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Applying Activity-based Costing at Logistics Service Providers

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Zoltán Bokor[1], Rita Markovits-Somogyi[2 *]

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Abstract

Logistics service providers run business under a considerable pressure. They have to provide high quality logistics services at lowest possible prices and at the same time have to ensure a sustainable, profitable operation. This kind of business management requires reliable and true information about service costs. Distortions of costing information shall be minimised and the drivers of costs shall be accurately explored. Activity-based costing with methodological and industry specific adaptations may be used to improve the accuracy of logistics service providers' costing procedures. Additionally, it can deliver information on cost efficiency as well. Thus this paper aims to analyse the applicability of activity-based costing for the case of logistics service providers. A specialised cost calculation model is elaborated and tested under real-world circumstances. The functionality of the model is illustrated by pilot calculations. This shows that significant differences might exist between the results of activity-based costing and the outcomes of traditional costing. The significance of differences is in line with the complexity and heterogeneity of logistics services.

Keywords

activity-based costing, cost calculation, logistics service provider

[1] Department of Transport Technology and Ecomics, Budapest University of Technology and Economics, H-1521 Budapest, Hungary

[2] HungaroControl – Hungarian Air Navigation Services
H-1185 Budapest, Iglo u. 33-35., Hungary

[*]Corresponding author, e-mail: rita.somogyi@hungarocontrol.hu

1 Introduction

The strong competition in the logistics market enforces the service provider companies to enhance the capabilities of their management accounting systems (Karmazin, 2014). It is of high importance to know the real costs of services as well as the cost efficiency of activities contributing to the production of services. This information is needed for assessing the profitability and operation efficiency and for determining the price of services.

Traditional costing methods, however, are not always able to provide the information necessary for decision support in the required quality. They may even distort service cost calculations as detailed cost driver analyses are not applied within conventional costing regimes. Thus it is worth introducing alternative cost calculation methods which improve the accuracy and reliability of service cost data. Activity-based costing (ABC) is one of the applicable methods. It was chosen as it has already been implemented in logistics and has proven its usefulness in several industries. Nevertheless, there are relatively few case studies where the full scale costing results of logistics service providers or similar companies are reported.

The logistics service provider company examined in the present case study is a typical, small or medium sized enterprise being active in the Central-European logistics market. Thousands of similar firms are doing business in this macro-region. The sample company operates 15 leased heavy goods vehicles and a small-sized, so called forwarding warehouse with relatively short storage times. Its core activity is road haulage with full truck load services. The basic services may be supplemented by short-term warehousing and other value-added services. The logistics services offered vary according to the composition of the delivery (from single transport tasks to more complex tasks), the geographical relation (West, North-East or South-East) and the commodity type.

The specific aim of the research presented in this paper was to develop a cost calculation scheme for the sample company on the basis of ABC. At the same time the costing model is intended to be applicable for other similar enterprises as well. This requirement has been observed throughout the construction of the model.

2 Methodological background

The concept of activity-based costing was elaborated to solve the distortion problems of traditional costing systems (Cooper et al., 1988). This method allocates the indirect costs on a cause-effect basis instead of using arbitrary cost assignment techniques. Indirect costs are first assigned to activities and then, on the basis of relative performance consumptions, allocated to profit objects, i.e. elementary products or services. The allocation relies on the measured performance indicators, which serve as cost drivers. It shall be noted that if indirect costs cannot be assigned to activities, resource drivers may also be used to determine the activity costs.

La Londe et al (1994) pointed out that after its initial application in manufacturing, ABC can be a useful tool in logistics management as well. It can measure how products or customers consume logistics resources so the allocation of logistics related overhead costs can be carried out on a more exact basis.

Activity-based costing has been used in several studies where logistic processes have been analysed as an integrated function of production or retail processes. Pirttila et al. (1995) discussed ABC in the context of distribution logistics management of a manufacturing company. Instead of the traditional value-based approach an activity-based model was proposed for allocating distribution costs. Liberatore (1998) used ABC for calculating and projecting the true costs and profits of distribution channels. The improved costing model was also incorporated into the balanced scorecard oriented strategy monitoring system as the data provider of performance measurement. So ABC was established as a tool of enhancing the companies' ability to form an effective logistics strategy. Van Damme et al. (1999) presented a general logistics management accounting framework aiming to support logistics decisions. The distribution cost model combined ABC and cash flow based accounting. Manunen (2000) studied the logistics costs of industrial enterprises, i.e. manufacturers and wholesalers, by using ABC. Conclusions were drawn on the factors influencing logistics costs and cost efficiency. Stapleton et al. (2004) showed how ABC can be utilised as a tool of determining the true costs of logistics activities and how this information can be incorporated into the marketing strategy. Satoglu et al. (2006) evaluated the conversion of the storage system within a manufacturing company. The economic value of the conversion was assessed by a model taking advantages of ABC. Varila et al. (2007) elaborated a detailed activity cost model for the warehouse logistics of a wholesaler. The applicability of different cost drivers was examined and time-based multiple cost drivers were recommended instead of single transaction-based cost drivers. Comelli et al. (2008) proposed a tactical production planning tool in which logistics processes were analysed by ABC. Financial and physical flows and their parameters were combined to show the impact of production planning on indirect costs. The application of the planning tool was completed in a company supply chain. Nurminen et al. (2009) applied ABC for cut-to-length timber harvesting including short and long distance transport. Road transport related activities and cost drivers were analysed in detail within the forest industrial case study. Ye (2011) proposed to integrate ABC with economic value added (EVA) method so that capital costs can also be taken into consideration in the logistics costing model. Krajnc et al. (2012) increased the visibility of logistics costs as hidden overheads in a manufacturing company. Through ABC the management of material flows could be improved significantly in comparison with the traditional costing based case.

Logistics related ABC applications have been adapted even to complex supply chains. La Londe et al. (1996) proposed a supply chain costing principle which may use activities for tracing costs and connecting costs to performances, but at the same time the supply chain costing model shall be far more complex and use other techniques like total cost ownership (TCO) or efficient consumer response (ECR) as well. Goldsby et al. (2000) used ABC to reengineer the reverse logistics channel. The advantages that can be obtained by identifying the true costs of logistics operations were demonstrated and also how this information can be used to control and optimise the supply chain. Dekker et al. (2000) evaluated the role of management accounting in supply chain management and proposed an activity-based solution. The ABC model was built to assess the consequences of activity changes in supply chains. Lin et al. (2001) analysed the role of activity-based costing in the supply chain and proposed an ABC implementation framework. The study also looked at the managerial implications of introducing ABC. Askarany et al. (2010) examined how ABC can contribute to enhancing the capabilities of supply chain management by providing more accurate and detailed cost data. It has been concluded that smaller as well as non-manufacturing firms need to be more considerate when implementing the improved costing methods. Schulze et al. (2012) applied ABC in a supply chain environment as traditional intra-firm cost accounting was not appropriate in the context of supply chain management. A conceptual framework was developed which is able to identify inter-firm cost saving opportunities.

Compared to the application fields reviewed above there are only few ABC case studies available which analyse the detailed costs of logistics service providers or similar companies. Themido et al. (2000) conducted an activity-based cost calculation of service types offered by a third-party logistics operator. Additional outcome of the case study was the identification of data which are to be collected routinely for decision support purposes. Griful-Miquela (2001) developed the basic ABC model for third-party logistics companies. In the descriptive model the most common activities and cost drivers were identified for warehousing and transport. Baykasoglu et al. (2006) applied ABC to a road freight transport company. The costing model relied on a deep business process mapping which identified the activity structure. First as well as second stage cost drivers were used in the allocation procedure to determine the costs of transport service groups.

Service groups were arranged on the basis of target countries. It was observed that there may be a considerable difference between the results of ABC and the ones of traditional cost calculations. Bokor (2008) proposed an activity-based cost calculation scheme for logistics companies. Based on this model the corresponding implementation framework was also developed with sample activities and cost drivers (Bokor, 2009). Ma et al. (2011) found that indirect costs account for a high percentage of total costs in logistics enterprises. An activity cost accounting model using matrix algebra was developed and tested to cope with the problems of allocating indirect logistics costs.

It shall be noted that besides its methodological advantages ABC has some shortcomings as well. For example it may simplify the modelling of the operational structure for the sake of feasibility. Other methods, like multi-level full cost allocation, may overcome this problem by developing more sophisticated operational models for the calculations. Some related pilot applications can be found in the field of logistics, too (Bokor, 2012a ; Bokor, 2012b). At the same time multi-level full cost allocation is less flexible due to the fact that it relies on the static organisational structure. Furthermore, it requires more input data than ABC.

In spite of the methodological limitations ABC is still a powerful costing tool with a high implementation potential and can contribute to making logistics decision support more effective. Besides the accurate service costs, ABC delivers the average costs of activities as well. Average or specific activity costs may then be used for assessing the cost efficiency of main service generators. Last but not least, since ABC relies on the dynamic, activity oriented modelling of the operational structure instead of depicting the static organisation, the developed costing model can be adapted to various companies in a flexible way.

3 Calculation model

Summarising the literature review it can be concluded that activity-based costing is a suitable method for improving the cost calculation of logistics service providers and the reported logistics related ABC studies help defining the modelling framework of our calculations. Nevertheless, in our study the general ABC approach is fine tuned in the following way:

- the overall systematisation of the operations is carried out by separating the primary and secondary activities, following the principles of the value chain theory (Porter, 1985);
- fix and variable costs are differentiated and handled individually in the calculation process.

Primary activities take part in the production of ultimate services directly while secondary activities constitute the set of background operations. The latter group of activities consists of administrative functions like central management, human resource management, financial management and accounting, marketing, etc. Some company-intern services like information technology (IT) or housing may also be ranked among secondary activities.

Variable cost items vary according to different performance levels while fix cost items are independent from performance changes. Thus fix costs cannot be allocated on the basis of performance consumptions. They can be allocated on aggregated time basis instead. The costs connected to secondary activities are regarded as fix costs. The costs of primary activities may be fix as well as variable costs depending on their nature.

Considering the general features and the current modifications of ABC, the cost of a particular logistics service (as profit object) consists of four components (see Fig. 1):

1. assigned direct cost derived from the accounting system;
2. allocated variable indirect cost originating from primary activities, allocation is based on relative performance consumptions measured in detail;
3. allocated fix indirect cost originating from primary activities, allocation is based on the relative time consumption;
4. allocated indirect cost originating from secondary activities (can be regarded as fix cost), allocation is based on the relative time consumption.

Time consumption is the total duration of providing the logistics service including the time demand of corresponding transport, warehousing and sometimes also other tasks. The dominant time factors of logistics services in our case study are transport and warehousing. Time consumption is to be measured or industrial norms can be used instead.

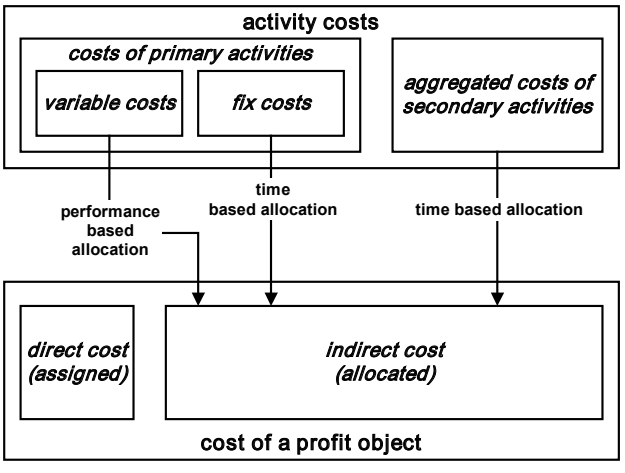

Fig. 1 ABC model for logistics service providers

Primary activities are indexed as i = 1…n, while profit objects, i.e. logistics services, are indexed as j = 1…m. So the cost calculation formula with the four components is the following.

$$C_j = C_j^d + \sum_{i=1}^{n} C_{v_i} \frac{P_{ji}}{P_i} + \frac{T_j}{\sum_{j=1}^{m} T_j} \sum_{i=1}^{n} C_{f_i} + \frac{T_j}{\sum_{j=1}^{m} T_j} C^{sa} \quad (1)$$

where

C_j – cost of profit object j;
C_j^d – direct cost of profit object j;
$C_{v\,i}$ – variable cost of primary activity i;
P_i – performance of primary activity i;
$P_{j\,i}$ – performance consumption of profit object j at primary activity i;
T_j – time consumption of profit object j;
$C_{f\,i}$ – fix cost of primary activity i;
C^{sa} – aggregated costs of secondary activities.

The four components can be merged into three components:

- assigned direct cost;
- allocated variable indirect cost, allocation is based on relative performance consumptions;
- allocated fix indirect cost, allocation is based on the relative time consumption:

$$C_j = C_j^d + \sum_{i=1}^{n} C_{v_i} \frac{P_{ji}}{P_i} + \frac{T_j}{\sum_{j=1}^{m} T_j} \left(\sum_{i=1}^{n} C_{f_i} + C^{sa}\right) \quad (2)$$

The cost efficiency, i.e. the average cost of a primary activity (as service generator) can be calculated as follows:

$$c_i = \frac{C_i}{P_i} = \frac{C_{v_i} + C_{f_i}}{P_i} \quad (3)$$

where

c_i – cost efficiency of primary activity i;
C_i – cost of primary activity i.

4 Calculations

Before applying Eq. (3) for the case of the examined logistics service provider, the set of primary activities is to be identified on the basis of the company's operational structure. The productive human and capital resources are then connected to these activities, which enables the assignment of corresponding indirect costs. Thus no resource drivers are necessary. Another task is to define adequate performance indicators (cost drivers) for each primary activity. The indirect costs which cannot be assigned to primary activities are aggregated into the set of secondary activity costs.

The primary activities and their possible cost drivers (with dimensions) are the following:

- sales including market research, customer relationship management and billing – working time (man-hour);
- service planning including the planning of transport, warehousing, forwarding and supplementary tasks – working time (man-hour);
- performing services:
  - operative transport management, dispositions – working time (man-hour);
  - vehicle management, i.e. providing vehicle capacity – running (vehicle km);
  - driver management, i.e. providing driver capacity – working time (man-hour);
  - warehousing, i.e. storing of consignments – occupation (sqm*day);
  - loading and conveyance of consignments – operation time (machine-hour);
  - providing supplementary services – working time (man-hour).

Direct costs of logistics services may be for example the costs of subcontractors (outsourced services), the so called dedicated costs, i.e. infrastructure user charges, and the fuel costs of freight transport tasks. Here fuel costs and infrastructure user charges are considered as direct costs due to the provided data structure of the management accounting system.

In the case study, three different elementary logistics services have been evaluated. Service 1 is a regular logistics service while Service 2 and Service 3 are unconventional ones. It means that the production of Service 2 needs relatively less effort while Service 3 is a more complex logistics service with above average efforts. The input data of the three calculation alternatives are presented in Table 1. Note that maintenance costs are included into leasing and material costs of ensuring vehicle capacity.

Table 2 shows the classification of cost items, i.e. the definition of fix and variable items. There are three versions of cost classification:

1. version A: even the short-time fix items are regarded as fix costs;
2. version B: vehicle and driver costs are regarded as variable costs since vehicle and driver capacities can be adjusted to performance changes in the short run;
3. version C: besides background functions (secondary activities), warehousing and loading capacities all other capacities are regarded as adjustable.

The more variable cost items are available the higher is the potential of cause-effect based indirect cost allocation. And by using cause-effect based indirect cost allocation the ratio of non-explainable allocations can be minimised. Of course, the decision on what cost items are fix or what items are variable depends on the business-technology characteristics of the particular enterprise. Anyway, it is advisable to classify the cost items carefully as it has an impact on the calculation and on the cost values (see later).

The calculations based on Eq. (2) have been carried out for three services (1, 2 and 3) and for three versions of cost classification (A, B and C). Additionally, each service has been evaluated by the traditional cost calculation method as well,

Table 1 Input data for the cost calculation

	Service 1	Service 2	Service 3
secondary activities	total cost: 172 305.17 EUR		
sales	personnel costs: 34 977.05 EUR		
	total working time: 3 869 man-hour		
	working time for Service 1: 6:44 man-hour	working time for Service 2: 3:38 man-hour	working time for Service 3: 8:26 man-hour
service planning	personnel costs: 44 970.49 EUR		
	total working time: 5 802 man-hour		
	working time for Service 1: 10:05 man-hour	working time for Service 2: 6:47 man-hour	working time for Service 3: 10:53 man-hour
operative transport management	personnel costs: 29 980.33 EUR		
	total working time: 3 867 man-hour		
	working time for Service 1: 6:43 man-hour	working time for Service 2: 5:50 man-hour	working time for Service 3: 9:14 man-hour
vehicle management	leasing cost: 182 950.82 EUR tax & insurance: 34 044.85 EUR material cost: 23 185.74 EUR		
	total running: 1 561 440 veh. km		
	running for Service 1: 2 689 veh. km	running for Service 2: 3 222 veh. km	running for Service 3: 1 522 veh. km
driver management	wages: 212 996.07 EUR bonus: 53 040.00 EUR		
	total working time: 32 882 man-hour		
	working time for Service 1: 57:11 man-hour	working time for Service 2: 65:29 man-hour	working time for Service 3: 34:05 man-hour
warehousing	depreciation: 10 928.96 EUR material cost: 9 836.07 EUR		
	total occupation: 228 125 sqm*day		
	occupation for Service 1: 396.74 sqm*day	occupation for Service 2: 182.74 sqm*day	occupation for Service 3: 642.34 sqm*day
loading and conveyance	depreciation: 6 557.38 EUR personnel costs: 24 983.61 EUR material cost: 19 016.39 EUR		
	total operation time: 3 780 machine-hour		
	operation time for Service 1: 6:34 machine-hour	operation time for Service 2: 4:16 machine-hour	operation time for Service 3: 10:40 machine-hour
supplementary service	personnel costs: 19 986.89 EUR		
	total working time: 3 876 man-hour		
	working time for Service 1: 6:44 man-hour	working time for Service 2: 0:00 man-hour	working time for Service 3: 12:20 man-hour
total indirect costs	879 759.80 EUR		
direct costs	fuel cost: 1 184.92 EUR infra. user charges: 327.88 EUR	fuel cost: 1 242.32 EUR infra. user charges: 560.88 EUR	fuel cost: 628.76 EUR infra. user charges: 162.58 EUR
	total fuel cost: 443 629.28 EUR total infra. user charges: 188 532.09 EUR total direct costs: 632 161.37 EUR		
time consumption	9.10 day	5.90 day	10.20 day
	total time consumption of services: 5 197.50 day		

Table 2 Classification of cost items

activity	cost item	version A	version B	version C
secondary activities	all	fix	fix	fix
sales	personnel cost	fix	fix	variable
service planning	personnel cost	fix	fix	variable
operative transport management	personnel cost	fix	fix	variable
vehicle management	leasing cost	fix	variable	variable
	tax & insurance	fix	variable	variable
	material cost	variable	variable	variable
driver management	wages	fix	variable	variable
	bonus	variable	variable	variable
warehousing	depreciation	fix	fix	fix
	material cost	variable	variable	variable
loading and conveyance	depreciation	fix	fix	fix
	personnel cost	fix	fix	fix
	material cost	variable	variable	variable
supplementary service	personnel cost	fix	fix	variable

Table 3 Results of the calculation

	Service 2		Service 2		Service 3	
	(EUR)	Trad. = 100	(EUR)	Trad. = 100	(EUR)	Trad. = 100
ABC/A	3051.50	84.34	2865.44	66.44	2470.62	130.54
ABC/B	3042.78	84.10	3249.29	75.34	2059.08	108.79
ABC/C	3041.25	84.06	3232.42	74.95	2099.89	110.95
Traditional	3618.13	100.00	4312.66	100.00	1892.63	100.00

where indirect costs have been allocated proportionally to the direct costs. The final result of the calculation is summarised in Table 3. ABC/A, ABC/B and ABC/C refers to the activity-based calculations differentiated by the three versions of classifying activity cost items (see Table 2).

It can be concluded that there are significant differences between the calculated service cost values of the traditional technique and the ones derived with the improved methods. The more unconventional a logistics service, the higher difference can be expected between the various cost values. The traditional costing method systematically overestimates the costs of logistics services produced with less effort and at the same time underestimates the costs of logistics services provided with higher performance intensities. Furthermore, the effect of the cost classification on the cost values is also stronger when the logistics service is unconventional. The costs of regular logistics services, however, are much less dependent on the definitions of fix and variable costs.

Thus, it is of high importance to use the more accurate ABC model and to differentiate between the fix and variable costs. These improved cost management tasks are particularly recommended when the service structure of the logistics company is heterogeneous, as it was in the case study presented above. Here it is strongly recommended that ABC procedures with identified direct and separated variable indirect costs be applied. If the data management system does not support the full differentiation of costs simpler ABC models can also be applied by taking the limitations of the results into account.

Besides cost calculations, the ABC model may deliver an analysis of the cost efficiency of service generators, i.e. primary activities, as well. The average costs of primary activities, as the indicators of cost efficiency, are presented in Table 4. The calculations have been performed by using Eq. (3).

Average cost values, as the tools of monitoring cost efficiency, can be evaluated by comparing them either to the corresponding values of previous years or to the values of similar indicators measured at other logistics service companies. Unfortunately, none of these values were available during the research. Nevertheless, this extra functionality can also be exploited if relevant benchmark data are accessible. The

introduction of the improved costing mechanism delivers these data within the company from year to year, so at least intra-company cost efficiency evaluations are possible with ABC.

Table 4 Average costs of primary activities

primary activity	average cost	dimension
sales	9.04	EUR/man-hour
service planning	7.75	EUR/man-hour
operative transport management	7.75	EUR/man-hour
vehicle management	0.15	EUR/vehicle km
driver management	8.09	EUR/man-hour
warehousing	0.09	EUR/sqm*day
loading and conveyance	13.37	EUR/machine-hour
supplementary service	5.16	EUR/man-hour

Let us have a look at the indicator of cost/vehicle km. This is a widely used index in logistics practice. Note that the index presented in Table 4 contains only the cost items assigned to vehicles, i.e. leasing costs, tax & insurance and material costs. Of course, more complex cost/ vehicle km indicators can also be determined by the ABC model if necessary:

- cost/vehicle km including assigned items and fuel costs: 0.44 EUR/vehicle km;
- cost/vehicle km including assigned items, fuel costs and infrastructure user charges: 0.56 EUR/vehicle km;
- cost/vehicle km including all costs: 0.97 EUR/vehicle km.

This example shows another advantage of ABC. It is able to produce consistent and specific cost information at different levels of the operational hierarchy.

5 Conclusion

Activity-based costing can be applied effectively to improve the cost calculation practices of companies, among them the ones of logistics service providers. Thus the general ABC model has been adapted to the special operational characteristics of such kind of companies. Methodological developments have also been added: the relevant activities have been systematised on the basis of the primary-secondary approach on the one hand and the differentiation between fix and variable cost items has been introduced on the other hand. Originally the model has been set up for a particular logistics service provider company. Nevertheless, the methodology developed is flexible enough to extend the application field to other companies with similar operational features.

The results of the pilot cost calculation have highlighted that service cost values delivered by ABC may be more accurate than the ones of the traditional costing regimes. The increase of the accuracy is generally in line with the complexity and heterogeneity of logistics services offered. Furthermore, ABC calculations can be sophisticated by the different classification modes of fix and variable cost items. Regular services are less sensitive to such differentiations, but the calculation results of unconventional services may be affected by the definition of fix and variable costs significantly. That is why special attention shall be paid not only to the appropriate costing approach but also to the correct definition of cost types.

Logistics ABC models require extra input data in comparison to the traditional approaches. The management information systems are generally able to provide the accounting data needed. Some data transformations may be necessary, but nothing further is required. The performance indicators and their actual values can be derived from the technology information systems or are to be recorded separately. The latter solution is more expensive but sometimes it is unavoidable. The majority of input data can be made available with minor effort after all. The extra tasks are mostly associated with the combination and integration of accounting and technological data, which highlights the main added value of ABC.

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