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Evaluation of Lead Logistics Provider Using the SMART Process: A Case Study in a Taiwan Automotive Industry

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ABSTRACT

Taiwan's automotive industry has undergone tremendous changes during the past decades as a result of joining the World Trade Organization (WTO) in 2002. This membership has affected the operating costs and the competitive advantage of automotive companies. The selection of an effective logistics service provider is a key strategy to reinforce competitiveness. This type of selection is a multi-attributes decision-making problem that includes both qualitative and quantitative attributes. This study presents a comprehensive methodology for evaluating a lead logistics provider (LLP). The evaluation of an LLP is the precondition and foundation of logistics operation; it is the important task of choosing the best logistics service provider for logistics management. The proposed methodology consists of 2 parts: (a) using a decision-making analysis framework to structure the objective hierarchy and to identify the evaluation attributes; and (b) applying the simple multi-attribute rating technique-rank order centric (SMART-ROC) method to drive the weights by ranking and rating. After they are identified, the evaluation attributes are used to construct a SMART model. This SMART model is subsequently applied for the final evaluation of a provider, as demonstrated in the case study presented here. The results of this case study indicate that quality is the most important criterion for the user and the provider companies because this factor influences the final evaluation process. The proposed method also enables decision makers to understand the complex relationships between relevant attributes, thereby improving the reliability of their decisions.

Keywords: *automotive industry, lead logistics provider, SMART process.*

1. INTRODUCTION

After Taiwan gained membership to the World Trade Organization (WTO) in 2002, Taiwanese automotive industries faced the effects of tariff reduction, open imports, and the cancellation of self-made rate and taxation preferences. This industry also encountered the threat of competition from the global markets. Moreover, net profits of the automobile industry are decreasing continuously, heralding a low-profit era. This condition has forced manufacturing industries to put more consideration to their core capability, thus outsourcing activities become an important and strategic decision (Surjandari et al., 2010). However, outsourcing can provide a number of long terms benefits: lower operating cost, improve competitiveness, reduce in capital investment, shift resources to focus on core functions, generate demand for new growth and market segment, access to world class capability, sharing risks and making capital funds available for core business investment (Chelliah et al., 2011). Often called "the third profit source," the logistics of automobile manufacturers must meet production goals and also adapt to market changes to save cost and enable quick response time.

Evaluating and selecting the right logistics service provider (LSP) involves much more than scanning a series of price list. The evaluation process considers a wide range of quantitative and qualitative factors. Various individual and integrated multi-criteria decision making (MCDM) approaches have been proposed for the LSP selection. Recent researchers who used the MCDM approach for LSP evaluation and selection are Jharkharia & Shankar (2007) who proposed methodology consisting of two parts: (i) preliminary screening of the available providers, and (ii) analytic network process (ANP)-based final selection. Ho et al. (2012) developed an integrated approach, combing quality function deployment (QFD), fuzzy set theory, and analytic hierarchy process (AHP) approach, to evaluate and select the optimal third-party logistics service providers (3PLs). Buyukozkan et al. (2008) proposed a MCDM approach to effectively evaluate e-logistics-based strategic alliance partners. For effective LSP evaluation and selection, Isiklar et al. (2007) proposed a hybrid intelligent decision support model integrating case-based reasoning, rule-based reasoning and compromise programming techniques in a fuzzy environment. Buyukozkan et al. (2009) proposed an analytical multiple criteria decision making approach to evaluate fourth party logistics (4PL) operating models.

Lead Logistics Provider (LLP) is a Logistics Company that has expertise in optimizing material movement in a supply chain, which is one of the Synchronized Material Flow (SMF) sub-processes to manage all in-bound & out-bound transportation of materials to ensure delivery of material. It's principle is more frequent and smaller delivery quantities within a specified window time. This means that these companies will lead the logistics operations across the entire supply chain with the ability to provide superior expertise in the transportation services, the warehousing capabilities, the information technology, the replenishment and supply of material among others logistics activities. The

role of the LLP is to coordinate the logistics operations of various parties throughout the automotive supply chain. The LLP solution is based on the proposed framework which consists of resource management, information nervous system and logistics synchronization components (Huang et al., 2010). In the logistics field, the general contractor is the LLP, and the subcontractors are the LSPs, carriers, forwarders, brokers, and other firms. Table-1 compares the main differences between LLP and LSP.

Table 1. The main differences between LLP and LSP

Item/Description	LSP	LLP
Scope of service	Logistics managed model including transportation, warehousing, inventory management and freight forwarding.	Full supply chain service including resource management, information nervous system and logistics synchronization.
Characteristics of service	Logistics specialty services focus on transportation and warehousing operation.	Manages internal and external logistics in synchronizing material flow.
Facility & warehouse	Possession of facility and warehouse.	Outsourcing
Fleet	Possession of fleet	Outsourcing
Information Technology service	Nil	Develop and provide IT service

Many companies use the service of lead logistics provider (LLP) to improve their efficiency and promote market competitiveness. The evaluation strategy for LLP is based on the Ford Production System (2005). By selecting the best LLP, a company can optimize the logistics operations process which includes implementation speed, service improvement, reduced inventory and logistics costs.

Based on the growing trend of logistics outsourcing, many providers are now offering various services. These services involve business-to-business relationships in which users are critical stakeholders and their customers are directly affected by the service quality of the provider (Andersson & Norrman, 2002). Therefore, a user must identify exactly what he or she needs from the provider. For logistics outsourcing, many researchers (Razzaqe & Sheng, 1998; Simchi et al., 2000; Lynch, 2000) have discussed the criteria for selecting a provider. However, selecting the best provider to suit the needs of the outsourcing company is not an easy task. The complexity of this task increases as the number of selection criteria increases (Meade & Sarkis, 1998).

Multi-attribute value analysis composes alternative values with respect to each attribute and the weights of the attributes. If the attributes are mutually preferentially independent, an additive value function can be used to aggregate the component values. The elicitation of attribute weights is a key component in developing an additive multi-attribute value model to select the best multi-attribute alternative. As reviewed by Stewart (1992) and Weber and Borcherding (1993), many techniques can be used to elicit attribute weights. Previous researchers applied the DIRECT point allocation approach to generate attribute weights to select the best alternative. In this study, the decision maker allocates numbers to describe the attribute weights directly. Intentionally, the decision does not provide any guidance on which number to use, so that decision makers can select the numbers randomly. The attribute ranges are described by the subjects. However, the decision analyst's information set does not consist of a ranking of relative importance of the attribute ranges. Edwards (1977) originally described the simple multi-attribute rating technique (SMART) as the whole process of rating alternatives and weighting attributes. To overcome these shortcomings of DIRECT (direct point allocation), SMART was developed to handle the complexities of the decision environment. SMART ranks the importance of attribute changes from the worst attribute levels to the best levels, and makes ratio estimates on the importance of each attribute. However, in recent years, SMART has been increasingly used in multi-attribute decision-making problems. The attributes used in evaluating a provider are both subjective and objective. Because these attribute definitions are vague and complex, the precise and consistent weights given for the evaluation of a logistics service provider cannot be captured using the DIRECT method. Therefore, this study proposes a SMART-based model for the evaluation of a provider.

This study proposes a methodology for selecting the best LLP. The implementation of this LLP process offers various benefits: logistics operation manpower flexibility, logistics operation synergy, simplicity regarding speed, agility, and flexibility, and best logistics service quality. This study proposes an evaluation model for LLP selection using SMART methodology and presents a case study to demonstrate the proposed model for the automotive industry LLP selection.

The organization of this paper is as follows. Section 2 provides an explanation of the research methodology of the evaluation model using SMART for LLP selection. Section 3 provides an example to illustrate the proposed model. Finally, Section 4 presents the conclusion and suggests directions for future works.

2. THE SMART DECISION MODEL

Edwards (1977) was the first to propose the concept of ranking and rating multi-attribute value analysis for the best alternative selection. This approach serves as the whole process of rating alternatives and weighting attributes, where complex multi-attribute value analysis is a special case. The ranking and rating approach, which became popularly known as SMART, has become an attractive tool for understanding decision problems because it overcomes the limitations of the DIRECT method. Such systems can be represented by a systematic process with guidance for multi-attribute value analysis to drive an overall value for each alternative.

Edwards (1977) originally described SMART as the process of rating alternatives and weighting attributes. SMART elicits the weights in two steps (Edwards, 1977):

1. Rank the importance of attribute changes from the worst attributes levels to the best levels.
2. Make ratio estimates of the importance of each attribute relative to the one ranked lowest in importance.

   In Step 2, the ratio estimates of the relative importance of each attribute given by the decision maker are usually normalized to obtain the weights. Edwards and Barron (1994) listed the shortcomings of this procedure,

stressing the importance of attribute ranges. Edwards and Barron (1994) presented a new version, SMARTER (SMART Extended Ranking), which uses the ranking of attributes to derive the weights. This approach uses the rank-order centric weights method (SMART-ROC). In this case, if the attributes' entire ranking is R_1, R_2, R_3,…, R_n, then the weight of the attributes is W_1, W_2, W_3,…, W_n, where $1>W_1>W_2>W_3….W_n$.

The weight of the i^{th} attribute can be formulated as:

$$W_i = \frac{1}{n}\sum_{k=i}^{n}\frac{1}{k}\ , i = 1, 2, 3, …., n \qquad (1)$$

where n is the number of attributes.

Take the case of three (3) attributes as an example to calculate the weight of attribute by equation (1). Using Excel, the weight of attributes (w_1, w_2, w_3) = (0.6111, 0.2778, 0.1111) are derived as follows:

$$W_1 = \frac{1}{3}\sum_{k=1}^{3}\frac{1}{k} = \frac{1}{3}(\frac{1}{1}+\frac{1}{2}+\frac{1}{3}) = \frac{11}{18} = 0.6111$$

$$W_2 = \frac{1}{3}\sum_{k=2}^{3}\frac{1}{k} = \frac{1}{3}(\frac{1}{2}+\frac{1}{3}) = \frac{5}{18} = 0.2778$$

$$W_3 = \frac{1}{3}\sum_{k=3}^{3}\frac{1}{k} = \frac{1}{3}(\frac{1}{3}) = \frac{1}{9} = 0.1111$$

The SMART decision model is a commonly used simple multi-attribute decision method that includes both quantitative and qualitative attributes, and ranks the attribute in order of importance and weighted rate. Based on the SMART decision model (Edwards & Barron, 1994), this study proposes a decision model for LLP evaluation that includes five phases: (1) understand and define the decision problem, (2) structure the objective hierarchy and influence relation, (3) sense and describe anticipating outcomes, (4) perform overall judgments and value assessments, and (5) identify tradeoffs and select the best alternative (Fig. 1).

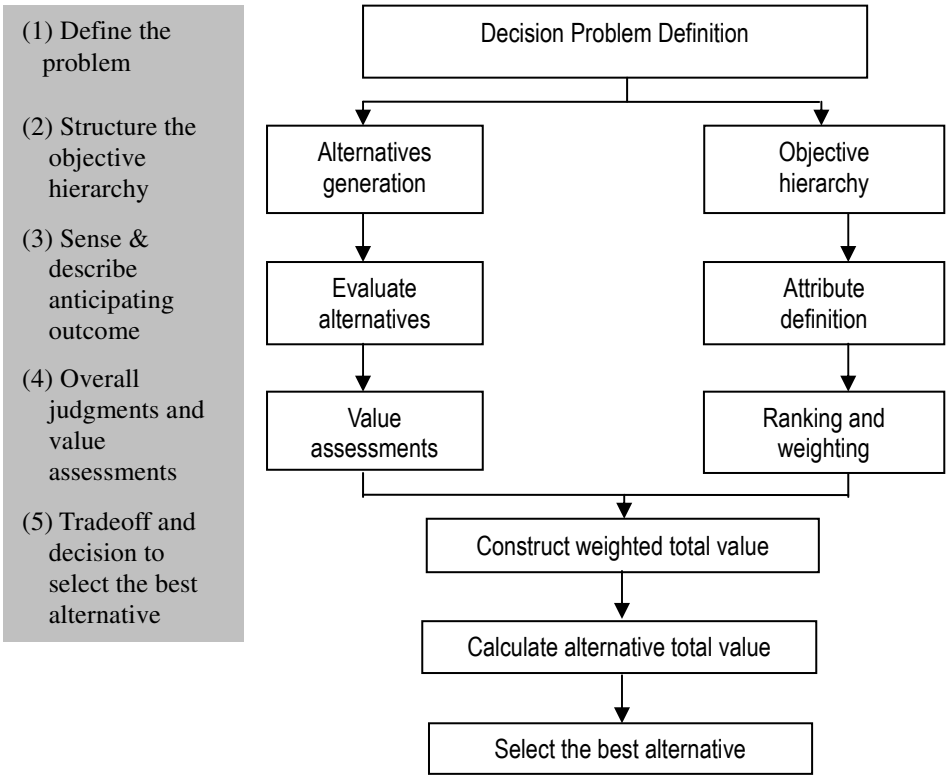

Figure 1. The SMART decision model for LLP evaluation framework

2.1 Define the problem

The proposed decision model starts with problem definition. To understand and define a problem, a decision maker must ask a number of questions. This may involve making a checking list that enumerates the decision elements, including customers, competitors, industry, available resource, executing cost, decision makers, decision stakeholders, objectives, evaluation attributes, alternatives, and expected outcomes. Regarding the decision context of the logistics provider industry, the full supply chain services, including resource management, logistics management, information central system, and logistics synchronization and cost position, are crucial for maintaining a competitive advantage.

2.2 Structure the objective hierarchy

The objectives should be structured to generate alternatives through value-focused thinking that clarifies the relationships between uncertain events. To restructure the objectives by moving downwards in the hierarchy or away from the fundamental objectives, one may ask, "What do you mean by that?" or "How could you achieve this?". However, when moving upward in the hierarchy towards fundamental objectives, a decision maker should ask, "What is the general objective?" or "Why is that important?" (Clemen, 1996). In addition, the problem should be stated clearly. The hierarchical structure includes main objectives, sub-objectives, attributes, and alternatives related to the problems that should be selected through brainstorming or other methods. The objective hierarchy structure should then be constructed with the appropriate assessment attributes based on the structural relationship in the SMART model.

2.3 Sense & describe anticipating outcomes

This step describes and assesses the evaluation attributes, the expected outcomes of alternative strategies, and the possible states of uncertain events. The attribute is an indicator to assess each objective. The set of objectives should be complete, measurable, decomposable, non-redundant, and minimal to ensure the validity of the objective construction (Keeney & Raiffa, 1993).

2.4 Perform overall judgments and value measurements

Evaluation is a key process in decision-making, and is a subjective judgment that depends on the decision maker's preferences. Thus, the SMART-ROC method (Edwards & Barron, 1994) should be used to derive the weights using the ranking of attributes from the worst attributes levels to the best levels. The relative weights can be generated by Eq. (1), as Table 2 shows.

Table 2. SMART-ROC weights lists

	Attribute numbers *(n)*										
Rank *(i)*	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	0.7500	0.6111	0.5208	0.4567	0.4083	0.3704	0.3397	0.3143	0.2929	0.2745	0.2517
2	0.2500	0.2778	0.2708	0.2567	0.2417	0.2276	0.2147	0.2032	0.1929	0.1836	0.1753
3		0.1111	0.1458	0.1567	0.1583	0.1561	0.1522	0.1477	0.1429	0.1382	0.1336
4			0.0625	0.0900	0.1028	0.1085	0.1106	0.1106	0.1096	0.1079	0.1058
5				0.0400	0.0611	0.0728	0.0793	0.0828	0.0846	0.0851	0.0850
6					0.0278	0.042	0.0543	0.0606	0.0646	0.0670	0.0683
7						0.0204	0.0335	0.0421	0.0479	0.0518	0.0544
8							0.0156	0.0262	0.0336	0.0388	0.0425
9								0.0123	0.0211	0.0275	0.0321
10									0.0100	0.0174	0.0229
11										0.0083	0.0145
12											0.0069

2.5 Tradeoff and decision

This phase evaluates alternatives when transforming from qualitative descriptions to quantitative value measurement. The SMART-ROC method (Edwards & Barron, 1994) is used to calculate the alternative total value. As Table 3 shows, the X-axis represents alternatives S_1, S_2 and S_3, while the Y-axis represents attributes A_1, A_2 and A_3. The relative weights of each attribute are w_1, w_2, and w_3, and the objective evaluation value of alternative S_1 under attributes A_1, A_2, and A_3 is x_{11}, x_{21}, and x_{31}, respectively. This leads to the subjective values $V1$ (x_{11}), $V2$ (x_{21}), and $V3$ (x_{31}) through value function transformation, and ultimately selects the best alternative by the weighted total value.

Table 3. Multi-attribute weighted value list for alternatives

Value		Alternative-S_1	Alternative-S_2	Alternative-S_3
Attribute-A_1	Weight-w_1	$V1$ (x_{11})	$V1$ (x_{12})	$V1$ (x_{13})
Attribute-A_2	Weight-w_2	$V2$ (x_{21})	$V2$ (x_{22})	$V2$ (x_{23})
Attribute-A_3	Weight-w_3	$V3$ (x_{31})	$V3$ (x_{32})	$V3$ (x_{33})
Weighted value		V (S_1)	V (S_2)	V (S_3)

3. SMART MODEL OF EVALUATION OF LEAD LOGISTICS PROVIDER

This section shows how the proposed model is illustrated in a case study. This case study shows the stages of LLP evaluation for a Taiwanese automotive company. FT Company is one of the four largest automobile manufacturing enterprises in Taiwan. FT Company has established an integrated supply chain management (SCM) system that includes various components: (a) Upstream: in total, 110 qualified suppliers including five qualified LLPS; (b) Interior: five manufacturing plants-body shop, paint shop, engine plant and two final assembly plants; and (c) Downstream: thirty dealers with service firms. The products of FT Company include large passenger cars, medium passenger cars, small passenger cars, commercial cars, and sport utility vehicles.

Facing challenging market competition, FT Company must reduce the total cost of its whole supply chain. Thus, a team of purchasing task force was organized for LLP selection and evaluation to help FT Company select the best logistics provider with the highest quality and lowest cost. In this case example, FT Company formed a committee with four decision makers (DM 1, DM 2, DM 3, and DM 4) to evaluate four LLPs (LLP-A, -B, -C, and -D). All of these

LLPs have provided logistics services to FT Company.

The following paragraphs explain the implementation of the proposed model in FT Company based on the SMART-ROC method for the LLP selection model.

3.1 Problem definition

This study starts with the problem definition, including the decision elements and decision objectives. After Taiwan entered the WTO in 2002, Taiwanese automotive industries encountered the threat of the global competitive environment. Moreover, the net profits of the automobile industry are decreasing continuously, suggesting that a low-profit era is coming. Therefore, outsourcing logistics through an LLP is one way to reduce supply chain costs and improve service leadership. The goal of this study is to evaluate and select the best LLP. The main factors of LLP selection in the automotive industry are cost, quality, compatibility, and finance performance (CQCF).

3.2 Structure objective hierarchy

This study establishes the LLP evaluation attributes and objective hierarchy. This is typically decided by the logistics and purchasing management of an organization with the help of an expert in brainstorming methods. To clarify which evaluative attributes affect the decision objective the most, this study proposes an objective hierarchy of the SMART-based model for LLP evaluation as shown in Fig. 2. The four alternatives LLP are then identified by purchasing decision-making team based on the LLP information files of the FT Company. These attributes are defined as follows:

1. *Pricing*
   There is high percentage of material cost in automotive industry, and the logistics cost is a key cost in this category. Thus, the logistics outsourcing is a key consideration in LLP evaluation.
2. *Total Value Management (TVM)*
   The logistics cost reduction is a key objective in the value analysis/value engineering (VA/VE) approach.
3. *Delivery performance*
   Two dimensions of delivery performance (DP), namely “speed” and “reliability,” are important to ensure user satisfaction. An LLP provides logistics services based on the “Supplier Release,” shipping the best-quality parts at the right time and in the right quantity to the specified area.
4. *Order fulfillment*
   Order fulfillment can be defined as activities that occur from the moment a purchaser/customer places an order until that order has been delivered in full. How well the order fulfillment process functions is a critical determinant of how well a provider satisfies, and therefore retains, its customers. Thus, the order fulfillment process plays a crucial role in SCM, and many consider it to be the most important business process.
5. *Quick response*
   A just-in-time inventory partnership is a strategy between suppliers and retailers. The main goal of this approach is to reduce order response time and achieve greater accuracy in shipping the correct goods in correct quantities. This method also emphasizes promptness in attending customers’ complaints by employing computerized equipment such as barcodes and EDI to accelerate the flow of information.
6. *Flexibility*
   Flexibility in logistics operations and delivery may enable the user to provide a customized service to its customers. This is particularly suitable for special or non-routine requests. Flexibility in billing and payment conditions also increases goodwill between the user and provider.
7. *Surge capacity of the provider*
   This factor becomes important if there is a sudden rise in the logistics needs of the user (because of an increase in demand for the product).
8. *Continuous improvement*
   The continuous improvement process is the ongoing effort of engaged employees and improvement teams to improve information, materials, products, services, or processes. These efforts generally seek small "incremental" improvements over time or larger, rapid "breakthrough" improvements. These efforts improve customer value and reduce non-value by adding activity and reducing costs, increasing delivery velocity.
9. *Information Technology (IT) capability*
   The advanced IT capabilities of the logistics provider can help reduce uncertainty and inventory levels. In some cases, LLPs may allow users to take advantage of their advanced IT capabilities. In these cases, the user companies need not invest in advanced IT capabilities merely to track goods and raw materials.
10. *Business process*
    A business process is an activity or set of activities that accomplish a specific organizational goal. Business process management (BPM) is a systematic approach to improving these processes. The BPM approach is a collection of activities designed to produce a specific output for a particular customer or market. This places a strong emphasis on *how* the work is done within an organization, in contrast to a product's focus on *what* is done. Thus, a process is a specific ordering of work activities across time and place, with a beginning, an end, and clearly defined inputs and outputs; a structure for action.
11. *Supply chain management*
    SCM is the oversight of materials, information, and finances as they move from supplier to manufacturer to wholesaler to retailer to consumer. SCM involves coordinating and integrating these flows both within and among companies. The ultimate goal of any effective SCM system is to reduce inventory.
12. *Cultural fit*
    Cultural fit represents congruence with an organization’s culture. Culture, the environment a company creates for its employees in the workplace, consists of the values, beliefs, underlying assumptions, attitudes, and behaviors shared by a group of people. Culture is the behavior that results when a group of people arrives at a set of (generally unspoken and unwritten) rules for working together.

13. *Market share*
    Market share represents the percentage of an industry or market's total sales that is earned by a particular company over a specified period. Market share can be calculated by taking the company's sales over the period and dividing it by the total sales of the industry over the same period. This metric provides a general idea of the size of a company relative to its market and its competitors. The market share of provider reflects its financial performance, customer satisfaction, and reputation.
14. *Geographical spread (GS) and range of service (RS) provided*
    A wide geographic spread and range of services offered by the provider are desirable because these create enhanced access to market and provide more avenues to the user. A large GS and RS offered by the provider may also enable the user to save money on distributing and marketing the product.

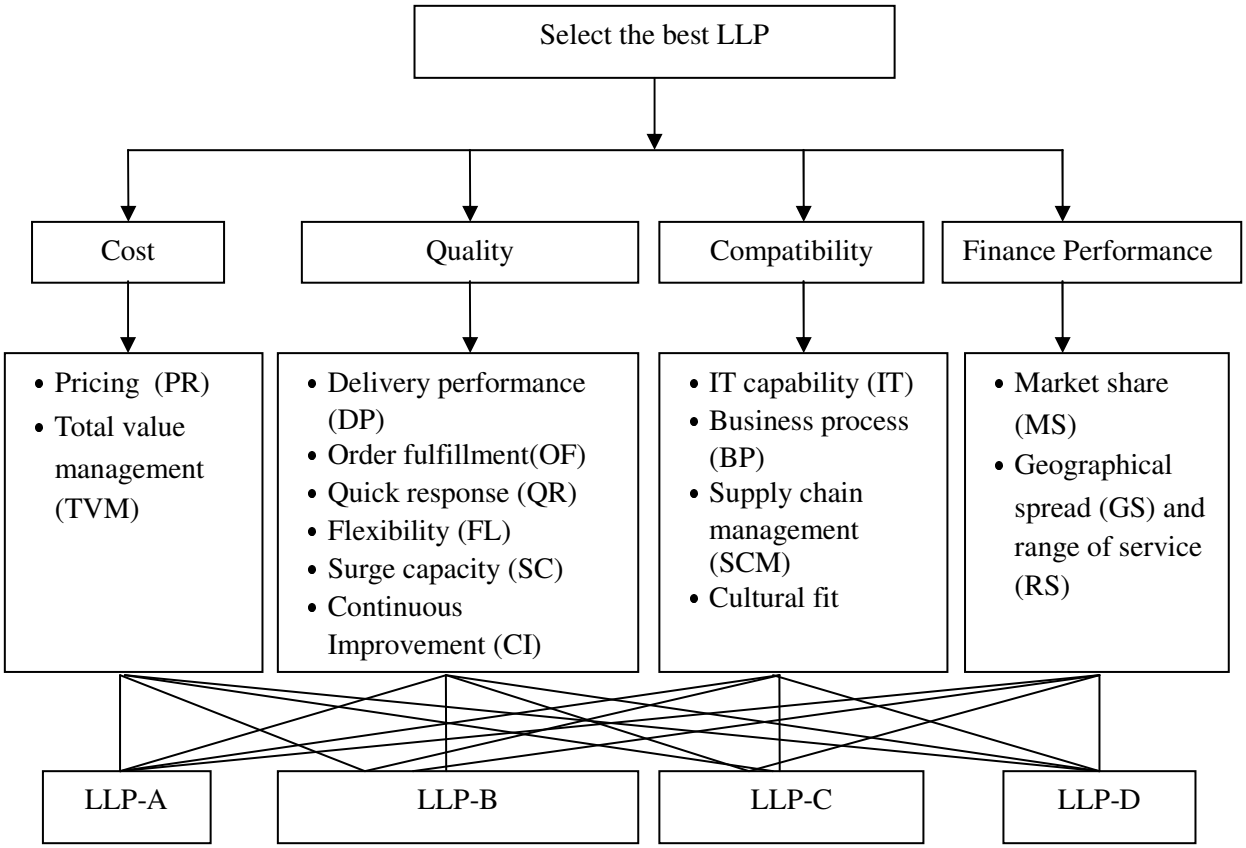

Figure. 2. Objective hierarchy structure for LLP selection

3.3 Evaluation attributes for LLP selection.

This study sorts the evaluative attributes by the decision-making team based on an objective hierarchy structure and the evaluation attributes for LLP selection in Step 2. Table 4 presents a summary of the key evaluation attributes for LLP selection.

3.4 Overall judgments and value assessments

This step adopts the evaluation attributes to evaluate alternatives. Based on the selected twelve attributes in Table 4 lists the evaluation attributes for LLP selection. This study applies the SMART-ROC method (Edwards & Barron, 1994) to derive the weights using the ranking of attributes from the worst attribute levels to the best levels. Table 5 shows the attribute rankings and comparative weights.

Table 4. Evaluation attributes for LLP selection

Objective	Attributes	Metric	Definitions & descriptions
Cost	Pricing (PR)	Unit cost: Max. NT$ 10,800	• Logistics outsourcing cost.
Quality	Delivery Performance (DP)	DP rate: 100% (10) 95% (5)	• On-time delivery with the right quantity and best quality to the specified area.
	Order Fulfillment (OF)	OF rate: 100% (10) 95% (5)	• Accuracy of order fulfillment.
	Quick Response (QR)	QR<7 days (10) QR<14 days (5)	• Promptness in attending customers' complaints. • Quick response on IT problems.
	Flexibility (FL)	100% flexibility (10) 95% flexibility (5)	• Flexibility of logistics operations. • Flexibility of delivery.
	Surge capacity of provider (SC)	100% support (10) 95% support (5)	• Sudden rise in the logistics needs of the user.
	Continuous Improvement (CI)	CI cases >10 (10) CI cases >5 (5)	• Commitment to continuous improvement on logistics operation performance.
Compatibility	IT and technology capability (IT)	IT system support (5) Logistics tech. (5)	• The advanced IT system of provider helps in reducing uncertainties and inventory level. • User directly use IT system for the sake of tracking of goods and materials. • Support system capability • Logistics management skill • Risk management capability to address any unforeseen problem.
	Business Process (BP)	BP provide 100%(10) BP provide 90% (5)	• Provided perfect business process and conform to user.
	Supply Chain Management (SCM)	Sup train-10times(5) Sup f/up-best (5)	• Supplier training. • Supplier follow-up. • Transportation management.
Financial Performance	Market Share (MS)	Customer satisfaction Rate: 90% (10) Customer satisfaction Rate: 80% (5)	• Market share of provider reflects its financial performance, customer satisfaction and reputation.
	Geographical Spread (GS) and Range of Service provided (RS)	Large GS and RS Provided: Best: (10) Good: (5)	• Wide geographic spread and range of services provided enhanced access to market and many more avenues to the user. • Large GS and RS offered by the provider may also enable the user to save some money on distribution and marketing of the product.

Table 5. The attribute ranking and comparative weights

Rank	Attributes	Comparative weights
1	Delivery Performance (DP)	0.2517
2	Pricing (PR)	0.1753
3	IT and technology capability (IT)	0.1336
4	Supply Chain Management (SCM)	0.1058
5	Order Fulfillment (OF)	0.0850
6	Flexibility (FL)	0.0683
7	Quick Response (QR)	0.0544
8	Surge Capacity (SC)	0.0425
9	Continuous Improvement (CI)	0.0321
10	Business Process (BP)	0.0229
11	Market Share (MS)	0.0145
12	Geographical Spread (GS) and Range of Service (RS) provided	0.0069

3.5 Tradeoff and decision

In this section, we show how the proposed model is applied in a case study. There are four alternative LLPs A, B, C and D to be evaluated, the background and service characteristics of these four LLPs are described as Table 6.

Table 6. LLP background and service characteristics

LLP	Description of LLP background and service characteristics
LLP-A	• N logistics company established in 1885. The company offers thorough supply-chain management services that include warehouse storage; processing, such as inspection, sorting, labeling, and repackaging; delivery to designated recipients; milk-runs; VMI (vender managed inventory); and IT-based inventory management. N logistics company operates 332 logistics centers in 36 countries and is capable of providing a variety of transport services by sea, land, and air between a large number of locations around

LLP	Description of LLP background and service characteristics
	the around the world, including numerous in Europe, North America, Asia, and China. The core competency includes shipping company, container transport, logistics & car transportation. The business presence for automotive related in regions about 9 business units.
LLP-B	• D logistics company established in 1969 is part of the world's leading postal and logistics group, The company's approach to lead logistics provider partnerships involves the management, optimization and execution of inbound and outbound logistics - including the implementation of origin-based networks for the entire supply chain solution. The core competency includes air ocean freight forwarding. The business presence for automotive related in regions about 10 business units.
LLP-C	• MT logistics company established in 1998 is the oversea branch of the Logistic Department of Japan Mitsubishi. The company has good experience of lead logistic management in Japan and made information technology cooperation with "LOGICOM Company". The company offers through LLP approach services that include logistics center operations; milk-run distribution; warehousing/trucking; packing; international transport and IT support. MT company has operated lead logistics services over its 30 global locations. The business presence for automotive related in regions about 19 business units.
LLP-D	• E logistics company established in 1992 is the leading contract logistics provider in the America with experienced robust customer growth and expanded operations to include Canada and Latin America. The company offers supply chain solution to include transportation management, freight consolidation, contract packaging, contract manufacturing, demand planning, and other supply chain services. The core competency includes contract logistics provider and supply chain management. The business presence for automotive related in regions about 4 business units.

This study evaluates alternatives from qualitative descriptions transforming to quantitative value measurement by direct scoring based on decision-maker preferences, yielding an appropriate quantitative value. The decision-making task force team includes purchasing and logistics managers who use brainstorming and discussions to score each attributes and alternatives within a scoring range of [0, 10]. Take item-1 as example, the attribute of "DP" is scored by task force team using direct scoring with range of [0, 10].

Based on their preferences through brain storming, consensus to obtain the scores of "DP" attribute (LLP-A, LLP-B, LLP-C, LLP-D) = (6, 8, 10, 6) is made. Table 7 shows the value measurement for LLP selection. Finally, the total weighted value of LLP selection alternatives is obtained by multiplying the value of each alternative by the attribute's weights, as shown in Table 8. Based on the evaluation result listed in Table 8, the total weighted value of LLPs A, B, C, and D are 8.0134, 8.2681, 8.6006, and 7.6398, respectively; one can see that LLP-C is the best logistics provider because it has the highest total weighted value of 8.6006, and should therefore be selected.

Table 7. The value measurement for LLP selection

Item	Attributes	Rank	Weights	LLP-A	LLP-B	LLP-C	LLP-D
1	Delivery Performance (DP)	1	0.2517	6	8	10	6
2	Pricing (PR)	2	0.1753	9	8	8	9
3	IT and technology capability (IT)	3	0.1336	10	9	9	8
4	Supply Chain Management (SCM)	4	0.1058	7	8	6	8
5	Order Fulfillment (OF)	5	0.0850	8	10	9	9
6	Flexibility (FL)	6	0.0683	9	6	7	8
7	Quick Response (QR)	7	0.0544	10	10	9	8
8	Surge Capacity (SC)	8	0.0425	10	10	9	8
9	Continuous Improvement (CI)	9	0.0321	6	8	10	7
10	Business Process (BP)	10	0.0229	10	7	10	8
11	Market Share (MS)	11	0.0145	7	8	9	6
12	Geographical Spread (GS) and Range of Service (RS) provided	12	0.0069	9	6	7	8

Table 8. Total weighted value of LLP selection

Item	Attribute	LLP-A	LLP-B	LLP-C	LLP-D
1	Delivery Performance (DP)	1.5102	2.0136	2.5170	1.5102
2	Pricing (PR)	1.5777	1.4024	1.4024	1.5777
3	IT and technology capability (IT)	1.3360	1.2024	1.2024	1.0688
4	Supply Chain Management (SCM)	0.7406	0.8464	0.6348	0.8464
5	Order Fulfillment (OF)	0.6800	0.8500	0.7650	0.7650
6	Flexibility (FL)	0.6147	0.4098	0.4781	0.5464
7	Quick Response (QR)	0.5440	0.5440	0.4896	0.4352
8	Surge Capacity (SC)	0.4250	0.4250	0.3825	0.3400
9	Continuous Improvement (CI)	0.1926	0.2568	0.3210	0.2247
10	Business Process (BP)	0.2290	0.1603	0.2290	0.1832
11	Market Share (MS)	0.1015	0.1160	0.1305	0.0870
12	Geographical Spread (GS) and Range of Service (RS) provided	0.0621	0.0414	0.0483	0.0552
	Total weighted value	8.0134	8.2681	8.6006	7.6398

4. CONCLUSION

In recent years, many practitioners and researchers have presented studies on the importance of logistics service provider selection. The SMART decision model for LLP selection proposed in this study has received considerable attention. In the proposed model, four major criteria (i.e., CQCF) have been introduced to evaluate the performances of the four LLPs for an automotive components logistics service firm. To depict the SMART decision model more systematically, the first stage uses the decision-making analysis framework to structure the objective hierarchy and identify evaluation attributes and alternatives. Table 4 shows the 12 evaluation attributes are identified. The second stage applies the SMART-ROC method to derive the weights using the attribute ranking from the worst attributes levels to the best levels. Table 8 shows that the respective total weighted value of LLPs A, B, C, and D to be 8.0134, 8.2681, 8.6006, and 7.6398; the greater weighted value of LLP-C denotes the best LLP performance. Therefore, LLP-C should be the best LLP.

The major contribution of this paper is in the development of a fast and systematic process for LLP selection strategy using an automotive industry as a case example. The SMART model not only leads to a logical result, but also enables decision makers to visualize the effects of various criteria on the final result. At a time when outsourcing of logistics activities has become a global trend, this paper provides an insight into the various aspects of logistics outsourcing. The proposed methodology serves as a guideline to the logistics managers in outsourcing related decisions. The SMART approach is capable of taking into consideration both qualitative and quantitative criteria. The findings of this study offer valuable insights and methodology for other industries wishing to apply the SMART decision process to logistics service provider selection. However, one limitation in applying the proposed methodology is the complexity in implementing the procedure. Further study is needed to develop a user-friendly software with a graphical user interface.

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