Application of Activity Based Costing Metod in Heat Treatment Processes

Aplikace metody Aktivity Based Costing v procesech tepelného zpracování

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The paper describes an implementation of the Activity Based Costing application in a selected metallurgical enterprise which operates heat treatment processes of metallic materials. Activity Based Costing (abbr. ABC method) principle is different from the traditional approach of costing methods because it allocates consumed resources to the particular activities in order to achieve distribution of overheads according to real causality of their origin. These activities consume resources and at the same time, they are consumed by cost objects themselves. The analysis of the activities defines cost drivers, which make it possible to express a causal relation among consumed resources and cost objects. Activity-Based Costing assumes that the cause of costs is the activities, not the products directly. The goal of this paper is a description of Activity Based Costing application for costs evaluation in the case of heat treatment processes.

***Key words**: heat treatment; Activity Based Costing; activities; cost drivers; cost object*

Trend postupující celosvětové globalizace způsobuje, že výrobní podniky jsou pod stále větším konkurenčním tlakem a musejí budovat svoji konkurenční výhodu prostřednictvím inovací transformačních procesů, rozvoje lidského kapitálu nebo investic do nových technologií. Je zřejmé, že na tuto situaci by měly podniky reagovat i prostřednictvím důsledného řízení svých nákladů. Většina průmyslových podniků tuto potřebu vnímá, avšak v období změn reprezentovaných čtvrtou průmyslovou revolucí si již nevystačí s tzv. tradičními metodami řízení nákladů. Je nezbytné využívat takové metody řízení, které drží krok s dynamicky se vyvíjejícím ekonomickým prostředím. V oblasti řízení nákladů by tak neměla zůstat stranou metoda, která je sice teoreticky již dostatečně propracována, ale v praxi, zejména tuzemských podniků, je stále poněkud opomíjena. Touto metodou je ABC (Activity-based Costing). Předkládaný příspěvek je věnován popisu implementace metody ABC ve vybraném provozu tepelného zpracování. Tato implementace plně respektuje princip metody, který je odlišný od tradičního přístupu kalkulačních metod, neboť rozděluje spotřebované zdroje na tzv. aktivity s cílem dosáhnout rozvržení režijních nákladů podle skutečné příčinnosti jejich vzniku. Aktivity podniku na jedné straně spotřebovávají zdroje a na druhé straně jsou spotřebovávány nákladovými objekty. Analýzou podnikových aktivit jsou definovány vztahové veličiny, které umožňují vyjádřit příčinný vztah mezi spotřebovávanými zdroji a nákladovými objekty. Metoda ABC tak předpokládá, že příčinou vzniku nákladů jsou činnosti, nikoli přímo produkty. Cílem předkládaného příspěvku je popsat jednotlivé kroky praktické aplikace metody ABC pro účely hodnocení nákladovosti procesů tepelného zpracování kovových materiálů.

***Klíčová slova**: tepelné zpracování; metoda ABC; aktivita; vztahová veličina; nákladový objekt*

ABC is a relatively new method of cost control that originated in the United States. American authors Kaplan and Cooper, who presented this method in a research paper titled "Measure Costs Right: Make the Right Decisions" [1] in 1988, are considered to be its founders. An important role in defining and stabilizing principles and increasing awareness of ABC was played by an American institution, Consortium for Advanced Management – International (CAM-I), which defines the ABC method as "methodology that measures costs and performance of activities, resources and cost objects. Resources are assigned to activities and activities are assigned to cost objects based on their use. ABC recognizes causal relationships among resource consumption, activities and cost objects." [2] As well as many other economic instruments and methods, the ABC method also originated as a reaction to changes in economic environment. The current business environment is characterized by an excess of supply over demand (for most markets), shortening of product lifetime, a wide range of offered products, use of different distribution channels and effort to provide a wide range of additional services to the customers. This dynamic development of business environment has had a significant impact on companies' cost structures over past decades. The proportion of overheads needed for providing support, service, information, control and other activities increases particularly. The above mentioned changes taking place in the business sector and therefore in the costs structures of companies generated criticism of the traditional approach, which was primarily based on an effort to manage (and thus calculate) the cost of final outputs and gradually led to a primary focus on the costs of realized activities, actions and process as a whole. [3] The creation and

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gradual application of ABC method is also due to growing demands on company costing systems because the pressure on quality and structure of information for managerial decision-making processes increases. The company managers often try to find out which products are profitable and which ones are unprofitable, whether individual company activities are carried out efficiently and how much company really pays for these activities. The reasons highlighted above indicate that traditional costing methods and procedures are not able to deal with the nature of relationships between costs and outputs in all its complexity. Activity Based Costing is a method which should be able to do this.

1. Application of the ABC method in heat treatment pro cesses

The ABC method consists in the fact that it does not divide resources among in-house centres, but among activities in order to achieve overheads distribution based on the real cause of their origin. "The application starts with division of company activities into partial activities (e.g. material ordering, receiving and delivering, transporting and storing, production equipment adjusting, quality control, in-house transport, product packaging and expedition etc.) focusing primarily on areas, where overheads arise. It examines which costs are generated by the activities and tests their necessity. The relations which generate costs are called cost drivers (e.g. the number of orders or invoices, the number of suppliers, the number of customers, hours of machine work, the number of inspections etc.). The costs related to an activity are allocated to outputs (i.e. goods or services), i.e. individual customers as unit costs." [4] In practice, this procedure has been proven to be an appropriate way to eliminate the generalization of costs in various simplified allocation methods. The process of ABC application can be summarized into the following steps [5, 6]:

a) In the first step, an economic resource (i.e. indirect cost) is assigned to individual activities based on the resource cost driver, which defines the way of recalculating costs from accounting onto individual defined activities.
b) In the second step, the total costs of individual activities are determined, the activity cost driver is defined and the unit cost of activity is determined as well.
c) In the third step, the cost object (i.e. an output, a service, a customer etc.) is determined based on costs per activity unit and volume of the units that cost object consumes.

An activity represents a fundamental element of the business process, which can be defined at least in terms of costs that need to be expended in connection with its realization, but also in terms of measurable output resulting from this activity. [3] Activities can be divided into activities adding some value to product (i.e. primary activities) and those once which do not add any value to product (i.e. supporting activities). Supporting activities (i.e. secondary activities) are carried out for internal needs and support primary activities in company. It is usually not possible to define any relation between their consumption and cost objects. Therefore they are not allocated directly to a cost object, but only to primary activities. Then costs of individual activities are assigned to defined cost object. Cost objects are any objects to which costs can be allocated. This includes not only products and services, but also for example customers, divisions, departments, product groups, production lines, manufacturing processes etc. So called activity cost drivers are defined by analysing business activities; they allow to express a causal relation among consumed resources and cost objects. ABC assumes that the cause of generating costs is activities, not directly products.

1.1 Five steps of the ABC method practical application

The ABC method was applied under conditions of a hardening shop in a selected industrial plant which manufactures agricultural machines. The main processes of heat treatment realized by this hardening shop include carburizing, quenching, carbonitriding, tempering and annealing. The above listed processes are realized by using continuous carburizing and quenching line, multipurpose furnace, a few tempering chamber furnaces, vacuum furnace, annealing furnace, a few induction quenching machines and press quenching machine. The main heat treated products include the components of gearboxes and engines, especially various types of gears and shafts. In accordance with theory represented by many authors [2, 3, 5, 6, 7, 8, 9, 10] the following steps were defined for a successful implementation of the ABC method in the selected hardening shop.

The Modification of accounting data

The goal of this stage was to determine only the real economic costs related to currently performed activities. First, it was necessary to exclude costs which are not related to these activities or do not correspond to currently spent resources and therefore their allocation would be difficult and distorting. For example, such costs include exchange rate differences, adjusting items, reserves, gifts, inventory differences etc. It was also decided to exclude costs which can be considered as an investment from an economic point of view as they are rather considered to be future long-term benefits (e.g. advertising costs or development and education costs). On the other hand, there were also costs included into ABC calculation which are not recorded in financial accounting – so called opportunity costs.

Activities and cost objects identification

In this follow-up phase of the ABC implementation, it was necessary to identify the structure of activities and cost objects which were monitored in the calculation. The reason for determining cost objects already in this

moment is the fact that appropriately defined cost object has a positive impact on creating the structure of activities. Activities of the hardening shop were identified based on the types of heat treatment performed in the selected enterprise. The basis of activity structure creation was a detailed analysis of the hardening workplaces, the used technologies, the logistics flows and the human work. The aim of this analysis was to describe the mutual connection of single heat treatment processes, sub-processes, material flows and work organization in all workplaces. Based on obtained findings, a proposal of activity structure was made. This proposal was further specified by leading interviews with the production director, the hardening shop supervisor, a heat treatment engineer and all the involved heart treatment operators. Additional specification was done by using a detailed analysis of available production data. Based on the above defined steps, primary activities, which represent cost-important activities performed within the hardening shop, were defined in the first stage. Activity structures can have the following form (Tab. 1).

Tab. 1 Example of primary activity structure in the selected hardening shop. Source: own
Tab. 1 Příklad struktury primárních aktivit konkrétního provozu kalírny. Zdroj: vlastní

PRIMARY ACTIVITY STRUCTURE			
Workshop Code	**Activity Code**	**Activity Name**	**Activity Description**
2610	1710	AICHELIN KSGS / carburizing	*Carburizing and quenching in continuous furnace.*
	…	…	…
	1111	Handling and handwork	*Servicing activities taking place within hardening shop.*

The above described process was used to identify 15 primary activities, which correspond to individual heat treatment processes as well as finishing and service processes such as blasting, degreasing or handling and handwork. The possibility of obtaining relevant data from the existing company information systems, their regular updating and using in the ABC system was taken into account during practical application of ABC. The individual activities were assigned numerous codes, mainly because of the possibility of further expansion of the ABC calculation within production department in the selected company (i.e. within other in-house centres). The workshop code is based on an internal designation of individual centres in the selected company, activity codes then correspond to internal designations of workplaces. An important element of creating activities structure is also a detailed description of activities because a precise definition of their content simplifies the following phases of ABC application, mainly cost allocation. Only the relevant groups of costs (i.e. volume significant group of costs) should correspond to the activities. For this reason, all servicing activities performed within the selected centre were united in an activity no. 1111 Handling and handwork. In this initial phase of the ABC method implementation, a structure of so-called supporting activities was defined too. There were 10 supporting activities identified in total. Among these supporting activities were included activities supporting purchasing raw-materials, technological preparation of production, production itself such as quality control and maintenance, production administration activities or certain form of opportunity costs (i.e. so-called costing rent). The definition of the supporting activity structure was processed in accordance to the above described procedure of defining primary activities. In order to understand interrelations of all the activities, their illustration was designed by using an activity diagram. This visualization of all activities being processed in the selected company centre was very useful in following steps of the ABC method implementation. Cost object, which represents an object of consumption of individual activities outputs, was also defined in this phase. In accordance to company management requirement, the cost object was defined as one kilogram of heat treated material. The identification of activities, cost objects and individual links among them may be considered as a definition of ABC structure.

Allocating costs to activities

For the purpose of assigning costs to activities (i.e. valuation of activities), all cost types were divided into direct and indirect costs. Indirect costs were under higher focus in the following application of ABC, whereas direct costs were allocated to cost object within the last phase of method implementation. The transformation of individual indirect costs items from accounting and their allocation to the defined activities were done by using so-called Activity Cost Matrix, which clearly presents all links among cost items and activities. While creating the cost matrix of primary activities, the costs associated in different groups of cost types were divided based on the identified links to individual activities, which generated their origin. To identify these links, both so-called Resource Cost Drivers (RCD) and a specific form of direct allocation were used. RCD used was a time analysis of performance, a direct allocation, units of measure and a qualified estimation. A specific example of used RCD is the number of workers assigned to individual activities, which served for dividing personnel costs. The direct allocation of costs to primary activities was used for example in the case of allocation of depreciation of spring stabilizer used in connection to the press quenching machine. It resulted in quantification of real costs associated with primary activities outputs. The cost matrix of primary activities had the following structure (Tab. 2).

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Tab. 2 Example of cost matrix used for primary activities. Source: own
Tab. 2 Příklad matice nákladů primárních aktivit. Zdroj: vlastní

PRIMARY ACTIVITY COST MATRIX								
Activity Code	**Activity Name**	**Material CONS**	**Energy CONS**	**Repairs and Maint.**	**Personnel Costs**	**DEPN**	**Other Costs**	**Total**
1710	AICHELIN KSGS / carburizing	… CZK	… CZK	… CZK	… CZK	… CZK	… CZK	**… CZK**
…	…	…	…	…	…	…	…	**…**
1111	Handling and handwork	… CZK	… CZK	… CZK	… CZK	… CZK	… CZK	**… CZK**
	TOTAL	… CZK	… CZK	… CZK	… CZK	… CZK	… CZK	**… CZK**

The nature of activities does not allow to allocate supporting activities directly to cost objects. In order to meet the allocation principle of causality it is necessary to allocate the costs of support activities to primary activities in the first step and then to allocate costs of primary activities to cost objects. The transformation of individual indirect cost items from accounting and their allocation to the supporting activities were done by using a so-called Supporting Activity Cost Matrix, which clearly presents all the links among primary and supporting activities. The costs associated in different groups of supporting activity costs were divided based on the identified links to individual activities, which generated their origin. Resource Cost Drivers (RCD) were used to identify these links. These RCD were: production volume, number of parts assigned to individual processes of heat treatment, working hours of heat treatment devices, number of heat treatment processes, number of workers assigned to individual heat treatment processes, a qualified estimation of production area. In practice, the process of allocating supporting activities costs is complicated by the fact that support activity outputs are not consumed only by primary activities but also by other supporting activities. There may be a situation in which particular activity outputs are consumed by an activity itself (personnel department outputs can be a typical example). In practice, this problem can be solved by several approaches including the use of structural analysis. In the case of this application, both methods of allocating supporting activities costs were processed; the above described procedure using the resource cost drivers as well as the structural analysis. However, both approaches brought insignificant differences in their results. This was due to the character and status of the hardening shop in the company organizational and economic structure. The supporting activities assigned to the hardening shop were allocated in regard to the fact that they included their mutual consumption and self-consumption. However, this is a rather specific case when supporting activity costs, or their mutual consumption, is determined at higher company level. In practice, especially in the case of a custom hardening shop, a structural analysis can be an appropriate tool used for determination of supporting activity costs. This ABC application phase resulted in quantification of total real costs associated with primary and supporting activity outputs. The total costs of activities (i.e. Cost Pool) represents a group of costs associated with a particular company activity (i.e. with performance of this activity) and determination of their value represents a partial step within ABC method application, because it serves for the purpose of assessing effectiveness of performed activity and analysing its added value.

Activity Cost Drivers definition and Activity Primary Rate calculation

There is a fundamental difference compared to the model of traditional calculation methods in this application phase. First, so called Activity Cost Drivers (ACD) were established. ACD can be defined as a value by which an activity can be measured. A selected ACD was chosen in order to capture causality among costs and activity outputs and to be relatively easy quantified. For these reasons, a universal transaction driver was chosen as an appropriate ACD – namely production volume of individual heat treatment processes in kilograms in year 2017. Subsequently, Activity Recovery Rate (ARR) was determined. ARR basically represents number of ACDs generated by chosen activity in defined period. In this study, the ARR was determined based on the actual output of individual heat treatment processes in monitored period, which was relatively easily identifiable from company information system. After determining total costs of the activities (Cost Pool) and the ARR, it was possible to calculate total unit cost of activities (Activity Primary Rate). APR indicates how much costs are associated to output of an activity unit (i.e. costs allocated to 1 kg of heat treatment process, servicing or finishing activity). APR amount was determined as a proportion of total costs of activities and the ARR. The obtained APR values represented an appropriate information for assessing effectiveness of realized outputs and eventual benchmarking of individual activities. In the case of the performed study, a comparison of carburizing and quenching carried out in continuous and multipurpose furnaces can be given as an example. Of course, it is an assessment of performed outputs effectiveness done only by allocated hardening shop overheads in this phase. An analogous procedure allowed to determine the unit cost of primary activities (PAPR) and unit cost of supporting activities (SAPR). The values of ARR, APR, PAPR and SAPR can be displayed by suitably chosen table (Tab. 3).

Tab. 3 Example of calculating ARR, PAPR, SAPR and APR. Source: own
Tab. 3 Příklad kalkulace míry výkonu aktivit (ARR), primárních jednotkových nákladů aktivit (PAPR), sekundárních jednotkových nákladů aktivit (SAPR) a celkových jednotkových nákladů aktivit (APR). Zdroj: vlastní

CALCULATION OF ACTIVITY UNIT COSTS					
Activity Code	**Activity Name**	**ARR**	**PAPR**	**SAPR**	**APR**
1710	AICHELIN KSGS / carburizing	…	… CZK	… CZK	**… CZK**
…	…	…	…	…	**…**
1111	Handling and handwork	…	… CZK	… CZK	**… CZK**

Allocating costs of activities to cost objects

The cost object was defined as a kilogram of heat treated material. In this step full costs of cost object (FCCO) were determined by calculation of the APR and total unit direct cost (TUDC). The following Tab. 4 gives an example of activity costs allocation by using a so called Bill of Activities.

Tab. 4 Example: Bill of Activities (BoA). Source: own
Tab. 4 Příklad: Účet aktivit. Zdroj: vlastní

BoA	**Company Centre**	**Period**	**ARR**	**APR**	**TUDC**	**FCCO**
	2610	01/2017 – 02/2017				
Activity Code	**Activity Name**	**ARR**				
1710	AICHELIN KSGS / carburizing	Material QTY (kg)	1	… CZK	… CZK	**… CZK**
…	…	…	…	…	…	**…**
1111	Handling and handwork	Material QTY (kg)	1	… CZK	… CZK	**… CZK**

It is obvious from the described steps that the ABC calculation provides a very detailed analysis of overhead causes, identification of activities generating the highest costs or costs which are disproportionate to their nature.

1.2 Costing Sheet of heat treatment

The last step in this practical application of ABC method in the monitored enterprise was designing of a so called heat treatment Costing Sheet. It is a simple tool for operative costing of specific heat treatment processes, which should be used by the hardening shop supervisor or a heat treatment engineer for a relatively easy costing of a selected heat treatment process realized on specific equipment. The principle of this spreadsheet is very simple because all input data are arranged in source tables

(i.e. primary and supporting activities cost matrix, direct cost matrix, APR table and bill of activities) so that it can be easily updated and changed based on the information provided by accounting and managerial reports. Using the spreadsheet is very simple because it is only necessary to enter the weight of the part and choose the appropriate processes of the intended heat treatment. The Costing Sheet then provides heat treatment costs of 1 kg, or the entire production batch.

Conclusions

The traditional calculation methods very often lead to a distortion of resulting costs allocated to outputs. This distortion primarily lies in the way these methods work with fixed costs and becomes very significant when a company is facing an increase in proportion of indirect costs and change in structure of realizing overhead activities. In response to these issues and changes of cost structures in companies, the ABC method was used in greater extent. The principle of ABC method is very simple, logical and conceptually different from the traditional approach of calculation methods. ABC does not allocate resources to centres, but to activities in order to achieve allocation of overheads based on real causality of their origin. Therefore its basic purpose is to find a procedure which better expresses the real causal effect – relationship of cause and effect. The aim of this paper was to describe a practical application of the ABC method focused on assessing the costs of a particular heat treatment operation. This goal was achieved by analysing partial steps of its implementation in the selected industrial company.

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EuroBLECH 2018: Vstupte do digitální reality

EuroBLECH 2018 – 25. mezinárodní veletrh technologií zpracování plechu – se koná ve dnech 23. až 26. října 2018 na výstavišti v německém Hannoveru. Šest měsíců před zahájením akce má prostory pro svoje stánky na celosvětově vedoucím veletrhu pro průmysl zpracování plechu zajištěno již zhruba 1400 vystavovatelů z 38 zemí. Nejvíce vystavovatelů je z Německa, Itálie, Turecka, Číny, Nizozemska, Španělska, Švýcarska, Rakouska a USA. V současné době již mají vystavující společnosti zajištěn téměř celý výstavní prostor z předchozí akce. Předchozí ročník veletrhu EuroBLECH 2016 totiž dosáhl rekordu: čistý výstavní prostor činil 87 800 metrů čtverečních.

Každé dva roky se EuroBLECH stává akcí, kterou navštěvují konstrukční inženýři, manažeři výroby, manažeři kvality, nákupčí, výrobci, techničtí ředitelé a odborníci z asociací či výzkumu a vývoje, aby zde objevili nejnovější trendy a strojní zařízení v oblasti zpracování plechu. Návštěvníci letošního veletrhu mohou očekávat celé spektrum inteligentních řešení a novátorských strojních zařízení pro moderní výrobu v oblasti zpracování plechu, které jsou představeny v podobě mnoha živých předvádění na výstavních stáncích. V současné době hraje digitální transformace v průmyslu hlavní roli, což zajišťuje vyšší účinnost, a tím i vyšší úroveň automatizace a prediktivní údržby. Tento vývoj se odráží v mottu letošního veletrhu EuroBLECH „Vstupte do digitální reality", protože Průmysl 4.0 a související Chytrá továrna se staly hlavními tématy v oblasti zpracování plechu. Ta se nyní stala důležitou oblastí pro malé a střední podniky, které do těchto technologií chtějí v blízké budoucnosti investovat, aby získaly konkurenční výhodu na svých trzích.

„Digitální transformace je momentálně důležitým tématem v oboru. To vyžaduje úzkou spolupráci v celém hodnotovém řetězci od řízení výroby až po údržbu", říká Evelyn Warwicková, ředitelka výstavy EuroBLECH jménem pořadatele Mack Brooks Exhibitions. „Pro společnosti v odvětví zpracování plechu je největší výzvou vytvoření inteligentního výrobního prostředí, které je založeno na bezpečné výměně dat a síťovém propojení strojů a procesů. EuroBLECH 2018 svým návštěvníkům nabízí možnost najít řešení těchto výzev a navázat kontakt s obchodními partnery, aby jim pomohli s integrací těchto procesů, strojů a systémů do jejich výroby", pokračuje Evelyn Warwicková.

Profil veletrhu EuroBLECH

EuroBLECH je celosvětově největším veletrhem pro odvětví zpracování plechu, a pro návštěvníky je tržištěm, kde objeví a získají nejnovější novátorská výrobní řešení. Četná živá předvádění na výstavních stáncích nabízejí obchodním návštěvníkům příležitost zažít v akci stroje a systémy ze všech oblastí zpracování plechu. Profil veletrhu EuroBLECH pokrývá patnáct technologických sektorů, a proto pokrývá celý technologický řetězec zpracování plechu: plech, polotovary a hotové výrobky, manipulace, separace, tváření, flexibilní zpracování plechu, zpracování trubek/řezů, spojování, svařování, aditivní výroba, povrchová úprava, zpracování hybridních konstrukcí, nástroje, řízení kvality, systémy CAD/CAM/CIM, vybavení továren a skladů i výzkum a vývoj.

- z tiskové zprávy -