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THE KEY ACTIVITIES OF GREEN LOGISTICS MANAGEMENT IN THE THAI AUTOMOTIVE INDUSTRY

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ABSTRACT

Thai automotive industry needs to be developed for understanding activities management on inbound logistics that is an essential element of business operations for a manufacturing firm. The purpose of research is to study the main activities of green logistics management (inbound logistics) in the Thai automotive industry. Survey research was used in this study to collect data by sampling from the people in the field of logistics and environmental management of Thai automotive industry to examine the key activities of Green logistics management. Inferential statistics analysis using Confirmatory Factor Analysis (CFA) is applied to determine the key activities that influence to the logistics management in the sense of environmental friendly. There are two finding of research. Firstly, the conceptual framework presents three dimensions i.e. Green Transportation Activity (GTA), Green Purchasing Activity (GPA) and Green Inventory Activity (GIA) for key activities of green logistics management (inbound logistics). Secondly, the measurement model of the main three activities that GTA, GPA, and GIA are tested. The Goodness of fit statistic is 0.546. These suggest the fit of collected data to the hypothesized model.

Keywords: Green Logistics Management; Inbound Logistics; Thai automotive industry; Thai Industry Estate Authority; Key activity.

INTRODUCTION:

In the early of the 21st century, environmental concept was considered as the priority of international standards and regulations in order to manage company and industry with integration of environmental management in their business processes. In business process of most countries, the concept of Supply Chain Management (SCM) is the important strategic of all industries (Hsu, Choon & Laosirihongthong, 2014; Isaksson & Brodin, 2013; Styles, Schoenberger & Galvez-Martos, 2012a; Styles, Schoenberger & Galvez-Martos, 2012b). SCM is the integration of logistics activities and management of product, service and information that flows from first suppliers to end users and organizing the cooperation of the three main SCM dimensions; i.e. Economic, Social and Environment dimensions (Bernon & Mena, 2013; Fayezi, O'Loughlin & Zutshi, 2012).

The goal of SCM is to minimize the total cost and adding value to the supply chain that uses a variety of natural resources and energy while causing minimal waste and pollution to the community and environment (Bak & Boulocher-Passet, 2013; Department of Primary Industries and Mines, 2011; Lorentz, Toyli, Solakivi & Ojala, 2013). Then, this development produces pollution that affects the environment and communities which are solved by Sustainable Supply Chain Management (SSCM) (United Nation Environment Programme, 2014). SSCM is considered to be important as it is green logistics management, the management of logistics activities while considering the environmental concept, in parallel with decrease in the environmental effects (Dey, Guardia & Srinivasan, 2011; Xia & Tang, 2011).

In the industry manner, the knowledge of green logistics management is important for studying key activities of this management. Also, this knowledge is the key information for companies to start green logistics management within their business processes. Furthermore, this information supports fundamental knowledge to plan the logistics management towards a company operating with environmental concept. Apparently in 2013, the automotive industry was a major sector in Thailand with a significant contribution to the country's economy, in the amount of 12% of Thailand's gross domestic product (GDP). In 2014, Thailand had the world 17th largest manufacturer and host economies for 2013-2015 in Rank 8 of the world. Also motor vehicle production capacity was nearly 2 million vehicles with an export value of US$30 billion according to the Thailand Ministry of Commerce. (Thailand Board of Investment, 2015)

Moreover, ASEAN countries are trying to promote green and environment friendly technology. Thailand has high potential to become the hub of global green automotive production towards global trend (ASEAN Automotive Federation, 2014; Thai Automotive Industry Association, 2015). Also, the government and private sectors have been collaborating to create the master plan for automotive industry (2012-2016) in order to develop Thailand to be a global green automotive production base and to support the research and development in automotive technology (Thai Auto parts Manufacturers Association and BOI, 2012).

As the results, the information of main activities of green logistics management (inbound logistics) in the Thai automotive industry needs to be developed for understanding activities management. This research focus on inbound logistics that is an essential element of business operations for a manufacturing firm, involving the processes of receiving, storing and distributing raw materials for use in production. Therefore, the purpose of this research is to study the main activities of green logistics management (inbound logistics) in the Thai automotive industry.

THE CONCEPTUAL FRAMEWORK OF THE KEY MAIN ACTIVITIES:

The indicators and dimensions of key activities are analyzed with two data sources which are the reviewed of literatures from journal articles and reports of the automotive organizations. This research uses the content analysis to analyze the two source information, which was summarized in Table 1. The three dimensions for key activities of green logistics management (inbound logistics) show these indicators that present to green logistics management as following:

The first dimension, Green Transportation Activity (GTA) has four main indicators that are utilization vehicles capacity, reducing transportation amount, Route transportation optimization and using eco-energy transportation. The second dimension is Green Purchasing Activity (GPA) that includes selecting green supplier, using green raw material and supporting locally raw. Finally, Green Inventory Activity (GIA) is optimizing order of raw material and lot size inventory of raw material as shown in table 1.

Then, the conceptual framework is developed using peer-reviewed journal research (Table 1). The three dimensions for key activities of green logistics management (inbound logistics) show their indicators that present to green logistics management as shown in table 2.

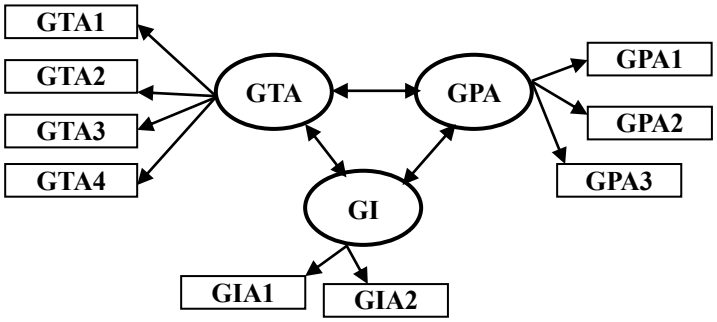

Figure 1: Conceptual framework of the key main activities of green logistic management

Table 1: The indicators and dimensions of key activities of green logistics management (Inbound logistics)

Key activities of Green logistics management		
Dimensions	**Indicators**	**References**
1.Green transportation activity	1.1 Utilization vehicles Capacity 1.2 Reducing transportation amount 1.3 Route transportation optimization 1.4 Using eco-energy transportation	Souza and Pires, 2010/ Dey, Guardia and Srinivasan, 2011/ Isaksson and Brodin, 2013/ Kim and Lee, 2012/ Martinsen and Bjorklund, 2012/ Song, Wang, Jiang, Yang and Wang, 2012/ Lau, 2011
2. Green purchasing activity	2.1 Selecting green supplier 2.2 Using green raw material 2.3 Supporting locally raw material	Chen and Chang, 2012/ Akehurst, Carolina and Gonçalves, 2012/ Nijaki, and Worrel, 2012/ Miemczyk, Johnsen and Macquet, 2012/ Pereira, Mykletun and Hippolyte, 2012/ Seifi, Zulkifli, Yusuff and Sullaiman, 2012/ Rahbar and Wahid, 2011/ Zuo, Potangaroa, Wilkinson and Rotimi, 2009/ Juwaheer, Pudaruth, and Noyaux, 2012/ Tang, Wang and Lu, 2014
3. Green inventory activity	3.1 Optimizing inventory of raw material 3.2 Lot size inventory of raw material	Ayad, 2008/ Aghazadeh, 2003/ Stamm, Golhar and Smith, 1989/ Lodree, 2011/ Azzi, Battini, Faccio, Persona and Sgarbossa, 2014/ Matar, Jaber and Searcy, 2014/ Bushuev, Guiffrida, Jaber and Khan, 2015/ Liu and Shao,2013

Table 2: References of the green logistic activities management model

Dimension	Indicators
Green transportation activity (GTA)	1. Utilization vehicles capacity (GTA1) 2. Reducing transportation amount (GTA2) 3. Route transportation optimization (GTA3) 4. Using eco-energy transportation (GTA4)
Green purchasing activity (GPA)	1. Selecting green supplier (GPA1) 2. Using green raw material (GPA2) 3. Supporting locally raw material (GPA3)
Green inventory activity (GIA)	1. Optimizing inventory of raw material (GIA1) 2. Lot size inventory of raw material (GIA2)

The conceptual framework that presents the key main activities of green logistic management is shown in Figure 1.

METHODOLOGY:

Survey research was used in this study to collect data by selected sampling from the people in the field of logistics and environmental management of Thai automotive industry to examine the key activities of Green logistics management. In this research the automotive companies, certified with International Standard Organization of environment management (ISO 140001 and TS 16949), and logistics and supply chain management responsibility of companies in automotive factory in Amata Nakorn Chonburi, Industry Estate Authority of Thailand, are interested. There are 90 companies in total. The population of this work is defined as officers who are working related to the ISO 14001 and TS16949 department and logistic department.

The total number of population is infinite. Therefore the sample size is calculated using the Yamane's formula (Singh, & Masuku, 2014) as shown in Table 3. The maximum number sample size taken in this research 472 (Four hundred and seventy two) officers were randomly selected from 29 companies using cluster sampling method. The coordinators of companies are explained for the objective of the research and asked for the permission to participating in this study. In order to investigate the key activities of green logistics management, questionnaire about the key activities reviewed by literatures and real working process is constructed. There are two main sections; demographic information and the importance of significant indicators to the key activities of Green logistics management (Inbound logistics). The first section includes age, gender, education, and position. The second section covers, the key questions about transport activity, purchasing activity, and inventory activity. The questions asked to indicate how importance of significant indicators to the key activities of Green logistics management (Inbound logistics) in Thai automotive with 5-point Likert scales.

Testing of the instrument was used by Index of consistency (IOC) and Cronbach's alpha. The IOC, the questionnaire is sent to 7 experts in logistic management field in order to examine the content and construct validity of each item and decide the consistency of questionnaire with scores. The possible scores are +1, 0 and -1, indicating the conforming, uncertain and not conforming to item with the content and research objective respectively.

Cronbach's alpha, the questionnaire with valid items is again examined for the reliability through pilot survey. Target sample of 30 will test the questionnaire and the scores are analyzed for the reliability using Cronbach's alpha.

The analysis has two phases. In the first phase, the researcher conduct pretest analysis by distributing questionnaire to 30 officers belonging to 2 companies, and performed reliability analysis using Cronbach's alpha and the result is 0.973 which is an indication of high reliability and the validity of the measurement items in the questionnaire. The index of consistency is also calculated and the results are between 0.57 – 1.00; indicating that the items conform to the content and research objective. In the second phase, the researcher conducted field survey by sending the questionnaire to coordinator of each company. The coordinators were explained about the objective of research and questionnaire, and then sent to the respondents. The respondents were given adequate time to answer the questionnaire and returned to the coordinator. This process was conducted during July 2015. There were 472 respondents from 29 companies.

Table 3. Sample Size for ±5% and ±10% Precision Levels

Size of population	Sample size (n) for precision (e)	
	±5%	±10%
500	222	83
1,000	286	91
2,000	333	95
3,000	353	97
4,000	364	98
5,000	370	98
7,000	378	99
9,000	383	99
10,000	385	99
15,000	390	99
20,000	392	100
25,000	394	100
50,000	397	100
100,000	398	100
>100,000	400	100

Descriptive statistics are used to analyze the level of officer's opinion in the importance of significant indicators of key activities of Green logistics management (Inbound logistics). Inferential Statistics Analysis using Confirmatory Factor Analysis (CFA) is used to determine the key activities that influence to the logistics management in the sense of environmental friendly. The three main activity topics are set as underline latent variables and their sub-activities are treated as observed variable as shown in the conceptual framework. The CFA is to test the hypothesis that a relationship between the observed variables and their underlying latent variables exists as shown in Figure 2. The measurement model can also be carried out using structural equation modeling with partial least square method (Asparouhov, & Muthan, 2009).

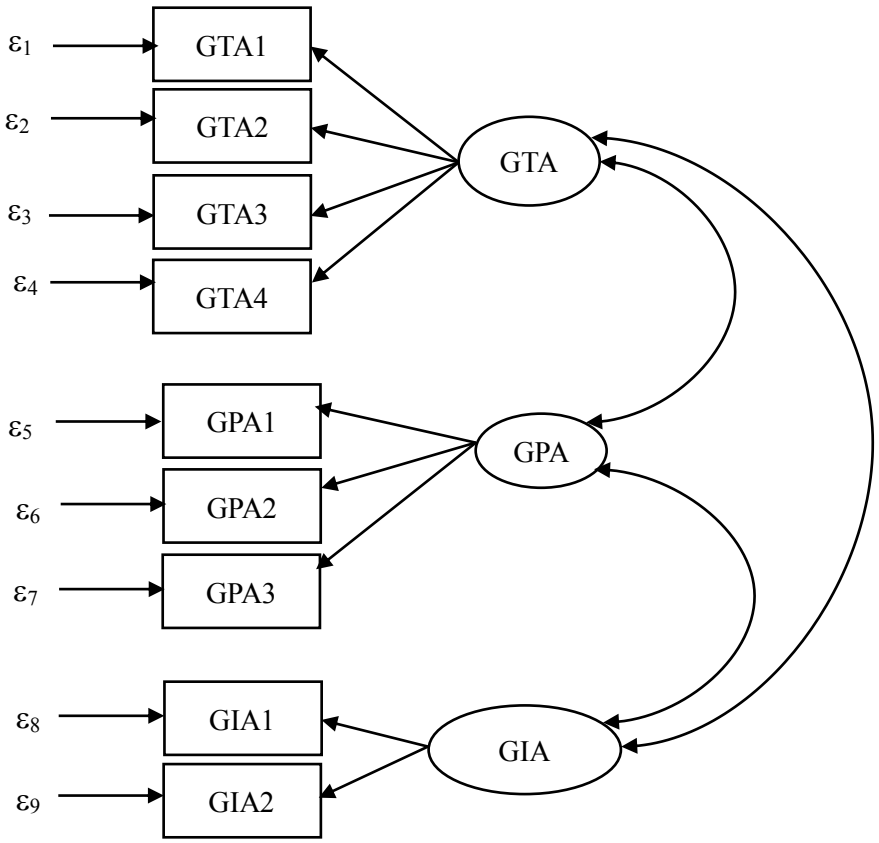

Figure 2: First-order factor measurement model for logistic activity.

RESEARCH RESULTS AND DISCUSSIONS:

In the finding, a total of 472 respondents, who are working related in the ISO 14001 and TS16949 department and logistic department of 29 companies, participate in this study. Of this total 38.77% are female and 61.23% are male. More than a half of respondent's age range between 30-39 years old, 36.02% range between 20-29 years old, 11.23% range between 40-49 years old and 1.27% are 50 years old or more. Over two third of the officers graduated in Bachelor's degree, 26.91% graduate in high school or diploma, 6.36% in Master degree and there is no one graduate in Doctoral degree. Most respondents work in administrator position with 74.79%, in operation manager with 15.89%, in middle manager with 7.84% and in top manager with 1.48% as shown in table 4.
Moreover, this analysis presents mean and standard deviation of the importance of significant dimensions and indicators of key activities of Green logistics management (Inbound logistics). There are three main dimensions; Green Transportation Activity (GTA), Green Purchasing Activity (GPA), and Green Inventory Activity (GIA). The respondents give 1-5 level of indicator importance. The most important dimension of key activities of Green logistic management is GTA with the mean score of 4.04 and standard deviation of 0.86. The means of importance of the GTA's indicators range from 4.01 to 4.09. The second most important dimension is GPA with the mean score of 4.00 and standard deviation of 0.88. The means of importance of GPA's indicators range from 3.88 to 4.06. The last dimension is GIA with the mean score of 3.99 and the standard deviation of 0.84. The means of importance of GIA's indicators range from 3.85 to 4.13. From the mean score, the important of the three dimensions are fairly similar as shown in table 5.

Table 4: Mean and standard deviation of the importance of significant indicators to key activities of Green logistics management (Inbound logistics)

Indicators of key activities of Green logistics management dimensions	$\bar{x}$	sd
1. Green transportation activity (GTA)	4.04	0.86
Utilization vehicles capacity (GTA1)	4.02	0.83
Reducing transportation amount (GTA2)	4.02	0.87
Route transportation optimization (GTA3)	4.09	0.84
Using eco-energy transportation (GTA4)	4.01	0.88
2. Green purchasing activity (GPA)	4.00	0.88
Selecting green supplier (GPA1)	4.03	0.78
Using green raw material (GPA2)	4.06	0.89
Supporting locally raw material (GPA3)	3.88	0.94
3. Green inventory activity (GIA)	3.99	0.84
Optimizing inventory of raw material (GIA1)	4.13	0.77
Lot size inventory of raw material (GIA2)	3.85	0.89

Table 5: Frequency and percentage of personal information

Personal Information	Number	Percentage
Gender		
Male	183	38.77
Female	289	61.23
Age		
20-29 years old	170	36.02
30-39 years old	243	51.48
40-49 years old	53	11.23
50 years old or more	6	1.27
Education		
High school; Diploma	127	26.91
Bachelor's Degree	315	66.74
Master's Degree	30	6.36
Doctorate's Degree	0	0.00
Position		
Top manager	7	1.48
Middle manager	37	7.84
Operation manager	75	15.89
Administrator	353	74.79
Total	**472**	**100.00**

CORRELATION ANALYSIS:

In order to perform Factor analysis, all pairwise indicators in each dimension are tested whether there is relationship between them. The results are shown in Table6-8

Table 6: Correlation matrix of indicators in Green transportation activity (GTA) dimension

	GTA1	GTA2	GTA3
GTA2	0.587*		
GTA3	0.538*	0.639*	
GTA4	0.504*	0.588*	0.667*

* Significant at 0.05 level

For Green transportation activity (GTA) dimension, it can be seen that all indicators are related.

Table 7: Correlation matrix of indicator in Green purchasing activity (GPA) dimension

	GPA1	GPA2
GPA2	0.756*	
GPA3	0.626*	0.704*

* Significant at 0.05 level

The correlation coefficients between all possible indicators in GPA dimension are shown in Table 7. This indicates that the indicators in GPA dimension are related each other.

Table 8: Correlation matrix of indicator in Green inventory activity (GIA) dimension

	GIA1
GIA2	0.475*

* Significant at 0.05 level

The correlation coefficients between all possible indicators in GIA dimension are shown in Table 8. This indicates that the indicators in GIA dimension are related each other.

Table 9: Kaiser-Meyer-Olkin statistic and p-value

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.912
p-value	0.000

The Kaiser-Meyer-Olkin measure statistic is 0.958 with p-value 0.000 indicating again that there is relationship between indicators. This shows that the principal component should be done in order to group the related indicators into factors.

MEASUREMENT MODEL FOR EN-SCM PERFORMANCE:

We test the measurement model of the main activities of green logistics management (inbound logistics) construct using reliability and correlation analysis, followed by confirmatory factor analysis with principal component method extraction and verimax rotation is adopted as a step for evaluating the terms of error of indicators that composes the dimensions. The number of factor is fixed to 3 factors.

The confirmatory factor analysis suggests that the three factor model supported the sample data. Table 10 shows that the indicator GTA1-GTA4 are grouped into the same factor with the loading greater than 0.59. The indicators GPA1-GPA3 are again grouped into the same factor. However the indicator GIA1 is allocated into the same factor as GPA1-GPA3 and the indicator GIA2 is assigned a latent factor.

Table 10: Loadings and extraction

Indicators	Factor1	Factor2	Factor3
Utilization vehicles capacity (GTA1)	0.164	0.711	0.447
Reducing transportation amount (GTA2)	0.273	0.833	0.131
Route transportation optimization (GTA3)	0.474	0.727	0.026
Using eco-energy transportation (GTA4)	0.568	0.592	0.129
Selecting green supplier (GPA1)	0.801	0.284	0.155
Using green raw material (GPA2)	0.840	0.346	0.127
Supporting locally raw material (GPA3)	0.775	0.181	0.353
Optimizing inventory of raw material (GIA1)	0.625	0.461	0.257
Lot size inventory of raw material (GIA2)	0.271	0.174	0.903

Table 11: Score reliability for the three-factor model

Factor	GTA	GPA	GIA
# Items	4	4	1
Cronbach's α	0.851	0.873	0.644
AVE	0.691	0.797	0.732
CR	0.899	0.922	0.844

The reliability test provided in Table 11 suggests a reasonable fit of the latent factors to the data collected. Cronbach's alpha values for all the three factors of main activities of green logistics management are greater than 0.6. The Average Variance Extracted (AVE) of all factors are greater than 0.69. The Composite Reliabilities (CR) are more than 0.84. Therefore, the latent factors are well presented by their indicators.

The measurement model for testing the of main activities of green logistics management (see Figure 3) implies that GTA, GPA, and GIA are collected but not governed by a common latent factor. The numbers at the left side show the portion of each variable's variance that can be explained by the factors. These figures show that the variances explained by factor are greater than 68%. The Goodness of fit statistic is 0.546. This suggests the fit of data collected to the hypothesized model.

Figure 3 shows the relationship of three main activities for managing to business. Firstly, Green transportation activity (GTA) has the most relationship to green purchasing activity (GPA), and has the relationship to green inventory activity (GIA). Secondary, GPA has the most relationship to GTA and the relationship to GIA. Finally, GIA has the relationship to GTA and GPA. Moreover, this model represents the relationship of their indicators of the three activities.

The green logistics management of inbound logistics has three key activities that are GTA, GPA, and GIA to business management. The GTA dimension is the management of transport activity with considering environment concept which focuses on reducing the environmental effects. The main indicators are utilization vehicles capacity, reducing transportation amount, route transportation optimization, and using eco-energy transportation. These indicators explain the relationship to GTA that the most important GTA indicator is reducing transportation amount (GTA2) and follow by route transportation optimization (GTA3), Utilization vehicles capacity (GTA1) and using eco-energy transportation (GTA4) respectively. Secondly, the GPA dimension is the purchasing activity that relates the management between supplier and manufacturer. This dimension is to provide the material or product for manufacturing the finish goods to customers with investigating the environmental impact analysis. These main indicators include selecting green supplier, using green raw material, supporting locally raw and optimizing inventory of raw material. The order of the relationship priority of indicators explanation are using green raw material (GPA2), selecting green supplier (GPA1), supporting locally raw material (GPA3) and optimizing inventory of raw material (GIA1). The last dimension, GIA is to integrate the concept of inventory and environment management to decrease the environmental problems with main indicator which is to manage the lot size inventory of raw material (GIA2).

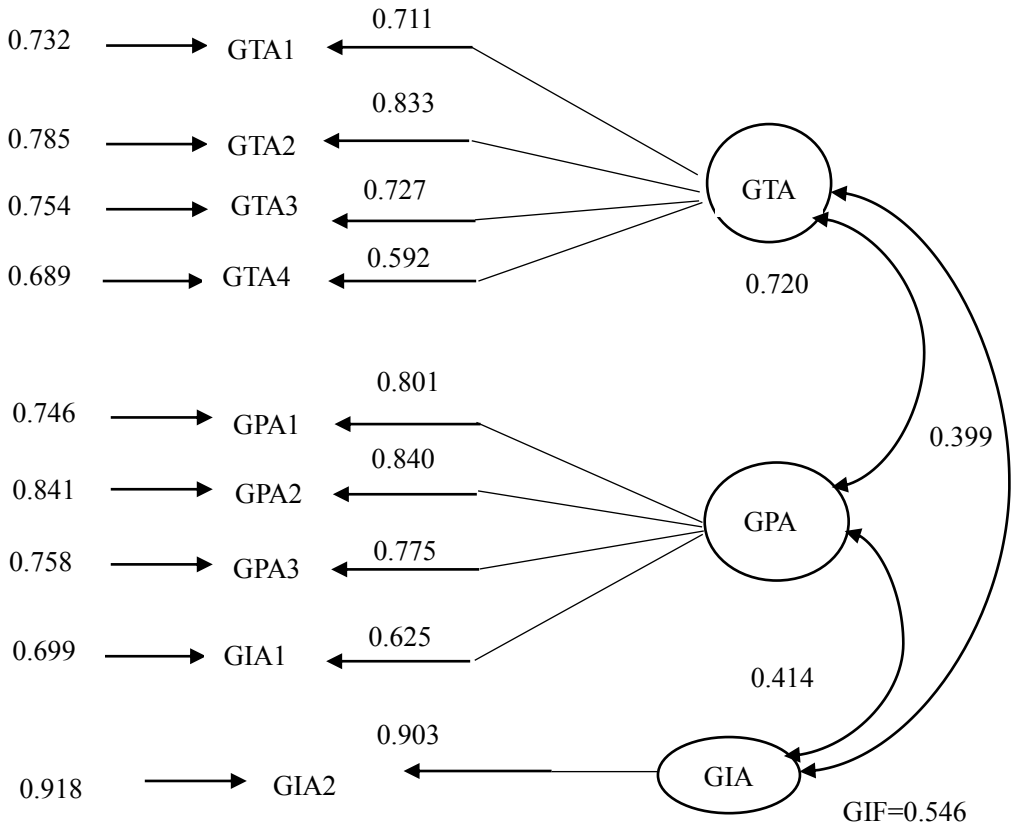

Figure 3: First-order factor measurement model for En-SCM performance

CONCLUSION:

The information of main activities of green logistics management needs to be developed for understanding activities management. This research focuses on inbound logistics and the Thai automotive industry that is an essential element of business operations.

The objective of this research is to study the main activities of green logistics management (inbound logistics). Furthermore, this research covers the main activities of green logistics management of inbound logistics, and focus on the Thai automotive industry in Amata Nakorn Chonburi, Industry Estate Authority of Thailand. Research Design is survey research. The population of this work is defined as officers who are working related in the ISO 14001 and TS16949 department and logistic department. The total number of population is infinite. Therefore the sample size is four hundred officers are randomly selected from this population using cluster sampling method. Data analysis includes Descriptive statistics and Inferential Statistics Analysis using confirmatory factor analysis (CFA).

The research results, a total of 472 respondents, who are working related in the ISO 14001 and TS16949 department and logistic department of 29 companies, participate in this study. This analysis presents that the most of answerers are 61.23% for male. More than a half of respondent is age range between 30-39 years old, 36.02%. Over two third of the officers graduated in Bachelor's degree, 26.91% and has the most of work in operation manager. Moreover, this analysis presents mean and standard deviation of the importance of significant dimensions and indicators of key activities of Green logistics management (Inbound logistics). There are three main dimensions; Green transportation activity (GTA), Green purchasing activity (GPA), and Green inventory activity (GIA). The respondents give 1-5 level of indicator importance. The most important dimension of key activities of Green logistic management is Green transportation activity with the mean score of 4.04 and standard deviation of 0.86. The means of importance of the Green transportation activity's indicators range from 4.01 to 4.09. The second most important dimension is Green purchasing activity with the mean score of 4.00 and standard deviation of 0.88. The means of importance of Green purchasing activity's indicators range from 3.88 to 4.06. The last dimension is Green inventory activity with the mean score of 3.99 and the standard deviation of 0.84. The means of importance of Green inventory activity's indicators range from 3.85 to 4.13. From the mean score, the important of the three dimensions are fairly similar.

This model for testing of main activities of green logistics management implies that GTA, GPA, and GIA are collected but not governed by a common latent factor. The Goodness of fit statistic is 0.546. This suggests the fit of data collected to the hypothesized model. Therefore, green logistics management of inbound logistics has three key activities that are to manage GTA, GPA, and GIA to business management. This research result is main activities information that helps to prepare business management towards green logistics management followed the government policy, international standard and world regulations as well.

As the result, the two main benefits of this research are shown that; firstly, this knowledge shows the information which explains the main activities of green logistics management (inbound logistics) in the Thai automotive industry. Secondly, this information is a guideline of main activities for planning green logistics management (inbound logistics) in the Thai automotive industry. Finally, this information supports the international standard of industry sector, and a good image of environmental aspects of the Thai automotive industry. The Limitations of this research is the data collection focuses on the Thai automotive industry. Therefore, other businesses cannot directly use the result of this research in practice, because there is a difference in business factors. However, they can use the principles of this research and apply it in their business processes.

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