



Clustering analysis prioritization of automobile logistics services

Clustering
analysis
prioritization

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Abstract

Purpose – The purpose of this paper is to provide a clustering approach to segment supply chain partners in the automobile industry and prioritize services offered by third party logistics service (3PL) providers.

Design/methodology/approach – In total, 98 automobile and auto-parts manufacturers are surveyed to identify service needs, preferences, and outsourcing commitments. By applying a two-stage clustering approach combined with Ward's minimum-variance method and the *K*-means algorithm, the logistics companies prioritize their services to better satisfy groups of customers with specific preferences.

Findings – Four distinctive groups of manufacturers are identified using the two-stage clustering approach. The clusters separate logistic preferences and outsourcing patterns of after market parts suppliers, original equipment service parts suppliers, original equipment manufacturer parts suppliers, and tier one car makers. The paper finds that distribution and delivery services hold the highest percentage of services outsourced among the manufacturers.

Originality/value – This paper models logistic services as customizable services and develops a data system methodology to define the profiles of automobile manufacturers and their preferred logistic services. Through the analysis of service preferences and clustering, the paper identifies the key logistic services that can be customized for members of the automobile supply chain. A case is provided which demonstrates how a logistics company can provide customized service designs for specific target markets and customers.

Keywords Automotive industry, Distribution channels and markets, Channel relationships, Cluster analysis

Paper type Research paper



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1. Introduction

Automobile and components manufacturers recognize the strategic importance of integrated delivery systems for the global market. Current research over the last decade has demonstrated many ways to integrate and synchronize materials and information flows, enhance supply chain efficiency, and reduce logistic management costs for supply chain intermediaries. An important development is the outsourcing of logistics services. Researches show that third party logistics (3PL) providers enhance the availability of products and materials on-demand and facilitate the consolidation of orders (Sohail and Sohal, 2003; Carbone and Stone, 2005; Kim *et al.*, 2008). Using good quality 3PL services, the supply chain intermediaries increase information sharing, build more robust working relations, and decrease the uncertainty of the product life cycle (Trappey *et al.*, 2007; Govindan *et al.*, 2010). The scope of logistics management has been extended from intra-organization coordination to inter-organizational coordination and combines customized services for the building of long-term customer loyalty (Wang and Sang, 2005; Gol, 2007; Sihm and Schmitz, 2007).

This research provides a methodology for 3PL companies to customize services for the automobile and components manufacturers. For the first phase of the study, the industrial customers for 3PL firms are surveyed to collect the outsourcing status quo of logistics activities, logistics service preference attributes, and general industrial demographic information. For the second phase, a two-stage clustering method classifies customers into distinct clusters so that specific logistic services can be defined for members of a given cluster. Once the customers' preferences and product distribution attributes are known, the data clustering provides decision support for logistic services that will improve logistics effectiveness and lower distribution costs. A survey is used to collect the customer and service preference data and the *K*-means algorithm clusters customers into sub-segments according to their logistics service attributes. The 3PL then uses the clusters to create customized delivery and distribution services that better satisfy the requirements and preferences of each customer group.

This research paper is organized as follows. Section 2 reviews and discusses the background literature. The proposed two-stage clustering method and the decision support methodologies are described and discussed in Section 3. Section 4 presents the case implementation. The concluding remarks for implementation and further design of customized services are provided in Section 5.

2. Literature review

The literature related to customer relationship management (CRM), clustering for market segmentation, and the logistic management processes for the automobile industry channel intermediaries are reviewed and discussed in this section. The importance of these research outcomes to 3PL service providers is highlighted.

2.1 Customer relationship management

Business research promotes CRM as a means to maximize the value of customers, target profitable segments, and cultivate high-quality relationships to ensure customer loyalty (Peppard, 2000; Chen and Popovich, 2003; Wang and Sang, 2005). Companies are changing their business process models and building information technology solutions that better enable the acquisition of new customers, the retention of existing ones, and maximize customer lifetime value (Peppard, 2000; Lin *et al.*, 2010). Key objectives of

supply chain CRM include creating customer value through better communications (Paulraj *et al.*, 2008), providing customized promotions, delivering faster, and offering personalized products and services (Ruiz *et al.*, 2004; Trappey *et al.*, 2009). Piercy (2009) further proposed a strategic alignment between CRM and supplier-relationship management systems. Wang and Sang (2005) conclude that customer value is best maximized when the 3PL reengineer their logistics business process to accommodate the supply chain customers' needs. Following these research outcomes, logistic service providers can apply CRM with segmentation strategies as a means to analyze orders and customize delivery preferences. By dividing target customers (e.g. manufacturers, wholesalers, retailers, and end customers) into submarkets, suitable logistic services can be selected that best meet customer requirements and preferences.

2.2 Clustering method for market segmentation

The general approach to manage market diversity is the application of customer segmentation techniques (Freytag and Clarke, 2001; Kuo *et al.*, 2002; Kim *et al.*, 2006; Chu, 2008). Customer segmentation is a core function of CRM and frequently uses geographic data, demographic data, and behavioral variables to group customers (Lee and Park, 2005). Enterprises utilize clustering methods to identify different target submarkets. Though there are many clustering methods available, six criteria are commonly used to evaluate a target segmentation that is homogeneous within and heterogeneous between segments or groups (Steenkamp and Ter Hofstede, 2002). Even with the applications of market segmentation, not all customer classifications satisfy profitability requirements (Sampaio and He, 2005). Thus, companies often categorize customers in terms of their profitability and target those who contribute the most towards profit objectives.

Several researchers indicate that data mining contributes to increased customer satisfaction and loyalty (Rygielski *et al.*, 2002; Magnini and Honeycutt, 2005; Ngai *et al.*, 2009). Through data mining, companies identify valuable customers, predict behaviors, and support customized service strategies. Several researchers use data-mining techniques to extract meaningful patterns and build predictive customer relationship models (Cheng and Chen, 2009). Clustering, as a data-mining approach, groups members that are fairly homogeneous within clusters but significantly heterogeneous between clusters in many application domains (Hsu *et al.*, 2006; Solomon *et al.*, 2006). Since analysts do not need to predefine group membership, businesses can focus on their efforts using readily available attributes to create the clusters by customers, products, or services.

Clustering is commonly used for market segmentation (Punj and Steward, 1983; Hruschka and Natter, 1999; Tsai and Chiu, 2004; Hung and Tsai, 2008). For example, Hung and Tsai (2008) use the hierarchical self-organizing segmentation model for dealing with market segmentation of multimedia on demand. Clustering approaches have also been successfully applied to text processing. For instance, Runkler and Bezdek (2003) clustered web pages and the sequences of pages visited by web users. Another example of text clustering was demonstrated by Hsu *et al.* (2006) who used the *K*-means approach to cluster patent documents for strategic planning.

2.3 Logistic services for the automobile industry

This section reviews the research related to the automobile supply chain and the logistic services for the central car manufacturers, part suppliers, and other intermediaries in the supply chain. Recent studies by Govindan *et al.* (2010) provide a comprehensive

discussion of the management of the flow of materials, information, and funds across the supply chain from suppliers, to component producers, to central core manufacturers (final assemblers), to distributors (e.g. warehouses and retailers), and ultimately to consumers. Their research defines a 3PL service provider as a company that profits by taking charge of logistics services in the supply chain. The 3PL connects the information flow between suppliers, manufacturers, and distributors while transportation and delivery services are performed. The core competitive advantage of a 3PL is its ability to integrate services to help customers optimize their logistics management strategies, build up and operate their logistics systems, and even manage their distribution systems (Romano, 2003; Wang and Sang, 2005). Trappey *et al.* (2008) provide the logistic model which depicts the automobile industry in terms of the relationships among 3PL providers, automobile manufacturers, automobile parts and components suppliers, dealers, independent distributors, and end customers. Wang (2010) and Vaidyanathan (2005) provide a discussion of just-in-time (JIT) applications and an evaluation of 3PL services.

The product types provided by the automobile industry include completed vehicles as well as parts and components. The parts manufacturers are classified as original equipment manufacturer (OEM) parts suppliers, original equipment service (OES) parts suppliers and after market (AM) parts suppliers. The OEM suppliers sell parts and components directly to the automobile manufacturers that assemble final vehicles. The OES and AM parts suppliers provide parts and components for maintenance service providers, and the retail marketplace. The supply chain logistics activities include parts and components delivery, parts assembly, vehicle distribution, and warehouse management. The automobile manufacturers and parts suppliers maintain their own warehouses to consolidate goods before shipping to intermediaries and final destinations. The 3PL providers are contracted by the manufacturers and suppliers to manage intermediary logistic tasks, such as receipt of goods, storage of goods, delivery, and logistic information support. For the automobile manufacturing supply chain, manufacturers, suppliers, and other intermediaries have distinct and variable logistic requirements based on their unique business models. Therefore, 3PLs that provide customized services reflecting their industrial customer's need gain a substantial competitive advantage.

3. Research method and theoretical framework

This section provides a systematic approach that can be used by 3PLs to customize service offerings for industrial customers. A two-stage clustering method, combining hierarchical clustering with non-hierarchical clustering (Punj and Steward, 1983), is used to analyze the customer survey data and, afterward, prioritize their logistic services. Ward's minimum-variance method (hierarchical clustering) and the *K*-mean algorithm (non-hierarchical clustering) are introduced and the survey method used for data collection is also discussed in this section.

3.1 Two-stage clustering

Multivariate clustering algorithms are a class of data-reduction techniques. Clustering methods are classified into hierarchical or non-hierarchical types (Johnson and Wichern, 2002). The two-stage clustering method that combines Ward's minimum-variance method (hierarchical clustering) (Ward, 1963) and the *K*-means method

(non-hierarchical clustering) was first proposed by Punj and Steward (1983). Ward's minimum-variance method is used to determine the number of clusters, but the method is easily affected by the outliers. On the other hand, the *K*-means method is more accurate and works better with large amounts of data. Thus, researchers have concluded that a two-stage clustering method is the best combination of methods (Kuo *et al.*, 2002). The step-by-step descriptions of Ward's minimum-variance method, the *K*-means method, and the criteria for calculating inter- and intra-cluster similarities are provided by Han and Kamber (2000), Johnson and Wichern (2002) and Sharma (1996).

3.2 The procedure of logistic service prioritization methodology

We present a logistics decision support methodology covering several steps as shown in Figure 1. First, a survey is used to collect customers (channel intermediary) preferences. Logistic service attributes are defined for the questionnaire after in-depth interviews with experienced managers working for automobile suppliers and 3PL providers. Then, these surveys are distributed to the 3PL's customers. Afterward, data collection, Ward's approach is used to determine the best number of clusters. Finally, the *K*-means clustering algorithm is applied to cluster customers into target segments. The target segments are then analyzed to determine the service preferences within these distinct groups.

3.3 Survey method for data collection

A survey is used to collect data from channel intermediaries and these data include the logistics outsourcing status quo, logistics preferences, and customer demographics.

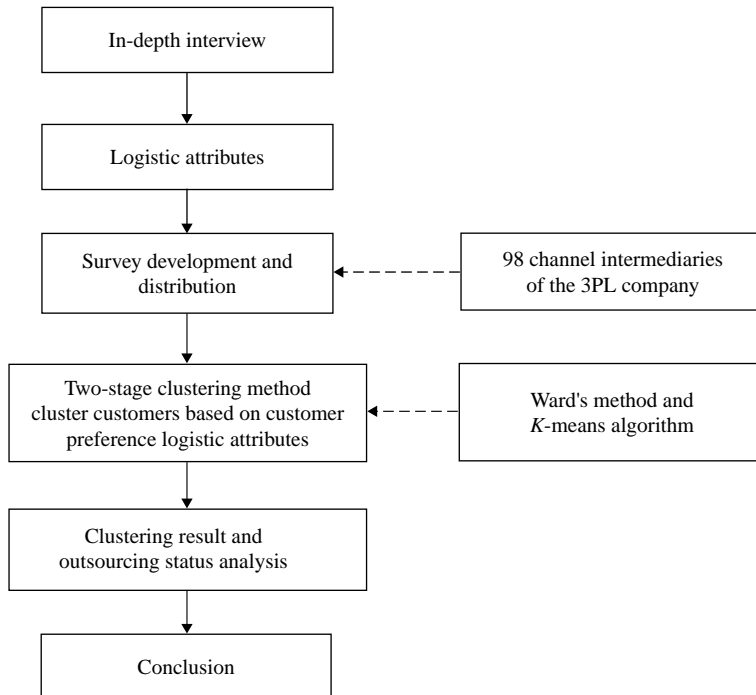


Figure 1.
The research procedure
of logistic service
prioritization methodology

The survey was circulated in two stages. During the exploratory stage, in-depth interviews were conducted with three 3PL managers and three senior managers with experience working for AM suppliers, OES parts suppliers, and OEM parts suppliers. The exploratory questionnaires contain open- and close-ended questions, which were analyzed by domain experts. The final version of the survey was then derived and used to measure logistics activity preferences and to collect demographic data about 3PL service providers.

The first section of the survey measures the degree of outsourcing ranging from partial outsourcing to in-house self-management as a means to benchmark service utilization. The second section used a five-point Likert-like scale (1 to indicate “strongly disagree” and 5 to indicate “strongly agree”) to measure logistic attribute activity preferences. These measures are used to sort the customers into cluster types. The survey data were collected using a self-administered e-mail survey sent to industrial customers who are the auto-industry’s channel intermediaries, such as central car makers, AM, OES, and OEM parts suppliers. A total of 132 surveys were distributed and 98 valid and complete surveys were received yielding a response rate of 74 percent.

3.4 The characterization of the survey respondents

The survey respondents include central car makers (39 percent), OEM parts suppliers (28 percent), OES parts suppliers (19 percent), and AM parts suppliers (14 percent). The major customers for car delivery services include car makers and dealers. The automotive parts industry is divided into spare parts (OES and AM parts) and product parts (OEM). The relationships among customer types in the automotive industry are shown in Figure 2.

4. Case implementation

The case study analyzes the data collected from the 3PL’s customers that include automobile manufacturers and parts suppliers. The logistics case company, the clustering of customer service preferences, and the customization of logistics outsourcing are introduced in this section.

4.1 Profile of the case company

The company provides automobile distribution and other logistics services that account for over 50 percent of the outsourced services in the Taiwan market. As shown in Figure 3,

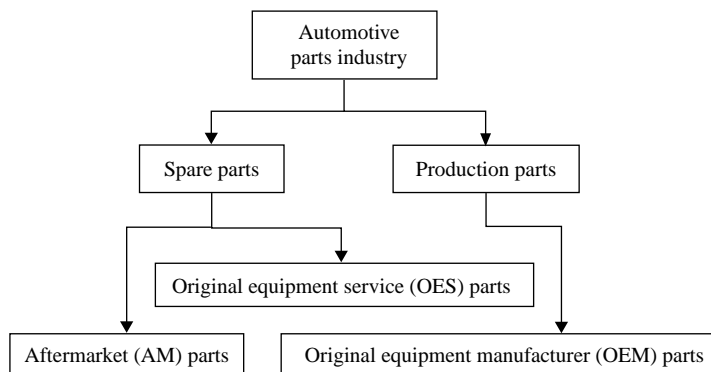


Figure 2.
Product and part
categories by
manufacturing type

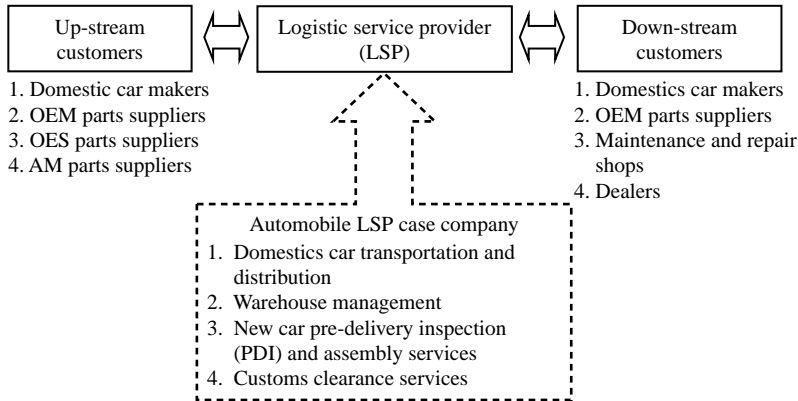


Figure 3.
The Taiwan automobile industry channel intermediaries

the service provider cooperates with more than 70 percent of the upstream and downstream intermediaries including domestic car makers, car dealers, OEM parts suppliers, OES parts suppliers, and automobile maintenance and repair shops. The services offered by the case company include domestic car transportation and distribution, warehouse management, new car pre-delivery inspection, and assembly services as well as import and export customs clearance services. The upstream intermediaries include domestic car makers, OEM parts suppliers, OES parts suppliers, and AM parts suppliers. The downstream intermediaries include domestic car makers, OEM part suppliers, maintenance shops, and dealers. The customer base of the case company covers the entire value chain of the Taiwan automobile manufacturing industry.

4.2 Clustering customers service preferences

With the goal of increasing the accuracy of customer segmentation and prioritizing logistic services offered to the segmented customers, the *K*-means clustering algorithm is used to group target customers based on their logistics preference attributes. In order to determine the best number of clusters, the minimal root mean square standard deviation and maximal R^2 for intra- and inter-class similarity measures are used to select the optimal number of clusters for the given data set (Sharma, 1996). Ward's approach indicates that four clusters are most appropriate to segment the industrial customers. The Euclidean distances among the four clusters and the correlation between the 20 survey questions provide information about the valued logistics preferences for each cluster. The statistical results of the Euclidean distances among four clusters are shown in Table I. The larger values represent greater dissimilarity between clusters. Finished

| Cluster number | Euclidean distances among clusters | | | |
|----------------|------------------------------------|------|------|------|
| | 1 | 2 | 3 | 4 |
| 1 | 0.00 | 0.83 | 0.78 | 0.29 |
| 2 | 0.68 | 0.00 | 0.28 | 1.19 |
| 3 | 0.93 | 0.23 | 0.00 | 0.95 |
| 4 | 0.23 | 0.63 | 0.90 | 0.00 |

Table I.
Euclidean distances among clusters

goods of the AM parts manufacturers (Cluster 1) and the central car makers (Cluster 4) are delivered directly to end customers and show similarities between the preference results. Clusters 2 and 3 show similarities both produce OES and OEM parts. Table II shows that the majority of customers in Cluster 1 are AM parts suppliers (67 percent) whereas OES parts suppliers (63 percent) constitute the majority in the Cluster 2. OEM parts suppliers (71 percent) dominate Cluster 3 and most central car makers (81 percent) belong to Cluster 4.

The *K*-means algorithm is implemented using STATISTICA 7 software to cluster customers based on their preferences and attributes. Table III presents the results and describes which service attributes are highly valued overall and within the four-customer segments. Since the average of each cluster is close to four points on the five-point scale, the 3PL can offer customized logistics services based on the survey results. Given that aftermarket parts manufacturers dominate Cluster 1, the result is explained from the viewpoint of AM parts suppliers. AM parts manufacturers primarily serve the export market. Therefore, delivery services covering domestic and overseas markets incur

Table II.
Customer types by clusters

| Customer type | Cluster 1 (%) | Cluster 2 (%) | Cluster 3 (%) | Cluster 4 (%) | Total number |
|---------------------------------|---------------|---------------|---------------|---------------|--------------|
| AM parts suppliers | 67 (10) | 4 (1) | 4 (1) | 6 (2) | 14 |
| OES parts suppliers | 13 (2) | 63 (15) | 4 (1) | 3 (1) | 19 |
| OEM parts suppliers | 7 (1) | 12 (3) | 71 (20) | 10 (3) | 27 |
| Central car makers | 13 (2) | 21 (5) | 21 (6) | 81 (25) | 38 |
| Total percentage (total number) | 100 (15) | 100 (24) | 100 (28) | 100 (31) | 98 |

Table III.
Customer preference survey statistics – overall and by clusters

| Survey questions | Overall mean | Cluster mean | | | | SD |
|-------------------------------------------------|--------------|--------------|------|------|------|------|
| | | 1 | 2 | 3 | 4 | |
| Q1. Accurate and timely delivery services | 4.53 | 4.50 | 4.50 | 4.50 | 4.60 | 0.65 |
| Q2. Comply with customers' SOP | 3.99 | 3.82 | 4.32 | 3.56 | 4.27 | 0.81 |
| Q3. Certified logistics services | 3.92 | 3.71 | 3.50 | 4.33 | 4.13 | 0.75 |
| Q4. Maintain products in a good condition | 4.40 | 4.50 | 4.36 | 4.39 | 4.37 | 0.64 |
| Q5. Convenient domestic service network | 4.16 | 3.93 | 4.27 | 4.17 | 4.27 | 0.69 |
| Q6. Delivery with flexible quantities | 4.19 | 3.89 | 3.82 | 4.50 | 4.57 | 0.70 |
| Q7. Emergency delivery services | 3.98 | 3.82 | 3.77 | 4.22 | 4.10 | 0.68 |
| Q8. Efficient order processing cycles | 4.06 | 4.14 | 3.91 | 3.83 | 4.37 | 0.75 |
| Q9. Establish the online information support | 4.03 | 3.68 | 4.36 | 3.89 | 4.20 | 0.74 |
| Q10. Design customized logistics service | 4.00 | 4.32 | 3.82 | 3.39 | 4.47 | 0.71 |
| Q11. Negotiable service pricing | 4.30 | 4.75 | 4.00 | 4.50 | 3.97 | 0.68 |
| Q12. Staff maintains good services | 3.61 | 4.25 | 3.23 | 2.78 | 4.20 | 0.83 |
| Q13. Good complaint handling | 3.89 | 4.36 | 3.73 | 3.78 | 3.70 | 0.80 |
| Q14. Warehouse allocation | 3.97 | 3.71 | 3.77 | 3.94 | 4.43 | 0.77 |
| Q15. VMI services | 3.91 | 3.79 | 3.14 | 4.33 | 4.37 | 0.83 |
| Q16. Provides equipment advertisement | 3.48 | 3.43 | 4.00 | 3.17 | 3.33 | 0.66 |
| Q17. Warehouse security | 4.03 | 4.18 | 4.27 | 3.78 | 3.90 | 0.69 |
| Q18. Data and information confidentiality | 4.11 | 3.82 | 4.45 | 4.28 | 3.87 | 0.67 |
| Q19. Real time merchandise tracking | 4.23 | 3.96 | 4.14 | 4.33 | 4.47 | 0.73 |
| Q20. Provide service crew's contact information | 4.27 | 4.43 | 4.00 | 4.50 | 4.17 | 0.62 |

higher costs. Thus, maintaining products in a good condition, providing tracking information, and offering negotiable pricing are important attributes for Cluster 1.

The majority of customers in Cluster 2 are OES parts manufacturers. Given the variety of OES parts, the 3PL's logistics services should comply with customers' standard operation procedure (SOP) to provide parts and components to the maintenance centers or repair shops. Data and information confidentiality is also important since the logistic services are authorized by the original automobile manufacturers.

The majority of customers in Cluster 3 are the OEM parts manufacturers. The demand quantities are determined by the production schedule of the central car makers. Therefore, delivery with flexible quantities provides great value for Cluster 3 customers. Since the domestic automobile manufacturers import large volumes of OEM key components from tier-1 companies, flexible pricing will also help to control costs.

Finally, the central car makers constitute the majority of companies in Cluster 4. For this industry cluster, delivery with flexible quantities is the essential attribute since new car demands varies between distributors and regions. The delivery quantities are determined by the dealers and are delivered JIT. Hence, the ability to design and offer customized logistic services for each automaker provides the greatest competitive advantage for the 3PL. Establishing a 3PL hub as a satellite station to serve customers is also a critical service offering.

4.3 Customer logistics outsourcing analysis

For the automobile industry's channel intermediaries, seven logistic activities are introduced, which include customer order management, inventory and warehouse management, product circulation processing, after-sales services, distribution and delivery services, real-time logistics information support, and return and recycling services. The outsourcing status quo of the surveyed 3PL customers (based on the seven-logistic activities) are shown in Table IV. Most customers manage their own logistics activities for distribution and delivery services. The numbers in italics indicate that customer order management, after-sales services, product logistics information, and return and recycling services define the largest proportion of the self managed logistic activities. Therefore, the case company should target these activities to extend its service offerings.

The outsourcing status of customers (channel intermediaries) is based on classifications of total outsourcing, partial outsourcing, and in-house self management

| Customer Cluster Outsourcing status (%) Logistics activity | Overall | | | C1 | | | C2 | | | C3 | | | C4 | | |
|------------------------------------------------------------------|---------------------------|-----------|-----------|-----------|----|----|----|----|----|----|----|----|----|----|----|
| | T | P | S | T | P | S | T | P | S | T | P | S | T | P | S |
| | Customer order management | 6 | 14 | <i>80</i> | 2 | 14 | 84 | 3 | 17 | 80 | 6 | 17 | 77 | 5 | 12 |
| Inventory and warehouse management | 19 | 41 | 40 | 13 | 47 | 40 | 19 | 45 | 36 | 21 | 44 | 35 | 17 | 40 | 43 |
| Product circulation processing | 22 | 37 | 41 | 5 | 8 | 87 | 16 | 26 | 58 | 20 | 39 | 41 | 19 | 37 | 44 |
| After-sales services | 4 | 8 | <i>88</i> | 1 | 3 | 96 | 2 | 6 | 92 | 6 | 9 | 85 | 5 | 8 | 87 |
| Distribution/delivery services | 43 | <i>47</i> | 10 | 21 | 27 | 52 | 19 | 28 | 53 | 35 | 45 | 20 | 49 | 46 | 5 |
| Product logistics Information | 5 | 17 | <i>78</i> | 3 | 4 | 93 | 4 | 9 | 87 | 2 | 6 | 92 | 7 | 24 | 69 |
| Return and recycling services | 3 | 11 | <i>86</i> | 2 | 3 | 95 | 3 | 5 | 92 | 7 | 8 | 85 | 6 | 12 | 82 |

Notes: T, total outsourcing; P, partial outsourcing; S, in-house self-management

Table IV.
Outsourcing logistics
services

as shown in Table IV. The 3PL can provide customized logistics services for each customer based on their preferred attributes and order requirements. In-house self-management activities dominate the four clusters in the series of logistic activities except for basic distribution and delivery services. The distribution and delivery services are most frequently outsourced to the 3PLs in practice. The characteristics of independence and simplicity for distribution and delivery services better enables 3PL customers to control logistic costs and focus on core competencies. Further, Cluster 4 delivers the largest outsourcing percentage for distribution and delivery services. Central car makers largely rely on 3PLs to provide final car distribution and delivery to dealers and eventually to end customers.

The logistics activities of customer order management, after-sales services, product logistics information support, and return and recycling services are largely managed in-house. Few companies outsource services to 3PLs when the services can impact customer relationships and brand images. Most of the returned goods and recycling services often follow companies' own business processes; nonetheless, these services are in the early stage of outsourcing to 3PLs. Inventory and warehouse management and product circulation processing have higher levels of outsourcing since these are labor-intensive logistics activities. If 3PLs can enhance their vendor managed inventory (VMI) and win the customers' confidence, human resource and warehouse costs can be reduced.

5. Conclusion

This research proposes the provision of customized logistics services derived from customer preferences. The study provides detailed observations about customers in four clusters and their preferences. According to the cluster results, the implementation of real-time logistic data and decision management (e.g. RFID tags and readers) will best facilitate real-time merchandise and service tracking, a quicker response to customers' requests and complaints, and provide service crew information and support. As a result, the 3PLs can support standardized services for specific customer cluster to enhance customer's satisfaction.

The satellite manufacturing partnership is regarded as the central manufacturer with warehouses and many satellite suppliers that implement JIT for reducing logistics and production time and cost. The ability to better understand and customize the needs of logistic services is greatly desired industry innovation. The automobile industry and other manufacturing industries as well, require these types of innovations to enhance productivity and reduce costs across the supply chain. In summary, even though most logistics activities between channel intermediaries are currently managed by manufacturers, these services can be outsourced to better enable manufacturers to focus on their core business operations. This paper provides the method to segment the 3PLs' potential customers in automobile industry (AM, OES, OEM suppliers and central car makers) while identifying and prioritizing their logistic service needs. Thus, 3PLs can improve their service offering, particularly for high-priority services, with the support of information systems that apply the advanced analytical tools described in this paper. As indicated in the survey reports of Lieb (2008) and Lieb and Butner (2007), the three challenges for 3PL providers are to find and keep managerial talent, invest in information technology, and reduce the cost of services. Confronted with these challenges, building long-term collaborative working relationships between 3PL

providers and their industrial customers via prioritized or customized services are critically important for the success of 3PL operations and the supply chains they serve. The objectives of future research will study the advancement of logistic services that match the diverse needs of segmented customers in industrial domains.

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