)(Veleva et al. (2001), Veleva and Ellenbecker (2001), Szekely and Knirsch (2005), Hassini et al (2012), Zhu and Sarkis (2004, 2012)). Except Figge et al., (2002) adopted the balanced scorecard (BSC) to classified performance measures in sustainability context by adding environmental and social aspects to business strategy. In addition, they proposed a new perspective called non-market perspective in order to integrate strategically relevant but not market-integrated environmental and social aspects. Indicators in non-market aspect can impact company's performance in all four perspectives of the conventional BSC. For example, indicators relevant to legality or human rights can effect to expenditure of company, employee satisfaction, or customer satisfaction.

Veleva et al. (2001) argued that sustainable production indicators should also include economic and social measures. They also proposed a framework that consists of five levels for categorizing existing indicators relative to the basic principles of sustainability. Their study provided a method of

evaluating a set of indicators that focus on environmental, health and safety aspects of production, and work is underway to expand their method to include social and economic aspects to inform decision-makers and measure progress towards more sustainable production. Furthermore, Veleva and Ellenbecker (2001) presented a set of indicators of sustainable production for promoting business sustainability. They first introduce the concept of sustainable production which includes six dimensions and desirable qualities. Based on that framework, they suggested five stages of core and supplemental indicators for raising the awareness of firms and measuring their progress toward sustainable production systems. The six dimensions are, namely, (1) energy and material use, (2) the natural environment, (3) economic performance, (4) community development and social justice, (5) workers, and (6) products.

Phillis and Davis (2009) proposed a multi-stage fuzzy model to assess a corporation's sustainability. This model consists of two fundamental components: human and ecological. The human component has four inputs: economic, political, knowledge, and welfare. The ecological component has also four inputs: air, water, land and biodiversity. However, this model is used to assess only lagging indicators of corporation's sustainability. It is suitable to monitor historical evolution and compare the company with competitors. But it is not suitable for managing risk or giving improvement actions.

Another aspect is using component in supply chain as a criterion to identify performance metrics. Components in supply chain can be considered by processes, sustainable practices, or partners in SCM. Zhu and Sarkis (2004) developed GSCM practices metrics to measure an extent of adopting GSCM practices in their companies. They collect the data, using survey approach, in 186 respondents of Chinese manufacturing. The respondents were requested to indicate, using a five-point Linkert-type scale, the perceived extent of adopting each of the GSCM practices. They classified the practices into four group based on SC processes which are (1) internal environmental management (2) external GSCM practices (3) investment recovery and (4) eco-design. Then Zhu et al. (2007) has separated the second group (external GSCM practices) into two groups. Hence the new evaluation of GSCM practices are classified into five groups, which are (1) internal environmental management (IEM) (2) green purchasing (GP) (3) customer cooperative (CC), (4) investment recovery (IR) and (5) eco-design (ECO). They studied the adoption of GSCM practices in different industry (Zhu et al., 208), examined the relationship between GSCM practice and GSCM performance (Zhu and Sarkis (2004), Zhu et al. (2007, 2012)). Again a five-point Likert scale was used to determine if associated with their implementation of GSCM practices. The GSCM performance is classified into three groups which are (1) environmental performance (EP), (2) positive economic performance, and (3) operational performance (OP).

Process and partner in supply chain cab be used for classifying performance metrics in sustainable supply chain. Hassini et al (2009) proposed a framework for sSC metrics using TBL principle and supply chain partner (supplier, manufacturer, distributor, retailor, and customer). Moreover, they addressed to use decision level (strategic, tactical, and operational) at the stage of choosing appropriate measures.

In addition to consider performance metric from research works, the metrics from existing tool and guideline are analyzed in this section, which are GreenSCOR and GRI. The GreenSCOR is separated from conventional SCOR in version9.0. This model focuses only environmental dimension and measures environmental impacts in term of carbon emission, air pollutant emission, liquid waste generated, solid waste generated, and percent recycled waste. GRI is a guideline to report company sustainability performance. Performance metrics are classified into six categories: economic, environmental, labor practices and decent work, human rights, society, and product responsibility

The proposed sSCM measurement model

Conceptual Framework

The previous work (Santiteerakul et al., 2015) has developed the framework to measure sustainability performance for sSCM. This framework allows decision makers identifying the sustainability measures based on their interesting area in sustainability criteria. There are eight categories of sustainability criteria in this framework which are financial, non-financial, raw material, natural resources, energy, human health and safety, human resources development, and ethical issues (see Figure 1). The sustainability criteria in this framework have developed based on the concept of

human needs and the TBL concept and have justified by analyze with standards, guide lines, and regulation involving sustainable development perspective.

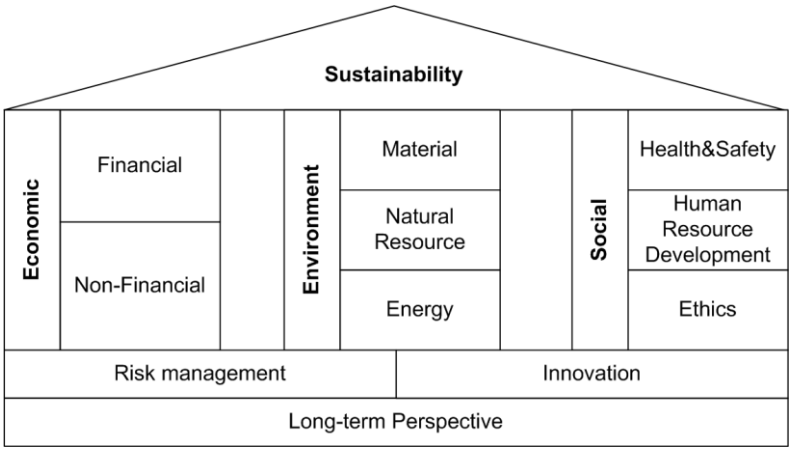

Figure 1 Sustainability Criteria Categorization

In order to measure sustainability performance for supply chain management, it is needed to link the concepts of supply chain and sustainability. The term “supply chain” consists of multiple firms, both upstream and downstream, and the ultimate consumer. Supply chain involves with flows of products, materials, information, and finances from a source to a customer (Mentzer et al., 2001; Santiteerakul et al., 2012). Activities in supply chain concept have to be identified by an engagement level in both upstream and downstream. The engagement divided into three levels, which are company level, supply chain level, and stakeholder level. The engagement level is shown in Figure 2.

- Company level considers activities of owned company which does not engage with any external groups or companies.
- Supply chain level considers activities under taken to create opportunities for negotiation, consultation or simply exchange of information between or among company and its supply chain (suppliers, outsourced companies, customers, users or others). However, the supply chain level consists of three sub-levels which are direct supply chain, extended supply chain, and ultimate supply chain following degrees of supply chain complexity from Mentzer et al., (2001).
- Stakeholder level considers activities under taken to create opportunities for negotiation, consultation or simply exchange of information between or among company and stakeholders. In this work, stakeholder is defined as individual or group that has an interest in any decision or activity of a company including second-tier suppliers, customer’s customers, users, and so on. The local communities or the government can be considered as the stakeholders of supply chain.

Moreover, this proposed framework enhances an engagement level of elements in supply chain as an important perspective to identifying the sustainability measures. According to the literature review, the existing process categorization in sSCM focus on primary activities regarding to material flow process but the human resource management and business ethics are supporting (or secondary) activities. Therefore, the processes or activities, which relating to social dimension, are missing in consideration in sSCM. This work enhances the valuable of adopting the value chain model (Porter, 2008) which covers both primary and secondary activities for constructing the sustainability performance measurement model. Hence the value chain model and the process based approach (Chan and Qi, 2003) are adopted for constructing the sustainability measures model. This leads to an implementation of the proposed framework allowing decision makers to measure sustainability performance in any process or activity in the company and its supply chain. In order to implementing the proposed conceptual framework and the model construction method in practical situation, this work has implemented the proposed sSCM model

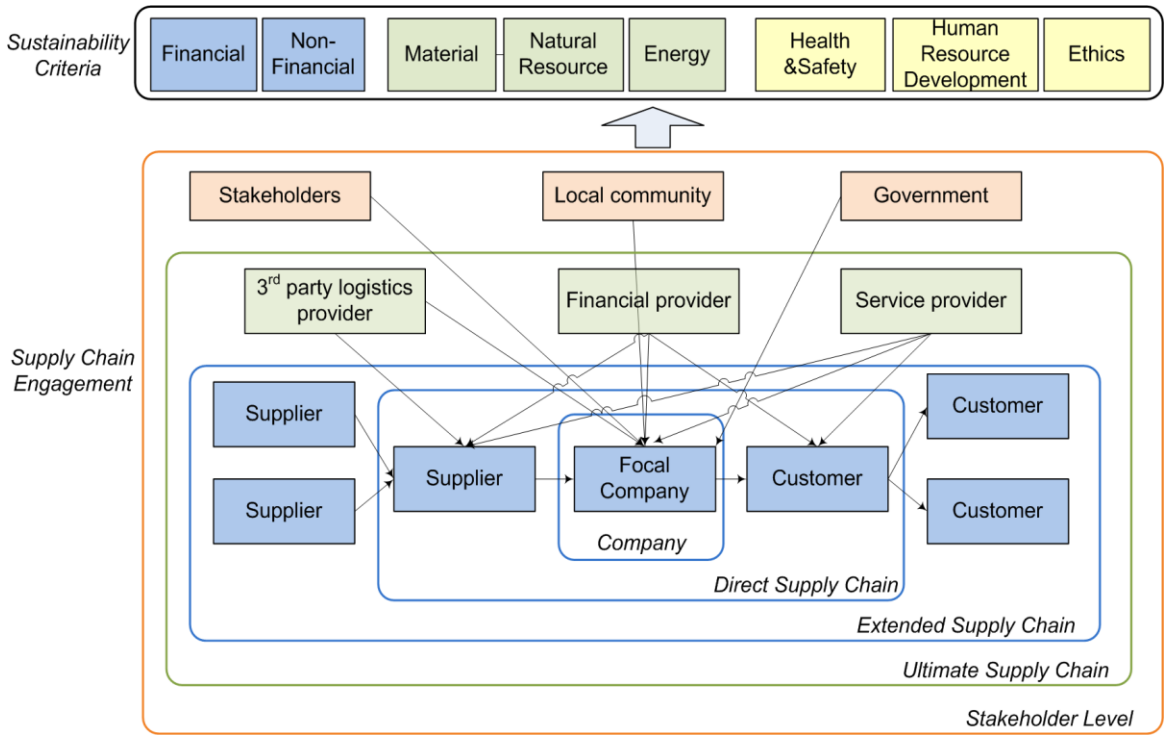

Figure 2 The sSCM assessment framework

Case 1: Supplier evaluation in electronics industry

The hard disk drive (HDD) manufacturer in Thailand aims to motivate suppliers for participating in EICC (Electronics Industry Citizenship Coalition) program. The company needs to measure supplier's sustainability performance integrate their suppliers with their existing supplier performance assessment system for supporting company's decision-making. Until now, the company works with 247 suppliers who produce parts and components for manufacturing HDD. 127 suppliers are located in Thailand, 36 suppliers are located in China, 21 suppliers in Malaysia and 21 suppliers in Singapore respectively.

The procurement manager has developed the supplier' s performance measurement system based on the proposed sSCM assessment framework (Figure 2). The indicators and measures are selected by a brainstorming meeting among the middle management team of the company. The sustainability measurement system consists of three dimensions, 10 indicators, and 25 measures, which are shown in Figure 3.

The performance measurement model development consists of two parts. (1) Determining the priority weight of indicators and measures. The fuzzy AHP (FAHP) is selected to determine the priority weight. In this case, the procurement manager is a decision-maker who identify the weight of indicators. The global priority weight of 25 measures, 10 indicators, and 3 dimensions are shown in Figure 3. (2) Develop the supplier's performance assessment method. After weighting the FAHP model for determining priority weight for alternatives, the decision maker evaluates suppliers in each sustainability measure (level 3) by using the measurement rating scale. All quantitative and qualitative measures are converted to five-level performance rating, which are very poor (VP), poor (P), average (AVG), good (G), and very good (VG).

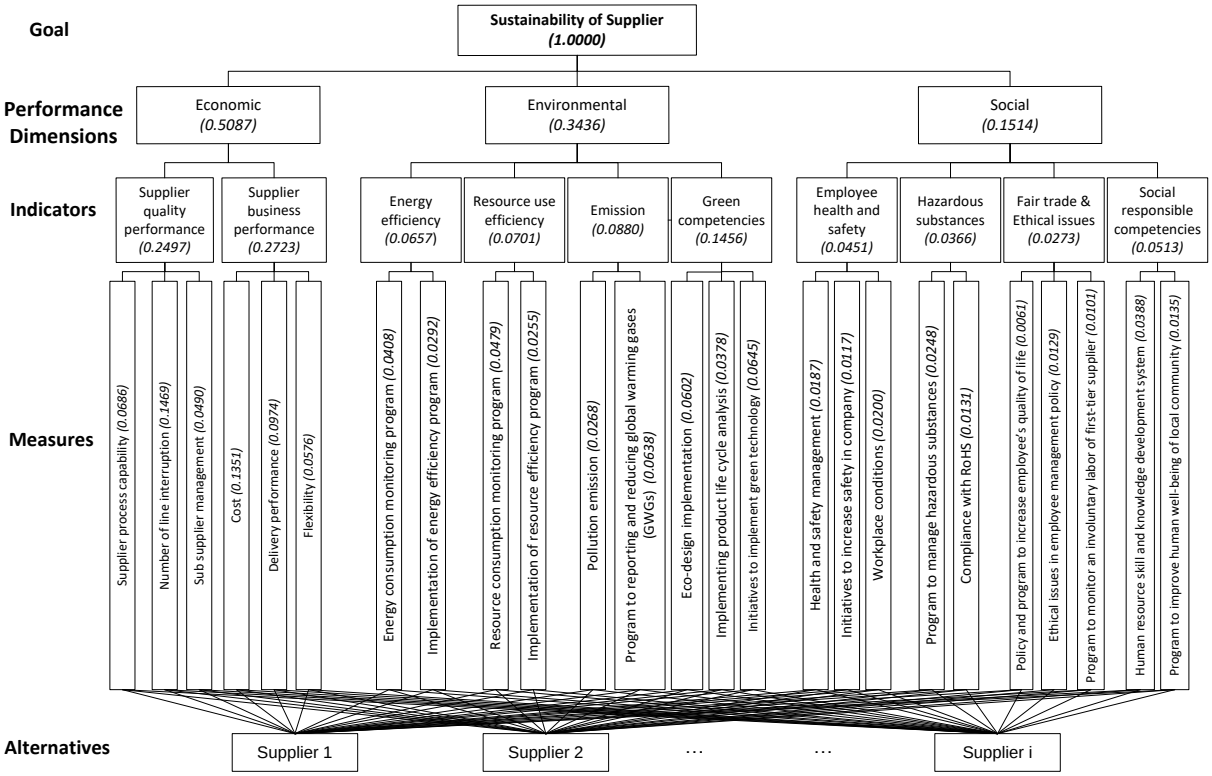

Figure 3 The sustainability indicators and measures of supplier evaluation

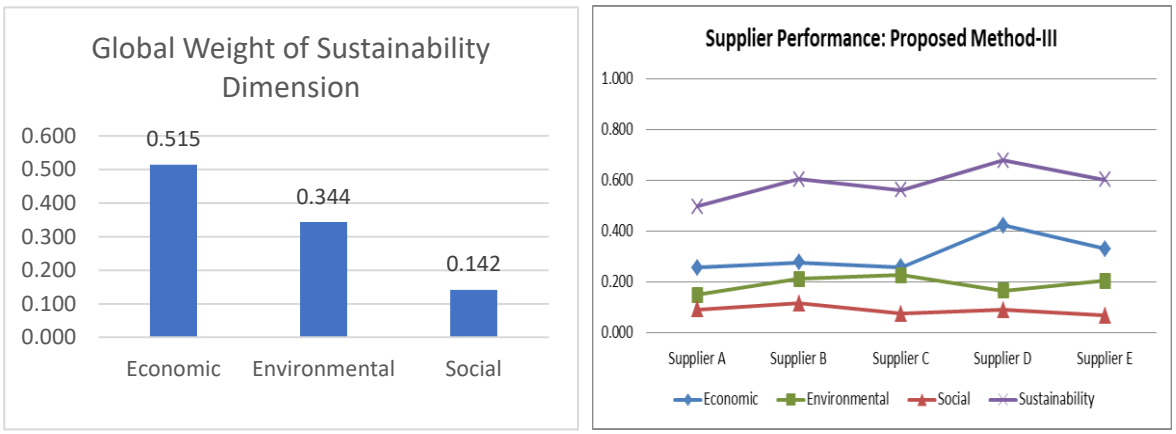

Figure 4 Global weight of sustainability dimension and supplier performance: Electronics

Based on the global priority weight of sustainability measures and the supplier performance rating, the final priority weight of each supplier can be evaluated. The results of overall sustainability performance in each supplier are shown in Figure 4. It can be noted that among five given suppliers, supplier D has the highest sustainability performance followed by supplier B, E, C, and A respectively. Therefore, the sustainability performance ranking among five suppliers is D>B>E>C>A. An analysis of supplier's performance in economic, environmental, and social dimension found that for economic performance, supplier D is the best performance followed by E, C, B, and A respectively. For environmental performance, the best supplier is C, followed by B, E, D, and A respectively. For social performance, the best supplier is B, followed by A, D, C, and E respectively.

Case 2: Sustainable Supply Chain of Organic vegetable

The researchers aim to evaluate the sustainability performance in an organic vegetable supply chain. The developed measurement model measures the sustainability performance of firms in a direct supply chain level, which are the organic farmers, 1st tier supplier, and 1st tier customer (seller or retailer).

There are 3 sets of sustainability indicators and measures to assess the sustainability of supplier, farmer, and seller respectively. All of indicators and measures are identified based on the eight criteria of sSCM framework in Figure 2. There are 15 experts from academic, government, local communities, and enterprise sectors who select and evaluate a suitability of indicators and measures.

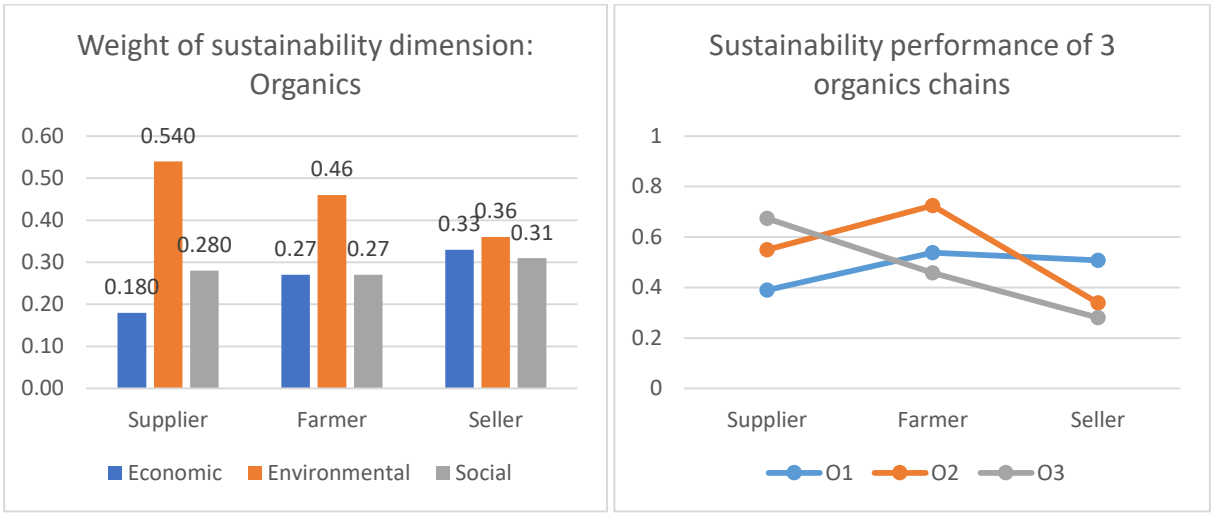

Figure 5 Global weight of sustainability dimension and supply chain performance: Organics

This work obtains 19 measures and 8 indicators for evaluating sustainability of supplier, 20 measures and 8 indicators for evaluating sustainability of organic farmer, and 15 measures and 8 indicators for evaluating sustainability of seller/retailer. The AHP approach is selected to determine the priority weight of indicators and measures by 10 decision makers from academic, government and enterprise sectors. The global priority weight of sustainability dimensions in each element of supply chain are shown in Figure 5. For organic vegetable supply chain, an environmental dimension obtains the most important priority in all elements of supply chain (supplier, farmer, and seller). An economic and social dimension obtain similar important priority in farmer and seller element. An economic dimension obtains the least priority in supplier element.

This model evaluates the sustainability performance of three organic supply chains. This means that 3 organic farms, 3 suppliers, and 3 sellers are evaluated by the proposed model by using TOPSIS. The results of sustainability evaluation are shown in Figure 5.

Case 3 Sustainable Supply Chain of Hydroponic vegetable

The researchers aim to evaluate the sustainability performance in a hydroponics vegetable supply chain. The developed measurement model measures the sustainability performance of firms in a direct supply chain level, which are the organic farmers, 1st tier supplier, and 1st tier customer (seller or retailer). There are 3 sets of sustainability indicators and measures to assess the sustainability of supplier, farmer, and seller respectively. All of indicators and measures are identified based on the eight criteria of sSCM framework in Figure 2. There are 15 experts from academic, government, local communities, and enterprise sectors who select and evaluate a suitability of indicators and measures.

This work obtains 18 measures and 8 indicators for evaluating sustainability of supplier, 20 measures and 8 indicators for evaluating sustainability of organic farmer, and 15 measures and 8 indicators for evaluating sustainability of seller/retailer. The AHP approach is selected to determine the priority weight of indicators and measures by 10 decision makers from academic, government and enterprise sectors. The global priority weight of sustainability dimensions in each element of supply chain are shown in Figure 6. For hydroponics supply chain, all the elements in supply chain (supplier, farmer, and seller) give the most priority to the performance in economic dimension. The raw material supplier gives the priority of environmental dimension more than social dimension. The farmer gives the same priority of environmental dimension as social dimension. The seller gives the priority of social dimension more than environmental dimension.

This model evaluates the sustainability performance of three hydroponic supply chains. This means that 3 organic farms, 3 suppliers, and 3 sellers are evaluated by the proposed model by using TOPSIS. The results of sustainability evaluation are shown in Figure 6.

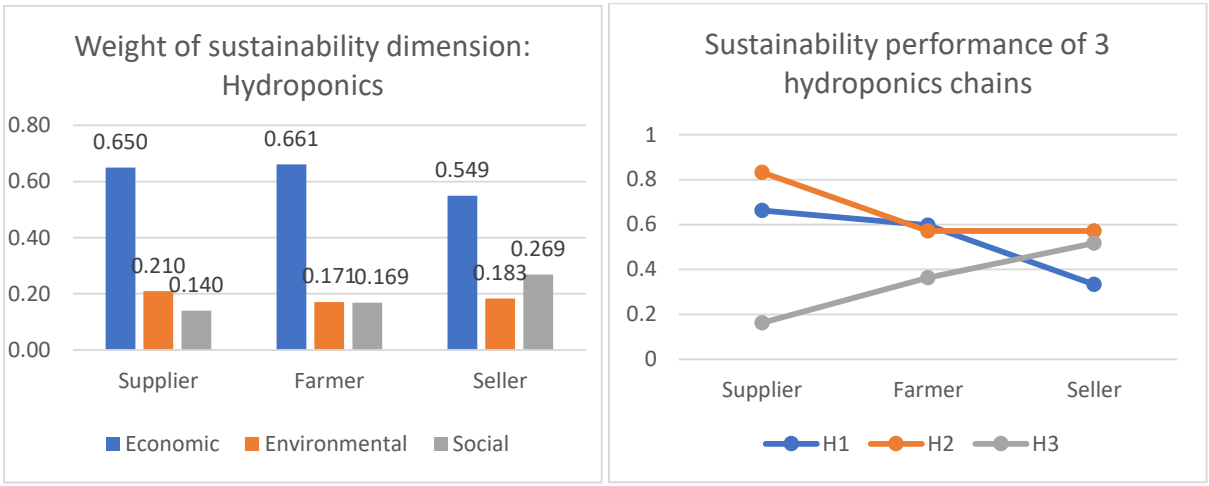

Figure 6 Global weight of sustainability dimension and supply chain performance: Hydroponics

Results of comparative study

The proposed sSCM assessment framework is a generic framework that helping the decision makers construct the sustainability measures model. This approach leads to an implementation of the proposed framework allowing decision makers to measure sustainability performance in any process or activity in the company and its supply chain. In order to implement the proposed conceptual framework and the model construction method in a practical situation. This work implements the sSCM assessment framework to develop the sustainability performance measurement model into 3 case studies, i.e. one case in the electronics industry and two cases in the agriculture industry. The results of comparative issues are shown in Table1. The results show that the proposed framework can implement to construct the sustainability model in a direct supply chain level either the business activities of a company or the firm strategy in a supply chain.

Table 1 Comparative of sSCM assessment implementation of 3 case studies

Comparative issue	Electronics	Organics	Hydroponics
Supply chain engagement level	Direct supply chain	Direct supply chain	Direct supply chain
Business activity	Procurement	Firm's strategy	Firm's strategy
Number of set of indicators and measures	1	3	3
Number of sustainability dimension	3	(3, 3, 3)	(3, 3, 3)
Number of indicators	10	(8, 8, 8)	(8, 8, 8)
Number of measures	25	(19, 20, 15)	(18, 20, 15)
Method to determine priority weight	FAHP	AHP	AHP
Method to evaluate alternative's performance	Criteria rating	TOPSIS	TOPSIS

Note: (x, y, z) represents the number of (supplier, farmer, seller)

Conclusions

There are two aspects for managing sustainability in business i.e. sustainability of product and sustainability of process. This research focuses on the second aspect. Hence, the sustainability

performance measurement model is developed based on process point of view. Moreover, our research work focuses more on strategic and tactical level more that operational level in order to dealing with an implementation of sustainability practices in company and direct supply chain level. An approach to construct sustainability indicators and metrics is based on sustainability in process point of view. In other words, this performance measurement system measures corporate sustainability competitiveness. The proposed approach is not suitable to construct sustainability indicators and metrics for product life cycle assessment or product life cycle management.

The selected sustainability indicators and metrics are specific to implement only in case study company and specific supply chain (organics and hydroponics cases). It means that if other companies/supply chains need to measure sustainability performance of firm or specific activity. They should construct their own performance indicators and metrics. However, the proposed sSCM assessment framework provides a generic approach to construct sustainability indicators and metrics.

Because of the research work on measuring social performance in supply chain is still in the beginning stage. Researchers can adopt the proposed sustainability criteria to enhance key social practices for sSCM in industrial sector.

According to our limitation that this work focuses the sustainability only in process point of view. However, there are various research works that try to measure sustainability of product. This work has proposed well-defined sustainability criteria in industrial sector and it can be adopted as criteria for sustainability of product. The research challenges are how we can adopt these sustainability criteria into the product aspect and how we can integrate these two aspects for considering the sustainability in supply chain at same time.

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TOWARDS LONGTERM REFUGEE CARE: AN ADVOCACY FOR PERMANENT CAMPS AND HOUSING

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Introduction

The United Nations High Commissioner for Refugees (UNHCR), estimates in its most recent report that almost 66m people are displaced worldwide (UNHCR, 2017), of which roughly 21m are considered refugees (UNHCR, 2017), and over 40m are IDPs. IDPs are people uprooted within the borders of their own countries while refugees are those outside their countries (UNHCR, 2017). In each of the past five years, annual increases in the total global displacement arising from human-induced disasters such as conflict and persecution have been in the millions (UNHCR, 2017; Oloruntoba and Banomyong, 2018). Such enormous numbers of vulnerable displaced people requiring healthcare, shelter, sustenance, and protection have become problematic to efficiently and effectively manage within temporary camps. The problem of refugees and IDPs is a significant global problem that needs addressing. Hence, this paper raises the overarching research question: How can the supply chain logistics of care for refugees and IDPs be made more efficient and effective?

In order for humanitarian logistics and supply chains as well as refugee care to be more efficient and effective, this paper advocates for deployment and use of more permanent housing or permanent camps through long term planning. This paper contrasts and compares the short-term emergency approach to refugee and internally displaced persons (IDP) sheltering to longer term or permanent refugee and IDP settlement options. The rest of this paper is structured as follows:

Section 2 discusses the lack of universal definition of refugee as a precursor problem. Also, section 2 highlights key characteristics and features of temporary camps, and the logistics and supply chains that enable them as currently generally deployed. Section 3 briefly highlights how the research was conducted using content analysis of practitioner and academic literatures on refugee camps methods and why the method was deployed. Section 4 highlights current problems with the short term / temporary camp mindset and argues for longer term, more permanent structures in refugee care. Section 5 summarises and concludes the paper.

Refugee definition, funding and features of temporary camps

The refugee

The Geneva Convention established in 1951 that a refugee is a person who, because of well-founded fear of prosecution because of race, religion or political opinion is outside the country or nationality he or she has, while not being able to rely on protection of their country. Refugees have an international right to protection (Weis, 1954). However such a term is not accepted by some countries and governments who did not ratify the Geneva Convention. Such governments see refugees as guests or displaced persons thus they avoid legally binding responsibility as well as confer a temporary and insecure state of residence in the host country on such refugees, and this adversely affects every aspect of planning and management of refugees.

Donor funding

The cost of relief provision is rising at an alarming rate and many donors make pledges which they often never fulfil. Between 2004 and 2015 the total sum needed for humanitarian actions rose six-fold to $19,5 billion (Grubmuller, 2017) which the UN agency for peace building is convinced is not sustainable.9 This concern is exercerbated by economic problems regularly faced by multilaterial humanitarian agencies (e.g. UN agencies) and international humanitarian non-government organisations (IHNGOs). As a result, humanitarians often need to reduce their already low assistance of basic goods to refugees (Dunn, 2015). Hence, there is a need for a provision of more efficient humanitarian aid enabled by better planned logistical and supply systems.

Features of camps

There are multiple alternative interpretations of a refugee camp. A camp may be described as a city-like structure of temporary dwellings (e.g.tents), supplied by outsiders, or can be a settlement similar to an open village (Black, 1998). The UNHCR's Camp Management Toolkit differentiates

between planned camps and self-settled camps. Other types of temporary settlements are described as reception/transit centers, emergency evacuation centers, and collective centers (Camp Management Toolkit, 2015) Overall, the temporarity of a camp is derived from the temporary nature of the definition of a refugee. Ideally, a refugee camp is meant to provide a safe and healthy temporary residence, until refugees and displaced persons can return to their usual place of abode. A camp can only be a place, where it is possible to provide the refugees with necessary materials and services through key logistical services. This paper defines a refugee camp as a planned or self-settled place, which is supplied by outside helpers through the accessibility of logistics, with the goal to safely shelter refugees temporarily.

Through such camps, the UNHCR and host governments provide refugees and IDPs with food, water, shelter, sanitation, hygiene and other necessities. The UNHCR is mandated to lead and coordinate international action for the worldwide protection of refugees and the resolution of refugee problems as well as to ensure the well-being of refugees and internally displaced persons (IDPs). However, there are difficulties in achieving these laudable goals partly due to receiving countries handling the influx through the building of temporary camps, to seek centralised control over incoming populations (Huynh et al 2010). Indeed, over 40% of global refugees and IDPs live in over 1000 temporary camps around the world (Huynh et al.,2010)

Economics of relief in camps

The parts of humanitarian response that have a large impact on the economic performance of camps and the overall humanitarian effort for refugees include (1)food (2)water (3)sanitation, and (4)other complexities.

Food

The necessity of adequate food and nutrition for refugees is the first priority of survival, and the minimal requirements of food for refugees is defined as 2100 kcal per person per day. This ration is to be adjusted as the emergency develops. Despite this small personal food intake, there is an enormous logistics and economics effort required. For example, a camp of only 10.000 people requires more than 39 metric tons of food per week based on an intake of 2.100 kcal roughly equaling 560 grams) (Birkeland and Vermuelen, 2004). In short, minimal requirements for food equal a big financial and logistical involvement in transportation.

The World Food Program (WFP) is usually the lead organisation for procurement and delivery of food, and it is responsible for most of relief related food cargo transportation across the world (WFP, 2015). Food supply stays relevant in short- and long-term camp involvement. Food quality, food safety, and food allocation to displaced people is important as efficient, economic and reliable food supply are required goals.

Water

The necessity of potable drinking water (and sanitation) is just as important as food. Water is needed to preserve human life. Hence, an economical provision of water and related services to refugees (in camps) is necessary. There are health related risks, associated with the provision of drinking water. The minimal quantity of water required per person is according to UNHCR and USAID 15-20 liters per person per day, while additional water is needed for health centres. An urgent emergency is given, if the available quantity per person falls below 10 liters per day (UNHCR, 2007). The minimal provision of the recommended quantities for displaced persons results in a lot of logistical effort.

Sanitation

Like water, proper sanitation is crucial to preventing epidemics and illnesses (e.g. diarrhoeal diseases and cholera). Poor water quality causes diarrhea which results in malnutrition, a common cause of death in refugee camps for adults and infants.Sanitation has to do with the removal of waste materials. The management of waste and waste water needs to be handled (efficiently) in camp settings. Waste is defined as an unwanted object, not needed by the previous owner since it doesn´t hold any value (Lemann, 2008) Like every community, a refugee camp produces waste, either in a solid form or in the form of waste water. Waste water is defined as any water discharged by human settlements because of contamination, with the distinction between black water (containing human excreta) and grey water (wastewater without excreta) (Singh, 2008) The problem of health risks through waste is often discounted and pit latrines dug for such wastes (Singh, 2008).

Other complexities

There are many stakeholders in refugee camp settings each with a different perspective and a different purpose. There are the (1)UN- agencies (2) the NGOs involved (3)the Camp Management

Agency (CMA)(4) host national and local governments, and (5) host communities and its private sector. Logistically, the CMA manages individual camps, including the assistance and assurance of well-being of displaced persons registered in the camp (Camp Management Toolkit, 2015). The CMA is also is responsible for allocation of services and facilities necessary to satisfy the provision of basic sustenance needs such as food and water.

Governmental approaches to the refugee situation, UNHCR, and camp management may differ. Host governments are responsible for refugees in their territory according to the UNHCR and Geneval convention. Hence, the UNHCR claims that a government, which hosts refugees, is accountable for keeping them safe and secure, while also maintaining order among them (UNHCR, 2007). This leads to an inconsistent situation when host governments who may not consider fleeing people as refugees giving unclear legal definitions or definitions that do not align with UN definitions, thus further exercerbating an already complex situation.

In summary, the building of camps in a host country in response to sudden large influxes of people may overwhelm and preclude any pre-existing planning system in place. Hence, a separation from local communities appears like the only option to governments in charge (Black, 1998). To open a camp, logistical access, water sources and distribution sites must be planned (Birkeland and Vermeulen, 2004). In addition, humanitarian work is subject to an unpredictable and fast changing environment. For example, uncertainty in demand and supply, short time frames for decisionmaking, and shortage of staff through fatigue.In short, the logistics and the supply chains are defined by the unknown in almost every respect (Van Wassenhove, 2006). The refugee camp environment is thus characterised by volatility, uncertainty, complexity, and ambiguity. Nonetheless, overall, the refugee camp serves multiple financial benefits such as centralization of needs therefore reducing the costs of distribution of relief.

Method

This is a conceptual paper that compares the often used short term temporary model of camp relief delivery structure and processes with the options of a more permanent longer-term care of refugees. While no primary data was collected, a review and analysis of a broad range of relevant practitioner and academic literature and reports by various IHNGOs and United Nations agencies 1998-2018 was undertaken through content analysis, and conclusions obtained.

Content analysis is a research technique used to make replicable and valid inferences through the interpretation and coding of textual material (Duriau et al 2007; Lincoln and Guba, 1985). Content analysis is the process of systematically evaluating texts such as documents, books, journal articles, written communication, and graphical illustrations (Duriau et al 2007; Lindkvist, 1981). Content analysis is used to interpret meaning from the content of text data and, as such, adheres to the naturalistic paradigm (Lindkvist, 1981). There are many variations in the use of content analysis as regards derivation of codes based on the purpose of the research, the state of science in the area of interest, and the nature of the research question (Hsieh and Shannon, 2005). In this use of content analysis, the author derived coding categories directly from the text data under analysis (Duriau et al 2007; Hsieh and Shannon, 2005).

The technique of content analysis has the advantage of allowing researchers to analyse socio-cognitive and perceptual constructs that are otherwise hard to study through conventional quantitative and archival techniques (Duriau et al 2007). The major advantage is that content analysis enables the collection and analysis of large samples of texts that may be hard to employ in purely qualitative studies such as narrative approaches, observation, ethnography, grounded theory, phenomenology, historical research, interviews or case studies (Duriau et al 2007; Hsieh and Shannon, 2005). As such content analysis is good for rigorous exploration of many significant but hard-to-study topics of interest to organizational and logistics researchers in diverse areas and disciplines (Duriau et al 2007; Hsieh and Shannon, 2005).

Examples of current problems with the short term / temporary camp mindset

Refugee camps are complex multidimensional situations, and the supply chains that serve them are extreme as regards uncertainty and risk (e.g. in funding, transportation, last mile distribution and sourcing). For brevity, I use a few examples (food inventory and quality, complexity of stakeholders, centralisation, sanitation) to illustrate the benefits of long term planning and permanent structures.

First, agencies such as the World Food Programme (WFP) often focus on short-term flexibility to cope with volatility in evolving situations through short-term planning and forecasts that are likely to be more accurate giving short term planning horizons. Appropriate supply strategies are often executed e.g. through WFP's network of global storage hubs (United Nations Humanitarian Response Depots) (UNHRDs) (WFP, 2015). These emergency warehouses, placed close to regions likely in need of relief, can supply potential disaster areas globally within 48 hours. The UNHRD stockpiles are the result of a

trade-off. While they are expensive to keep, the ability of instant relief of spontaneous demand is valued greatly (McCoy and Brandeau, 2011).

Second, this approach also reflects in the kinds of food purchased due to the necessity of short, streamlined supply chains for products that are perishable. Perishables are not compatible with uncertain storage time and sudden supply to spontaneous camps. For low costs, WFP claims to buy food stockpiles with regard to seasonality and savings through bulk buying (e.g. buying rice in bulk during the rice harvest season) (WFP, 2016)

Third, humanitarian actors often rely on the storage of their relief items to be able to provide them to people in need in the future. With WFP, logistics activity mostly comprises procurement of food, food logistics and transportation, and last mile delivery. To execute these core processes, WFP stores up to 1 million metric tons of food in warehouses across the world, thus bearing significant inventory costs in a bid to reduce costs and lead time (WPF, 2016). However, inspite of this, McCoy and Brandeau (2011) report long and variable lead times. They also argued that WFP stockpiles are not planned with analytics and decision support but are mere subjective approximations.83 Criticism on systematic inefficiency of the field of aid delivery has also been voiced by humanitarian actors (Oloruntoba and Gray, 2002).

Fourth, there are often multiple stakeholders and actors in refugee camp settings each serving different purposes (Kovacs and Spens, 2007). However, UN- agencies and NGOs often have a prominent and influential involvement in refugee camps (Rutinwa, 2017). The so-called Camp Management Agency (CMA) manages individual camps, and is responsible for the assurance of assistance and well-being of displaced persons at the camp level (Camp Management Toolkit, 2015). The CMA is responsible for the provision of basic needs, such as food and water, and allocates resources, services and facilities as necessary to satisfy these needs (Birkeland and Vermeulen, 2004).

The official UN Camp Management Toolkit states that the maintenance of camp infrastructure (e.g. roads and distribution sites) is the responsibility of the CMA as well as maintaining relationships with all stakeholders and agencies in the camp (Camp Management Toolkit, 2015) In theory, because of their responsibility for food provision and distribution, the most important agency in the refugee camp context is the UNHCR and the WFP. They are mainly funded by voluntary contributions of the member states of the UN.

The second most important stakeholder group is the host government involved as it is responsible for refugees in its territory. Specifically for keeping refugees safe and secure, while also maintaining order (UNHCR, 2007). Due to vague and inconsistent definitions, often, host governments do not consider people fleeing as refugees (e.g. in the case of Syrian refugees in Lebabnon). The difference in the UN's point of view and that of the host government thus blurrs constituted roles and responsibilities, and often contributes to hindering possible solutions. The third most important stakeholder is the local government of the area the camp is situated in, the 'host' community and associated private sector in form of local markets and businesses (WFP, 2016). Hence, refugees are not only impacted by their flight, they are also impacted by multiple actors and stakeholders with different goals and motivations, resulting in complex multidimensional situations. Although the roles and responsibilities are clearly divided in theory, in practice they are often blurred and unclear (Grubmeller, 2017).

Fifth is the centralisation of camp logistics. A commonly used organisational tool of humanitarian aid is the refugee camp and associated logistical activities. A camp serves the centralisation of needs and scale economies (aggregation of people and their needs in one place) and therefore reduced cost of distribution of relief items.

The erection of camps in a host country is not always a conscious, planned, systematic or economical choice because sudden large influxes of people arrive and overwhelm almost every system in place. Thus, a separate system (or temporary camp) away from local communities appears like the only logical option to host authorities (Camp Management Toolkit, 2015). In order to open a new camp considerations often include logistical access, water sources and distribution sites.61 The environment is unpredictable, fast changing, uncertain in supply and demand, extreme time for decisionmaking, shortage of knowledgeable staff and so forth paint a picture of a hostile operating environment. Hence, the camp supply chain is defined by the unknown in almost every aspect (Oloruntoba and Gray, 2006; Olaogbebikan and Oloruntoba, 2017). It is characterised by volatility, uncertainty, complexity, and ambiguity (Grubmuller, 2017).

Sixth, as a response to uncertainty volatility, complexity and ambiguity, relief agencies tend to focus on getting short-term flexibility before an event occurs or in evolving situations i.e. contingency planning and the constant monitoring and analysis of high risk areas/countries (Grubmuller, 2017). The necessity of short-term planning means that forecasts in this short reaction time frame are more likely to be accurate than those made for the distant future. To reach people in need as quickly as possible,

as previously mentioned, a global network of storage hubs is used and run by WFP. These emergency warehouses, can supply potential disaster areas all over the world within 48 hours. The UNHRDs (United Nations Humanitarian Response Depots) include items (amongst others emergency food) for various humanitarian organisations (WFP, 2017). While such stockpiles are costly to keep, the ability of instant relief of spontaneous demand is valued greater (McCoy and Brandeau, 2011).

Seventh, the necessity for shorter supply chains for products that are perishable, is not compatible with uncertain storage time and sudden supply to countries in need (WPF, 2016). To provide food items efficiently, WFP purchases food in peak harvest time when supply is high through optimal contract modality deriving quantity savings through bulk buying (WPF, 2016). The efficiency of the supply chain methods is thus very important to such humanitarian organisations.

The specific setting of the refugee camp is impacted heavily by the flexible and short-term view of camps and relief aid taken by the whole humanitarian systems (e.g. UN agencies, donors, host governments, humanitaruian organisations, NGOs). The distribution of relief items is centralised and temporary given the nature of camps). The provision of food in camps is done in a centralised manner, in the center of the camp or at the edge of the camp, close to the entrance, to avoid food trucks hampering the camps' processes (Camp Management Toolkit, 2015). The same approach is used for water and sanitation. Such flexibility and short-term involvement of humanitarian aid is based on the short-term non-permanence of refugee camps just like the definition of the refugee. The ultimate goal is to close a camp upon completion of its purpose, aside from reasons of insufficient funds or security risks to relief workers. Camps close when either protection is no longer needed or there has been an agreement with the country of origin that guarantees a safe return (Camp Management Toolkit, 2015). Hence, agencies withdraw from the campsite/country leaving little, or no lasting structures.

Adverse economic effects of short term approach

While humanitarian aid is short-term, ad-hoc and flexible because of the sudden nature of disasters, there is inefficiency built into the process as a result. For example, WFP stores up to 1 million metric tons of food in warehouses across the world (WFP, 2016). McCoy and Brandeau (2011) argue that WFP and UNHCR are inefficient in their supply chain logistics because they have long and variable lead times and stockpiles not planed with analysing decisions but approximation.

McCoy and Brandeau (2011) also mention limited funding of agencies which results in a short funding horizon (sometimes only one month!) and minimal funding and operational/logistical considerations of the length of a crisis). As a result, humanitarian actors face economic challenges such as inefficiency in negotiating for shipping rates as they are often unable to secure long-term rates (since their long-term funding is uncertain) and therefore have less planning stability (Heaslip et al. 2012).

Another challenge is inadequate allocation of relief goods as a result of underfunding and inefficiency. Underfunding and inefficiency thus results in public criticism, which, in turn results in shortage of donor funding (Oloruntoba and Gray, 2009). Furthermore, as a result of the temporary nature of the current approach, indirect problems and supply gaps in disaster affected communities that outlive the immediate emergency situation can have severe long lasting consequences after the humanitarian operation has ended and the camp is closed (e.g. cholera in Zimbabwe and Haiti, with negative impacts on recovery and rebuilding and child abuse/rape in Congo and Haiti) (Oloruntoba and Banomyong, 2018)

A major economic challenge arising from such ad-hoc short term perspective to humanitarian aid and refugee camps is the organised private sector which is often minimally represented by a few selected vendors. Van Wassenhove (2006) thus argues that there is less drive in improving performance and evaluating past operations. Oloruntoba and Gray (2002) argued that variations in humanitarian field operations result in missed opportunties for transmitting logistical experiences from one event to another. As a result, it can be logically argued that is no development of lasting or resilient structures (Oloruntoba and Gray, 2002). Centralised food/water distribution in camps results in challenges and risks for refugees and IDPs. Food is often of insufficient quantity and quality because of the economic problems previously mentioned. Imported food may also be unfamiliar to refugees and to locals, which results in confusion about how to adequately prepare the food (Oloruntoba, 2005).

Additionally, a limited range of the diet (often rice) results in malnutrition and related diseases in refugee camps (Camp Management Toolkit, 2015). Storage of food in warehouses leads to massive presence of commuting food trucks in camps, and attendant endangerment and pollution (Camp Management Toolkit, 2015). Centralisation in distribution of food and water results in long treks for individuals to transport the water back to their dwelling, hence, burning up to one sixth of the calorie intake provided (given 80 litres transported over 200m and 2100 kcal) (Camp Management Toolkit, 2015). Refugees cope by using alternative possibly contaminated water close by, but is a risk to health (Camp Management Toolkit, 2015). Dug pit latrines common in camps often contaminate groundwater

resulting in cholera (Camp Management Toolkit, 2015).

Advocacy for a longer term perspective and more permanent structures

The current short term system of humanitarian aid provided in camps has major flaws and inefficiencies. Hence, I argue that (1) aid provision would benefit economically from a longer term view that involves (2) private sector cooperation. The requirement for quick action to save lives and appropriately designed supply chains for camps (or refugee settlements)is a necessity. It is noteworthy that the average time a refugee spends in a camp is approximately 12 years (Dunn, 2015). Camps are always planned with only short-term relief in mind, even though they usually exist for a long time (Van der Helm et al., 2015).

The post-emergency phase of camp life may be described as a camp's possible settling into permanence. Van der Helm et al (2015) and Van Wassenhove (2006) argue that in post-emergency settings, economical provision of aid becomes important. The time span of displacement and therefore an operational camp often outlives the crisis itself, since a return is often hindered by remaining weapons or absent infrastructure (e.g. Palestinian refugee camps opened in Jordan in 1948, and camps opened again in 1968 in Lebanon, Syria, the West Bank and the Gaza Strip. These camps contain the world's largest and oldest refugee population (UNHCR, 2017b). There are also Somali refugee camps in Kenya and Ethiopia opened since 1992 and the Mayukwayuka refugee settlement was established in Zambia in 1966 to host refugees fleeing from Angola's civil war (UNHCR, 2017b).

To provide aid economically, an adaption to the circumstances seems necessary. Although, response still needs to be fast and responsive to the volatile environment, this paper argues that prolonged refugee settings could benefit from inclusion of long-term planned measures. For example, having long-lasting fixed investments with high fixed costs and sustainable development view instead of short term immediate relief that could be financially optimized through longer involvements that reflect the camps existence.

First, the principle of a long-term approach has its origins in the economic concept of the breakeven point. Without delving into the breakeven concept, costs consist of fixed costs (unrelated to output of units) and variable costs (linear to unit output) (Sanders, 2012). Under the assumption that an investment such as infrastructure lowers the variable costs and that a long term involvement results in a high unit output, an initial significant investment becomes more economical the longer the crisis and attendant displacement lasts (Sanders, 2012).

Second, this longer term view will enable (a) the strategic decision of structuring the supply chain according to the humanitarian situation and (2) allow the improvement of the execution of delivery. The supply chain may be described as a string of processes, activities, operations and organisations through which a material passes before reaching its final goal, the customer (Waters and Donald, 2011).It is a "network of entities involved in producing and delivering a finished product (...)" (Waters and Donald, 2011). An effective and efficient supply chain must exhibit responsiveness, reliability and relationship management (waters and Donald, 2011).

Third, because of an uncertain demand meeting an uncertain supply (through funding insecurity or disruptions) an agile supply chain emerges (Oloruntoba and Gray 2006; Oloruntoba and Gray 2015). If supply can be provided in a more secure way, the supply chain becomes more responsive (Waters and Donald, 2011). To be responsive while still being economical, the private sector takes advantage of lean supply chain management principles which eliminates waste (e.g. excessive inventory or high lead times) and benefits value-adding processes. More precise timing of supply chain activities and cutting of wasted time will make the supply chain more efficient.

In camps, the peak consumption of water and food and unnecessary storage could be prevented through a lean approachment to the management of their supply chains. Lean management is enabled because of the longer term stability of the post emergency situation.

Fourth, a more economical supply chain execution may be derived from the practice of outsourcing less significant parts of supply chain performance to companies specialized in the field, resulting in a cheaper service through economies of scale (higher efficiency through size) and a larger geographic market, thus making it an attractive option for businesses in the host community. The provision of food in a refugee camp for instance may be outsourced, and the need for material handling equipment to move them (Luce, 2014). Third party logistics providers (3PL) can be made to guarantee specific service levels in legal agreements (Rodrigues et al 2018). Thus conferring supply chain reliability. Outsourcing may thus be described as a longer term supply chain management tool.

Fifth, supply chain relationship management and effective communication amongst the multitude of stakeholders in and outside the camp is required to respond effectively to the growing complexity of aid situations/relief camps (Balcik et al, 2010). The financial and coordination benefits of information sharing can be observed in commercial supply chain management. With better information

sharing and cuperior communications, lead times and inventories across the chain can be reduced, resulting in waste reduction.

Sixth, partnership with the organised private sector in host communities could provide resources to overcome the problem of financing fixed costs in infrastructure investments. The supporting role of the private sector is encouraged by UNHCR by e.g. including it in their futuristic vision. Public-Private- Partnerships (PPP) may be beneficial to the wellbeing of refugees, while also supporting the local host community (Stewart et al 2009).

The characteristics of successful business supply chains (responsiveness, reliability and relationship management) are achievable in the humanitarian aid sector through long-term measures, and investments in infrastructure can deliver more efficient aid and reduced supply chain risk.

Currently, the provision of only minimal standards of food consumption (2100 kcal) per day triggers enormous transport, storage and distribution activities within the camp. The emergency supply of non-perishable food (rice) does not include important vitamins and minerals that need to be consumed in a prolonged situation for health (WFP 2016). To give people the opportunity to obtain the food they need in a protracted situation, there are a range of food vouchers that could be used.

Seventh, rather than in- kind provision of food (rice) through WFP, vouchers can be distributed for food to be used in participating markets (even supermarkets inside refugee camps) (Oloruntoba and Gray, 2015). An electronic card that can be recharged regularly is more easy to use than a paper based system of vouchers (Sodhi and Tang, 2014). The economic benefits of voucher based food provision is generally acknowledged: i.e. price reduction of the products (Hidrobo et al. 2014). UNHCR also sees a benefit in the reduction of its logistics costs, as according to UNHCR, 98% of support reaches the refugees instead of being used for logistics (UNHCR, 2013). As regards supermarkets inside refugee camps, a physical infrastructure investment is given as well, which indicates the long-term approach to aid.

Eighth, the water sector in camps can clearly benefit from infrastructure. In short-term disaster situations, water is trucked to the people who are displaced. However, I argue for the construction of a pipeline network in camps to replace the truckingof water. Existing water infrastructure can also be expanded to camps.

Nineth, long-term measures in waste management of refugee camps involves garbage collection/recycling and adequate waste water handling. Instead of private latrines, integrated water and waste water infrastructure may be built. Hence, collection of household waste can be made economical (and ecological) in the long term through the principle of avoidance, minimization, recycling and environmental decontamination. Long-term waste handling can result in less exposure to health risks.

Tenth, as regards camp and settlement planning, the quickly realised grid planning as currently used in the short term view of humanitarian aid and refugee camps is less effective than the more sophisticated cluster approach to camp planning. Grid planning is not effective in growth, ecological issues or infrastructural usage. Cluster planning (more logical planned arrangement of elements) performs better in these fields and poses an objectively better long-term solution.

Summary

This paper has argued for a longer term perspective in the provision of humanitarian aid and in setting up refugee relief camps using several practical examples. The paper has responded to the question of how the supply chain logistics of care for refugees and IDPs can be made more efficient and effective through the humanitarian system taking a longer term view and making the appropriate investments that will deliver lean, effective and efficient supply chains on the long run. The paper advocated for deployment and use of more permanent systems through long term planning as well as longer term sustainable development rather than short term assistance

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Admission Information >>>

Admission Criteria

Admission to the program will be based on the Admission Committee's careful evaluation of the applicant's qualifications.

Master's degree requirement

Applicant must hold a Master's degree in related field.

Interview

Applicant must show strong commitment, strong research capability, and ability to communicate in English.

Research Proposal

Only an applicant enrolling for plan I has to submit a research proposal in area of interest and the Ph.D. executive committee will consider and suggest the dissertation advisor who might be interested in the proposal.

Admission Requirements

1) A TU-GET score of 550 or TOEFL score of 550 (paper based), 213 (computer based), 79 (Internet Based) or IELTS score of 6.0 taken within 2 years on the application date.
2) A GMAT score of 550 or GRE score of 1100 (verbal and quantitative parts) or SMART II score of 600 (minimum of 250 for each part) or satisfactory level score of Graduate Program Admission Test taken within 5 years on the application date.
3) Three letters of recommendation
4) A statement of intent to pursue a Ph.D. degree
5) The Research Proposal (for application to Plan I)

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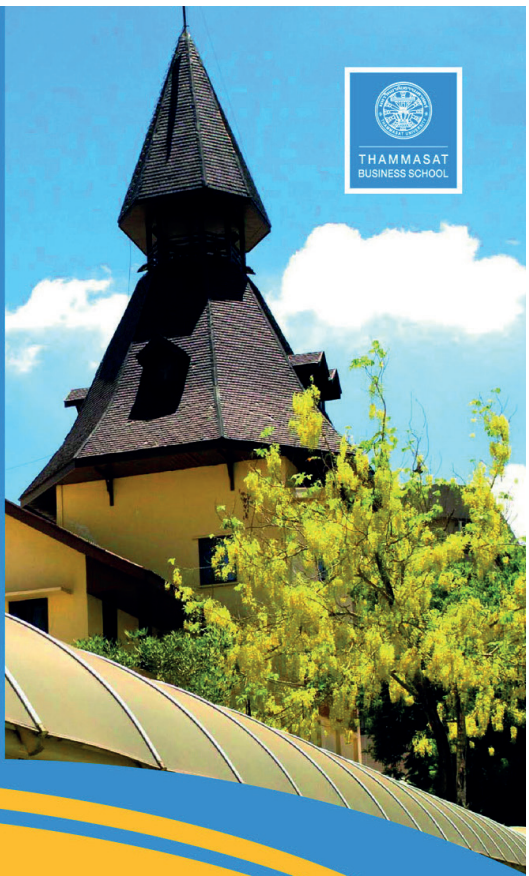
Tuition and general fees are approximately 230,000 Baht per annum.



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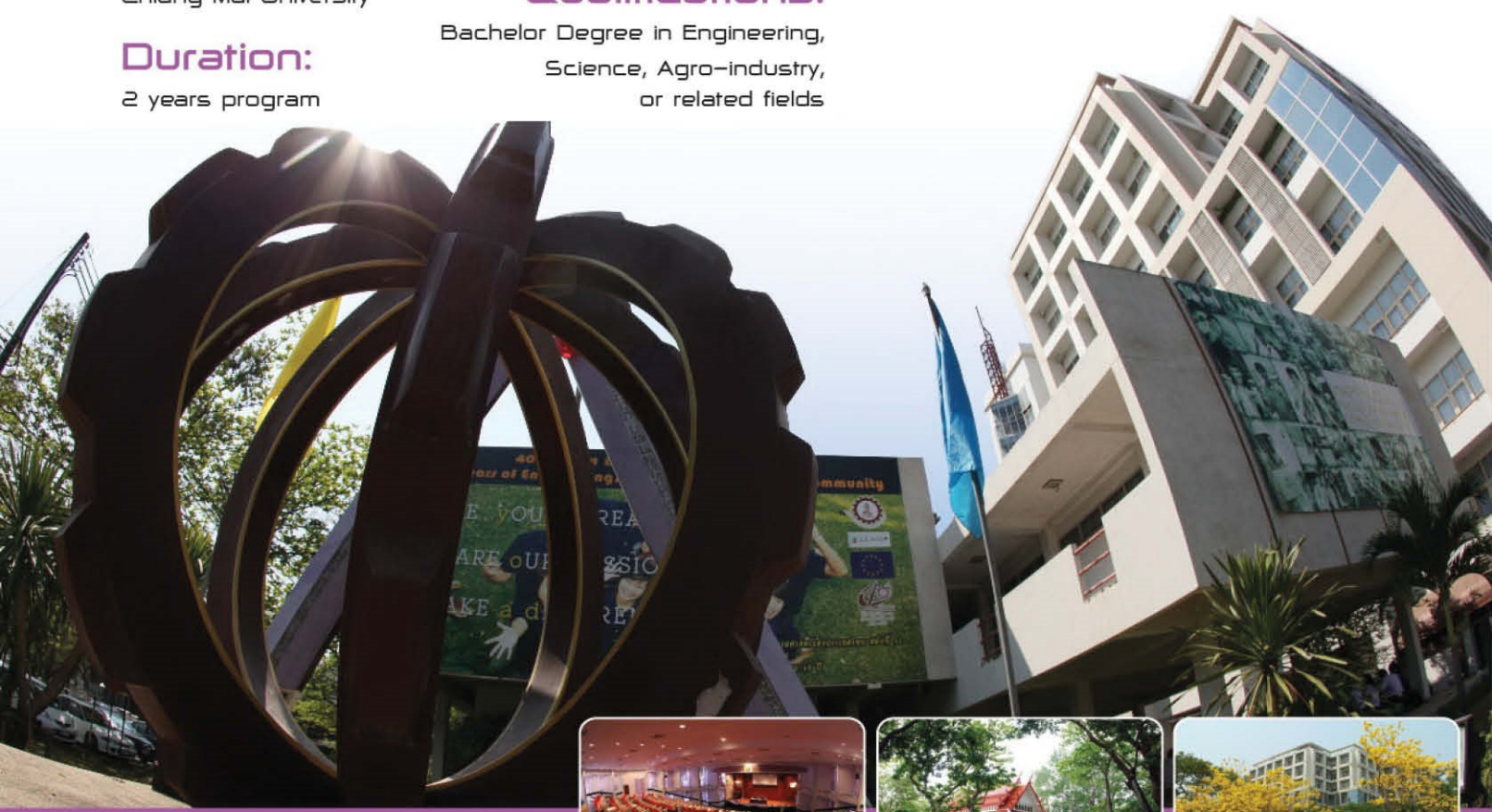

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- *Hold a Bachelor's cumulative GPA of at least 3.00 or minimum 2 year working experience in related fields*

Plan A2. (Coursework + Research)
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Plan A2. (Double Degree)
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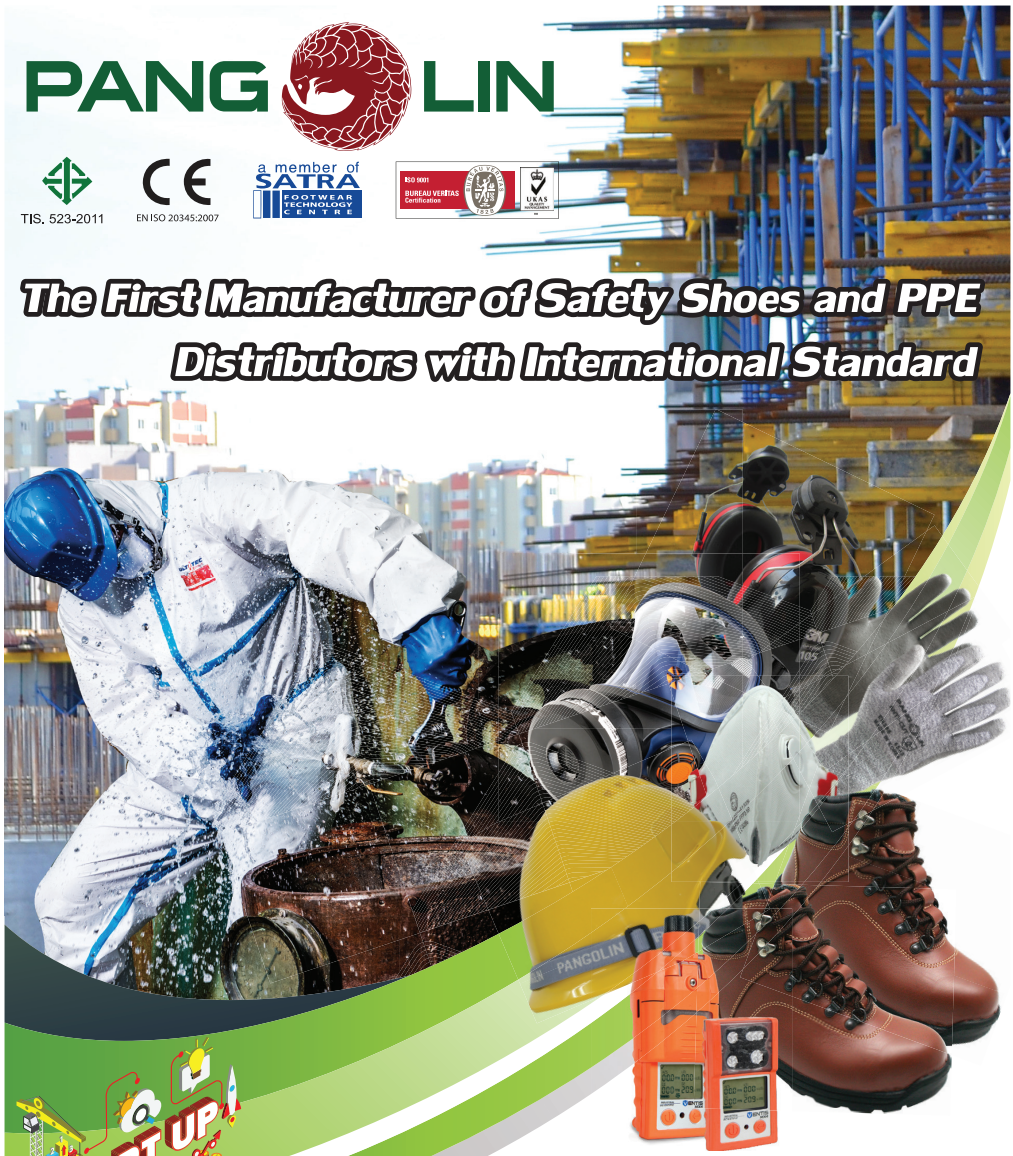

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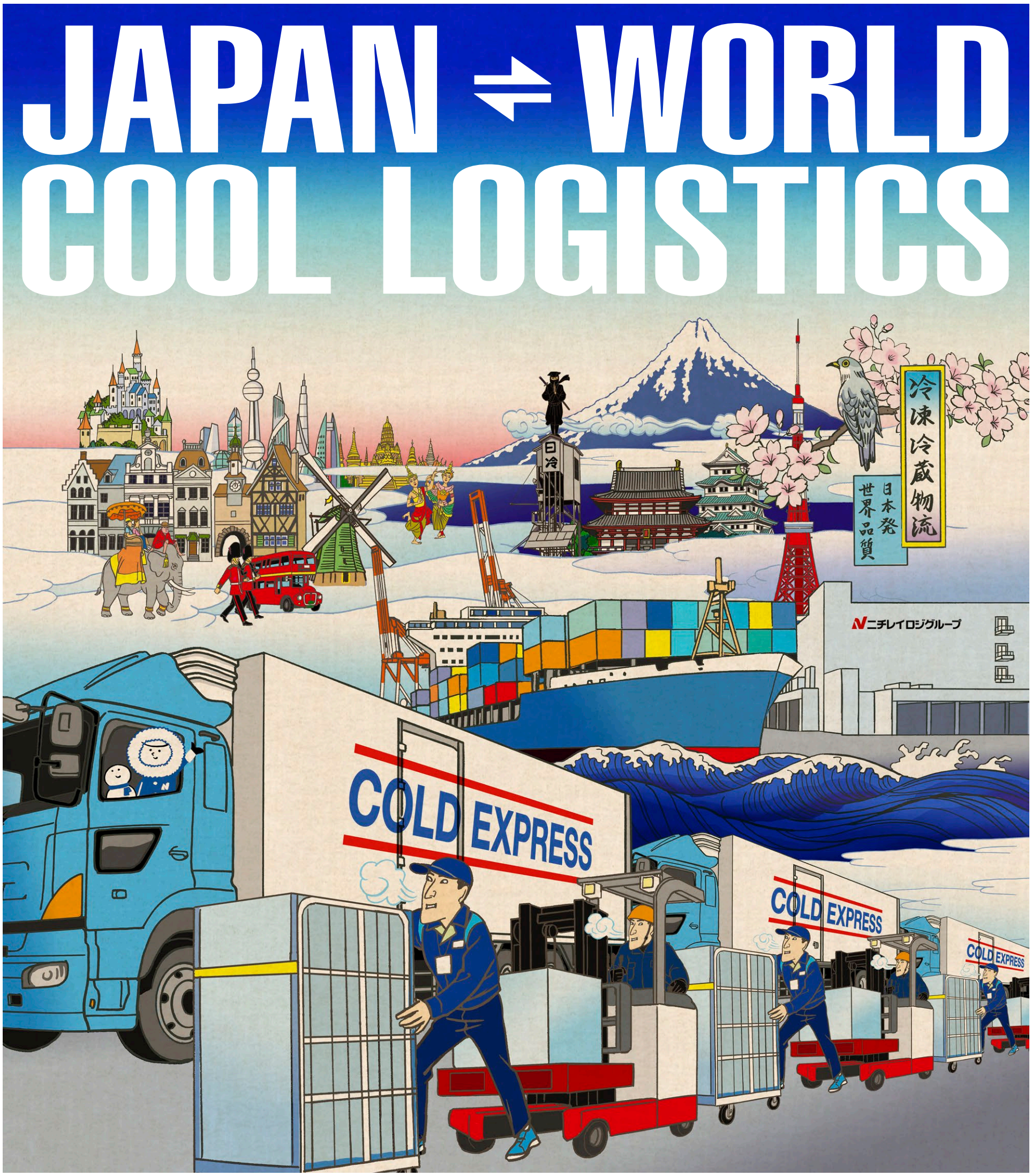

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