University of Economics in Katowice

Volume 12 2013

Journal of Economics & Management

Krzysztof Niestrój

THE CONFORMITY ASSESSMENT OF LEAD LOGISTICS PROVIDER AND THIRD PARTY LOGISTICS PREFERENCES USING ANALYTIC HIERARCHY PROCESS METHOD (AHP)

The dynamic development of logistics service industry has become apparent worldwide in the last several years. New types of logistics service providers have evolved: first of all 3PL and 4PL as well as to a lesser extend 5PL. Broad scale cooperation based on a new formula has begun – contract logistics. Service providers, on the basis of a contract with a business entity, taking over the performance of logistics functions in the long term, allow for achieving a *trade-up* effect within the logistic network. In this case, it is based on increasing the efficiency and effectiveness of supplies with a simultaneous reduction of logistics costs in a part of or in a whole logistics network. This effect would be unattainable without the participation of logistics service providers and constitutes a major prerequisite for their rapid development.

The decision to choose particular logistics service providers, however, is associated with a risk for all parties involved in the movement of goods. A 3PL service provider (or several such service providers) takes over from an enterprise the realization of key physical logistics functions; and moreover if it acts for a given enterprise as a Lead Logistics Provider (LLP), which is illustrated in Figure 1, then apart from physical functions, it also acquires managerial functions, resembling in this way a 4PL provider (Rushton, Walker, 2007; Schneider, 2010). The adaptation of logistics functions by service providers is also connected with the suppliers' and consignees' interference in logistics systems, and simultaneously "cuts" them from the entity commissioning logistics service, at least in the operational field. On the other hand the LLP, 4PL and 5PL providers become hubs, in which the flows of most important information in the logistics network intersect, which results in the fact that the entity starts to operate in a peripheral zone – with incomplete information. In all these cases there occurs partial or entire subordination of entity's logistics system to logistics service providers, who – providing services to other customers – do not have to aim at offering the highest standards of logistics services, but e.g. at optimalization of own resources utilization.

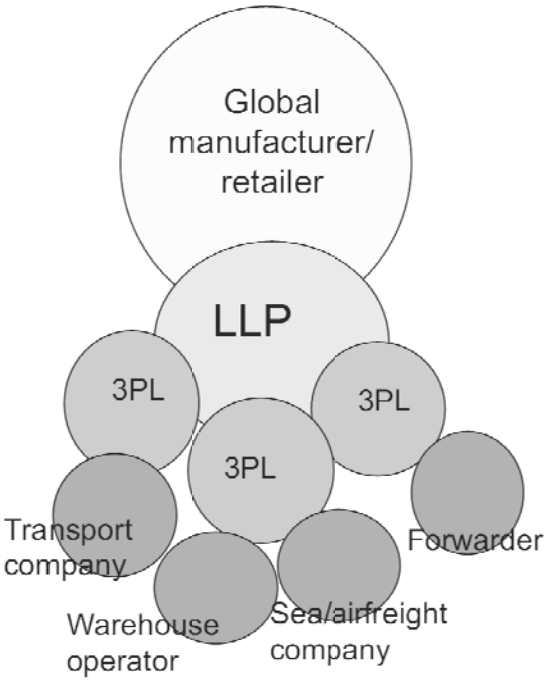

Figure 1. LLP and 3PL cooperation idea while servicing mutual customer

Source: (Williams, 2006).

Logistics services are often conducted under different market conditions than at the time of making the contract arrangements. It constitutes another thread for an entity because it is difficult to agree adequate scope and level of logistics services in advance.

As far as 3PL providers are concerned, the risk is connected with the lack of opportunities to use most effectively owned material resources while cooperating with a given customer. For the number of 3PL providers is so big that they are competing against each other for the best customers. The 4 PL and 5PL service providers' situation seems to be much better in this respect – as they do not use material resources – however the risk on their side also exists and lies in the fact that the functions they perform may be taken over by the LLP, and also by the customers themselves, after the implementation of appropriate network management software for logistics and its competent use.

The selection of a logistics service provider, a multi-criterion by its nature, is now one of the most important theoretical and practical dilemmas in logistics and many studies have been dedicated to it (e.g. Zhou, Min, Xu Cao, 2008). Numerous attempts to verify what aspects determine the proper cooperation of

the company and the logistics service provider can be found in the subject literature and, therefore, to the greatest possible extent, these aspects should be taken into consideration when making such decisions (e.g. Leahy, Murphy, Poist, 1995). A wide range of possibilities of using multi-criteria decision methods (MCDM) have also been provided, allowing for the objectivity of such a selection (see: Trzaskalik, 2008), out of which the Analytic Hierarchy Process (AHP) method, proposed by T.L. Saaty, is very popular. In the literature many research approaches using the AHP method have been described and its generalising extension – the method of Analytic Network Process (ANP) as well as regarding selection and evaluation criteria of a cooperation process with a logistics service provider, but authors focus here on the selection of a 3PL service provider by a client almost exclusively (for example: Kumar, Parashar, Hale, 2009). Still the literature considerably less frequently addresses the issue of 3PL provider selection (as a service provider of a lower order) by the LLP or 4PL (higher order) before the beginning of vertical cooperation* for the purpose of servicing a mutual customer. As one of the few studies can be quoted here: Xu, Zhang, Tang (2010).

This article attempts to examine the LLP service provider's preference conformity, in the course of choosing a 3PL service provider, with 3PL preferences, which are used by it while designing own logistics services offer. Two entities were qualified for the research, which cooperated with each other horizontally at the time of research (December 2011), but they have not engaged in vertical cooperation yet. The horizontal co-operation takes place within the *Silesia Logistics* cluster formed at the beginning of 2012 and it primarily embraces joint ventures in the field of investment, education, and image building for the partners involved and the region itself. One of the entities is a 3PL cluster service provider, belonging to a global group offering this kind of logistics services. By contrast the other entity is a highly specialized LLP provider, belonging to a group focused on servicing the automotive industry. The representatives of both entities were persons of very high logistics knowledge, able to look systematically at logistic cooperation, maintaining a direct contact with recipients of services.

The study was based on the classic AHP methodology, however, limited to determining the preference vectors of both entities. Then the compliance of set preferences was assessed using the Index of Dissimilarity and Relative Index of Similarity, and on the basis of the preference rankings charts. Due to the fact that the AHP method is extensively described in the literature, the study primarily focused on describing aspects of cooperation between the researched service providers and the obtained results while omitting some calculations. Although,

* In fact, 3PL and LLP cooperation is quasi-vertical. A mutual customer service often requires from them performing parallel logistics operations.

as it has been mentioned earlier, many important aspects of vertical cooperation among the logistics service providers can be indicated, the AHP methodology, however, has imposed a restriction in the form of maximum nine aspects that could be subjected to reliable research (Saaty, Ozdemir, 2003). These aspects, presented in Table 1 and briefly described below, were chosen on the basis of preliminary discussions with various logistics service providers, before the proper research.

1. *Accuracy of provided services* means that the service is delivered by the 3PL every time strictly according to previous arrangements between the parties as to the quantity, structure, and quality conditions, such as the way of packaging, the sequence alignment, etc. This aspect is often indicated in the literature as the most important in the whole logistics services (in addition to the timeliness of deliveries).

Table 1

Selected cooperation aspects for testing 3PL and LLP preferences compliance

Symbol	Cooperation aspects
a_1	Accuracy of provided services
a_2	Flexibility in service delivery
a_3	Cost of services offered
a_4	Possibility of fast, cost-free termination of cooperation
a_5	Goodwill of service provider
a_6	Financial stability
a_7	Range of logistics services offer
a_8	Timeliness of service delivery
a_9	Exchange of information

2. *Flexibility in service delivery* means adjusting the 3PL to the changing conditions in which logistics services are completed; it both refers to the way they are provided, as well as the infrastructure used. This aspect is important due to the fact that logistics service consists of so many components that it is practically impossible to consider all options in the contract.
3. *Cost of services offered*, it primarily refers to providing the lowest rates for logistics services on the basis of actual costs incurred, adjusting the degression or progression rates thresholds to the customers' expectations, as well as a tariff structure constructed on the most convenient basis for the customer.
4. *Possibility of fast, cost-free termination of cooperation* is a necessary aspect reducing the risk of the need for continued cooperation, or the need to pay

damages in a situation where for at least one of the parties it would appear reasonable to stop it.

5. *Goodwill of service provider* increases the confidence in all entities that directly or indirectly benefit from the logistics service. Goodwill means responsibility and experience in the market and allows for commissioning a service provider to perform key logistic functions.
6. *Financial stability of a service provider* is an aspect positively influencing the cooperation of service providers – not only does it allow the parties to employ high-class specialists, invest in modern logistics technologies, and maintain good infrastructure, thereby reducing the risk of interruption in service, but also it allows for mutual assistance in times of reduced profits, along with the commissioning company (e.g. deferring a payment, acquisition of foreign exchange risk, etc.).
7. *Range of logistics services offer* – in the conducted studies this aspect means the wide range of services availability. However, in relation to the width of the offer, LLP expectations or the commissioning company may be different than the assumptions that 3PL has made. Driven by the desire to reduce the market risk 3PL offer should be wide and provide the opportunity to work with multiple customers. On the other hand – many industries look for specialized service providers, focusing exclusively on satisfying the needs of one customer.
8. *Timeliness of service delivery* means ensuring that individual logistics operations will be performed each time according to predetermined schedule. It mainly applies to deliveries within narrow time frames for Just-In-Time on the cross docking or assembly lines of the LLP or the commissioning company.
9. *Exchange of information*, this aspect relates to offering high quality information flows and coordination of planning, among the logistics network hubs, by the service provider. In practice this means the ability to use logistics management software coupled with the software of the service commissioning company, its suppliers and customers, and other logistics service providers involved.

Using these aspects, in accordance with the AHP method, two research tabulation sheets were built, one for each of the providers. The sheets consisted of pair lists of all aspects. The number of necessary pairwise comparisons has been described by formula:

$$L_p = \frac{n^2 - n}{2}$$

where: L_p – number of comparisons in pairs, n – number of aspects selected for research.

Therefore, it was necessary to prepare 36 lists in each sheet for the nine aspects. In order to assess preferences a standard scale for AHP has been used, which is shown in Table 2. The AHP method usually describes the importance of symbols with odd numbers only, because of the difficulty in drawing the names for the intermediate ratings. The symbols with even numbers are used for answers situated between the odd, for example – the choice of 4 means a rating between "slightly more important" and "clear preference".

Table 2

Comparisons scale between selected aspects

Symbol	Verbal evaluation comparing each pair
1	Equilibrium
3	Slightly bigger importance
5	Clear preference
7	Very strong preference
9	Absolute preference, dominance

A fragment of a sheet, which was filled in by the investigated persons, is presented in Table 3. The respondents were asked to rate each pair of aspects and to select one of preference degrees or the balance between the aspects.

Table 3

A fragment of a sheet used in the study

		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
		Absolute preference, domination		Very strong preference		Clear preference		Slightly bigger importance		Equilibrium		Slightly bigger importance		Clear preference		Very strong preference		Absolute preference, domination	
1	Accuracy of provided services																		Possibility of fast, cost-free termination of cooperation
2	Exchange of information																		Goodwill of service provider
…	…																		…
36	Flexibility in service delivery																		Timeliness of service delivery

As a result two matrices of pair assessments of particular aspects were obtained. They have been presented in Table 4 (for the 3PL service provider) and Table 5 (for the LLP service providers). For example, in the first matrix: rating 5 in a2 row and a3 column means "clear preference" of provided logistics services flexibility over their cost.

Table 4

The matrix of pairwise ranking – 3PL provider

	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9
a_1	**1**	1/3	4	5	1	1/2	1/3	1	1
a_2	3	**1**	5	5	2	1/2	1	4	3
a_3	1/4	1/5	**1**	2	1/4	1/4	1/4	1/3	1/4
a_4	1/5	1/5	1/2	**1**	1/4	1/5	1/5	1/4	1/4
a_5	1	1/2	4	4	**1**	1/2	1	1	1/3
a_6	2	2	4	5	2	**1**	2	2	2
a_7	3	1	4	5	1	1/2	**1**	3	4
a_8	1	1/4	3	4	1	1/2	1/3	**1**	2
a_9	1	1/3	4	4	3	1/2	1/4	1/2	**1**

Table 5

The matrix of pairwise ranking – LLP provider

	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9
a_1	**1**	3	1	5	5	1	7	1	3
a_2	1/3	**1**	1	3	1	1	3	1/3	3
a_3	1	1	**1**	5	1	1	7	1	3
a_4	1/5	1/3	1/5	**1**	1/3	1/5	1/2	1/3	1/5
a_5	1/5	1	1	3	**1**	1/3	3	1/3	1/7
a_6	1	1	1	5	3	**1**	5	1	3
a_7	1/7	1/3	1/7	2	1/3	1/5	**1**	1/3	1/3
a_8	1	3	1	3	3	1	3	**1**	3
a_9	1/3	1/3	1/3	5	7	1/3	3	1/3	**1**

The resulting sets of ratings were checked for internal consistency. For this purpose, the Consistency Ratio (CR), proposed by Saaty, was used according to the following formulas:

$$CR = 100 \times \left(\frac{CI}{RI}\right)$$

$$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

where:
CR – Consistency Ratio,
CI – Consistency Index,
RI – Random Consistency Index, which should be read from the Table 6,
λ_{max} – Maximum Matrix Eigenvalue,
n – rank of matrix (the number of studied aspects),

Table 6

Random Consistency Index (R.I.) depending on matrix size (*n*)

Matrix size *n*	3	4	5	6	7	8	9
Random Consistency Index *R.I.*	0.52	0.89	1.11	1.25	1.35	1.40	1.45

Source: (Saaty, Vargas, 2001).

The largest Maximum Eigenvalues of the matrices were calculated with the use of the Matrix and Linear Algebra 2.3 Package* for Microsoft Excel ®. Consistency Indexes and Consistency Ratios are respectively: – for the matrix of 3PL provider:

$$CI = \frac{(9{,}7047-9)}{(9-1)} \approx 0{,}0880$$

$$CR = 100 \times \left(\frac{0{,}0880}{1{,}45}\right) \approx 6{,}08\%$$

– for the matrix of LLP provider:

$$CI = \frac{(10{,}0973-9)}{(9-1)} \approx 0{,}1371$$

* The package is available at: (WWW1). This package has also been used for further preference vectors calculations.

$$CR = 100 \times \left(\frac{0{,}1371}{1{,}45}\right) \approx 9{,}46\%$$

The sets of ratings can be considered consistent, and therefore they can be used to determine the preference vectors, if the quantities of CR < 10%. In both cases, this condition has been fulfilled. The calculated preference vectors (i.e. Matrix Eigenvectors Maximum) are presented in Table 7.

Table 7

Preference vectors of 3PL and LLP service providers

Studied aspect	Preferences	
	3PL	LLP
Accuracy of provided services	8.76%	19.59%
Flexibility in service delivery	19.24%	10.73%
Cost of services offered	3.26%	14.88%
Possibility of fast, cost-free termination of cooperation	2.51%	2.74%
Goodwill of service provider	9.39%	6.51%
Financial stability	20.00%	15.56%
Range of logistics services offer	18.01%	3.10%
Timeliness of service delivery	9.01%	16.53%
Exchange of information	9.82%	10.37%

The compliance of the designated preferences was assessed by using the Index of Dissimilarity and Relative Index of Similarity. The first indicator was calculated on the basis of the formula (Kestenbaum, 1980):

$$D = \frac{1}{2} \times \sum_{i=1}^{n} |W_{1i} - W_{2i}|$$

where:
D – Index of Dissimilarity,
W_{1i} – calculated i-th 3PL preference,
W_{2i} – calculated i-th LLP preference,
n – the number of aspects studied.

While the Relative Index of Similarity was determined according to formula (Kornacki, Wesołowska-Janczarek 2008):

$$Z = \frac{\sum_{i=1}^{n} min\ (W_i)}{\sum_{i=1}^{n} max\ (W_i)}$$

where:
Z – Relative Index of Similarity,
W_i min – smaller of the i-th preferences,
W_i max – greater of the i-th preferences,
n – the number of aspects studied.

Both indices take values from the interval <0;1>. The D ratio indicates what percentage of preferences should be changed (here: to move into other aspects of logistics cooperation) so the structures will become identical. The Z indicator shows what percentage of the preferences of both studied parties coincides. When Z = 1 structures are identical, while for Z = 0 structures are completely different. In the case of surveyed service providers the preference vectors are D = 0.307 and Z = 0.530. According to the first of the indicators in order to get the full compliance of the preference structures, figuratively speaking, about 30% of the preferences of each service provider should be changed. The second indicator shows that only just over half the respondents' preferences coincide. Both indicators confirm that rankings of preferences are very far from compliance, which at first may be surprising, given that the business activity of both entities is similar. In order to be able to draw conclusions from the studies the comparative rankings of 3 PL and LLP preferences have been presented in the Table 8.

Table 8

Preference rankings comparison of researched service providers

3PL preference hierarchy	Position	LLP preference hierarchy
Financial stability	1	Accuracy of provided services
Flexibility in service delivery	2	Timeliness of service delivery
Range of logistics services offer	3	Financial stability
Exchange of information	4	Cost of services offered
Goodwill of service provider	5	Flexibility in service delivery
Timeliness of service delivery	6	Exchange of information
Accuracy of provided services	7	Goodwill of service provider
Cost of services offered	8	Range of logistics services offer
Possibility of fast, cost-free termination of cooperation	9	Possibility of fast, cost-free termination of cooperation

Large discrepancies can be noticed while comparing the rankings of preferences. Several aspects were evaluated differently: the accuracy of provided services is not considered as a priority by 3PL, and it even can be found at one of the last places, on the other hand this is what above all is expected by LLP. Similar differences concern the timeliness of delivery and cost of logistics services. It seemed that the key aspect of accuracy, timeliness and cost of logistics services, has already become a canon in contemporary logistics. Compatibility between the studied 3PL and LLP virtually exists only in reference to long-term willingness to engage in the logistics cooperation, which may not be completed, taking into account the remaining incompatibilities. It is visible in the fact that 3PL is more focused on assuring its own benefit, while the LLP is primarily guided by the value for the customer. 3PL is an entity with greater versatility, looking for emerging market opportunities. It is not as tied to a specific client, or a specific logistics network, as LLP.

The issue of implementing possible changes in preferences by both parties, in particular by the 3PL, which could occur before undertaking a possible cooperation, remains a challenge for further research.

References

Adamus W., Gręda A. (2005): *Wspomaganie decyzji wielokryterialnych w rozwiązywaniu wybranych problemów organizacyjnych i menedżerskich*. "Badania Operacyjne i Decyzje", Vol. 2.

Kestenbaum B. (1980): *Notes on the Index of Dissimilarity: A Research Note***.** "Social Forces", Vol. 59, No. 1.

Kornacki A., Wesołowska-Janczarek M. (2008): *O weryfikowaniu poprawności matematycznych modeli procesów w oparciu o dane empiryczne*. "Problemy Inżynierii Rolniczej", No. 3.

Kumar S., Parashar N., Haleem A. (2009): *Analytical Hierarchy Process Applied to Vendor Selection Problem*. "Business Intelligence Journal", August, Vol. 2, No. 2.

Leahy S.E., Murphy P.R., Poist R.F. (1995): *Determinants of Successful Logistical Relationships: A Third-Party Provider Perspective*. "Transportation Journal", Vol. 35-2, No. 2.

Rushton A., Walker S. (2007): *International Logistics and Supply Chain Outsourcing: from Local to Global*. Chartered Institute of Logistics and Transport (UK).

Saaty T. L., Vargas L. G., (2001): *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process*. Wolters Kluwer Academic Publishers, Norwell, MA.

Saaty T.L., Ozdemir M.S. (2003): *Why the Magic Number Seven Plus or Minus Two*. "Mathematical and Computer Modelling", Vol. 38, No. 3-4.

Schneider O. (2010): *Adding Enterprise Value: Mitigating Investment Decision Risks by Assessing the Economic Value of Supply Chain Initiatives*. Verlag der Fachvereine Hochschulverlag, ETH Zurich.

Trzaskalik T. (2008): *Wprowadzenie do badań operacyjnych z komputerem*. PWE, Warszawa.

Williams M. (2006): *3PL, 4PL, LLP – Is There a Real Difference and What is the Future*, http://bishamconsulting.com/logistics/news/documents/3PLor4PLGefco.pdf (30 December 2011).

Xu Y., Zhang M. Tang S. (2010) *Research on Workflow Model of Cooperation Between 4PLs and 3PLs Based on Petri-net*, ICIII, 3rd International Conference on Information Management, Innovation Management and Industrial Engineering, Kunming, Vol. 3.

Zhou G., Min H., Xu C., Cao Z. (2008): *Evaluating the Comparative Efficiency of Chinese Third-Party Logistics Providers Using Data Envelopment Analysis*. "International Journal of Physical Distribution & Logistics Management", Vol. 38/4.

(WWW1): http://digilander.libero.it/foxes.