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The Relationships among Resources Commitment, Reverse Logistics Innovation, Reverse Logistics Performance and Reverse Logistics Cost Savings

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Abstract: The purpose of this study is to test the relationships among resources commitment, reverse logistics innovation, reverse logistics performance and reverse logistics cost savings. The study was done by means of mixed method. Regarding quantitative aspect, a survey was conducted with 330 current top and middle managers working in Thai manufacturing and service industry. The results indicated that there were positive relationships between resource commitment and reverse logistics innovation, resource commitment and reverse logistics performance, reverse logistics innovation and reverse logistics performance and reverse logistics performance and reverse logistics cost savings. The results further indicated that there was a partial mediate effect of resource commitment on reverse logistics performance through reverse logistics innovation. The result revealed that the type of industry had moderate effect on the path from resource commitment to reverse logistics performance and the path from reverse logistics innovation to reverse logistics performance. The result reported that the model was not different across length of reverse logistics implementation. Considering quality, the in-depth interview was conducted with top and middle managers working in Thai manufacturing (20 participants) and service industry (20 participants). According to the results, it was found that the companies launched the reverse logistics program together with green logistics in order to enhance good company image. Firms coped with the reverse logistics program by means of reuse, recycle, repair, refurbish, scrap sale, discount and sale in outlet.

Key words: Resources commitment, reverse logistics, reverse logistics innovation, reverse logistics performance, reverse logistics cost savings

INTRODUCTION

Presently, most of the supply chain management researches focus on the forward flow that transforms raw materials to final products, from suppliers to end customers (Prahinski and Kocabasoglu, 2006; Abdullah and Yaakub, 2014). Meanwhile, the reverse material movement from end customers to suppliers has received much less attention (Rogers and Tibben, 2001; Shear *et al*., 2002; Richey *et al*., 2005; Abdullah and Yaakub, 2014). This is unfortunate in that well-managed reverse logistics programs can reduce costs. Consistently, reverse logistics should be seen as an opportunity to build competitive advantages, cut costs and improve customer satisfaction (Richey *et al*., 2004, 2005). With a good returns handling system, reverse logistics can even evolve into a profit center (Andel, 1997). However, many companies that previously did not devote much time or energy to the management and understanding of reverse logistics, have begun to pay more attention. These firms are benchmarking return operations with best-in-class operators (Rogers and Tibben, 1998). The projected exact cost of reverse logistics is difficult because many companies overlook and neglect it. The market for reverse logistics in the United States (US) was approximately $58 billion in 2004, comprising 0.5% of the US Gross Domestic Product (Reverse Logistics Executive Council in 2007). Reverse logistics cost is increasingly (Dekker *et al*., 2004) which covers a wide range of industries such as automotive, electronic, chemicals, publishing, petroleum, garments and food and beverage industry as well as service industry (Rogers and Tibben, 1998). In addition, Rogers and Tibben (2001) reported that the reverse logistics cost accounted for 4% of total logistics cost. This is consistent with the findings of Japan Institute of Logistics Systems (JILS) which revealed that in 2004 the reverse logistics cost in Thailand accounted for 3.5% (42 billion Baht) of total logistics cost (1,193 billion Baht), whereas the total logistics cost accounted for 16.8% of the country's GDP (7,103 billion Baht). According to fierce competition, companies need to improve productivity as well as reduce cost. Based on the above mentioned, reverse logistics cost is high-value and worth paying

more attention. Recently, both academic researchers and practitioners are intensifying the level of interest in reverse logistics. However, the studies of antecedents and consequences of reverse logistics are scarce (Veerakachen, 2006). Considering the antecedent factors, some studies supported the direct effect of resource commitment including technology, management and financial resource commitment on reverse logistics performance (Daugherty *et al*., 2001; Richey *et al*., 2004; Jack *et al*., 2010). However, some studies opposed that the resource commitment was not directly related to reverse logistics performance but there was a moderate effect via length of reverse logistics adoption, reverse logistics innovation, information system, internet integration, external factors, business strategy and independent return policy (Richey *et al*., 2005; Veerakachen, 2006; Pfohl *et al*., 2012). Richey *et al*. (2005) contended that reverse logistics innovation is related to reverse logistics performance both economic and operational dimension. In addition, Huang and Yang (2014) supported this relationship and further explained that there is a moderate effect via legal pressure, competitors and customers. On the other hand, many studies on consequences of reverse logistics focused on cost savings and firm's performance (Daugherty *et al*., 2001; Jack *et al*., 2010; Pfohl *et al*., 2012; Abdullah and Yaakub, 2014; Ramirez and Morales, 2013).

According to the lacking of studies on reverse logistics, some studies confirmed the direct relationship between resource commitment and reverse logistics performance, reverse logistics innovation and reverse logistics performance, reverse logistics performance and cost savings. However, the studies which revealed the simultaneous relationships among resources commitment, reverse logistics innovation, reverse logistics performance and reverse logistics cost savings are scarce. Moreover, there are few studies interested in the moderate and mediate effect. Thus, this study proposes to examine the simultaneous relationships among resources commitment, reverse logistics innovation, reverse logistics performance and reverse logistics cost savings. This study contains nine research questions: is there a relationship between resource commitment and reverse logistics innovation? Is there a relationship between resource commitment and reverse logistics performance? Is there a relationship between resource commitment and reverse logistics cost savings? Is there a relationship between reverse logistics innovation and reverse logistics performance? Is there a relationship between reverse logistics innovation and reverse logistics cost savings? Is there a relationship between reverse logistics performance and reverse logistics cost savings? Is there a mediate effect of reverse logistics innovation on the relationship between resource commitment and reverse logistics performance? Is there a moderate effect of type of industry? and Is there a moderate effect of length of reverse logistics implementation?

Literature review: Now a days, companies struggle with fierce competition which is difficult to succeed by only one way of increasing orders to gain profit while the other important alternative is reducing costs. This is due to that fact that the total logistics cost is high proportion of total cost. Efficient reverse logistics management can reduce 10% of total logistics cost (Minahan and Planning, 1998), increase customer satisfaction, good image and profitability (Daugherty *et al*., 2001, 2002). Thus, organizations need to pay more attention in reverse logistics and relevant areas to get a competitive advantage.

Reverse logistics: The council of Logistics Management defined logistics as the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. In contrast, reverse logistics includes all of the activities that are mentioned in the definition above which operate in reverse. Therefore, reverse logistics is defined as the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal.

The current research defined that reverse logistics involves product return, source reduction, recycling, material substitution, reuse of material, waste disposal, refurbishing, repair and remanufacturing (Kumar and Yamaoka, 2007). Meanwhile, reverse logistics process can be separated into two general areas, i.e., return of primary products and primary packing. Considering the primary products, the reverse logistics activities consists of return to supplier, resell, sell via outlet, salvage, recondition, refurbish, remanufacture, reclaim materials, recycle and landfill. On the other hand, the reverse logistics activities of primary packing consists of reuse, refurbish, reclaim materials, recycle and salvage. The magnitude and impact of reverse logistics vary by industry and channel positions, e.g., the automobile companies, electronic products, publishing, garments and retailing companies.

Resource commitment: Resource commitment is associated with allocation of company's resource, both tangible and intangible, in order to improve productivity,

meet customer's need and increase market share (Hunt, 2000). Resource commitment consists of three aspects including managerial, financial and technology resource commitment (Richey and Wheeler, 2004). First, managerial resource commitment refers to allocation of talented, skilled and expert human resources to create and managed strategy. Second, financial resource commitment is associated with the financial allocation to cover the costs of operation. Finally, technology resource commitment refers to technology and information system allocation which can lead to a sustainable competitive advantage since technological capabilities are difficult to imitate (Daugherty *et al*., 2001). A major obstacle to a successful application of reverse logistics is insufficient resource commitment (Rogers and Tibben, 1998; Richey *et al*., 2005).

Reverse logistics innovation: Reverse logistics innovation is defined as a firm's capacity to seek creative or novel ideas, behaviors, products and processes in carrying out reverse logistics activities to reduce environmental burdens and foster sustainable development (Christmann, 2000; Rennings, 2000; Hart, 2005). In addition, the sustainability initiative capabilities of reverse logistics are often referred to as reverse logistics innovation. Richey *et al*. (2005) proposed that the reverse logistics innovations are composed of five components, i.e., customization, formalization, flexibility, information-related ability and cross-functional integration. First, customization is defined as the act of tailoring a product of technology to the special and unique needs of the customer. Second, formalization is the extent of firm's standard rules, procedures, instructions and communications (Pugh *et al*., 1968). Third, flexibility is the extent to which one party is willing to make changes to accommodate a business partner's needs (Cannon and Homburg, 2001). Next, information-related ability is the measure of connectivity, usefulness, accuracy and availability of information. Finally, cross-functional integration involves the magnitude of interaction and communication, the level of information sharing, the degree of coordination and the extent of joint involvement across functions during a specific return task. Although, it is widely accepted that effective reverse logistics innovation can improve customer satisfaction (Li and Olorunniwo, 2008; Richey *et al*., 2005) and create cost savings (Jack *et al*., 2010; Srivastava and Srivastava, 2006), the impact of reverse logistics is often ignored and not well understood by many firms.

Reverse logistics performance: Conventionally, a firm performance has been observed and measured in accounting words (Conant *et al*., 1990; Jennings and Seaman, 1994). However, a literature concerning with measurement of business performance (Kaplan and Norton, 2001; Lynch and Cross, 1991; Otley, 1999) proposed that managers prefer to locate relatively less importance on traditional financial performance's measures such as return on investment or net profits. It is consistent with Baross and Santos (2006), who proposed that firm performance is an outcome from the ability to use resources and CEO cares for overall result of both finance and non-finance performance. In general, the word performance results in the leading position of measurements such as profit, cost and market share (Laitinen, 2002). Sink and Tuttle (1989) asserted that performance should not be dealt barely as a financial perspective. In addition, Li *et al*. (2009) suggested that performance can be evaluated by non-financial performance such as efficiency, growth and profit.

Reverse logistics performance can be measured by two familiar dimensions including economic and environmental performance. Economic performance refers to operational efficiency and effectiveness, financial performance, customer responsiveness and satisfaction. Meanwhile, environmental performance is associated with creative effective process and recognition of the supply chain partnerships, transcend the strict rules, protection of the environment and reducing pollution (Judge and Doughlas, 1998; Autry *et al*., 2001; Daugherty *et al*., 2002; Richey *et al*., 2004; 2005; Sarkis *et al*., 2010; Huang and Yang, 2014).

Reverse logistics cost savings: The structure of forward and reverse logistics is the same, including cost of transportation, holding, stealing, obsolete, collecting, sorting, analyzing, managing, refurbishing, repackaging and changing in book value. However, the proportion of each cost for forward and reverse logistics is different.

Considering reverse logistics cost, the transportation cost is important as collecting small and uncertain quantity of the return products results in high amount of total reverse logistics cost. Meanwhile, the holding cost and stealing cost are low whereas obsolete, collecting, sorting, analyzing, managing, refurbishing and repackaging costs are high. Companies may apply the policy of recovered or reused raw materials or packaging materials in order to reduce costs and enhance the business image. Companies that effectively cope with the returned product such as customer's independent returned product policy will be able to respond quickly, increase satisfaction and lead to higher profitability (Dawe, 1995).

Theoretical framework: The proposed theoretical model is to test the simultaneous relationships among resources commitment, reverse logistics innovation, reverse logistics performance and reverse logistics cost savings (Fig. 1).

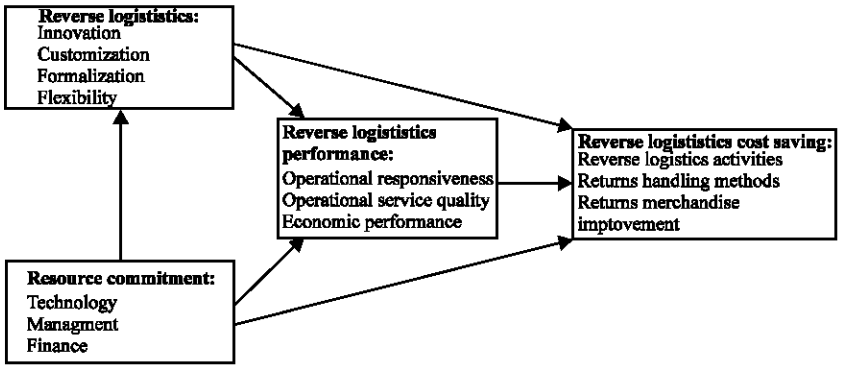

Fig. 1: The proposed theoretical model

MATERIALS AND METHODS

Samples and procedure: The population for the study consists of top management and middle management managers of organizations operating in both manufacturing and service industry in Thailand. Free parameter is not constrained and is to be estimated by using observed data (Weston and Gore Jr., 2006). Bentler and Chou (1987) suggested that under normal distribution theory, the ratio of sample size to number of free parameters should be at least 5:1 in order to get trustworthy parameter estimates. The number of free parameters equals 46; therefore, the minimum sample size is 230. A total of 330 samples (163 respondents from manufacturing industry, 167 respondents from service industry) were collected from August to November, 2016 by using simple random sampling, in which the top management and middle management managers were contacted and were provided with the letters authorized by the university to ask permissions to send the paper or online survey. On the other hand, qualitative approach was conducted by in-depth interview from 40 top management and middle management managers (20 participants from manufacturing industry and 20 participants from service industry).

Instruments: The design of this study is a mixed method. Quantitative approach was done by using questionnaires composed of five parts: demographic information of respondents, Resource Commitment (RC) which was developed by Richey *et al.* (2005) at 0.870 alpha scales, Reverse Logistics Innovation (RLI) survey which was developed by Richey, etc. at 0.817 alpha scales, Reverse Logistics Performance (RLP) which was developed by Richey *et al.* (2004, 2005) including Operational Responsiveness (RLPOR), Operational Service Quality (RLPOSQ) and Economic Performance (RLPEP) dimension at 0.816, 0.781, 0.890 alpha scales and the Reverse Logistics Cost Savings (RLCS) which was developed by Jack *et al.* (2010) at 0.893 alpha scales. In contrast, qualitative data was done by in depth interview composed of current situation of companie's reverse logistics efficiency, overview, recommendations and expected results of reverse logistics implementation.

Structure Equation Model (SEM): Wright (1921) defined that SEM is a statistical technique for testing and estimating causal relations using a combination of statistical data and qualitative causal assumptions. This study is comprehensive by the following nine hypotheses:

- H_1: there is a positive relationship between resource commitment and reverse logistics innovation
- H_2: there is a positive relationship between resource commitment and reverse logistics performance
- H_3: there is a positive relationship between resource commitment and reverse logistics cost savings
- H_4: there is a positive relationship between reverse logistics innovation and reverse logistics performance
- H_5: there is a positive relationship between reverse logistics innovation and reverse logistics cost savings
- H_6: there is a positive relationship between reverse logistics performance and reverse logistics cost savings
- H_7: there is a mediate effect of resource commitment on reverse logistics performance through reverse logistics innovation
- H_8: there is a moderate effect of type of industry on the simultaneous relationships of proposed theoretical model
- H_9: there is a moderate effect of length of reverse logistics implementation on the simultaneous relationships of proposed theoretical model

This study is to determine the appropriate research model related to seven indicators. The relationships among variables were determined by t-test related to Critical Ratios (CR) and p-value.

RESULTS AND DISCUSSION

Quantitative results: The completed 330 of 700 questionnaires (response rate 47.14%) were used to do analysis. The majority of the respondents were female which accounted for 60.3% with age below 30 years old accounting for 53.0%. The level of education was mostly Bachelor's degree which accounted for 84.8%. Besides, the respondents working in service industry accounted for 50.6%, working for small and medium companies for 53.3% and working in company without union for 63.6%. Besides, the length of reverse logistics implementation between 1-5 years accounted for 45.8%.

The value of skewness should be between-3 and+3 to judge the normal distribution (Decarlo, 1997). The results indicated the values of skewness range from -0.296-0.042 and the values of kurtosis range from -0.982-0.062. Meanwhile, the Pearson's bivariate correlations of all relationships were significant. Thus, it could be concluded that the rule of normal distribution and linearity was satisfied.

Considering an overview, respondents evaluated all factors i.e., resource commitment, reverse logistics innovation, reverse performance and reverse logistics cost savings, at some extent corresponding with the evaluation from service industry. Meanwhile, the managers from manufacturing industry evaluated resource commitment, reverse logistics innovation and reverse logistics cost savings at some extent whereas reverse performance was evaluated at extensive extent.

Model fit and hypothesis testing: The Chi-square is essential statistic. However, a statistical significance test is sensitive to sample size which means that the Chi-square statistic nearly always rejects the model when large samples are used (Bentler and Bonnet, 1980). Therefore, several authors indicated that a model could also be accepted if the majority of fit indices show good adoption measures and only a few are less than the required threshold (Fornell and Larcker, 1981; Bagozzi and Yi, 1988). Although, the Chi-square statistic of the proposed theoretical model provided a significant result at a 0.05 threshold, the remaining results were above the minimum criterion (Table 1 and 2). Thus, it could be concluded that the structure of resource commitment, reverse logistics innovation, reverse logistics performance and reverse logistics cost savings were appropriate to explain the interrelationships among items and latent variables. After model fit was assessed, the hypothesis was tested, starting with test of significant of regression weight. Considering overall group, most of the p-value of regression weights are <0.05, except that the effect of resource commitment and reverse logistics innovation on reverse logistics cost savings are above 0.05. The findings are consistent with both manufacturing and service industry group. Thus, it can be concluded that H_1, H_2, H_4 and H_6 are supported whereas H_3 and H_5 are rejected. Then both of them were deleted from the structural model. The revised model is presented in Fig. 2 and 3. The results of model fit testing of the revised proposed model are shown in Table 3. Although, the Chi-square statistic provides a significant result at a 0.05 threshold, the remaining results are above the minimum criterion. Thus, it could be concluded that the revised proposed theoretical model is appropriate to explain the interrelationships among items and latent variables Fig. 1 and 2.

Mediate effect testing: The competing model was to investigate the direct effect of resource commitment,

Table 1: The minimum criterion of model fit indices

Model fit index	Threshold/minimum criterion
χ^2 or CMIN	Should not be significant at a 0.05 threshold (p>0.05) (Hu and Bentler, 1999)
χ^2/df or CMIN/df	Should be <5.0 to judge the fitness of the model (Bentler, 1989)
CFI	Should be >0.9 to judge the good fit (Bentler and Bonett, 1980)
IFI	Should be >0.9 to judge the good fit (Bentler and Bonett, 1980)
AGFI	Should be >0.9 to judge the good fit (Joreskog and Sorbom)
AGFI	of 0.8 is sometimes proposed as sufficient as recommended cut-off (Chau and Hu, 2001)
PGFI	Should be >0.5 to judge acceptable fit (Hair *et al*., 1998)
RMSEA	Should be <0.05 to judge good fit and between 0.05 and 0.08 to judge reasonable fit (Browne and Cudeck, 1993)

Table 2: Model fit indexes of the revised proposed theoretical Model

CMIN	p-value	df	CMIN/df	CFI	IFI	NFI	TLI	AGFI	PGFI	RMSEA
122.919	0.000	54	2.276	0.985	0.985	0.974	0.979	0.911	0.562	0.062

AIC (Default model); 196.916; BCC (Saturated model); 200.207; BIC (Independence model); 337.485

Table 3: Model fit indexes of the revised proposed theoretical model

CMIN	p-value	df	CMIN/df	CFI	IFI	NFI	TLI	AGFI	PGFI	RMSEA
125.731	0.000	56	2.245	0.985	0.985	0.973	0.979	0.912	0.582	0.062

AIC (Default model);195.731; BCC (Saturated model); 198.842; BIC (Independence model); 328.699

Table 4: Model fit indexes of the competing model

CMIN	p-value	df	CMIN/df	CFI	IFI	NFI	TLI	AGFI	PGFI	RMSEA
178.734	0.000	57	3.316	0.974	0.974	0.962	0.964	0.880	0.579	0.081

AIC (Default model); 246.734; BCC (Saturated model); 249.756; BIC (Independence model); 375.903

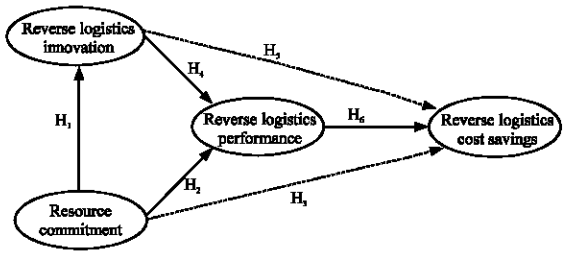

Fig. 2: Results of test of significant of regression weight

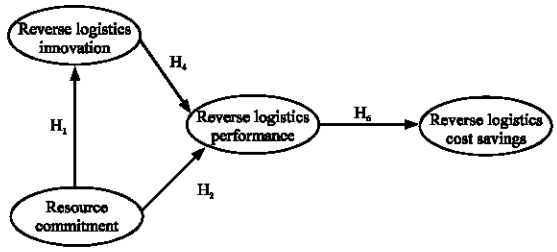

Fig. 3: Revised proposed theoretical model

reverse logistics innovation, reverse logistics performance and reverse logistics cost savings which are presented in Fig. 4. Comparing the model fit statistics of the competing model (Table 4) and the revised proposed theoretical model (Table 3), these results indicated that the model fit statistics of the revised proposed theoretical model is better than the competing model. Thus, it could be concluded that the relationships among resource commitment, reverse logistics performance and reverse logistics cost savings are greater explained by an effect of resource commitment on reverse logistics performance through reverse logistics innovation. Considering the competing model, the standardized direct effect between resource commitment and reverse logistics performance is 0.795. In contrast, the results from the revised proposed theoretical model showed that the standardized direct effect between resource commitment and reverse logistics performance is 0.0.309 while the standardized indirect effect is 0.441 and standardized total effect is 0.471. According to the standardized direct effect of the revised proposed theoretical model, it is less than that of the competing model. Therefore, it could be concluded that there is a partly mediate effect of resource commitment on reverse logistics performance through reverse logistics innovation. As a result of the better model fit statistics and the low level of the standardized direct effect, it could be concluded that H_7 is supported. Regarding the results in Table 5 and 6, the equations for the revised proposed theoretical model were conducted Table 5 and 6:

$$\widehat{ZRLI} = 0.846RC \quad (1)$$

$$\widehat{ZRLCS} = 958\ RLI \quad (2)$$

$$ZRLP = 0.780RC + 0.557RLI \quad (3)$$

Moderate effect testing: Considering the moderate effect of manufacturing and service industry, the Chi-square of the unconstrained was 274.843 and degree of freedom equal 112 whereas the Chi-square of the fully constrained was 304.123 and degree of freedom equal 125. The different of the Chi-square was 29.28 and degree of freedom equal 13. The p-value is 0.006 which can be concluded that the model is different across type of industry. After checking each specific path, the results reported that type of industry has moderate effect on the path from resource commitment to reverse logistics performance at 99% confidence and the path from reverse logistics innovation to reverse logistics performance at 90% confidence. Thus, it can be concluded that H_8 is partly supported.

Considering the moderate effect of length of reverse logistics implementation, the Chi-square of the unconstrained was 286.117 and degree of freedom equal 112 whereas the Chi-square of the fully constrained was 304.887 and degree of freedom equal 125. The different of the Chi-square was 18.77 and degree of freedom equal 13. The p-value is 0.130 which can be concluded that the model is not different across length of reverse logistics implementation. Thus, it can be concluded that H_9 is rejected.

Qualitative results: Regarding the results from in-depth interview from manufacturing industry, the participants proposed that the reverse logistics program was done at some extent since the reverse logistics management cost was inconsistent and very high compared to the cost of producing new products both in terms of money and time consumption. In addition, the companies decided to launch the reverse logistics program together with green logistics in order to enhance good company image. Returned materials and packaging were coped by reuse, recycle and scrap sale. In addition, returned work in

Table 5: Hypotheses testing of the revised proposed theoretical framework

Hypotheses	Estimate	SE	CR	p-value
H_1: resource commitment→reverse logistics innovation	0.846	0.043	21.511	***
H_2: resource commitment→reverse logistics performance	0.309	0.048	4.184	***
H_4: Reverse logistics innovation→reverse logistics performance	0.557	0.047	7.170	***
H_6: Reverse logistics performance→reverse logistics cost savings	0.958	0.078	15.435	***

***p<0.001 (p<0.001 was at the significant at 0.001 level)

Table 6: Standardized direct, indirect and total effect among variables of the revised proposed theoretical framework

Hypotheses	Standardized direct effect	Standardized indirect effect	Total effect
H_1: resource commitment→reverse logistics innovation	0.846	0.000	0.846
H_2: resource commitment→ reverse logistics performance	0.309	0.471	0.780
H_4: reverse logistics innovation→reverse logistics performance	0.557	0.000	0.557
H_6: reverse logistics performance→reverse logistics cost savings	0.958	0.000	0.958

process inventory and products were managed by repair send to outlet store. Regarding large companies which have many suppliers, they will apply milk-run to reduce both forward and reverse transportation cost. Moreover, food and beverage industry handles the abundant or waste raw materials by producing other products or animal feed. On the other hand, participants from trading, store and restaurant proposed that because customer's satisfaction is most important; thus in case of returned products, they decided to change new product for them. Defective products were discount or sale in outlet. Participants working for governmental university proposed that most of returned products were books and formal documents. Books would be donated or sent to the branch requiring these books while documents were reused and then destroyed as some of the information is confidential. Accordingly, logistics companies will manage routes which will carry full loads both depart and return transportation.

H_1: The result reported that there is a positive relationship between resource commitment and reverse logistics innovation which confirmed the results of the previous studies. For example, the study of Daugherty *et al.* (2001) and Richey *et al.* (2004). The company provides good resource including technological and financial support as well as good coach and advice will provides an opportunity for employees to express diverse and valuable opinions or ideas which can lead to reverse logistics innovation resulted in high competitive advantage (Hunt and Morgan, 1996).

H_2: The result reported that there is a positive relationship between resource commitment and reverse logistics performance which confirms the results of the previous studies, for example, the study of Daugherty *et al.* (2001), Richey *et al.* (2004) and Jack *et al.* (2010). The company provides good resource including technological and financial support and the good coach and advice will increase confidence of employees, not worrying about their work, daring to make decision, suggestions and actively participating in organization's activity. This turns to higher reverse logistics performance.

H_3: The result revealed that there is not a positive relationship between resource commitment and reverse logistics cost savings which is opposed to the findings of the previous studies such as Abdullah and Yaakub (2014) and Raminez and Morales (2013). This is because there is less strictness of enforced laws related to return and destroy the products in Thailand, unlike developed countries. The cost savings are concerning with reverse logistics consisting of product, remanufacturing and transportation which is low level compared to resource allocation.

H_4: The result reported that there is a positive relationship between resource logistics innovation and reverse logistics performance which confirms the results of the previous studies, for example, the study of Richey *et al.*, (2005) and Huang and Yang (2014). Innovation is hard to create and imitate which makes different from rivals, resulting in higher performance.

H_5: The result reported that there is not a positive relationship between reverse logistics innovation and reverse logistics cost savings which is opposed to the findings of the previous studies such as the study of Huang and Yang (2014). Investment in reverse logistics innovation requires a lot of money and resources while cost savings are low; thus, the managers evaluated that there is not worth to invest.

H_6: The result reported that there is a positive relationship between reverse logistics performance and reverse logistics cost savings which confirms the results of the previous studies such as Jack *et al.* (2010). The company running an efficient business will use fewer resources and inputs than the standard or than competitors which is possible to reduce costs more than low level efficient firms.

H_7: The result reported that there is a partly mediate effect of resource commitment on reverse logistics performance through reverse logistics innovation. Reverse logistics innovation can make company different from rivals. Due to these differentiations, customers judge company better than competitors. The employees work with confidence, resulting in higher reverse logistics performance and sale volume.

H_8: The result presented that the type of industry has moderate effect on the path from resource commitment to reverse logistics performance and the path from reverse logistics innovation to reverse logistics performance. Accordingly, there is difference of resource of manufacturing compared to service industry. Thus, the suitable allocation and the providing resource are different. Regarding reverse logistics innovation, manufacturing industry will be interested in product and process innovation whereas service industry tends to do better in customer satisfaction.

H_9: The result reported that the model is not different across length of reverse logistics implementation. Since there are fewer attractive results from implement reverse logistics program, especially low level of cost savings. Thus, most of the companies do this program at some extent.

CONCLUSION

Even though reverse logistics is one of the most interesting strategies in business firms and practitioners, an academic study is scarce (Veerakachen, 2006). Due to the lack thereof at present time, it is likely to be a challenge for the future research to explore both independent and dependent variables which leads to better understandings of the concepts and applications. Moreover, the future research can further explore the possible variables into the model which could be moderators and/or mediators which can lead to better understanding about the complex organizational phenomena relating to situation and issues of resource commitment, reverse logistics innovation, performance and cost savings. Finally, the study and the other additional future researches may continue to explore how resource allocation and utilization could enhance the reverse logistics innovation which is the most valuable factor leading to reverse logistics and an organizational success.

LIMITATIONS

Several potential limitations were expected in this study. The first limitation is the effect of extraneous variables which may affect resource commitment, reverse logistics innovation, reverse logistics performance and reverse logistics cost savings such as macroeconomics and economic crisis. Second, since the study used cross-sectional and self-report data, the conclusions could not only make causal inferences but also raise some concerns about common bias. Therefore, a longitudinal study is required to provide more definitive conclusions. The final limitation is the findings explaining activities and situations of Thai companies which may not be corresponding with foreign organizations.

IMPLICATIONS

Implications for practice: The findings provide some implications for the organization. The result showed that resource commitment and reverse logistics innovation can enhance level of reverse logistics performance. Thus, companies should emphasize more on suitable resource allocation and utilization and approach to create innovation. Though the reverse is ignore, it accounts for high proportion of GDP. Thus, the government should provide attractive return to implement reverse logistics program.

RECOMMENDATIONS

Implications for future research: The findings provide several implications for researchers. First, the future research would be to investigate other potential antecedents and consequences of reverse logistics program. Regarding the fact, the relationship between various antecedents and reverse logistics performance tend to be stronger for customer satisfaction, regulation pressure and rate of competitive. As a result, the future research would be to test the moderate effects of these factors on the relationship between antecedents and reverse logistics performance. Finally, the future research might investigate the extent to which interventions could create a reverse logistics innovation for leading higher reverse logistics performance.

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