

# The Use of Process-Oriented Methods of Calculation to Determine the Costs of Logistics Processes

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**Abstract**—The aim of this paper is to create a proposal for determining the costs of logistics processes by using process-oriented calculation methods. The traditional approach is that logistics costs are part of manufacturing overhead which is usually calculated as a percentage surcharge. Therefore in the traditional approach it is not obvious where and in which activities costs were incurred. So it is impossible to trace logistics costs to products. Our point of view is trying to fix or at least improve this issue. Another benefit of applying the process approach is identification of logistics processes which are otherwise part of manufacturing overhead. In the first part this paper describes the development of process-oriented methods over time. The next part shows the possibility of implementing the process-oriented method called Prozesskostenrechnung to logistics processes. The conclusion summarizes advantages and disadvantages of using this method in logistics.

**Keywords**—Cost, logistics, calculation, process-oriented method.

## I. INTRODUCTION

**C**OSTS and cost control have been at the forefront of all companies since Peter Drucker (1962) [1]. It is a known fact that the level of logistics costs does not only affect the productivity of supply chains but manufacturing companies as well. For traceability of logistics costs it is essential to break down these costs by logistics processes. One logistics process is the process of storing material in the warehouse. If we look at how the costs of storage are observed in business practice we find that either they are not monitored at all or are expressed only by one total value. This fact is confirmed by a survey conducted by SupplyChainDigest<sup>TM</sup>. [2]

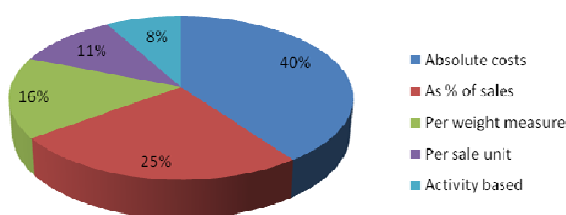


Fig. 1 Primary Logistics Cost Measure [2]

The SupplyChainDigest<sup>TM</sup> survey claims that the primary measures of logistics costs in a wide range of industries are either absolute cost (40%) or percentage of sales (25%), see

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Fig. 1. Therefore these companies lose the ability to identify the structure of logistics costs and so they cannot control them effectively. But this fact is in contrast with the growing importance of logistics costs [3].

The research described in this paper is based on theoretical research by Cechura [4] which deals with usage of cost calculation for setting standards for performance evaluation.

## II. LITERATURE REVIEW

Process-oriented control offers us a different view of cost control. In contrast to traditional calculation, which is focused on where and for what the different resources have been used, process-oriented control is focused on how much of the costs are actually caused by activities associated with products. The basic elements are cost activities. Generally, all activities can be displayed as the performances in processes and consequently in process costs. [5] The specific attribute of logistics processes is that usually direct material does not enter into activities.

Over time many process-oriented methods and their modifications have been developed. Among the most famous of them are Mission Costing (MC), Activity Based Costing (ABC) and Prozesskostenrechnung (PKR).

At the beginning of the 1970s the method called Mission Costing was first introduced while developing the total cost approach to physical distribution. [1] The basic principle is that the cost system should correspond to the material flow in the company. The second principle is that the system should be capable of enabling separate cost and revenue analyses to be made by customer type and by market segment or distribution channel. [6], [7] The significant disadvantage of this method is that it is only a theoretical model that has never been applied in practice.

Following the principles of Mission Costing at the beginning of the 1980s in the USA a method was developed called Activity Based Costing (ABC). This method is based on a comprehensive process control system. The cost system is also process-oriented. The development of this method was initiated because of the growing importance of monitoring overhead costs in companies. [8] This method is general so it can be applied to various parts of the company or various industries.

In 1989 a method called Prozesskostenrechnung (PKR) was developed by Horvath and Mayer on the framework of Activity Based Costing. This method is also based on allocating costs to activities that are consumed in the production. The main conceptual difference is that PKR limits overhead costs scheduling only to indirect performance area. Thus the process cost control system is not complex (unlike ABC); it is part of the methodology of scheduling overheads.

PKR allocates cost that cannot be expressed through consumption of activities by using other calculation techniques. [9]

In the following years there were many attempts to adapt these methods to the field of logistics processes. In most cases, these studies were focused on the implementation of ABC to supply chains or warehouses, see for example references [10]-[13]. In our research we want to look further and determine the possibility of application of PKR method to this area. We believe that principles of the PKR method better correspond with warehouse processes than the principles of ABC.

### III. THE POSSIBILITY OF APPLICATION OF PKR METHOD TO WAREHOUSE PROCESSES

In our solution, we consider that the warehouse process consists of five sub-processes, see Fig. 2. Essentially products are received, put-away and stored until they are required by the customer (i.e. production for us). On receipt of a customer order products are picked, packed, sorted, standardized (if necessary) and shipped to the customer (production).

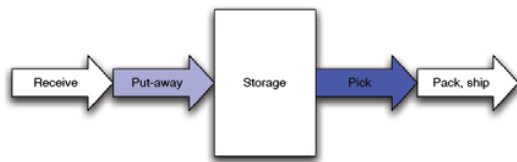


Fig. 2 The procedure of warehousing process [14]

The result of application of PKR to the warehouse processes is assignment of costs to products based on how much of the costs products actually caused. To determine the warehouse costs we use process-oriented calculation, see Fig. 3.

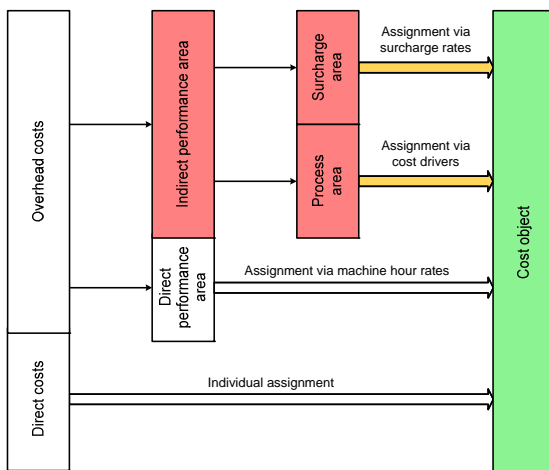


Fig. 3 Principle of costs allocation according the assignment to the cost object [15]

Since there are no material transformations in warehousing (therefore no direct creation of added value for the customer) warehouse costs are classified as overhead costs within the indirect performance area. It is necessary to analyse

warehouse processes first to determine how to allocate costs to them. There are two basic options – process way or surcharge way. In the process way we handle only those processes that are stable, standardized and repetitive. All other processes that do not meet these conditions are handled in the surcharge way. In the following text we look in detail at application of the PKR method.

The procedure of PKR application to warehouse processes has 7 consecutive steps:

- Analysis of warehouse processes and identification of repetitive, stable and standardized.* In this step we define the process area. In our case, we identified five processes: receive, put-away, storage, pick and ship (inc. pack).
- Choice of allocation basis.* We choose personnel capacity as the allocation basis for the warehouse processes. The reason is that the warehouse process is in most cases very personnel intensive and so personnel costs represent the major part of total costs.
- Description of sub-processes within standardized processes defined in the first step.* In this step we identify and describe sub-processes and further divide them into so-called lmi-processes (are quantity variable; depend on amounts of on-going processes) and lmn-processes (are quantity independent).
- Specification of cost drivers for repetitive sub-processes.* For lmi-processes we define our own metrics (cost drivers). These metrics are used for quantification of processes. We do not set metrics for lmn-processes. An example of sub-processes and cost drivers determination of picking process is shown in Table I.

TABLE I  
EXAMPLE OF SUB-PROCESSES AND COST DRIVERS DETERMINATION OF PICKING PROCESS

Sub-process	Type	Cost drivers
Ordering	lmi	Nr. of required SKUs
Transportation to/from picking location	lmi	Nr. of travelled kilometres
Searching for picking location	lmi	Nr. of lines Nr. of picked pieces
Picking	lmi	Nr. of picked cases Nr. of picked pallets
Checking, control	lmi	Nr. of lines
Paperwork and other activities	lmn	-

- Determination of the sub-process quantity.* In this step the total quantity for different metrics is specified. The term sub-process quantity means the expected frequency of a certain repetitive activity within the given timeframe (e.g. one month). For example for the picking process we expect 200 material orders, 150 searches for picking location, etc.
- Calculation of sub-process costs.* In this step we calculate cost rates for all sub-processes. First, cost rates for lmi-processes are calculated. Lmn-process costs are then allocated proportionally to lmi-processes according to the following formula:

$$\frac{\text{sub - processcost (lmi)}}{\text{sum of sub - processcosts (lmi)}} * 100 [\%] \quad (1)$$

G) *Summarization of several related sub-processes which exceed cost pools to a few main processes.* In this step costs are allocated to main processes according to their relativity, see Fig. 4.

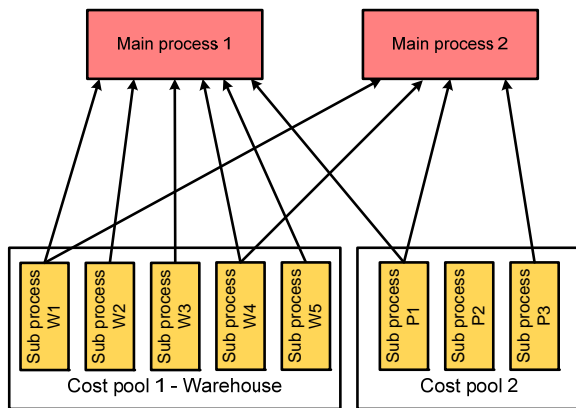


Fig. 4 Assignment of sub-processes to main processes

The total cost of the product is calculated according to the quantity of sub-processes related directly to the product. Calculation is as follows:

$$\frac{\text{sum of process costs of the main process}}{\text{quantity of the main process}} \quad (2)$$

By application of the whole procedure stated above we can calculate warehouse costs for each individual product.

#### IV. APPLICATION OF THE PROPOSED SOLUTION IN A MANUFACTURING COMPANY

The proposed solution was practically verified in a case study performed in the company PLAST, s.r.o. (real name

cannot be stated because of data confidentiality). PLAST, s.r.o. is a medium sized company with approximately 80 employees working in three shifts. The company has several manufacturing and assembly workplaces. The production is focused on thin-wall injection molding of plastic components for the automotive, cosmetic and telecommunication industry. The company produces various elements of switches, key components, body parts, etc. The typical product is cup holder for Mercedes.

The company has two warehouses. The first warehouse is used for storing parts for production – warehouse “C”. The second warehouse (warehouse “MG”) is used as a distribution centre for parts which cannot be stored in warehouse “C” (for example due to lack of capacity). Warehouse “MG” is also used by Mother Company for storing final products which are further distributed. Our solutions deal only with warehouse “C”.

In warehouse “C” the material is stored in pallet racks. The handling equipment is represented by one electric forklift truck and five hand pallet trucks. The material process involves five operators. One operator unloads trucks in the material receive area (goods-in), another puts away material to the pallet positions within racks. The remaining operators provide internal transport between manufacturing and assembly workplaces. The calculating of cost rates is shown for the put away sub-process. The total cost of this process has been estimated at € 64.162 per year.

The procedure of process cost allocation is as follows. First, based on the analysis of activities, sub-processes are established in existing costs pools. Cost drivers and process quantities for individual sub-processes are then defined. The data are obtained from the statistical analysis of repetitive warehouse processes. As allocation basis we choose personal capacity because put away is manual process with a high percentage proportion of personal costs on total costs. Identified data are summarized in Table II.

TABLE II  
A PRACTICAL EXAMPLE OF COST RATE CALCULATION

Nr	Sub-process	Type	Cost driver	Quantity	Nr. of employees	Nr.	cost <sub>lmi</sub>	cost <sub>lmi</sub>	cost <sub>lmi+lmi</sub>	rate <sub>lmi</sub>	rate <sub>lmi+lmi</sub>
1	order processing	lmi	Nr. of orders	800	0.25	1	3208.1	64.2	3272.3	4.0	4.1
2	searching for pallet placement	lmi	Nr. of lines in all orders	3,500	0.65	2	8341.1	166.8	8507.9	2.4	2.4
3	truck move to/from pallet space	lmi	distance traveled [m]	73,456	2.00	3	25664.8	513.3	26178.1	0.3	0.4
4	loading of pallet	lmi	Nr. of loaded pallets	2,400	1.00	4	12832.4	256.6	13089.0	5.3	5.5
5	unload of pallet	lmi	Nr. of unloaded pallets	800	1.00	5	12832.4	256.6	13089.0	16.0	16.4
6	Paperwork / control	lmi	-	-	0.10	6	1283.2	25.7	1308.9	-	-
<b>Sum lmi+lmi</b>					<b>5.00</b>	<b>Sum</b>	<b>64,162.0</b>	1283.2	65445.2		

The main output is a calculation of cost rates of all sub-processes. For instance sub-process nr. 4 called “loading of pallet” costs 5.5 euro. The next step would be allocation of costs for products. However, the detail description of further steps is not the objective of this article.

#### V.CONCLUSION

The most significant advantage of implementation of process-oriented calculation is increasing transparency of overhead costs. Traditional calculations use a percentage surcharge. The proportion of costs is then allocated as the

percentage of calculation basis. However this proportion does not have to match the actual consumption of resources. Using process-oriented calculation (and thus PKR method) we can allocate overhead costs more accurately. The cost allocation in PKR is based on the actual consumption of resources. This effect is significant especially in warehouse processes. In the traditional approach warehouse processes are part of manufacturing overhead where it is not possible to trace how much costs they actually caused. Another benefit of PKR implementation is apart from processes analysis also identification of bottlenecks and identification of non-value added activities.

On the other hand there are some disadvantages associated with using process-oriented calculation for warehouse processes. The most serious include determining how to spread fixed overhead costs. For example, reducing the quantity of a sub-process by 10% does not automatically mean that cost will also reduce by 10%. Fixed costs are fixed only within a certain range of a sub-process. Therefore some of the costs cannot be causally divided by any calculation technique to the costs objects.

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