



## TIME-DRIVEN ACTIVITY BASED COSTING AS A BASIS FOR UNDERTAKING LEAN ACTIVITIES

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**ABSTRACT.** **Background:** A constantly escalating market competition, new techniques and technologies development, as well as the aspiration to adapt to the dynamically changing market situation, forces the entrepreneurs to search and implement new methods of managing firms. For this reason, the effort is made to calculate, applying the Time-Driven Activity Based Costing analysis, the logistics costs of the client service process in the sphere of traditional and Internet trade. The aim of the article was to find answers to the following questions: 1. Is the use of T-D ABC method in the service sector (electronic warehouse) may indicate areas where the waste arises? 2. What financial benefits can bring such kind of identification in the context of waste elimination in accordance with the concept of Lean Management?

**Methods:** The research was conducted at a service enterprise, which is an electronic warehouse. The article presents the exact procedure of cost calculation according to the T-D ABC method. The work includes identification of the activities, undertaken by the employees in the process of clients' orders realization, calculation of their costs using the T-D ABC methodology and improvements that were made within the context of Lean Management concept.

**Results:** The paper presents theoretical knowledge concerning the T-D ABC method and the Lean Management concept. The steps for calculating the cost of processes are described, their analysis is carried out and the Lean activities are proposed – aimed at organizing the processes and shortening their duration.

**Conclusions:** The integration of T-D ABC and the Lean Management enables to implementation of the first steps towards the eradication of wasting money, identification of unused capacities, detection of potential of the resources involved, as well as makes it possible to identify the places of saving costs in the processes. The suggested example of costs calculation can be successfully used both at service enterprises and at the production ones.

**Key words:** Activity Based Costing, Time-Driven Activity Based Costing, costs, Lean Management, process, sale.

## INTRODUCTION

Functioning in the conditions of global market competition is a challenge for enterprises and the ways they do business. It is natural that such functioning leads to changes. Companies are looking for new solutions to improve their economic indicators, implementing the best available technologies, striving to increase processes efficiency. These changes directly lead to changes in the costs structure. At the same time, the importance of indirect costs in the general costs of an enterprise increases. Therefore, the proper

definition of the relevant costs for the offered goods, services or logistics processes is important.

The aim of the company is to deliver to a customer the product adjusted to his needs in terms of quality, functionality, reliability. The manufacturing process of the product or service is a sequence of actions, aimed at adding value to the product created for a customer. Hence, the necessity to separate activities that add value to the product from those that do not is obvious as well as the importance of calculating their costs. Analysis of the selected process provides

the basis for understanding and identification of the activities taking place in it, which, in turn gives, you the opportunity to improve the process in the direction of improving the quality, productivity, deadlines, as well as cost reduction.

The correct approach to the introduction of a new model for calculation of production costs provides a relatively large amount of information for decision making, quality management, continuous improvement of production, distribution and business processes, as well as provides the ability to control expenses of the company.

## ACCOUNTING OF COSTS BASED ON TIME - T-D ABC

In the 80-s of the twentieth century, the world saw a series of publications of Cooper, who described the methodology of calculating production costs by the method ABC - Activity Based Costing. The new approach to cost calculation emerged as a response to the increasing market competition, the need to introduce changes in technology of the manufacturing processes, broadening the range of products, offered by the company, as well as shortening their life cycle. Currently, Activity Based Costing is a powerful and widely used calculating system that helps in tracking the profitability of products and customers and in reducing operating costs [Ungureanu 2016, Jones and Dugdale 2002, Innes and Mitchell 1995, Malmi 1999]. Activity Based Costing takes into account the dynamics of indirect costs, allows to determine the cause of these costs, and also gives the possibility to assign (refer) the costs of the process to the finished product.

In the process of calculation particular actions are extracted, which together form the process [Kaplan and Cooper 2002]. Process calculation by ABC looks as follows [Wnuk-Pel 2009]:

- identification of relevant activities in the company (activity);
- determination of the cost of separate activities (cost pool);
- determination of the costs of activities (cost driver);

- calculation of indirect costs of particular actions on manufactured products.

In the early 2000s the ABC method has been criticized by the companies that applied it. Negative feedback resulted primarily from the conviction of the high cost of implementation, and the need to gather a vast amount of data about the costs and cost factors. Therefore, there appeared a modification of the ABC method, based on the indicators of time, which was called the Time-Driven Activity Based Costing (T-D ABC) [Namazi 2016, Kaplan and Anderson 2003]. The principle of this method is based on the transformation of cost drivers to time equation that express the time needed for performing of the activity as the function of sometime drivers [Dejnega 2011]. For the calculation of production or service costs with the T-D ABC methodology the two key parameters are required: 1) the practical capacity of committed resources and their cost, and 2) the time required to perform a transaction or an activity.

In the T-D ABC method appears the notion of "time equation" [Madhok et al. 2015], which divides the total time required to perform a particular action into a linear combination of various tasks of the operation, multiplied by the amount of time for each task. Typically, time equation building is based on interviews of employees about the time that they spend on performing particular tasks. The costs of the interviews are seen as a significant disadvantage of the classical model of ABC calculation. The calculations based on the T-D ABC [Siguenza Guzman et al. 2013, Adioti and Valverde 2014, Mandigo et al. 2015] also include these costs, but they are much lower.

The time-driven approach of ABC consists of the following six steps [Kaplan and Anderson 2004]:

1. Identify the various groups of resources that perform activities.
2. Estimate the cost of each group of resource.
3. Estimate the practical time capacity of each group of resource (i.e. available working hours).
4. Calculate the unit cost of each group of resource by dividing the total cost of the resource group by the practical capacity.

5. Determine the required time for each event of an activity based on different time drivers.
6. Multiply the unit cost by the time required to trace costs to cost objects.

In order to determine the cost of work for each unit the T-D ABC method suggests to determine the total cost connected with the maintenance of a particular department of a company, and the actual (practical) number of working hours that can be consumed to produce a product or a service for the customer. The actual number of working hours differs from the specified number of working hours by the fact that an employee spends 80-85% of the total time to perform a particular job, and the remaining 15-20% of time he spends on his own needs. Therefore, possessing knowledge about the cost of a unit of time as well as about the time required to produce a single product, it is possible to calculate the cost of a manufactured product.

In the context of ABC method it is also important to explain the concept of the “carrier” of costs of the action (cost driver). It is a measure of activity of a particular operation, which reflects the essence of this kind of operation and the relationship with the cost object, which must be understood as a cause of cost appearance, and, therefore, as the reason to undertake certain actions. Each activity should be characterized by one cost driver, which determines how and why the costs are referred to the analyzed object. However, certain activities can be referred to several cost drivers. In this case, it is necessary to choose the carrier that most accurately characterized the costs of action. The choice of a driver for a specific action depends on many factors, the most important of which is the availability of information and the cost of its acquisition.

Cost drivers indicate the amount of resources used for a particular action and may have a different character [Kaplan and Cooper, 2002]: quantitative drivers (e.g. the number of orders received), time duration drivers (e.g. the number of minutes devoted to the acceptance of the order), intensity drivers (e.g. the cost of use of the machine). Quantitative drivers are the least expensive and also the least accurate. On the other hand, the most accurate, and, at

the same time, the most expensive are the drivers of intensity.

T-D ABC is a method which is based on estimating the practical capacity, and then calculating and allocating the costs on the basis of the share of the consumed time. In this context, organization of work processes in a company is of particular importance. A number of modern management concepts allows to organize production and services processes, and thereby, shorten the time of their duration.

## LEAN MANAGEMENT AS A PROCESS ORIENTED CONCEPT

At the turn of XX-XXI century as a response to market changes a few modern management concepts appeared, different from the conventional methods of organization and management. One of them was the concept of Lean Management (LM) [Womack and Jones 2001 Rüttimann and Stöckli 2016, Rüttimann, and Stöckli 2015, Kwiatkowski et al. 2016], based on the process approach, which appeared at that time, proclaiming the thesis that work should not be focused on functions, tasks, or workplaces, but on processes that create the value added for the customer (Value added – These are all activities leading to changes in raw materials in the value for the customer, in other words, the customer is willing to pay only for the actions that transform the product or information, and which are made properly (without modifications or amendments) for the first time). The main task of the process-oriented concept is primarily to integrate people in the organization, establish new rules of cooperation and, consequently, to create the organizational culture that will identify and skillfully exploit the huge potential hidden within the enterprise.

Lean Management is a management methodology, creating such a working culture in an organization, which makes all participants of the organization interested in continuous reduction of costs, increase of the quality level and shortening of the delivery cycle. Everything is aimed at meeting maximize customer expectations at a maximum and at prospering, adapting

slightly to the environment [Pawlowski et al. 2010]. The concept assumes such a design and implementation of manufacturing processes, which will allow to do more with fewer human, material, time and territorial resources, in other words, to eliminate all kinds of wastage, which detains the process of creating the value added for customers. Every action that does not bring the value added causes the extension of production time and increase of costs.

The priority of the Lean concept is the elimination or reduction of wastage, therefore it defines 7 major sources of wastage, also called in the literature as “7 major wastage sins”:

1. overproduction - production of unnecessary products at the wrong time and in the wrong amount. It is considered as the worst type of wastage. The cause of overproduction may be the production in large batches, production before the demand for the product is known, a too long process of machines retooling, production of the products as an alternative for the products with manufacture defects. This type of wastage is the main generator of other types of wastage;
2. inventories - excessive amount of materials, semi-finished products, as well as excessive number of finished products. Increased number of inventories is a side effect of overproduction; if more products than required are produced, the inventories are built both finished and semi-finished products. Inventories also appear as a result of uneven pace of execution of particular operations (a previous process is faster than the following one);
3. unnecessary transport - the movement or transfer of components, parts, semi-finished and finished products from one location to another, for whatever reason, and more often than it is necessary. The result of the unnecessary transport movements may result in an incorrect machine placement, long distance or height, narrow specialization of employees;
4. deficiencies and defects – refers to the products, documentation, supply and information. Any deficiency or defect increases the cost of quality control, claims, costs of repair or utilization. Manual handling of materials and transport, the lack of operational and quality control standards, inspection at the end of the production process - all these are the reasons for this particular type of wastage;
5. excessive processing – conduction of operations and processes which are not needed. The cause of the unnecessary processing may consist in the lack of processes standardization, poorly selected raw materials or equipment, improper design of operations or processes, which lead to the execution of uselessly repetitive actions or also the operations that are in employee's habit;
6. unnecessary movements - means performing an excessive number of movements (search, bending, rotating, moving, lifting), connected with the poor organization of work places. Other causes of unnecessary movements when performing certain operations are: low moral principles of employees, lack of training, poorly developed skills, poor layout, lack of operations stability.
7. expectation - these are long periods of inactivity of people, machines, parts and materials. The reasons that cause this type of wastage are: production of large batches, unsustainable production capacity of machines, flow disturbances, incorrect machines placement.
8. In addition to the above-mentioned and briefly characterized seven types of wastage, Jeffrey Liker mentions the important eighth type of wastage [Liker 2003], namely:
9. unused employees' potential - symbolizes the non-used by the organization ideas, creativity, competences, talents, and available working time of its employees.

All kinds of wastage significantly affect company's efficiency, and hence - its costs. To reduce these costs it is necessary to assess the current state of the organization and focus on identifying the particular types of wastage. Methods for the elimination of the particular types of losses are shown in table 1, together with the possible consequences to which wastage leads.

Table 1. Ways of wastage elimination  
Tabela 1. Sposoby usuwania marnotrawstwa

Type of wastage	Effects	How to eliminate?
<i>Overproduction</i>	<ul style="list-style-type: none"> <li>- early use of the material;</li> <li>- excessive inventories;</li> <li>- loss of quality</li> </ul>	Heijunka, Just in Time, System Pull, SMED
<i>Expectation</i>	<ul style="list-style-type: none"> <li>- prolongation of the production process;</li> <li>- decrease of efficiency;</li> <li>- demotivation of people</li> </ul>	Value Stream Mapping, 5S, SMED
<i>Transporting</i>	<ul style="list-style-type: none"> <li>- increase of transportation costs;</li> <li>- increase of exploration costs;</li> <li>- damage to products during transportation</li> </ul>	Visual Control, Diagram Spaghetti
<i>Excessive processing</i>	<ul style="list-style-type: none"> <li>- increase of the costs of production;</li> <li>- extension of production time</li> </ul>	Standardized work, teamwork
<i>Inventories</i>	<ul style="list-style-type: none"> <li>- increase of storage space;</li> <li>- the need to search for inventories;</li> <li>- the probability of products damage</li> </ul>	Kan-Ban, Just in Time, One Piece Flow, Heijunka
<i>Unnecessary movement</i>	<ul style="list-style-type: none"> <li>- loss of productivity;</li> <li>- tiredness of personnel;</li> <li>- reduction of the work safety level</li> </ul>	Diagram Spaghetti, Standardized work, 5S, Poka-Yoke
<i>Deficiencies</i>	<ul style="list-style-type: none"> <li>- increase the costs of control;</li> <li>- the need for re-processing;</li> <li>- increase of utilization costs</li> </ul>	Jidoka, Andon, Visual Control

Source: personal elaboration

The Lean Management concept is accompanied by a number of tools, which is also shown in Table 1, thanks to which it is possible to achieve the elimination of seven major types of wastage. The more extended and accurate information about the tools of the Lean concept can be found in such literature: [Moulding 2010, Ortiz and Park 2011, Rother and Shook 2009, Willmott and McCarthy 2001, Louis 2006]. Among the most frequently mentioned in the literature tools the following stand out: 5S, VSM, Visual Management, SMED, TPM, Poka-Yoke etc.

The idea of Lean Management aims at permanent improvement obtained due to new orientation to the client and strict connection with suppliers and change of company's culture. All determined factors lead to improvement of productivity and flexibility, as well as to increase of the diversity of production while reducing employment, assets, time of realization of the investment and elimination of failures [Jünemann 1993]. The main idea of the continuous improvement is about the fact that the majority of members of every organization discover possibilities of improvement of processes, in which they take part; they find and put into practice solutions serving the increase of productivity and quality of operations and products [Grajewski 2007]. The skill of identifying and preventing wastage

gives companies the possibility of manufacturing products with level of quality that suits its potential recipients and simultaneously, it provides supplies on time and in place that is most comfortable to the client.

## COSTING IN TIME-DRIVEN ABC ON EXAMPLE OF AN ELECTRONIC WAREHOUSE

In order to determine real costs of initiated actions, there have been attempted a trial of analyzing one but principal process that takes place in the analyzed company - a process of sell.

The company presented in the case study is an electronic warehouse; it functions in the area of Wielkopolska province. It employs 7 people and it sells wholesale and retail of various industries, like household items RTV items, computer accessories, cables, navigation, toys. The warehouse supplies several dozen shops, stalls and other places in the market of Greater Poland. In this group, 30 units are regular customers of the organization. Assortment of goods offered in the analyzed unit includes about 2000 types of product. The warehouse has its own website. This allows buying its products online. It also

sells in shops and online auctions. Thus, the purchase is possible both in the seat of the company and via Internet – in this case the product is sent to any address from the entire country with use of service of a courier company.

The company cooperates with points of warranty service of companies supplying wholesale goods (external service). In case of firms, which goods are sold service costs are beard by the distributor of the determined brand. Thus, in case of goods not included by the warranty of the producer or in situations of expiry of the warranty on a product; as well as in case of sell of goods damaged by a client, the company uses the internal service – in such

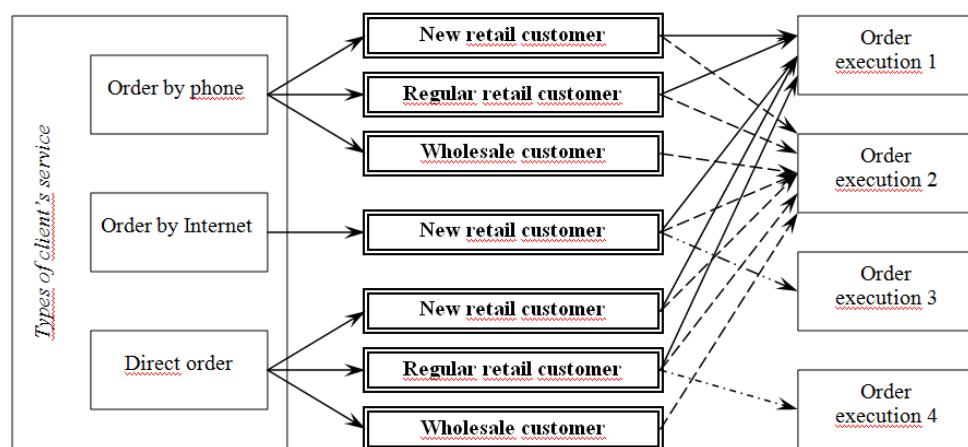
case the cost of reparation must be paid by the client.

The realization of costing in accordance to the Time-Driven ABC method of a determined process in the organization - in this case it concerns sell, there has been analyzed the determined process and selected a range of actions performed by company's staff. Table 2 illustrates identified actions and their duration in time for each of them. All data necessary for the analysis was gathered and processed on basis of measurements, observations and interviews realized with employees of the company. Determining duration of actions was realized with taking under consideration one position of the product of the determined action.

Table 2. Selected actions in the process of sell and their duration  
Tabela 2. Działania wyodrębnione w procesie sprzedaży oraz czasy ich trwania

Symbol of the action	Name of the action	Action's duration [min]
D1	Presenting a new product in an on-line auction	60
D2	Multiplying or extending an existing auction for a product that is already available online	2
D3	Service of incoming and outgoing mail	5
D4	Order execution 1	15
D5	Order execution 2	10
D6	Order execution 3	10
D7	Order execution 4	30
D8	Complaints service (external service)	20
D9	Complaints service (internal service)	35

Source: personal elaboration



Source: personal elaboration

Fig. 1. Scheme of potential courses within frames of ways of realization of orders  
Rys. 1. Schemat możliwych przebiegów w ramach sposobu realizacji zamówienia

Interviews revealed that the company has not only retail and wholesale customers – it also cooperates with clients, who are retail customers but from time to time, they realize purchase on the account of their companies. Therefore, in order to make a costing calculation, there have been assumed following names of recipients of the warehouse goods: new retail customer, regular retail customer, wholesale customer. The method of service and realization of the order was diversified in the company. Determined fact is well illustrated on the figure 1.

The term “client’s service” includes methods of reaching contact of the customer with employees in order to present his order. There have been distinguished three possible ways of ordering, which are:

- order by phone;
- order by Internet (e-mail);
- direct contact.

Table 3 shows duration of particular types of service.

Table 3. Types of client’s service and their duration  
Tabela 3. Rodzaje obsługi klienta oraz czasy ich trwania

Type of customer service	Duration [min]
Order by phone	10
Order by Internet	5
Direct order	15

Source: personal elaboration

Apart from kinds of customer service, there have been distinguished four types of realization of order. The first type symbolizes sending the product to the recipient by a courier company that cooperates with the warehouse. Determined sort of order can be related with the realization of operations, like: completing the order, packing it, preparing the bill of lading, contacting the courier, dispatch. The second type of order realization is direct contact, where it is required to complete the order and packing it. Third type is similar to the realization no. 1, only the client presents his own courier who provides the product. Comparing with the first type of realization of the order, the number of actions performed in this form of realization of the order is smaller (the employee does not have to prepare the bill of lading, etc.). And so, it takes less time. This type of realization is rare, still sometimes it takes place in the company. The last – fourth

type of realization concerns a determined regular retail customer, who systematically orders a selected number of products from the company’s assortment. In this case, the dispatch is realized via courier company that cooperates with the warehouse. It is worth to point at the fact that such orders are seasonal (they are realized only in summer). Summarizing, it should be noted that the significant part of realizations are direct contact and orders realized via dispatching goods via courier that cooperates with the described organization.

The realization of the Time-Driven ABC method requires determining assets and their costs, as well as estimating the efficiency of assets and time related with them. Tables 4 and 5 present determined dependencies.

Table 4. Listing of company's resources and their costs  
Tabela 4. Zestawienie zasobów firmy i ich kosztów

No.	Name of the asset	Cost of the asset [PLN]
1	Remunerations, contributions, insurance, taxes concerning employees	24 500
2	Amortization of intangible assets and technical equipment (computers, printers, etc.)	800
3	Rent for the premise, amortization and other charges	8 500
4	Telecommunication bills	500
Total		34 300

Source: personal elaboration based on [Bojnowska 2008]

Table 5. Summary of data on working time arrangements for employees  
Tabela 5. Zestawienie danych dotyczących ustalenia czasu pracy pracowników firmy

Number of employed people	7 people
Number of hours of work per month for each person	168 h
Nominal time of work for one person	1176 h
Effective time of work for employees (80%)	940,8 h

Source: personal elaboration based on [Bojnowska 2008]

Calculated costs for one unit of time are the next step in T-D ABC; then it is necessary to calculate the cost of the action’s product, therefore:

Cost of one unit of time = sum of costs of used assets / number of hours of effective work =  $34\ 300 / 940,8 = 36,46$  PLN/h = 0,61 PLN/min.

Cost of one product of action = time necessary for the realization of the action \* cost of one unit of time

Therefore costs of products of action are as presented in the table 6, taking under consideration their duration.

Table 6. Actions' costs  
Tabela 6. Koszty działań

Symbol of the action	Name of the action	Duration [min]	Cost of the products of the action [PLN]
D1	Presenting a new product in an on-line auction	60	36.6
D2	Multiplying or extending an existing auction for a product that is already available online	2	1,22
D3	Service of incoming and outgoing mail	5	3,05
D4	Order execution 1	15	9,15
D5	Order execution 2	10	6,1
D6	Order execution 3	10	6,1
D7	Order execution 4	30	18,3
D8	Complaints service (external service)	20	12,2
D9	Complaints service (internal service)	35	21,35

Source: personal elaboration

Table 7. Number of action's products and cost of actions in a period of one month  
Tabela 7. Ilość produktów działań oraz koszt działań w ciągu miesiąca

Symbol of action	Name of action	Product of action	Number of product in the period	Cost of action's product [PLN]	Cost of action [PLN]
D1	Presenting a new product in a on-line auction	Auction	4	36.6	146,4
D2	Multiplying or extending an existing auction for a product that is already available online	Auction	350	1.22	427
D3	Service of incoming and outgoing mail	E-mail	1176	3.05	3 586,8
D4	Order execution 1	Order 1	840	9.15	7 686
D5	Order execution 2	Order 2	420	6.1	2 562
D6	Order execution 3	Order 3	1	6.1	6,1
D7	Order execution 4	Order 4	4	18.3	73,2
D8	Complaints service (external service)	Notice of defect	50	12.2	610
D9	Complaints service (internal service)	Notice of defect	20	21.35	427
Total			3075		15 524,5

Source: personal elaboration based on [Bojnowska 2008]

The calculation of costs of particular actions within frames of one month, there has been assumed an average monthly size of the product for every action; it was calculated on basis of interviews and observations. Table 7 shows results of determined calculations.

The knowledge of duration of determined actions and their costs enables calculating costs generated by a new retail customer during one month. While actions D1, D2 and D3 are directed mainly on service of a new retail customer, just like actions D8 and D9, it was possible to count that he generated at least 90% of these actions. The action's cost was calculated suitably by counting the total time of duration, which resulted from the product of the number of products and times of duration

of particular action presented in the table 2 and next, multiplication the obtained time by the cost of one unit of time – in the analyzed case it is equal 0.61 PLN/min (table 8).

Additionally to costs of selected actions, the calculation must include times for service of a customer, which concern actions in the realization of the order, i.e. actions D4 and D5 (table 9). Costs of customer's service was counted on basis of the total product of time for selected sorts of service (number of occurrence of determined type of service\* time of their duration presented in the table 3) and costs of one unit of time.

Table 8. Actions producing costs concerning a new retail customer within the period of one month  
Tabela 8. Działania generujące koszty klienta detalicznego nowego w ciągu miesiąca

Symbol of action	Number of action's products	Total duration [min]	Action's cost [PLN]
D1	3	180	109,8
D2	280	560	341,6
D3	940	4 700	2 867
D4	830	12 450	7 594,5
D5	250	2 500	1 525
D6	1	10	6,10
D8	40	800	488
D9	16	560	341,6
Total	2 360	21 760	13 273,6

Source: personal elaboration

Table 9. Costs of a new retail customer  
Tabela 9. Koszty obsługi klienta detalicznego nowego

Type of service	Number of occurrence of the type of service	Total time for determined type of service [min]	Cost of determined type of service [PLN]
Order by phone	400	4 000	2 440
Order by Internet	471	2 355	1 436,55
Direct order	210	3 150	1 921,5
Total	1 081	9 505	5 798,05

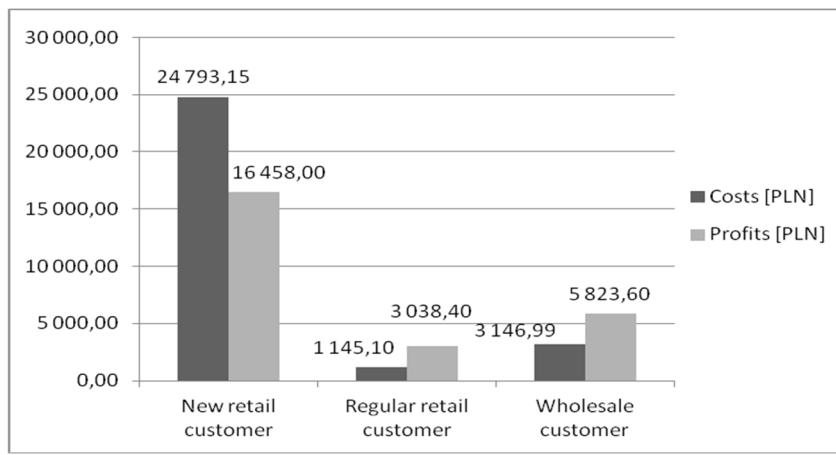
Source: personal elaboration

Taking under consideration total costs presented above, it is possible to count the cost of one new retail customer. In this case it is 19 062,5 PLN. However, considering the fact that the new retail customer absorbs 30% more time (as the observation shows) than a regular customer (20% more) or a warehouse customer (10%), author calculated the total cost of a retail customer:  $19\ 071,65 * 1,3 = 24\ 793,15$  PLN.

In order to compare costs generated by new retail customers with profits they bring

analysis of net profit was made. Net profit in the period analyzed was 25 320 PLN. and 65% was brought by retail customers, which was in that case 16 458 PLN. Hence, the conclusion is that new retail customers generate in the same time the largest costs and the largest profits.

At the same time the analysis was conducted considering the costs of the activities related to a constant retail and a wholesale customer (Fig. 2). The profits, which each of them generates, are also presented.



Source: personal elaboration

Fig. 2. Comparison of costs and profits generated by particular customers  
Rys. 2. Porównanie kosztów i zysków generowanych przez poszczególnych klientów

It is easy to notice that the profits generated by a constant retail and a wholesale customer are much higher than the costs that follow the service of these customers. However, this new retail client is the client, which is responsible for most of the profits earned by the company. Hence, it is logical to conclude that the company would not function without not meeting the needs of new retail customers. In addition, a new customer is the type of customer, thanks to which the company acquires new customers by means of information distribution.

## T-D ABC AS A BASIS FOR LEAN DECISIONS

Analysis of activities in the company according to the analysis of T-D ABC helped clarify the picture of how the organization is functioning. Information that has been collected from the cost analysis gave rise to reflect on the processes that taking place in the company. Some areas were pointed out as those which need significant improvement and following proposals have been shown:

- online auction is the most time-consuming activity;
- percent of acquisition of new goods is negligible;
- handling of incoming and outgoing mail and the performance of the contract 1 are activities which occurred to be the greatest demand in the reporting period;
- a significant number of incoming mail turned out to be complaints;
- costs of product operations complaints are some of the highest costs of products of activities included in the analysis;
- new retail customer is a key customer to the company.

After identifying the problems, management and the employees decided to make some improvements according to the concept of Lean Management.

Employees involved in the auction on the Internet headed to the store where the product was delivered and they checked if there were new product delivered that is going to be required for the Auction. An additional

complication was that the employee that ordered the goods, did not inform the persons issuing the auctions of the arrival of such goods. Therefore, the person issuing the goods on the Internet, they had to ask the person who ordered the goods and find out if there is a new delivery. If so, they had to identify which purchased items have already been exposed on the Internet, which in turn does not. Then they had to find the right product on the shelves, because after admission to the warehouse, the goods were placed on the shelves without checking whether they were placed on an online auction or not. The flow of information improvements has been made. First of all employees ordering product was obliged by an incoming delivery check and put the goods in the isolated and identified for the new product space. The next task was to inform the employee ordering people making auctions about new incoming goods to the warehouse. Data streamlining eliminated waste associated primarily with redundant verification of the goods, their exploration and walking.

Next streamlining concerned shorten the time to prepare and issue an online auction, as well as shipping ordered goods. Each employee issuing auctions of new goods devoted a lot of time associated with taking photos of goods, their processing, preparation of the text on the description of those goods, preparing the listing template and issuing auction. These same employees also engaged in packing orders, Internet-released. While the exposure time auction was very long and the number of listings of new goods has increased (the management has decided to ordering from different suppliers about 10 new products per month), and discuss how to shorten the time. It was decided then to divide and assign different tasks to specific employees. The work of one employee focused on taking the pictures and their treatment in the appropriate program, subsequent staff focused on developing descriptions of new products and placing listings on the Internet. Other workers packing orders and engaged in their shipment. This division of tasks has improved the work of employees, eliminated waste associated with unnecessary movement, anticipation, as well as unnecessary information processing.

The costs of the complaint is another important conclusion derive from the analysis of ABC. It is also evident waste in Lean Management, whose motto is to provide added value for the customer, the product satisfactory and satisfying their needs, the product free from defects. The main cause of complaint was unsuitable products, which were often returned to the external supplier. The management took the discussions and negotiations with suppliers, obliging them to provide the desired product quality. Some of the suppliers responded to the requirement of warehouse management, and some of them still do not meet them. For this reason, it has been decided to change some present suppliers.

The setting for the automatic extension of auction goods was another improvement. This

eliminated the need for going to such auctions, check the expiration dates and the need of constant extend.

Shelf storage of goods most frequently rotating on the shelves closest to the entrance warehouse was another improvement that was made, to shorten the time of completion and execution of customer orders.

Improvements that have been made were focused on reducing the duration of individual activities, as also had the task of eliminating the waste associated with unnecessary traffic, errors, unnecessary processing, poor quality etc. To visualize the result that were made due to the company change, then recalculate of T-D ABC. The results are shown below (Tab. 10).

Table 10. Actions' costs after implementation of Lean improvements  
Tabela 10. Koszty działań po wdrożeniu usprawnień Lean

Symbol of action	Name of action	Product of action	Number of product in the period	Cost of action's product [PLN]	Cost of action [PLN]
D1	Presenting a new product in an on-line auction	30	10	18,3	183
D2	Multiplying or extending an existing auction for a product that is already available online	2	331	1,22	403,82
D3	Service of incoming and outgoing mail	5	987	3,05	3010,35
D4	Order execution 1	14	910	8,54	7771,4
D5	Order execution 2	9	435	5,49	2388,15
D6	Order execution 3	9	3	5,49	16,47
D7	Order execution 4	29	3	17,69	53,07
D8	Complaints service (external service)	20	35	12,2	427
D9	Complaints service (internal service)	35	13	21,35	277,55
Suma			2727		14 530,81

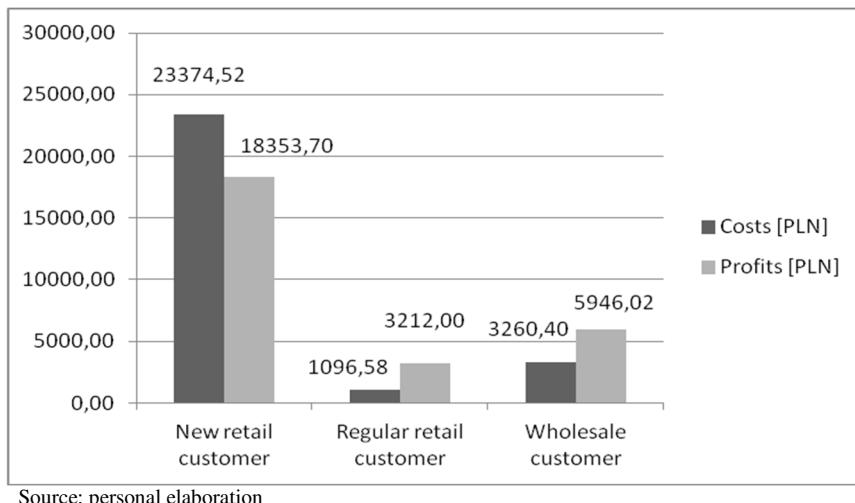
Source: personal elaboration

From the above table it can be seen shorten duration of the activities that have been analyzed and improvements (issuing auction, order fulfillment), as well as increasing the number of certain actions (execution of orders caused by an increase in product range), as well as reducing the number of some of them (reducing the number of complaints and thus - no need to take action associated with it).

It can be easily seen that the improvements of Lean, helped reduce actions' costs of almost 1000 PLN. Although it is not yet satisfactory result. A significant number of complaints is still assembled by customers, which means that customers are still not satisfied with the quality of purchased items. Another important activity, generating high cost of action is the order

execution 1. It is therefore necessary to consider the various activities that make up the action and look for different ways to streamline the operation.

Considering the costs in perspective of individual customers, it can be notice that after implementation of Lean Management improvements, the costs of new and regular retail customers have fallen and profits have risen (Fig. 3). Also, the profits of wholesale customer have risen. However, it must be noted that during considered period, the costs of wholesale customer have slightly increased. That could be the basis for analyzing of causes of such increase and searching for sources of waste.



Source: personal elaboration

Fig. 3. Comparison of costs and profits generated by particular customers after implementation of Lean improvements

Rys. 3. Porównanie kosztów i zysków generowanych przez poszczególnych klientów po wdrożeniu usprawnień Lean

## SUMMARY

As author mentioned in the beginning of present elaboration, the most important thing for the customer is the value he obtains in form of final product, which fulfills his requirements and needs. The formation of this added value takes place at the moment the asset, material or half-product is being transformed into the final product; it takes place in result of a series of actions that constitute such sort of operations. All realized actions should have a functional character, they should be effective and understandable for every employee in the company. Otherwise, the initiation of ineffective actions will be followed by the increase of costs, extending the time of realization and – in result – upraising the value of the product. All this constitutes an unnecessary wastage.

The most important function of T-D ABC analysis is the information, i.e. providing information about costs that are necessary in management. The analysis realized by authors in the examined unit gave the possibility of observing actions that occur in it and their costs. Calculations performed resulted in identification of problems, links and conclusions taken as a basis for further discussion on waste elimination according to Lean Management paradigm. Further analysis

of predetermined areas enabled development of improvement actions. Generally, they referred to elimination of waste emerging from time, place and use of resources. Elimination of waste was supposed to improve company's functioning. Analyzing received results of both calculations it can be established that T-D ABC analysis is a reliable basis for determination of improvement actions for better functioning of process with respect to Lean idea.

„The issue in Lean Management is that it is necessary to constantly change ways of defining the goal, organizing processes and involving employees. Lean gives the possibility to produce more and more and using less and less of human effort, devices, time and space; and simultaneously – approaching the objective, which is providing clients exactly what they want” – as it was explained by James Womack, world star and guru of the Lean Management concept, in Wrocław, during the 10th International Concept of Lean Management [Kostecka 2010]. It is known that problems always occur when the company will not involve energy into their deep solving, as well as preventing them or fighting against them; then it will remain in its initial point , where these problems change into waste that the company eliminated with such effort.

It is extremely important in the implementation of the process approach, which in this case is personalized in Lean Management concept, to be aware of necessary changes and be willing to initiate them. It is most of all the management that should know about benefits resulting from using this type of concept, in order to involve their staff in gradual improvement of processes. The Lean Management enables the company entering the process of continuous eliminating waste and obtaining satisfying results, which verification can be performed with use of T-D ABC analysis.

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## TIME-DRIVEN ACTIVITY BASED COSTING JAKO PODSTAWA DO PODJĘCIA DZIAŁAŃ LEAN

**STRESZCZENIE.** Wstęp: Ciągle zaostrzająca się konkurencja rynkowa, rozwój nowoczesnych technik i technologii oraz pragnienie dostosowania się do dynamicznie zmieniającej się sytuacji na rynku, wymuszą na przedsiębiorcach podjęcie prób poszukiwania i wdrażania nowych metod w zarządzaniu firmami. Ze tego względu podjęto próbę dokonania, za pomocą analizy Time-Driven Activity Based Costing, kalkulacji kosztów logistycznych procesu obsługi klienta w obszarze handlu tradycyjnego i internetowego. Celem artykułu było znalezienie odpowiedzi na pytania: 1. Czy wykorzystanie metody rachunku TDABC w sferze usług (hurtowni elektronicznej) może wskazać obszary w których powstaje marnotrawstwo? 2. Jakie korzyści finansowe może przynieść taka identyfikacja w kontekście eliminacji marnotrawstwa w myśl koncepcji Lean Management?

**Metody:** Badania przeprowadzono w przedsiębiorstwie usługowym będącym hurtownią elektroniczną. W artykule zaprezentowano dokładną procedurę kalkulacji kosztów według koncepcji rachunku kosztów działań opartym na czasie. Praca obejmuje zidentyfikowanie podejmowanych przez pracowników działań w trakcie realizacji zamówień klientów, kalkulację ich kosztów według metody T-D ABC oraz usprawnienia poczynione w kontekście koncepcji Lean Management.

**Wyniki:** W artykule zaprezentowane zostały wiadomości teoretyczne dotyczące metody T-D ABC oraz koncepcji Lean Management. Opisano poszczególne kroki obliczania kosztów procesów, dokonano ich analizy i zaproponowano działania Lean, które pozwolą uporządkować procesy i skrócić czasy ich trwania.

**Wnioski:** Integracja T-D ABC oraz koncepcji Lean Management umożliwia postawienie pierwszych kroków w kierunku wykorzeniania marnotrawstwa, zidentyfikowanie niewykorzystanych zdolności, wykrycie potencjału tkwiącego w zaangażowanych zasobach oraz daje możliwość wskazać miejsca oszczędności kosztów procesów. Zaproponowany przykład kalkulacji kosztów z powodzeniem może być stosowana zarówno w przedsiębiorstwach usługowych, jak też produkcyjnych.

**Słowa kluczowe:** Activity Based Costing, Time-Driven Activity Based Costing, koszty, Lean Management, procesy, sprzedaż.

## TIME-DRIVEN ACTIVITY BASED COSTING ALS GRUNLAGE FÜR DIE AUFNAHME VON LEAN-AKTIVITÄTEN

**ZUSAMMENFASSUNG. Einleitung:** Der immer wieder stärker werdende Wettbewerb, die Entwicklung von modernen Techniken und Technologien sowie der Wille zur Anpassung an die sich dynamisch verändernde Marktsituation zwingen den Unternehmern die Aufnahme von Versuchen hinsichtlich der Ermittlung und Einführung von neuen Methoden für die effektive Unternehmensführung auf. Aus diesem Grunde wurde der Versuch einer Kalkulation von logistischen Kosten des Kundenservice-Prozesses innerhalb des traditionellen und des E-Handels anhand der Analyse der Rechnungsmethode von Time-Driven Activity Based Costing (TDABC) unternommen. Das Ziel des vorliegenden Artikels war es, die Antworten auf die nachfolgenden Fragen: 1. Kann die Inanspruchnahme der Rechnungsmethode von TDABC im Dienstleistungsbereich (ein elektronischer Großhandelbetrieb) die Gebiete, in denen Verschwendungen entstehen, aufzeigen? 2. Was für finanzielle Vorteile kann eine solche Identifizierung im Kontext der angestrebten Beseitigung von Verschwendungsfällen angesichts des Lean Management-Konzeptes mit sich bringen? zu geben.

**Methoden:** Die betreffenden Forschungen wurden in einem Dienstleistungsunternehmen, also in einem elektronischen Großhandelbetrieb durchgeführt. Im Artikel projizierte man eine genaue Prozedur für die Ausführung einer Kostenkalkulation gemäß dem Konzept der zeitbedingten Kostenrechnung. Die Arbeit umfasst die ermittelten, von Mitarbeitern während der Ausführung von Kundenaufträgen unternommenen Aktivitäten, ferner die Kalkulation deren Kosten nach der TDABC-Methode und die erfolgte Vervollkommnung gemäß dem Lean Management-Konzept.

**Ergebnisse:** Im Artikel wurden theoretische Erkundungen bezüglich der TDABC-Methode und des Lean Management-Konzeptes dargestellt. Es wurden die einzelnen Schritte bei der Berechnung von Prozesskosten beschrieben, deren Analyse vorgenommen und die LEAN-Aktivitäten, die die Prozesse einordnen und deren Zeitdauer verkürzen lassen, vorgeschlagen.

**Fazit:** Die Integration der TDABC-Methode und des Lean Management-Konzeptes ermöglicht die Anbahnung von einleitenden Aktivitäten zur Ausrottung von Verschwendungsfällen, die Ermittlung von ungenutzten Kapazitäten, die Feststellung des in den betriebenen Ressourcen steckenden Potenzials und das Aufzeigen von Stellen etwaiger Kostenreduzierung innerhalb der betreffenden Prozesse. Das vorgeschlagene Beispiel der Kostenkalkulation kann sowohl in Dienstleistungs- als auch in Produktionsunternehmen effektiv in Anspruch genommen werden.

**Codewörter:** Activity Based Costing, Time-Driven Activity Based Costing, Kostenrechnung, Lean Management, Prozesse, Verkauf.

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