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Transportation Economy  
Preliminary Communication  
Accepted: Jan. 23, 2012  
Approved: Nov. 13, 2012

## COST CALCULATION MODEL FOR LOGISTICS SERVICE PROVIDERS

### ABSTRACT

*The exact calculation of logistics costs has become a real challenge in logistics and supply chain management. It is essential to gain reliable and accurate costing information to attain efficient resource allocation within the logistics service provider companies. Traditional costing approaches, however, may not be sufficient to reach this aim in case of complex and heterogeneous logistics service structures. So this paper intends to explore the ways of improving the cost calculation regimes of logistics service providers and show how to adopt the multi-level full cost allocation technique in logistics practice. After determining the methodological framework, a sample cost calculation scheme is developed and tested by using estimated input data. Based on the theoretical findings and the experiences of the pilot project it can be concluded that the improved costing model contributes to making logistics costing more accurate and transparent. Moreover, the relations between costs and performances also become more visible, which enhances the effectiveness of logistics planning and controlling significantly.*

### KEY WORDS

*logistics cost calculation, full cost allocation, multi-level cost allocation, logistics service providers*

### 1. INTRODUCTION

Due to efficiency considerations the non-core activities have more and more often been outsourced in various industries in the last decades. Logistics is one of the non-core activities frequently outsourced. These logistics tasks are performed by logistics service providers (LSP). They operate independently from their clients and offer complex logistics packages including not only such classic services as transport or warehousing but also value added services like postponed manufacturing or assembling, etc.

Logistics has become one of the main factors determining the competitiveness of the economy. As a considerable part of logistics tasks are undertaken by

LSP companies, they play a crucial role in making the operation of several industries more effective and efficient. That is why their operation shall also be made as efficient as possible. It means that the decision-makers of LSP companies shall be aware of the main operational factors of logistics processes evaluated and monitored by management information systems.

It has been concluded by earlier research that the control of logistics costs will become increasingly important to firms seeking competitive advantage. Managers will require more accurate and focused costing information of logistics functions or services to ensure profitability. Success of these efforts will largely depend on the ability of the firm's cost accounting system to trace costs to specific logistics activities [1].

Effective capacity allocations in LSP companies require more detailed and reliable information on the operational costs and performances. Decision makers need accurate data on the costs and the profitability of logistics services, and additionally also on the cost efficiency of logistics performance generators. It is also important to explore the cause-effect chains in the technology and business processes so that the interventions aiming to improve the operational efficiency within the company or along the entire supply chain can be established on a sound methodological basis.

To meet the requirements set before, an improved cost calculation mechanism shall be introduced in logistics costing. The traditional costing methods may fail when applying them in logistics as they ignore the consideration of cause-effect relationships and use ad-hoc cost allocation factors in case of overheads. They can only be used when the relevance of overheads or indirect costs is low [2, 3].

In this paper the logistics costing techniques applied in practice are investigated first. Then the basic methodological framework is built up through embedding the relevant outcomes of the related research. The proposed costing model for LSP companies is set up on the basis of the methodological framework and

by considering practical experience. The model is then tested by an illustrative numerical example based on empirical observations. Note that the pilot calculation aims to demonstrate the usefulness and the applicability of the elaborated costing model rather than delivering exact cost and profit information for concrete decision-making purposes. In a real-life application the structure of the model should be adapted to the specific features of the examined LSP company.

## 2. BASIC HYPOTHESIS

Before defining the basic hypothesis it is worth analysing the results of related research presented in the literature. The aim of this analysis is to find relevant principles, models and their verifications, which can be used to establish a reliable and transparent cost calculation methodology for logistics processes.

Activity-based costing (ABC) is often regarded as an alternative solution to the technique of fixed overheads. It uses activities to trace indirect costs while traditional systems of cost calculation treat indirect costs as a homogenous lump to be allocated to products or services on a single-volume related base like direct costs. Although ABC was developed for the needs of manufacturing, it can be applied in logistics, too. To prove this fact, a costing model for the purchasing function has been elaborated by identifying the corresponding activities and cost drivers [4]. Another example is when the logistics costs classified as overheads were analysed in a manufacturing company by using ABC. It has turned out that the detailed information on logistics costs obtained in this way enables a more efficient management of logistics functions within production companies [5].

The need for more accurate logistics cost information than traditional systems can produce arises in several decision-making situations. This applies to distribution costs as well. Traditionally, distribution costs were allocated on the basis of simple value-based factors. Although most of the applications dealing with ABC have their focus on manufacturing, this approach can be applicable in distribution logistics management as well and could yield more accurate logistics costs [6]. ABC applications can be found in a warehouse logistics environment, too. They increase the visibility of logistics costs and contribute to higher accuracy by measuring performances and using them for cost allocations. However, a case study with comprehensive and detailed data collection showed that single transaction based cost drivers may not be sufficient: automatic data collection can be a solution to this problem [7].

Some authors state that real life applications of ABC in transport or logistics are rarely presented in literature. A case study has proven that ABC can be

helpful for transportation companies to determine the costs of their operation with higher correctness. Detailed process and cost driver mapping was carried out where ABC was combined with business process modelling and AHP (analytical hierarchy process). It turned out that the proposed approach is a more effective costing method than the existing traditional costing system [8]. Other case studies examined how to calculate the accurate costs by ABC for individual airplanes and flights by identifying the main activity items and cost drivers of each airplane and flight and using a flow chart for cost assignment [9].

ABC can even be extended to the supply chains. ABC integrated into supply chain management (SCM) identifies the driving cost factors affecting the key logistics activities and helps improve the allocation of logistics costs [10]. SCM requires more accurate costing information and ABC can significantly contribute to making SCM more effective by delivering reliable and detailed cost and profit data, giving a clear picture of where the resources are spent, understanding the cause-effect relations between costs and the demands for activities, etc. [11]. When determining the cost in supply chains intra-firm methods are not appropriate; thus, a new, two step ABC approach can be used consisting of design and operation phases; moreover, the costing information shall be standardised along the entire chain [12]. ABC can be a tool of evaluating the tactical production planning in supply chains by adding financial evaluation to physical parameters and using logistics process activities. Here the links between financial and physical flows are to be determined exactly [13].

Some attempts have already been carried out to depict the operation of LSP companies and create ABC models for them. It has been concluded that the traditional costing methods may not be sufficient for such business actors. A model including warehousing and transport was set up with proposals for activities and cost drivers. It has been found that no general models can be used as each company has its unique operational characteristics. At the same time, appropriate ABC models enable to identify unused capacity and conduct what-if analyses. Nevertheless, special attention shall be paid to the model trade-off: the costs of introducing ABC shall not exceed the benefits of additional costing information [14]. A basic ABC model of LSP companies using matrix algebra has also been worked out and tested through a case study defining sample activities and cost drivers [15].

Having reviewed the relevant literature, it can be concluded that ABC is regarded as the most appropriate tool for enhancing the capabilities of logistics costing. Nevertheless, business surveys consistently indicate that managers prefer to use full cost data to make decisions e.g. about prices or capacity allocations [16]. ABC can also be used for full cost allocation (FCA) purposes but it may not take into account

the interactions between the units or entities applied for collecting and distributing indirect costs or overheads. Another variant of FCA can be the multi-level indirect cost allocation approach where the cost allocation mechanism relies on the operational model of the company depicting the organisational structure. This topic is not so often addressed in the logistics and transport sector as the implementation of ABC. Thus, it is worth investigating how a multi-level FCA can be adopted in logistics with special regard to logistics service providers.

The basic hypothesis of the research is that the costing system of LSP companies can be made more accurate, reliable and transparent by adopting an FCA approach based on multi-level indirect cost allocation.

### 3. RESEARCH METHODOLOGY

The principles of the proposed cost calculation model are defined on the basis of former, related research results incorporating also relevant ideas coming from the literature reviews [2, 3, 17]. The basic procedures and formulas have been elaborated by the author of this paper. Further general methodological details can also be found in the corresponding article analysing the improvement of logistics cost calculation in the frame of production costing [18].

The proposed methodology is similar to ABC but it uses organisational units, pieces of equipment or dedicated set of resources instead of activities. Moreover, it considers the hierarchical structure of such indirect cost generators, so that the relationships between these entities are also taken into account. Thus, the model needs sound information on the main features, i.e. organisational structures, operational rules, competences, etc. of the investigated business-technology system. The general structure of the multi-level full cost allocation model is shown in Figure 1.

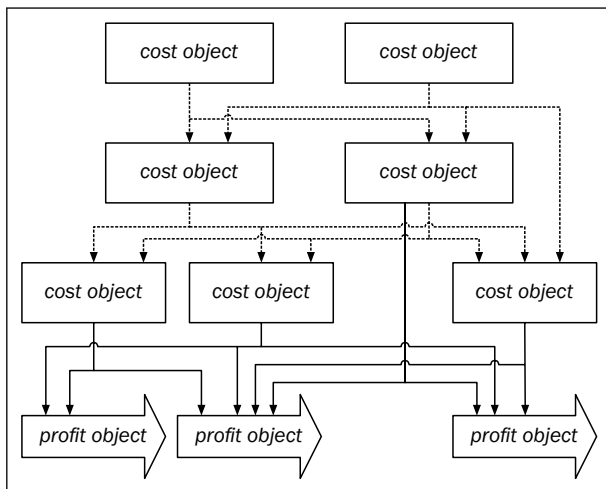


Figure 1 - Cost calculation model with multi-level indirect cost allocation

Source [17]

The model depicts the operation of the examined company by revealing the so-called intern service connections represented by the performance flows. It consists of the cost objects arranged into a multi-level hierarchy, the profit objects and the performance relations between these entities. Note that the definition of model elements (objects) is different from the one of ABC: ABC uses cost/activity centres instead of cost objects and cost objects instead of profit objects.

Indirect costs are recorded in the cost objects. These are the so-called primary costs of the cost objects. Cost objects serve as the first collection points of the indirect costs. They can be organisational (business or technology) units, pieces of equipment or machinery, groups of staff, etc. contributing to the production of the profit objects or they might serve other cost objects. Each cost object shall be supplied with a performance indicator measuring its performance. As the cost objects have intern service relations with each other (as shown in Figure 1) their total costs also contain the so called secondary costs which can be allocated by using the rate of the relative performance consumption, called performance intensity. If we summarise these procedures into a single mathematical formula, the total cost of a cost object can be calculated as follows:

$$C_{CO_k} = C_{P_k} + \sum_i C_{SCO_i} \frac{P_{CONS_{ki}}}{P_{SCO_i}} = C_{P_k} + \sum_i C_{SCO_i} p_{ki} \quad (1)$$

where:

- $C_{CO_k}$  - total cost of cost object  $k$ ;
- $C_{P_k}$  - primary cost of cost object  $k$ ;
- $C_{SCO_i}$  - total cost of serving cost object  $i$ ;
- $P_{SCO_i}$  - total performance of serving cost object  $i$ ;
- $P_{CONS_{ki}}$  - performance consumption of cost object  $k$  at serving cost object  $i$ ;
- $p_{ki}$  - performance intensity of cost object  $k$  at serving cost object  $i$ ;

index  $i$  goes through the relevant serving cost objects.

Note that the cost of a cost object can be calculated only if the total cost data of all preceding cost objects are already available. This fact determines the sequence of the calculation steps. The cost efficiency of the cost object can be evaluated by calculating the average (or specific) cost: total cost divided by performance. A too high value of average cost may reflect a low level of capacity utilisation so it may be an important indicator for capacity reallocations. Specific cost values can also be used for preparing outsourcing decisions: the prices of extern services can be compared with the "intern price" of performance creation.

Direct costs are recorded in the profit objects. Profit objects are the products or services which induce revenues for the company. The indirect costs are allocated to the profit objects from the relevant serving cost objects (for the relationships see Figure 1) on the

basis of the relative performance consumption. It is a similar approach to the one presented in Equation (1) so the total cost of a profit object can be determined according to the following formula:

$$C_{poj} = C_{dj} + \sum_i C_{scoi} \frac{P_{consji}}{P_{scoi}} = C_{dj} + \sum_i C_{scoi} p_{ji} \quad (2)$$

where:

- $C_{poj}$  – total cost of profit object  $j$ ;
- $C_{dj}$  – direct cost of profit object  $j$ ;
- $P_{consji}$  – performance consumption of profit object  $j$  at serving cost object  $i$ ;
- $p_{ji}$  – performance intensity of profit object  $j$  at serving cost object  $i$ ;

index  $i$  goes through the relevant serving cost objects.

Revenues are also recorded in the profit objects. The margin of the profit object, as the indicator of its profitability, can be calculated by subtracting the total cost from the revenue. Another indicator of profitability is the cost-coverage ratio which can be determined through dividing the revenue by the total cost. The general data structure of the entities in the calculation scheme can be identified as indicated in Table 1.

Table 1 - Data structure of the calculation objects

Cost object	Profit object
primary cost (recorded)	direct cost (recorded)
+ secondary cost (allocated)	+ indirect cost (allocated)
= total cost (calculated)	= total cost (calculated)
	+ margin (calculated)
performance (measured)	= revenue (recorded)
average cost (calculated)	cost coverage (calculated)

#### 4. RESEARCH RESULTS

To build up the cost calculation model of LSP companies the general model shall be transformed according to the operational characteristics observed. The business and technology models of several LSP running businesses in Hungary have been studied to identify the profit objects, to select the appropriate cost objects and to arrange them along cause-effect based performance chains. Another task was to add the suitable performance indicators and their measures to the cost objects.

Figure 2 illustrates a possible cost calculation model of a certain (medium-sized) LSP company having the core activity of road haulage and carrying out some additional activities like warehousing. This is an LSP costing model containing the most common objects and relations. It is detailed enough for conducting exact calculations; however, this model is still a general scheme and should be adapted to the concrete business-technology model when applying it under real life circumstances. It could be even more sophisticated if

more detailed or more accurate information was required.

The elementary profit objects in the sample model are the logistics services or service packages offered to the customers or clients. Their direct inputs represent the direct costs. They can be, for example, the extern logistics services purchased for completing one's own logistics services, individual cost elements like infrastructure user charges or even fuel costs depending on the data structure of the accounting system. Each cost item assigned to the logistics services directly can be regarded as direct cost.

The cost objects can be classified into three groups:

1. the cost objects representing the general management or background intern services in the company like the general, financial or human management units and the department for information technology (IT);
2. the cost objects representing the units of operative and tactical control or execution like service planning, transport control, maintenance, warehousing, sales and drivers. They are served by the cost objects of Group 1 and serve the cost objects of Group 3 or the profit objects;
3. the cost objects representing the assets (vehicle types) serving the profit objects.

There are additional intern services within Group 2 as service planning governs other objects in this group (excluding drivers) and transport control supervises drivers while maintenance serves warehousing.

Based on the model described before, a numerical calculation can be performed if the necessary input data are accessible. In our example modified and assumed input cost and revenue data have been utilised while the missing performance data have been estimated due to data restriction problems in the competitive logistics market. Although the input data are estimated or modified, their relative order of magnitude is in general correct as they rely on practical experience. Nevertheless, the results of the pilot calculation must not be used for decision-making purposes directly. The sample calculation aims rather to prove the practical applicability and usefulness of the theoretical model. Of course, on the other hand, it also reflects the constraints of implementation.

The sample LSP company operating according to the business-technology model and presented in Figure 2 has ten service packages and runs three vehicle types ( $n = 10$  and  $x = 3$ ). Table 2 contains the input data, i.e. direct costs and revenues, for the profit objects (logistics services 1-10) where th. MU = thousand monetary units. Table 3 contains the input data, i.e. primary costs and performances for the cost objects. Note that the sum of primary costs equals the total indirect cost of the company. Tables 4 and 5 contain the performance intensities, which are necessary for the cost allocations using Equations (1) and (2).

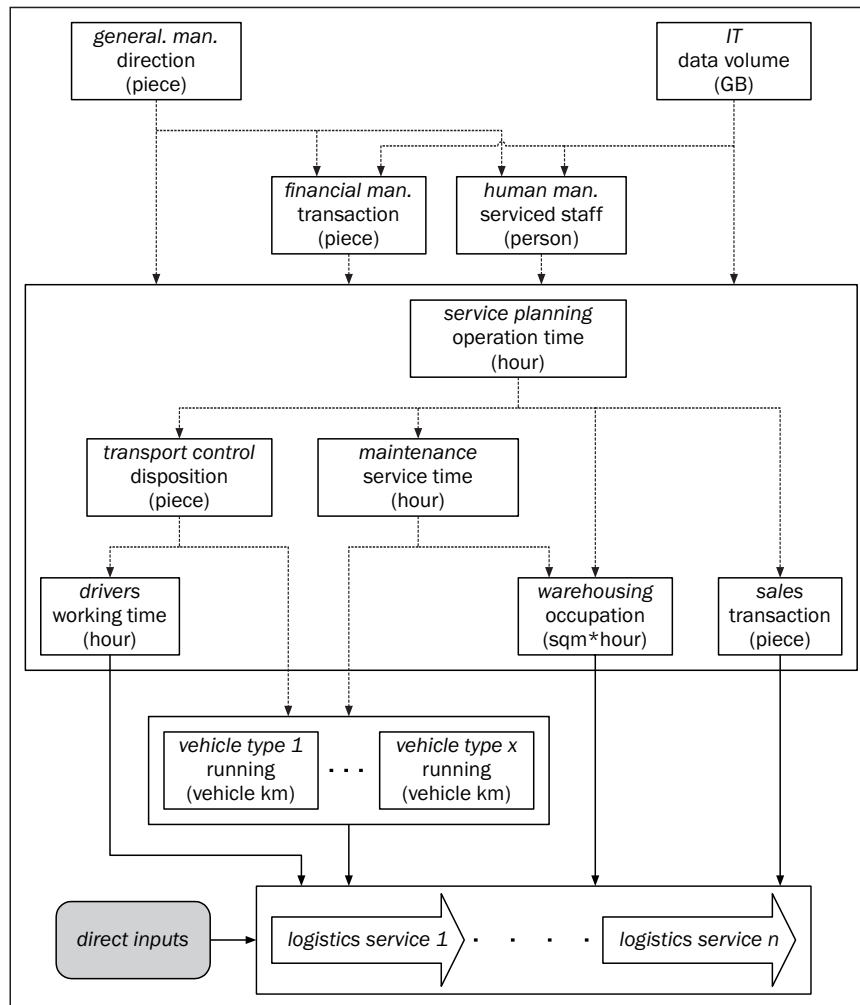


Figure 2 - Cost calculation model for LSP companies

Table 2 - Input data of profit objects

profit object	direct cost (th. MU)	revenue (th. MU)
log. serv. 1	180	490
log. serv. 2	220	610
log. serv. 3	180	880
log. serv. 4	300	930
log. serv. 5	240	690
log. serv. 6	330	990
log. serv. 7	250	800
log. serv. 8	260	700
log. serv. 9	220	790
log. serv. 10	160	520

Source: own estimation based on empirical information

Cost and revenue data can be obtained from the accounting systems, mainly from the general ledger. If the output data structure of the accounting system are not in line with the format of the requested input information, additional data transformation may also be necessary. Performance data can be extracted from the technology information systems or they might

be made available by dedicated data collection procedures. The performance intensity data have been determined on the basis of cause-effect interactions presented in Figure 2. The entities receiving (consuming) performances can be found in the first column, while the entities providing (serving) performances are listed in the first row of the tables. Note that not only the performance data are to be measured but also the distribution of performance consumption has to be assessed for completing the cost allocations.

Having obtained or estimated the input data, the calculation procedure can be started. The first task is to calculate the secondary, the total and the average cost of the cost objects by using Equation (1). The results are listed in Table 6.

Let us see how to calculate the output data (results) of cost objects by using Equation (1). In case of cost object “financial management” the primary cost is 30 th. MU. There are two serving cost objects:

- “general management” with a total cost of 20 th. MU and 6% of its performance is consumed by “financial management”;

- "IT" with a total cost of 40 th. MU and 23% of its performance is consumed by "financial management".

So, the total cost can be calculated by extracting Equation (1):  $30 + 20 * 0.06 + 40 * 0.23 = 30 + 10.40 = 40.40$  th. MU. The average cost can be calcu-

Table 3 - Input data of cost objects

cost object	primary cost (th MU)	performance	
		value	measure
gen. man.	20	1,500	(direction)
IT	40	3,000	(GB)
fin. man.	30	30,000	(transaction)
hum. man.	20	80	(person)
serv. plan.	30	3,800	(hour)
transp. c.	40	8,800	(disposition)
mainten.	430	4,000	(hour)
sales	170	19,000	(transaction)
warehous.	800	1,500,000	(sqm*hour)
drivers	720	23,300	(hour)
veh. typ. 1	310	600,000	(vehicle km)
veh. typ. 2	360	890,000	(vehicle km)
veh. typ. 3	410	970,000	(vehicle km)

Source: own estimation based on empirical information

Table 4 - Performance intensities between cost objects

(receive/serve)	gen. man.	IT	fin. man.	hum. man.	serv. plan.	transp. c.	mainten.
fin. man.	0.06	0.23					
hum. man.	0.05	0.12					
serv. plan.	0.21	0.08	0.07	0.03			
transp. c.	0.17	0.25	0.12	0.09	0.33		
mainten.	0.14	0.07	0.22	0.17	0.24		
sales	0.18	0.19	0.34	0.07	0.12		
warehous.	0.11	0.04	0.11	0.13	0.31		0.26
drivers	0.08	0.02	0.14	0.51		0.49	
veh. typ. 1						0.14	0.22
veh. typ. 2						0.13	0.19
veh. typ. 3						0.24	0.33

Source: own estimation based on empirical information

Table 5 - Performance intensities between cost objects and profit objects

(receive/serve)	sales	warehous.	drivers	veh. typ. 1	veh. typ. 2	veh. typ. 3
log. serv. 1	0.08		0.07	0.16		0.13
log. serv. 2	0.09		0.08	0.22		0.08
log. serv. 3	0.09	0.21	0.10	0.31		0.02
log. serv. 4	0.11	0.13	0.13	0.11	0.11	0.10
log. serv. 5	0.12		0.11	0.10	0.12	0.05
log. serv. 6	0.10	0.22	0.12	0.10	0.09	0.09
log. serv. 7	0.08	0.11	0.08		0.23	0.05
log. serv. 8	0.13	0.17	0.15		0.21	0.08
log. serv. 9	0.09	0.16	0.08		0.11	0.19
log. serv. 10	0.11		0.08		0.13	0.21

Source: own estimation based on empirical information

lated through dividing the total cost by the actual performance:  $40.40 / 30,000 * 1,000 = 1.35$  MU/piece. It means that one financial transaction costs 1.35 MU.

Let us see another example. The primary cost of cost object “service planning” amounts to 30 th. MU. There are four serving cost objects:

- “general management” with a total cost of 20 th. MU and 21% of its performance is consumed by “service planning”;
- “IT” with a total cost of 40 th. MU and 8% of its performance is consumed by “service planning”;
- “financial management” with a total cost of 40.40 th. MU and 7% of its performance is consumed by “service planning”;
- “human management” with a total cost of 25.80 th. MU and 3% of its performance is consumed by “service planning”.

So, the total cost can be calculated by extracting Equation (1):  $30 + 20 * 0.21 + 40 * 0.08 + 40.40 * 0.07 + 25.80 * 0.03 = 30 + 11.00 = 41.00$  th. MU.

The average cost is  $41.00 / 3,800 * 1,000 = 10.79$  MU/hour, so one operational hour of service planning costs 10.79 MU. The cost of this cost object can be calculated only if the total cost data of all preceding cost objects, i.e. “financial management” and “human management” have already been calculated.

The total and average costs of other cost objects can be calculated similarly by taking into account the corresponding cause-effect chains. Special attention shall be paid to the ascending-descending relations, which determine the sequence of the cost object calculations.

The second task is to calculate the indirect cost, the total cost, the margin and the cost coverage of the profit objects by using Equation (2). The results are summarised in Table 7.

Let us see how to calculate the output data (results) of profit object “logistics service 1” by using

Table 6 - Calculated data of cost objects

cost object	secondary cost (th. MU)	total cost (th. MU)	average cost	
			value	measure
gen. man.		20.00	13.33	(MU / direction)
IT		40.00	13.33	(MU / GB)
fin. man.	10.40	40.40	1.35	(MU / transaction)
hum. man.	5.80	25.80	322.50	(MU / person)
serv. plan.	11.00	41.00	10.79	(MU / hour)
transp. c.	34.10	74.10	8.42	(MU / disposition)
mainten.	28.71	458.71	114.68	(MU / hour)
sales	31.66	201.66	10.61	(MU / transaction)
warehous.	143.57	943.57	0.63	(MU / sqm*hour)
drivers	57.52	777.52	33.37	(MU / hour)
veh. typ. 1	111.29	421.29	0.70	(MU / vehicle km)
veh. typ. 2	96.79	456.79	0.51	(MU / vehicle km)
veh. typ. 3	169.16	579.16	0.60	(MU / vehicle km)

Source: own calculation

Table 7 - Calculated data of profit objects

profit object	indirect cost (th. MU)	total cost (th. MU)	margin (th. MU)	cost coverage (%)
log. serv. 1	213.26	393.26	96.74	124.60
log. serv. 2	219.37	439.37	170.63	138.84
log. serv. 3	436.24	616.24	263.76	142.80
log. serv. 4	400.43	700.43	229.57	132.78
log. serv. 5	235.63	475.63	214.37	145.07
log. serv. 6	456.42	786.42	203.58	125.89
log. serv. 7	316.15	566.15	233.85	141.31
log. serv. 8	445.51	705.51	-5.51	99.22
log. serv. 9	391.61	611.61	178.39	129.17
log. serv. 10	265.39	425.39	94.61	122.24

Source: own calculation

Equation (2). The direct cost is 180 th. MU. There are four serving cost objects:

- “sales” with a total cost of 201.66 th. MU and 8% of its performance is consumed by “logistics service 1”;
- “drivers” with a total cost of 777.52 th. MU and 7% of its performance is consumed by “logistics service 1”;
- “vehicle type 1” with a total cost of 421.29 th. MU and 16% of its performance is consumed by “logistics service 1”;
- “vehicle type 3” with a total cost of 579.16 th. MU and 13% of its performance is consumed by “logistics service 1”.

So the total cost can be calculated by extracting Equation (2):  $180 + 201.66 * 0.08 + 777.52 * 0.07 + 421.29 * 0.16 + 579.16 * 0.13 = 180 + 213.26 = 393.26$  th. MU. The margin can be calculated by subtracting the total cost from the revenue:  $490 - 393.26 = 96.74$  th. MU, while the cost coverage ratio is the quotient of these values:  $490 / 393.26 * 100 = 124.60\%$ .

The indirect cost, the total cost, the margin and the cost coverage ratio of other profit objects can be calculated similarly by taking into account the corresponding performance service relations.

## 5. DISCUSSION

By implementing the proposed costing model it becomes possible to evaluate the cost efficiency of each cost object, i.e. organisational unit, activity area, vehicle, etc., of LSP companies. The current values can be compared to benchmarks, i.e. to earlier values of the same entity or to the values of similar entities in other LSP companies of similar size. If the cost efficiency of a certain cost object is poor in comparison to a benchmark, low capacity utilisation can be suspected. For example, such a situation may occur when a vehicle operates at a too high value of the indicator “MU / vehicle km”. The problem can be swiftly identified so that interventions aiming to enhance the utilisation of capacities or rationalising the consumption of resources can be executed in time.

Outsourcing decisions can also be supported by cost object calculations as the average costs of cost objects can be compared with the prices offered by the potential extern service providers. Here, the outsourcing of background services, like for instance financial/human management or maintenance can be considered in case of logistics service providers on the basis of average cost information.

The profitability and the cause-effect chains of creating logistics services become transparent and the cost values are more exact than in case of using traditional costing regimes, due to the traceable allocation

of indirect costs. It is worth comparing the outcomes of the improved costing model with the results of the traditional cost calculation relying on a direct cost-based allocation of indirect costs, which means that indirect costs are allocated proportionally to the direct costs:

$$C_{po_j} = C_{d_j} + \sum_k C_{p_k} \frac{C_{d_j}}{\sum_j C_{d_j}} \quad (3)$$

Table 8 indicates the total cost of logistics services in the sample model calculated according to the traditional costing approach using Equation (3). The differences between the values of the two costing approaches are also indicated.

Table 8 - Results of traditional cost calculation

profit object	total cost (th. MU)	difference (%)
log. serv. 1	440.00	11.89
log. serv. 2	537.78	22.40
log. serv. 3	440.00	-28.60
log. serv. 4	733.33	4.70
log. serv. 5	586.67	23.35
log. serv. 6	806.67	2.57
log. serv. 7	611.11	7.94
log. serv. 8	635.56	-9.92
log. serv. 9	537.78	-12.07
log. serv. 10	391.11	-8.06

Source: own calculation

Let us see as an example how to calculate the total cost of “logistics service 1”. It is  $180 + 3,380 * 180 / 2,340 = 440.00$  th. MU, where 180 th. MU is the direct cost of this logistics service, while 3,380 th. MU is the total indirect cost and 2,340 th. MU is the total direct cost of the company. The values of other profit objects can be calculated similarly by inserting the actual direct cost value into the formula. The difference is  $(440.00 - 393.26) / 393.26 * 100 = 11.89\%$  and so on. In this example, differences can be seen between the values of the traditional and the improved cost calculation. The related real-life applications confirm the assumption that LSP companies with not homogeneous services may experience a similar situation [8]. Using the traditional approach can yield distortions in the allocation of resources or in the determination of prices. That is why it is important to use systematic, cause-effect based allocation of indirect costs instead of applying ad-hoc cost distribution techniques.

Another advantage of using the developed cost allocation method is that the causes of profitability can be accurately explored. For instance, the profitability of “logistics service 8” in our example may be negative because of the wrong setting of the price, which would lead to low revenues. Maybe the direct costs are too high due to the high prices of the extern logistics ser-



vices purchased or the expensive infrastructure user charges, etc. It might also happen that some of the entities generating the indirect costs, e.g. the vehicles operate with a low capacity utilisation, or others, e.g. the maintenance unit, operate at a high resource consumption, etc. In possession of such additional information the decisions aiming to enhance the profitability of logistics services or the cost efficiency of organisational units or pieces of equipment can be supported in a more exact way.

Beside the advantages, the constraints and the conditions of introducing the model shall also be investigated. Difficulties may occur if the operation of the selected LSP company cannot be modelled perfectly. It means that some simplifications have to be accepted during the process modelling to make the allocation model consistent and calculable. Another problem may arise when the input data are not available at the required quality or they are too aggregate. Estimations may help eliminate the lacking or incomplete data bases. Nevertheless, the simplifications or estimations generally reduce the correctness of the calculation.

To run the model, often additional data collection procedures are to be carried out as some of the performance data are not covered by the enterprise information systems. Some input data, mainly cost items, may need extra transformations before feeding them into the model. The most difficult task is to measure the performance intensities, i.e. the distribution of performances or the performance consumption. So, one has to make every effort to automate and improve the measurement or the collection of input data as far as it is possible. However, it will probably increase the costs of the implementation. That is why it is important to find the balance or trade-off between accuracy and feasibility, as already mentioned in the literature review.

## 6. CONCLUSION

Logistics service companies play an important role in national economy. They contribute to making several industries more competitive, at the same time they shall keep an eye on their own competitiveness as well. To be competitive, LSP companies shall be aware of their costs, profits and performances. Decision makers need as accurate and detailed data of these key operation parameters as possible. Furthermore, they want to get an insight into the cause-effect mechanisms of logistics performance creation.

To meet the requirements set above, logistics costing systems shall be improved as traditional approaches may not be sufficient. One of the ways to enhance

the correctness and reliability of logistics cost calculation is the adoption of the multi-level indirect cost allocation technique. This method is based on the cause-effect oriented cost allocation principle supported by the identification of intra-company performance generation and consumption while inter-company service contact points are also taken into account.

This research has yielded a cost calculation scheme for logistics service providers incorporating the principles and experiences of best practice and introducing an alternative way to logistics cost management. Of course, the proposed model is generalised so it needs to be adapted before applying it in practice: every LSP company has its special operational features which are to be included in the real-world calculation schemes. The developed sample model can serve as a starting point for further modelling initiatives.

Although no fully appropriate input data were available the illustrative example calculation has proven the advantages of the costing tool. The allocation of indirect logistics costs is traceable and transparent. Cost and profit data of logistics services have become more correct. Capacity problems can be identified and handled effectively due to the revealed information concerning the value chains. On the other hand, the implementation of the improved logistics costing methodology may need further considerable resources like extra data collection or transformation efforts. Also, the information quality may not reach the level of total accuracy due to the simplifications and estimations. Nevertheless, the improvement of accuracy concerning cost and profit information is still considerable in comparison with the outcomes of the traditional calculation methods.

Summarising the research results we can conclude that the basic hypothesis has been verified. Nevertheless, further research is needed to better understand the conditions and possibilities of the real-world utilisation of the developed costing model. So the model is intended to be run in a real enterprise environment as well – as far as possible.

## ACKNOWLEDGEMENT

This work is connected to the scientific program of the “Development of quality oriented and harmonized R+D+I strategy and functional model at BME” project supported by the New Széchenyi Development Plan (project ID: TÁMOP-4.2.1/B-09/1/KMR-2010-0002). Furthermore, this paper is prepared with the support of the project “Modelling and multi-objective optimization based control of road traffic flow considering social and economic aspects” of OTKA (Project ID: CNK 78168).

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### LOGISZTIKAI SZOLGÁLTATÓK KÖLTSÉGSZÁMÍTÁSI MODELLJE

A logisztikai költségek egzakt számítása igazi kihívássá vált a logisztikai és az ellátási lánc menedzsmentben. A megbízható és pontos költséginformációk elengedhetetlenek a logisztikai szolgáltató vállalatok hatékony erőforrásallokációja szempontjából. A hagyományos költségcsökkentési megközelítések ugyanakkor elégtelenek lehetnek összetett és heterogén logisztikai szolgáltatási rendszerek esetén. Ezért e cikk célja, hogy feltérképezze a logisztikai szolgáltatók költségcsökkentési módszereinek fejlesztési lehetőségeit és javaslatot adjon a többszintű teljes költség allokációs technika logisztikai gyakorlati adaptálására. A módszertani keretrendszer meghatározását követően egy minta költségcsökkentési séma kerül kifejlesztésre, majd becslési adatokkal tesztelésre. Az elméleti eredmények és a példa alkalmazás tapasztalatai alapján megállapítható, hogy a továbbfejlesztett költségkalkulációs modell hozzájárul a logisztikai költségcsökkentés pontosabbá és átláthatóbbá tételéhez. Ezen túl a költségek és a teljesítmények közötti kapcsolatok is láthatóvá válnak, ami lényegesen javítja a logisztikai tervezés és irányítás hatékonyságát.

### KULCSSZAVAK

logisztikai költségcsökkentés, teljes költség allokáció, többszintű költségallokáció, logisztikai szolgáltatók

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