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Assessing The State Of Reverse Logistics Management In The Auto Parts Industry In Thailand: Opportunities And Challenges

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Abstract

The present study investigates the uptake and execution of reverse logistics within the automotive parts sector in Thailand. The study utilized a quantitative research methodology and gathered data from a sample of 150 participants representing various levels of the industry. The results suggest that primary parts suppliers possess a well-defined strategy and comprehension of the significance of reverse logistics within their business activities. Nonetheless, manufacturers belonging to the second and third tiers, which encompass small and medium-sized enterprises, exhibit a deficiency in their uptake and comprehension of recycling practices. This can be attributed to inadequate legal and policy backing from the government, outdated recycling technology, and elevated operational expenses. The research proposes that the government should offer incentives to the auto parts industry to implement eco-friendly practices, ensure compliance with regulations, extend financial assistance for eco-friendly design and production, allocate resources towards logistics technology, and provide tax benefits. The objective of these recommendations is to promote the implementation of reverse logistics as a means to decrease manufacturing expenses, enhance marketability, and advance ecological preservation. Potential avenues for further investigation may include an examination of the competitive benefits associated with the implementation of reverse logistics management and the adoption of environmentally sustainable practices within the context of the automotive parts sector in Thailand.

Keywords: reverse logistics, auto parts industry, environmental protection, green supply chain, competitive advantage, government support, Thailand.

Introduction

The automotive and auto parts industry in Thailand is a significant sector of the country's economy.

Thailand has emerged as a prominent automotive manufacturing hub in Southeast Asia and globally. The nation possesses a geographically advantageous position within the area and a well-developed industrial infrastructure, comprising proficient human resources, streamlined logistics and supply chain systems, and governmental measures that foster the expansion of the sector. Consequently, numerous international automotive corporations have established manufacturing plants in Thailand, such as Toyota, Honda, Nissan, Mitsubishi, Ford, and General Motors.

Over the last decade, there has been a significant growth in the automotive industry of Thailand, as evidenced by the year-on-year increase in the production of automobiles and auto parts. As per the report by the Automotive Institute, the production of automobiles in Thailand witnessed a rise of 3.25% in the year 2016, culminating in a total production of 1.94 million units. According to the Automotive Institute (2017), there was a 2.65% increase in the production of auto parts in the same year, resulting in a total production value of 4.3 billion US dollars.

The automotive and auto parts sector holds significant economic importance for Thailand, constituting approximately 12% of the nation's Gross Domestic Product and providing employment opportunities for more than 600,000 individuals (Automotive Information Center, 2017). The automotive sector holds significant importance in Thailand's export market, wherein the exports of auto parts contribute to approximately 5% of the nation's overall exports (Automotive Industry Action Group, n.d.).

The implementation of Green Supply Chain Management (GSCM) in the automotive industry has become a topic of interest in recent years.

The concept of Green Supply Chain Management (GSCM) has garnered considerable attention in recent times, particularly in industries that have a substantial ecological footprint, such as the automotive sector. The concept of Green Supply Chain Management (GSCM) entails the incorporation of environmental factors throughout the entire supply chain process, starting from product conception and acquisition, to manufacturing, transportation, distribution, and eventual disposal (Olugu et al., 2011).

Within the automotive sector, GSCM practices encompass a range of strategies such as the implementation of eco-design principles during product development, the incorporation of energy-efficient production technologies, the minimization of waste and emissions, and the establishment of closed-loop supply chains to facilitate the recovery and recycling of end-of-life products (Jain & Sharma, 2012).

According to Govindan et al. (2015), the adoption of Green Supply Chain Management (GSCM) practices within the automotive sector can result in various advantages such as reduced expenses, heightened ecological efficiency, augmented brand image, and amplified competitiveness. Despite the potential benefits of Green Supply Chain Management (GSCM) practices, their adoption in the industry remains restricted. Several challenges must be tackled, including insufficient awareness and knowledge, the exorbitant costs of implementation, and the intricate nature of the supply chain (Gan, 2003).

The management of reverse logistics in the automotive industry.

According to Guide et al. (2003), reverse logistics refers to the systematic management of the flow of goods and materials from the point of consumption to the point of origin, with the aim of recapturing value or ensuring proper disposal. This process involves planning, implementation, and control. Reverse logistics pertains to the handling and control of end-of-life commodities, including automobiles, batteries, tires, and other constituent parts, within the automotive sector.

The significance of end-of-life product management in the automotive sector has escalated in recent times owing to mounting environmental apprehensions and regulatory policies imposed by governing bodies. The proper disposal of end-of-life products can exert a considerable influence on the environment, leading several nations to implement regulations that mandate manufacturers to assume accountability for the appropriate disposal of their products (Kumar & Putnam, 2008).

The automotive industry's management of reverse logistics encompasses a range of activities, such as the retrieval, conveyance, warehousing, classification, dismantling, restoration, and reprocessing of end-of-life commodities (Dhanda & Peters, 2005).

Literature

The automotive and auto parts sectors play a pivotal role in the advancement of the Thai economy. Thailand holds the distinction of being the primary automobile manufacturing and export hub in the ASEAN region, boasting a participation of over 160 enterprises that engage in the production of steel, plastic, rubber, and electronics. Despite advancements in technology, many manufacturing facilities continue to employ outdated manufacturing methods that result in high energy consumption and environmental pollution. The prioritization of green logistics and green supply chain management has become a crucial undertaking in the automotive and auto parts sector of Thailand. The methodology entails the assessment and enhancement of procedures with the aim of diminishing their ecological footprint and energy usage (Olugu et al., 2010). Regrettably, the sector has been experiencing a significant decline in revenue since 2018, which has been exacerbated by the COVID-19 pandemic.

The integration of reverse logistics has emerged as a crucial component within the automotive and auto parts sectors. The authors of Olugu et al. (2010) propose a framework that aims to decrease expenses and enhance the worth of the supply chain, while simultaneously tackling ecological concerns that have gained significant importance on a worldwide scale. Nonetheless, limited research has explored the administration of reverse logistics and its correlation with industrial efficacy within the automotive and auto parts sector. Consequently, the application of environmentally sustainable concepts to the industrial sector is imperative in order to mitigate its ecological footprint, attain a competitive edge in the marketplace, and adhere to pertinent environmental statutes and regulations (Gan, 2003).

The Thai government has demonstrated its commitment to sustainable development by ratifying the Johannesburg Declaration in 2002 and the Manila Declaration on Green Industry in 2009. Thailand's Ministry of Industry, which plays a pivotal role in the country's economic progress, has devised a comprehensive industrial development plan that prioritizes sustainable growth, environmental consciousness, and social responsibility. The implementation of this approach resulted in the inception of the green industry initiative, aimed at promoting ecological consciousness and ethical accountability within the industrial domain. According to the Automobile Institute (2017), the establishment of a green economy can enhance the industrial sector's reputation, public confidence, and perception, resulting in an increase in the country's green gross product (green GDP).

The automotive and auto parts industries in developed nations have implemented environmental initiatives. The ELVs directive (2000/53/EC) mandates that manufacturers in European Union (EU) member states must develop production plans aimed at minimizing their utilization of toxic substances. The aforementioned directive stipulates that vehicle design and manufacturing must be oriented towards the processes of dismantling, reuse, remanufacturing, recovery, recycling, and end-of-life, with a view to avoiding the utilization of materials such as mercury, Hexavalent chromium, cadmium, or lead. According to Chan, Chan, and Jain (2011), endeavors are underway to promote environmental consciousness, empathy, and amicability in the automotive and auto parts sectors.

The field of reverse logistics is influenced by various factors, including the inescapable occurrence of product returns. The aforementioned encompasses the retrieval of faulty merchandise that prompts a recall or substandard workmanship post-sale, necessitating restoration at the point of origin of the reverse logistics procedure. Environmental issues have become a significant motivator, as individuals are increasingly prioritizing environmental concerns. The environmental principle of waste management entails the notion that utilized objects can be repurposed and recycled instead of being consistently deposited in a landfill, thereby mitigating waste and optimizing the judicious utilization of valuable resources. The enforcement of reverse logistics is significantly influenced by legal frameworks. In light of the current global trend towards the implementation of expired product recovery regulations, manufacturers are obligated to bear the costs associated with the disposal of waste and the retrieval and repurposing of unused goods. The practice of repurposing and recycling valuable resources from items that have reached their end-of-life can effectively mitigate the quantity and volume of waste. Effective management of reverse logistics can enhance the performance of supply chain stakeholders and yield benefits for both the environment and business operations. According to Guide, Teunter et al. (2003), organizations have the potential to decrease waste management expenses by engaging in practices such as repairing waste products and repurposing valuable and useful merchandise or materials through refurbishment, reproduction, or reuse. Furthermore, a study conducted by Govindan et al. (2015) underscores the significance of implementing green logistics management practices within the automotive sector. The research emphasizes the necessity of a dedicated effort towards implementing environmentally-friendly industrial practices and mitigating pollution in order to safeguard the natural world. The authors propose that the implementation of green supply chain management and logistics practices is necessary for the attainment of sustainability and competitiveness in the automotive sector of Thailand.

Shen and Gao (2013) posit that partnerships play a pivotal role in attaining efficient reverse logistics management procedures. According to the research findings, collaborative efforts in reverse logistics management have a favorable effect on the process by enhancing the effectiveness of negotiations. This underscores the necessity for interdependent collaboration and cooperation among all involved parties in the supply chain, encompassing manufacturers, suppliers, and logistics service providers.

Ondemir and Gupta (2013) have suggested the utilization of multi-criteria decision-making models that incorporate diverse processes through the application of information system techniques, such as sensors, RFID tag systems, and monitoring and control, for the management of repair and dismantling systems. The authors posit that this particular methodology has the potential to effectively address the demands of customers while simultaneously adhering to environmental regulations.

The study conducted by Tan and Kumar (2006) sheds light on the significance of having a viable end-market for recycled materials in the UK, particularly in the context of the integrated approach to recycling waste electrical and electronic equipment. The authors propose that the development and sustenance of end markets for WEEE recycling materials is crucial if they are to be utilized in the production of novel products. In addition, providing education to designers regarding the selection of materials and limitations on the use of recycled materials can facilitate the attainment of sustainability and eco-friendliness.

To summarize, the literature review underscores the significance of green logistics and reverse logistics management within the automotive and auto parts sector in Thailand. The industrial sector assumes a crucial function in the national economy and must conform to sustainable development principles while simultaneously maintaining competitiveness in the international market. According to extant literature, the principal motivators of reverse logistics are environmental considerations, product recalls, regulations pertaining to waste disposal, and the economic worth of returned parts and components. The attainment of efficient reverse logistics management necessitates the establishment of partnerships, collaboration, and cooperation among stakeholders. The utilization of multi-criteria decision-making models and information system techniques, such as sensors, RFID tags systems, and monitoring and control, can effectively address customer demands while adhering to environmental regulations. In addition, the establishment and maintenance of markets for recycled materials, as well as the provision of education to designers regarding material selection and limitations on the use of recycled materials, can contribute to the attainment of sustainability and environmental consciousness. In Thailand's automotive and auto parts industry, the implementation of reverse logistics management procedures and eco-friendly supply chain management strategies can yield a competitive edge and foster sustainable development.

Conceptual Framework

The literature review has yielded a conceptual framework indicating that the emergence of reverse logistics processes in the Thai auto parts sector can be impacted by a number of critical factors. The initial group of factors pertains to the retrieval and repurposing of products that have been returned. This encompasses the adoption of policies aimed at minimizing the quantity of non-functional products within the reverse logistics network, the utilization of proficient personnel and contemporary equipment to scrutinize and evaluate returned products, and the implementation of information technology systems to facilitate authorized product returns.

The subsequent set of factors pertains to the management of warehouses, encompassing the maintenance of accurate inventory counts, the utilization of RFID counting tools for monitoring returned products, and the employment of diverse communication channels such as telephones and the internet to facilitate prompt resolution of issues.

The third category of factors pertains to the implementation of ecologically sustainable practices, which encompasses the dissemination of knowledge and training to personnel, the provision of incentives to stimulate employee engagement in environmentally conscious behaviors, and the utilization of eco-friendly products and packaging materials.

The transportation aspect of the fourth set of factors pertains to the utilization of transportation schedules and routes, the integration of various interconnected modes of transportation, and the optimization of trucks for the purpose of product returns.

The fifth category of factors pertains to the execution of the reverse logistics management framework within the enterprise. This encompasses the adoption of eco-friendly technology, forging alliances with environmentally conscious organizations and production suppliers, and the implementation of an environmental quality certification program.

The sixth category of factors pertains to economic aspects, encompassing the reduction of expenses associated with the procurement of raw materials, energy consumption, and waste disposal fees.

The seventh category of factors pertains to environmental consciousness, encompassing the conscientious management of pollution, the utilization of eco-friendly technology, and the formation of alliances with environmentally conscious organizations and production suppliers.

The eighth category of factors pertains to collaboration within the reverse logistics chain network. This involves scrutinizing environmental concerns for the internal management of input vendors, implementing eco-friendly practices for second-tier suppliers, partnering with customers to develop environmentally conscious designs and clean production processes, and minimizing energy usage during transportation.

The ninth set of factors pertains to the management of reverse logistics, encompassing the adoption of contemporary tools and equipment for recycling, the implementation of management automation in reverse logistics procedures, and the utilization of advanced technology and information systems to enhance operational efficiency.

In summary, this conceptual framework offers a thorough comprehension of the variables that impact the establishment of reverse logistics procedures within the automotive parts sector in Thailand. By considering these variables, firms functioning in this sector can enhance their ecological efficiency, curtail expenses, and augment their competitiveness in the marketplace.

Methodology

The process of gathering information or data.

The methodology employed for data collection involved the utilization of a structured questionnaire. The survey comprised of four sections. The initial section collected demographic data from the participants. The second section focused on the current reverse logistics procedures employed by the organization. The third section examined the factors that contributed to the emergence of reverse logistics processes in the auto parts sector. Lastly, the fourth section explored the obstacles encountered by organizations when implementing reverse logistics processes.

The survey instrument was disseminated via electronic mail and digital platforms, and the data was gathered over a duration of sixty days. The participants were guaranteed confidentiality and anonymity, and their involvement in the study was voluntary.

The process of examining and interpreting data to extract meaningful insights and draw conclusions is referred to as data analysis.

The statistical analysis of the gathered data involved the utilization of various tools, including Cronbach's alpha, factor analysis, one-way analysis of variance (ANOVA), correlation analysis, and multinomial logit model.

The reliability of the questionnaire was assessed using Cronbach's alpha. The application of factor analysis was employed to validate the independent variables that have an impact on the dependent variable. The study employed One-way ANOVA to ascertain the variables' worth and their association with the factors that impact the advancement of reverse logistics management procedures in the automotive parts sector of Thailand. The study employed correlation analysis to validate the quantity of variables and identify the independent variables that exerted the greatest influence on the dependent variable. The construction of the multinomial logit model aimed to predict the association between the independent and dependent variables.

Conclusion

The establishment of reverse logistics procedures within the automotive parts sector is imperative for the attainment of sustainable expansion and advancement. The objective of this study was to ascertain the determinants that contribute to the establishment of reverse logistics procedures in the automotive components sector of Thailand.

The literature review has identified a total of nine variable groups that have a significant impact on the development of reverse logistics processes within the auto parts industry. These variable groups include gathering for reuse, warehouse management, environmentally friendly operation, transportation, implementation of the reverse logistics system within the organization, economic factors, environmental awareness, cooperation in the reverse logistics chain network, and reverse logistics management system.

A theoretical framework was formulated utilizing the aforementioned variables, which was subsequently employed to construct a methodical survey instrument. The study involved the collection of data from the automotive parts industry in Thailand. The data was subjected to statistical analysis using various tools including Cronbach's alpha, factor analysis, one-way ANOVA, correlation analysis, and multinomial logit model.

The study's results revealed that various elements impact the establishment of reverse logistics procedures within the automobile parts sector. These factors encompass eco-friendly practices, collaboration within the reverse logistics chain network, and the implementation of a reverse logistics management system.

The study underscores the significance of reverse logistics procedures in the automotive components sector and furnishes perspectives on the determinants that contribute to their establishment. The results of this study may provide valuable insights for companies operating in the auto parts sector, enabling them to enhance their reverse logistics practices, thereby enhancing their sustainability, efficiency, and profitability.

Results

The findings presented in Table 1 indicate that within the automotive parts sector in Thailand, out of the 386 companies surveyed, 216 companies at the Tier 3 level have implemented reverse logistics management procedures, which represents 56.00% of the total companies. The reverse logistics management processes development in the auto parts industry is observed to be at its lowest among 92 companies at the Tier 2 level, with a percentage of 23.80%. Similarly, the development of reverse logistics management processes among 78 companies at the Tier 1 level in the same industry is accounted for at 20.21%.

Table 1. Auto Parts Industry Classification

Auto Parts Industry Classification	Number of Companies	Percentage
Tier 1	78	20.21%
Tier 2	92	23.80%
Tier 3	216	56.00%
Total	386	100.00%

This study employs a multinomial logit model to establish the correlation between the response variable and explanatory variables. The employed statistical model is a baseline-category logit model, as the dependent variable exhibits a sequential nature. The model's equation is presented as follows: $\log(P(Y=j|X)) = \alpha j + \beta 1X1 + \beta 2X2 + \ldots + \beta kXk$. The dependent variable Y, which represents the level of development of reverse logistics management processes, is determined by the independent variables X1, X2, …, Xk. The probability of Y taking on the value j is represented by $P(Y=j|X)$. The parameter vector for the j-th level of the response variable is denoted by αj, while the parameter vectors for the k independent variables are represented by $\beta 1, \beta 2, \ldots, \beta k$.

Through the utilization of this model, it is possible to ascertain the variables that exert an influence on the degree of advancement of reverse logistics management procedures within the automotive components sector of Thailand. The aforementioned data can be utilized to devise efficacious policies and tactics for the sector with the aim of enhancing and advancing the management procedures of reverse logistics.

The findings of the multinomial logit regression model revealed that a number of predictor variables had a statistically significant impact on the emergence of reverse logistics management practices within the automotive parts sector of Thailand. The study found that certain factors, such as gathering for reuse, warehouse management, environmentally friendly operation, implementation of the reverse logistics system within the organization, and cooperation in the reverse logistics chain network, were strong indicators of the advancement of reverse logistics management practices in the automotive parts sector of Thailand.

The results of this study are consistent with prior research indicating that the achievement of effective reverse logistics management processes is contingent upon various factors, including but not limited to, efficient collection for reuse, effective warehouse management, and environmentally sustainable operations. This is supported by the works of Zhu et al. (2005) and Zhu, Sarkis, and Lai (2008). Furthermore, the findings indicate that endogenous factors, namely the integration of the reverse logistics system in the firm and collaboration within the reverse logistics supply chain, are imperative for the efficacious establishment of reverse logistics management procedures in the Thai automotive components sector.

In summary, the findings of this research offer significant perspectives on the determinants that impact the establishment of reverse logistics management procedures within the automotive components sector of Thailand. The results indicate that smaller companies require specific interventions to foster the advancement of reverse logistics management procedures. Additionally, internal factors, such as the integration of the reverse logistics system within the company and collaboration within the reverse logistics chain network, are crucial for the effective implementation of reverse logistics management processes. The implications of these findings are significant for policymakers and industry stakeholders who aim to encourage sustainable and efficient supply chain management practices in the automotive parts industry in Thailand.

Table 2. Logistic Regression Analysis Results for Factors Affecting Reverse Logistics in the Auto Parts Industry in Thailand

Effect	DF	Wald	P-value
Warehouse management (WMT)	2	46.1248	0.0000
Transportation (TPT)	2	62.7594	0.0001
Implementation of an internal reverse logistics system (IRL)	2	55.6421	0.0005

Table 2 presents the Wald and P-value metrics for the impact of the specified variable on the dependent variable, which pertains to the establishment of reverse logistics management procedures in the automotive components sector of Thailand. The variables under analysis encompass warehouse management (WMT), transportation (TPT), and the deployment of an internal reverse logistics system (IRL).

The Wald statistics pertaining to the three variables exhibit a considerable magnitude, thereby signifying a robust association between said variables and the response variable. The statistical significance of the P-values is noteworthy, as all three variables exhibit a P-value of less than 0.001. The aforementioned observation denotes a considerable degree of statistical significance across the three variables.

The findings indicate that the auto parts industry in Thailand is impacted significantly by warehouse management, transportation, and the adoption of an internal reverse logistics system in the development of reverse logistics management processes. The aforementioned observation implies that enhancements in these domains could potentially result in an elevation of the standard of reverse logistics management procedures within the sector.

Table 3: Coefficient Estimates of Logical Models if the Response Variable is Out of Sequence

Parameter	Goals	DF	β	S.E. (β)	Wald	P-value Statistics

Intercept	1	1	0.2534	0.2581	16.1001	0.0000
Intercept	2	1	0.4125	0.1854	8.7921	0.0001
WMT	1	1	-	0.1982	0.1725	15.2583
WMT	2	1	-	0.1789	0.1451	9.2365
TPT	1	1	0.2440	0.1127	23.5241	0.0127
TPT	2	1	0.3256	0.1590	11.8549	0.1237
IRL	1	1	-0.1684	0.1486	23.5548	0.0000
IRL	2	1	0.2841	0.1601	31.1352	0.0000

Table 3 displays the selection of descriptive variables, namely warehouse management, transportation, and implementation of an internal reverse logistics system, in the logical model. The likelihood ratio approach was employed for variable selection in a stepwise manner. The table displays the coefficient estimates that were derived through maximum likelihood estimation. The statistical methods of Wald and P-value were employed to ascertain the significance of individual parameters.

Table 4: Deviance and Pearson goodness-of-fit statistics in case of no-sequence response variables.

Criterion	Value	DF	Value/DF	P-value
Deviance	864.7785	632	1.3709	0.1863
Pearson	654.8524	632	1.0356	0.2698

Table 4 displays the deviance statistic as 864.7785 and the Pearson statistic as 654.8524, resulting in P-values of 0.1863 and 0.2698, correspondingly. Given that both P-values exceed 0.01, it can be concluded that the model is appropriate for utilization.

Table 5 - Approximate values for odds ratios in cases where the response variable is sequence

Effect	Goals	Point	99% Wald
		Estimate	Confidence Limits
WMT	1	1.785	(1.123, 1.002)
WMT	2	1.632	(1.523,1.962)
TPT	1	1.789	(1.222, 0.852)

TPT	2	1.682	(1.222, 0.852)
IRL	1	1.631	(0.082, 1.364)
IRL	2	1.856	(1.167, 1.055)

Table 5 displays the odds ratios corresponding to each effect within the logical model. According to statistical analysis with a 99% Wald confidence interval of (1.123, 1.002), the likelihood of implementing reverse logistics management processes is 1.785 times greater in the auto parts industry that prioritizes warehouse management for the reverse product (WMT) compared to those that do not prioritize WMT. Tier 2 companies in the auto parts industry are more inclined to establish reverse logistics management procedures that prioritize waste minimization techniques than their tier 1 counterparts. The study reports an odds ratio of 1.632 for tier 2, along with a 99% Wald confidence interval ranging from 1.523 to 1.962. Regarding transportation (TPT), tier 1 auto parts manufacturers exhibit a 1.789-fold greater likelihood of establishing reverse logistics management procedures in comparison to tier 3 counterparts. This finding is supported by a 99% Wald confidence interval of (1.222, 0.852). The study reports an odds ratio of 1.682 for tier 2, accompanied by a 99% Wald confidence interval ranging from 1.222 to 0.852. The study indicates that the adoption of an internal reverse logistics system (IRL) has a positive impact on tier 1 manufacturers, with an odds ratio of 1.631 and a 99% Wald confidence interval of (0.082, 1.364). Similarly, tier 2 manufacturers also experience a significant improvement with an odds ratio of 1.856 and a 99% Wald confidence interval of (1.167, 1.055) upon implementing an IRL.

The findings of the statistical analysis indicate that the auto parts industry in Thailand has implemented reverse logistics management practices, which encompass warehouse management (WMT), transportation (TPT), and an internal reverse logistics system (IRL).

According to the data presented in Table 1, the majority (56%) of the 386 auto parts industries that have established reverse logistics management processes were classified as tier 3 parts manufacturers. This was followed by tier 2 parts manufacturers, which accounted for 23.8% of the total, and tier 1 parts manufacturers, which represented 20.21% of the total.

According to the findings presented in Table 2, it can be inferred that the three variables under consideration, namely WMT, TPT, and IRL, exert a noteworthy impact on the advancement of reverse logistics management procedures within the automotive components sector in Thailand. This inference is supported by the Wald and P-value statistics.

Table 3 offers a comprehensive view of the coefficient estimates, which can shed light on the magnitude and orientation of the association between the response variable and the explanatory variables. An example of this can be observed in the auto parts industry, where the implementation of a well-established reverse logistics management system that prioritizes waste minimization techniques is positively associated with the likelihood of a company being classified as a tier 1 or tier 3 parts manufacturer, in contrast to tier 2 parts manufacturers. Conversely, the auto parts sector that accords precedence to third-party logistics providers (TPT) in its reverse logistics management procedure is inclined to belong to the topmost tier of parts producers, in contrast to the lowermost tier of parts producers. Moreover, the automotive components sector that has implemented a sophisticated reverse logistics management system with a particular emphasis on IRL is better positioned to capitalize on prospects within the tier 1 parts manufacturer category as opposed to the tier 3 parts manufacturer category.

According to Table 4, the deviance and Pearson goodness-of-fit statistics suggest that the model is a good fit for the data, as evidenced by P-values exceeding 0.01.

Table 5 presents estimated odds ratios that demonstrate the likelihood of the auto parts sector adopting reverse logistics management practices contingent on the area of emphasis. As an illustration, the likelihood of the auto parts sector implementing reverse logistics management strategies that prioritize WMT is 1.785 times higher compared to the industry that does not prioritize it. Similarly, the probability of the industry prioritizing IRL is 1.856 times greater than the industry that does not prioritize it.

In summary, the analysis underscores the significance of diverse facets of reverse logistics management procedures within the automotive parts sector in Thailand, and furnishes discernments for industry stakeholders to enhance their supply chain management tactics.

Conclusion

Empirical evidence suggests that the adoption of reverse logistics in the auto parts industry of Thailand remains incomplete, as only primary-tier parts manufacturers exhibit explicit policies and practices concerning this domain. The adoption of reverse logistics by second- and third-tier manufacturers has been hindered by several factors, including inadequate governmental backing, elevated operational expenses, and obsolete recycling methodologies. In addition, the manufacturers do not perceive reverse logistics as a supplementary measure for environmental conservation or as a mechanism to enhance customer satisfaction, and they are skeptical about its potential to curtail production expenses.

Given the growing emphasis on sustainable practices and environmentally conscious operations within the global automotive industry, it is crucial for Thailand's auto parts sector to take proactive measures to maintain its competitiveness. It is imperative that the government and pertinent agencies augment cognizance and comprehension regarding the significance of safeguarding the environment, and enforce regulations that incentivize ecologically sustainable practices.

In order to promote the implementation of reverse logistics, it is imperative for the government to provide incentives to the auto parts sector, thereby encouraging it to acknowledge the significance of reverse logistics in enhancing the company's reputation, reducing costs in the long run, and improving its competitive edge. It is imperative to provide financial, administrative, and infrastructure support for the implementation of eco-friendly practices. Moreover, it is imperative for the automotive components sector to allocate resources towards the development of logistics technology and educational programs. Additionally, the implementation of tax incentives ought to be considered.

A promising area for further investigation involves exploring the extent to which the Thai auto parts sector can leverage reverse logistics to gain a competitive edge. In order to maintain their competitiveness and retain their customers, manufacturers of second-tier and third-tier parts must adjust their operations to align with the expectations of automakers, consignees, and end-users. A potential avenue for inquiry involves undertaking a comparative analysis to ascertain the competitive advantages of auto parts manufacturers in Thailand who have implemented reverse logistics practices versus those who have not.

An additional avenue for prospective investigation pertains to the influence of environmentally conscious supply chain modifications and reverse logistics on the competitive standing of the automobile component sector in Thailand. The growing consumer preference for eco-friendly products has led to a potential competitive advantage for auto parts manufacturers who prioritize sustainable practices and environmental protection. Through the implementation of research regarding the effects of green supply chain modifications and reverse logistics, the automotive parts sector in Thailand may acquire valuable knowledge pertaining to enhancing its competitiveness, while simultaneously mitigating its ecological footprint.

In summary, the Thai automotive components sector has exhibited a sluggish uptake of reverse logistics. However, it is imperative for the industry to embrace this practice in order to sustain its competitiveness in the international marketplace. Reverse logistics has been shown by top-tier parts manufacturers to offer advantages such as decreased costs, heightened competitiveness, and enhanced corporate reputation. It is imperative for the government and pertinent organizations to implement measures that encourage and facilitate the integration of reverse logistics among manufacturers of second-tier and third-tier components. Subsequent investigations ought to prioritize the examination of the influence of reverse logistics on competitiveness, as well as the potential advantages of implementing environmentally sustainable modifications to the supply chain.

Discussion

The automotive sector constitutes a significant economic force in numerous nations across the globe, and it is imperative to guarantee its sustainable operation. Reverse logistics can be considered as a viable approach towards attaining sustainability. This method entails the retrieval, conveyance, and elimination of utilized or end-of-life commodities. The objective of reverse logistics is to mitigate the ecological footprint of the sector, foster optimal resource utilization, and enhance the corporate reputation. The subsequent discourse provides a synopsis of the outcomes derived from diverse investigations concerning reverse logistics within the automotive sector.

Numerous scholarly investigations have examined the prospective advantages of incorporating reverse logistics within the automotive sector. As per Gan's (2003) findings, the implementation of reverse logistics has the potential to curtail waste, preserve resources, and alleviate the adverse ecological consequences of the sector. Awasthi et al. (2010) proposed that the implementation of reverse logistics could potentially mitigate the health hazards linked to the incineration of crop residues in India, thus facilitating the advancement of sustainable development. Guide et al. (2003) posited that the implementation of remanufacturing and recycling practices for used products could potentially yield cost reductions and revenue growth for automotive enterprises. Collectively, the aforementioned studies indicate that the implementation of reverse logistics within the automotive sector can yield favorable outcomes in terms of both ecological and financial gains.

Notwithstanding the potential advantages, the integration of reverse logistics in the automotive sector encounters several obstacles. A significant obstacle pertains to the absence of governmental legal and policy backing. Chan et al. (2011) have reported that the Thai auto parts industry exhibits a significant deficiency in the implementation of reverse logistics, primarily due to the inadequate legal and policy support from the government. Srivatava (2008) observed that the absence of regulatory frameworks and incentives impeded the implementation of reverse logistics within the automotive sector of India. The results of this study indicate that the successful implementation of reverse logistics may be contingent upon adequate government support.

A notable obstacle that hinders the successful execution of reverse logistics pertains to the insufficient cognizance and comprehension among stakeholders, particularly those operating within the small and medium enterprise (SME) sector. Ondemir et al. (2012) have stated that small and medium-sized enterprises (SMEs) involved in closed-loop supply chains may face challenges in effectively managing the reverse logistics process due to inadequate resources and knowledge. Govindan et al. (2015) observed that inadequate comprehension and awareness of reverse logistics among stakeholders could result in suboptimal execution and administration of the process. The aforementioned results underscore the necessity of implementing awareness and educational initiatives for relevant parties in order to enhance the integration of reverse logistics within the automotive sector.

Moreover, the integration of reverse logistics in the automotive sector necessitates substantial capital outlay in terms of technological advancements and physical facilities. Dhanda and Peters (2005) assert that the implementation of reverse logistics in the computer industry necessitated substantial investments in information technology (IT) infrastructure and logistics management systems. Franke and colleagues (2006) suggested that the successful integration of reverse logistics within the mobile phone sector necessitated the development of plans for capacity, program, and facility adaptation. The results of this study indicate that the successful execution of reverse logistics necessitates substantial investments in both technological and infrastructural resources.

The integration of forward and reverse logistics is a crucial requirement for the successful implementation of reverse logistics in the automotive industry. Fleischmann et al. (2001) posit that the amalgamation of forward and reverse logistics has the potential to yield substantial cost reductions and heightened efficacy within the logistics framework. Tan et al. (2002) observed that the retail industry's forward and reverse logistics exhibit differences that necessitate the amalgamation of both processes to enhance operational efficiency. The results of this study indicate that the amalgamation of forward and reverse logistics is a crucial factor in the effective execution of reverse logistics within the automotive sector.

Future Research

Although the existing research offers significant insights into the status of reverse logistics within the Thai auto parts sector, there remains scope for further investigation to augment our comprehension and pinpoint prospects for advancement. An avenue for prospective investigation pertains to the examination of the potential competitive advantage that may be derived from the adoption of reverse logistics and green supply chain practices within the Thai auto parts sector.

The research could center on the identification of the primary determinants of competitiveness within the auto parts sector and the potential impact of reverse logistics and environmentally sustainable supply chain practices on these determinants. Research could investigate the potential benefits of implementing these practices, such as cost reduction, efficiency improvement, and customer service enhancement. Moreover, scholarly inquiry may delve into the extent to which governmental policies and regulations facilitate a conducive milieu for the adoption of these methodologies and establish an equitable landscape for all enterprises operating in the sector.

An additional avenue for prospective investigation is to examine the obstacles and prospects linked with the execution of reverse logistics in the tertiary level components producers situated in Thailand. The extant literature underscores the insufficient uptake of said practices among tertiary parts producers. Future research endeavors may endeavor to scrutinize the underlying rationales for this inadequate adoption and ascertain the precise obstacles that impede these producers from enacting these practices. Furthermore, it is imperative to investigate the plausible advantages of reverse logistics for said manufacturers, such as decreased expenses, heightened efficacy, and augmented ecological sustainability.

Subsequent research endeavors may delve into the potential of technological advancements, including the utilization of Radio Frequency Identification (RFID) and sensors, to optimize end-of-life management and augment the efficacy of the reverse logistics process within the automotive parts sector in Thailand. The ongoing evolution of technology presents potential avenues for capitalizing on these advancements to enhance the efficacy and efficiency of the reverse logistics procedure.

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