A Three-dimensional Model on Performance Evaluation and Rating of Supplier Logistics in Automotive Manufacturing Industry

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Abstract. In order to comprehensively measure the logistics capability of suppliers from the perspective of logistics, we take the field of automotive parts manufacturing as an example, study how to objectively evaluate suppliers, and therefore to determine the strategies for different suppliers, and select long-term cooperative partners, which is strategic significance for the supply chain management of enterprises [1]. This paper proposes a three-dimensional evaluation model involved with three aspects of supplier evaluation: supplier’s internal logistics management ability, supplier’s logistics external output ability and logistics cost management ability. Through establishing an evaluation dimension according to each aspect, combined with the evaluation principles, the weight factors of parts, performance evaluation and rating of supplier logistics can be obtained according to the problems faced with the actual situation.

Key words. Performance evaluation, Logistics, Three-dimensional model, Automotive manufacturing.

1. Introduction
Logistics performance evaluation is an element to measure the overall performance of the whole logistics supply chain process. With the evaluation results, we can tell clearly whether the performance of each process enhances or deteriorates, and whether the actions are in line with the logistics operation standard by formal structured system and methods according to certain standards [1]. One of the principles of selecting logistics performance evaluation indicators is to be consistent with the strategic objectives of the supply chain, supporting the logistics strategy and benefiting the logistics performance objectives. At the same time, it needs to focus on the performance in combination with the actual logistics operation of the enterprise. The construction of logistics performance index system includes the overall performance evaluation of the whole logistics system, and also the performance evaluation on each single logistics activities in the whole operation process as well.

It is well known that the supplier performance evaluation should be based on collecting the related data and doing analysis for these data. Thereafter we can make judgement whether the supplier’s logistic system running status is going well or not. Making use of supplier’s strategy logistic service evaluation, we can identify which field of our current supplier needs to improve. As the supplier’s performance can be measured differently from industry to industry, with respect to cycle time reductions, possibility of process efficiency improvements [2], logistic cost reduction, quality and service improvement. In view of the character of rapid demand change with market, we propose a three-dimensional model involved with three aspects from automotive manufacturing practice.
2. Supplier’s Internal Logistics Management Ability

In order to evaluate the suppliers’ internal logistics management capability and the operation mode, it is necessary to understand the suppliers’ actual operation mode. Then we can evaluate the supplier logistics system more objectively. The supplier evaluation process can be informal or highly structured or formalized; it depends on the nature of the acquisition. Generally, the following factors are considered to evaluate comprehensively.

- Whether there is professional worker to do management or not; whether the workers who are in specific logistics posts are qualified or not; whether the logistics job is equipped with enough workers or not to support the workload;
- Whether the resources equipped in the work process is enough or not in logistics work process, including logistic storage, work site, special packaging area and equipment, etc;
- Whether the materials which supported in the logistics work process are enough or not, such as the materials used for turnover and package. And whether the materials are managed and protect effectively or not;
- Whether the logistics work operation method is safe and effective or not; whether the whole logistics management system can operate or not according to the specified operation method; And how to make and confirm the KPI for logistics work; How to avoid the common error of logistics work and whether the continuous improvement has been carried out or not;
- Whether the environmental factors in the logistics work have been considered or not; whether the storage conditions for special products have been met or not; whether the delivery conditions which are required by customer, or promised to customers, have been met and implemented or not.

Evaluation procedure: Base on the above factors, the first step is founding a team to evaluate; The second step is making a list of problems which found in the actual operation process; The third step is evaluating the annual logistics management ability of suppliers by professional personnel. The last step is forming a written audit report, and rating suppliers.

The significance of the evaluation of supplier logistics capability is to determine whether the supplier has the professional logistics management ability, whether there is sufficient resource allocation, and whether the logistics system has a room of improvement. All of these are based on fact data transformed and weighted through objective assignment.

3. Supplier’s Logistics External Output Ability

The evaluation of supplier's logistics external output capability is mainly for the customer's logistics delivery performance evaluation, including service quantity and service quality. This part includes the current customer number of suppliers, delivery coverage, circulation rate per unit time. In the meantime, the external output ability evaluation also considers the logistics delivery quality, delivery in time, order delivery lead time, and rapid response speed, etc [3]. The main factors of the evaluation are shown in figure 1.

3.1. The Number of Services Factors as Followed

Delivery quantity refers to the circulation quantity and coverage quantity to customer shipment; Delivery rate refers to the flow distance of product delivery within a unit time; Productivity refers to the circulation volume per unit time.

3.2. Service Quality Includes Following Factors

Inventory availability and supplement rate; Delivery reliability, accuracy and punctuality; Requirements for order cycle time and minimum order quantity; Flexibility factor, especially service evaluation such as quick response.
Figure 1. Supply Chain logistic capability evaluation system.

The following table 1 presents the evaluation items should be included in evaluation of quantity and quality [4].

Table 1. Logistic capability evaluation item and measurement method.

| Evaluation Item       | Evaluation standard                                                                 |
|-----------------------|--------------------------------------------------------------------------------------|
| Circulation quantity  | Number of processing logistics products in unit time provided by supplier chain system. |
| Production Rate       | Order quantity provided or circulation quantity in unit time.                         |
| Order cycle time      | Time from order releasing till parts arrival, including order transmitting, order processing, product producing, parts delivery and transferring to customer time. |
| Product availability  | Have storage for delivery, can cover customer demand. KPI would be shortage rate, Supply ratio, order fulfillment rate. |
| Delivery reliability  | The percentage of order quantity available and total order quantity required within the specified time. |
| Delivery flexibility  | The percentage of the number of processed urgent and special orders to the number of urgent and special orders requested by the customer. |
| Service performance   | The probability of logistics system meeting customers' needs. The probability of shortage and the probability of no out of stock. |
| Logistic cost         | Cost for logistic, such as storage cost, delivery cost and manpower cost.              |
The evaluation method is based on classifying the current multi factors of supplier logistics management, and sorting out the subordination among different factors according to the hierarchical method [5]. For each factor it is evaluated whether the output performance of suppliers meets the expectation, by transforming the subjective evaluation of suppliers into data in the form of objective assignment and weighting the data [6]. Firstly, we should build the evaluation team from multiple departments’ staff in the industry. Secondly, we evaluate the delivery and supplier logistics management service. The specific factors at each level are collected or evaluated objectively for the main factors, from the upper-level factors to the secondary factors. Finally, the weighted calculation is carried out to get the value of the external output capacity of supplier logistics, to complete the supply business rating [7].

The evaluation significance of the supplier logistics external output capability is to evaluate whether the current supplier logistics management performance can meet the organization's expectations or not from the perspective of outcome oriented, and we divide suppliers into three levels: A, B and C. The logistics operation mode of A-level suppliers is excellent, which is worth promoting. The logistics of B-level suppliers can operate normally, but there is room for improvement; The performance of C-level suppliers is poor, which must be rectified within a time limit, otherwise it will bring corresponding risks [8].

4. Supplier’s Logistics Cost Control Ability

The supplier logistics cost control ability is mainly to ensure the healthy development of all supplier logistics system evaluation indexes from the perspective of cost.

The transportation cost, logistics management cost, storage cost, including fixed storage cost and variable storage cost, distribution, packaging and circulation costs, interest cost, extra logistics delivery costs, are as shown in figure 2.

![Logistic Cost Model Sample](image)

Figure 2. The automotive industry company’s cost structure sample.

The evaluation method is to comprehensively evaluate the supplier’s system for similar products and formulate standards. Generally, we need classify the supplier’s logistics cost factors and analyse the supplier’s logistics cost structure, to define whether the supplier’s logistics cost is reasonable or not, to objectively evaluate the supplier logistics cost.

The significance of supplier’s logistics cost evaluation is to evaluate whether the supplier logistics cost is reasonable or not, and whether there is room for optimization and upgrading or not, rather than
keep a subjective view on the supplier logistics cost. Through horizontal comparison, we can also understand the advantages and disadvantages of current supplier. For the suppliers with advantages, it can play a benchmarking role, we can encourage them, and also can learn from their experiences; For the suppliers with weak cost control capability, it can guide them, optimize the logistics cost structure, and improve the market competitiveness of suppliers, and form a win-win cooperation relationship with suppliers in the end.

5. Establishment of 3D Model
A spatial three-dimensional model is established from the three dimensions of logistics internal management ability, logistics external output ability and logistics cost control ability. The supplier evaluation results data of each dimension are put into the model, and to comprehensively evaluate the objective and actual performance of suppliers. The three-dimensional model is shown in figure 3 [10].

![Figure 3. The three-dimensional model of logistic capability evaluation.](image)

For the supplier’s distribution in each region in the above model, the ideal result is to make suppliers in region VII. But in the actual work, some industry benchmark enterprises are more likely to be in Area III, so they need to reduce the cost further; While some private enterprises will be in area I, that is, the internal management is not in place, resulting in poor output capacity indicators, and the logistics cost control capability is not strong enough as big companies. These companies will be the focus of the follow-up work. By systematically interacting with suppliers, we will improve the supplier’s logistics management in order to optimize the organization’s supply chain. In other cases, objective analysis is needed according to the actual performance of specific suppliers.

If supplier’s performance is measured fairly and regularly based on the 3D model, it is possible to rank suppliers on a scale from unacceptable to exceptional.

Area I: Phase out. Supplier has the worst logistic management capability, the performance is bad, and the logistic cost is high. We must close business with this kind of supplier, because we can’t get any benefit.

Area II: Pre phase out. Supplier has poor internal logistic management, and the cost is high, but its performance looks well. We have no confidence for supplier’s further performance, it is better to keep monitoring supplier’s performance in long term. It is impossible to nominate new business to this kind of supplier, which must do immediate improvement action based on professional study.
Area III: Acceptable supplier. Supplier has strong logistic management capability, but it needs high cost to keep performance. This kind of supplier can do good job, but they also make trouble for quotation, because the cost is high. Corporation can use it only for high level OEM service if we already have good benefit.

Area IV: Pre phase out. Supplier has good internal logistic management, but the cost is high, supplier’s output is not good also. It means supplier doesn’t care business with corporation, because this kind of supplier can do much better if they want to do. On the other hand, supplier isn’t competitive due to high cost.

Area V: Monitoring. Supplier need to do improvement because logistic management is not well, and the performance is bad. The only good point is the low price, but we need to keep monitoring in a period to check the possibility for supplier’s improvement. After a period, we need to phase out it if no clear change, because it is always with trouble.

Area VI: Under improvement. Supplier has good performance with low price, but supplier need to do improvement for internal management, which is not stable. It means this kind of supplier need to do improvement if we want to make it as long-term business partner.

Area VII: Professional. Excellent internal management, good performance and low price are the main features which companies in these areas. These are the successful suppliers in whole supplier chain from the perspective of logistics. And these companies are standard in whole field. Strategy business cooperation needs to be built between supplier and corporation.

Area VIII: Under improvement. Supplier has good management, but performance needs to improve. This kind of supplier has enough potential capability. There is big chance to turn its role to excellent field.

For example, company H adopt this 3D mode evaluation system, logistics department clearly understood the weak point and strong point for every supplier, and suppliers easily knew what aspects need to improve. Suppliers carried out the internal evaluation base on the results of 3 dimensions deeply, identified the risk and analyzed it. One of the key suppliers saved more logistics cost by improving the products quality and reduced the delivery frequency. This was thanks to the production adjustment, such as strictly following the economic batch to arrange the production and reducing the changing times of production line. This mode has the practical guiding significance for logistics evaluation. It can be in favour of identifying the risk and improvement for very corporation. There is a clear link between evaluation data and decisions to avoid expending much resources getting information.

In conclusion, the establishment of three-dimensional data model is mainly to realize the objective evaluation of suppliers and point out the direction for the supplier’s subsequent logistics improvement. Of course, there is a certain optimization room for this model, and many logistics management factors may need to be further improved, for examples, how to distribute the relevant factors to the three evaluation model dimensions, and how to connect with the one dimension. However, in general, the three-dimensional data model is a positive and systematic evaluation method for the current supplier logistics management evaluation work, which is worth studying further.

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