

THE METHOD OF DETERMINING THE TECHNICAL COSTS OF MANUFACTURING PRODUCTS

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Abstract: One of the many challenges in running a business is cost accounting. While there are many different costing methods, there is still a need to create new ones. The aim of this article is to develop a new method of cost calculation, which is adapted to modern conditions related to the adaptation of products to the needs of customers. This article presents an original method of determining production costs, which is based on the labor consumption of products. This method is a combination and development of known methods; however, by applying more precise accounting bases, it leads to more precise results. The developed method of cost calculation, thanks to its universality, can be used in most enterprises.

Keywords: cost calculation, costing sheets, organization of production, manufacturing costs.

JEL Classification: L69, M41.

1 Introduction

Nowadays, the competitiveness of enterprises is determined by market conditions. What is required is a high quality of products and services, short-order fulfillment times, low production costs, and the ability to flexibly adjust the products to individual customer wishes. To adapt to these requirements, companies customize their production program by delivering final products to the market, individually tailored to the needs of the recipient. These products, however, are assembled from unified components manufactured in large series. The companies also diversify their production, producing products for various customer groups (Osadchy and Akhmetshin, 2015; Matuszek and Kaczmar-Kolny, 2022).

An increasing number of enterprises, depending on the market situation, undertake the production of products under conditions of nonrepeatable and nonrhythmic production. Companies in the second group are of great importance to the national economy. This is because these companies are characterized by a significant intellectual contribution to the products they produce, often in these companies, they create their own development offices, thanks to which they offer the market their products.

Usually, in such enterprises, production is single and small-series, and often it is also diversified, offering customers various products and services. The machinery of such companies is characterized by the flexibility of the processes performed and usually cooperative services have a large share in the operations performed (Matuszek and Kaczmar-Kolny, 2022). In such a situation, it is increasingly important to be able to determine the own costs of manufacturing products already at the stage of designing products, and accepting orders for manufacturing processes from the point of view of making decisions about accepting orders from customers and shaping the course of production processes (Więcek, Więcek and Dulina, 2020).

This article aims to present the proprietary, hybrid, generalized costing model, which is an extension of the traditional costing methods used so far. The paper has been divided into three parts. In the first part, the literature on the methods of calculating the cost of manufacturing products was reviewed. The second part is the presentation of a theoretical, generalized model of costing with the use of indicators. The third part is an example of the application of the developed model in a company dealing in the production of recreational equipment.

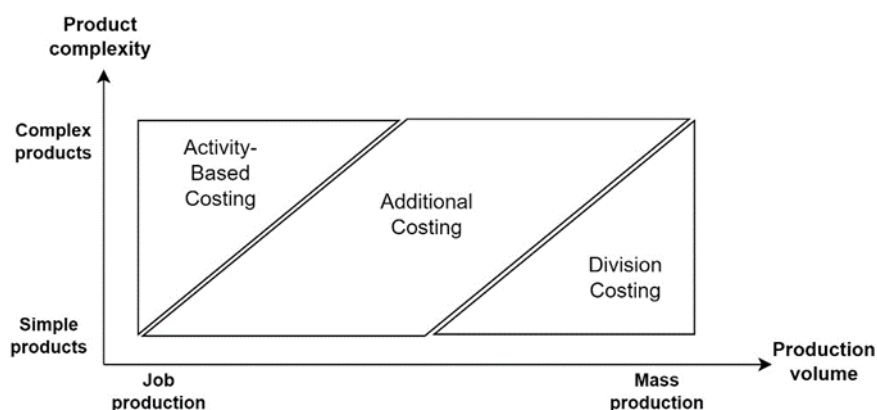


Figure 1. Application of cost calculation methods: activity-based costing, additional costing and division costing.
(Source: Matuszek, Kołosowski and Krokosz-Krynke, 2011)

2 Cost calculation methods

The methods of calculating costs of production, taking into account the criterion of building a computational algorithm, can be divided into two main groups: traditional calculations and activity-based costing methods (Jiran, et al., 2019; Matuszek, Więcek and Kaczmar-Kolny, 2021). As part of each of the abovementioned calculations, different calculation methods can be distinguished depending on the variety of products, the type of production-serialization, the required accuracy of calculations, or the type of information needed regarding the costs incurred (Matuszek, Kołosowski and Krokosz-Krynke, 2011) – Figure 1.

In the division costing method, the sum of costs incurred in a given period is divided by the total number of production units produced in that period. This method is used primarily in large-scale and mass production, in the case of the production of one simple product or similar products (Ankiewicz and Wyszowska, 2016; Matuszek and Kaczmar-Kolny, 2022). In the additional costing, direct costs are assigned to the cost object based on the source documentation, while indirect costs are added to them using the overhead rate (Brierley, Cowton and Drury, 2001; Drury, 2009; Matuszek, Więcek and Kaczmar-Kolny, 2021). This calculation method is widely used in production practice but is predisposed mainly for use in serial production.

Activity-based costing is an alternative to the traditional costing system, that is division and additional calculation, and is particularly used in job production (Alami and El Maraghy, 2020). According to this method, the production process is divided into activities, direct costs of activities are determined based on source documentation (similar to the additional costing method), and indirect costs are settled into activities using cost drivers corresponding to the share of these costs for individual activities (Kaczmar-Kolny and Więcek, 2021; Su, et al., 2021). Nowadays, in the value of products, in which the cost of manufacturing has a smaller and smaller share, the share of indirect costs related to obtaining information related to product design, manufacturing, and sales are growing. However, indirect costs, due to the difficulty of obtaining data, are averaged for the entire group of products (e.g., overheads for indirect costs for the entire department), which causes inaccuracy in the calculations performed (Kołosowski and Chwastyk, 2014).

The need to obtain increasingly accurate costing results has resulted in a wide variety of manufacturing costing algorithms. Nevertheless, there is still a need to create new methods, better adapted to the changing conditions of customized and diversified production processes (Kołosowski and Chwastyk, 2014).

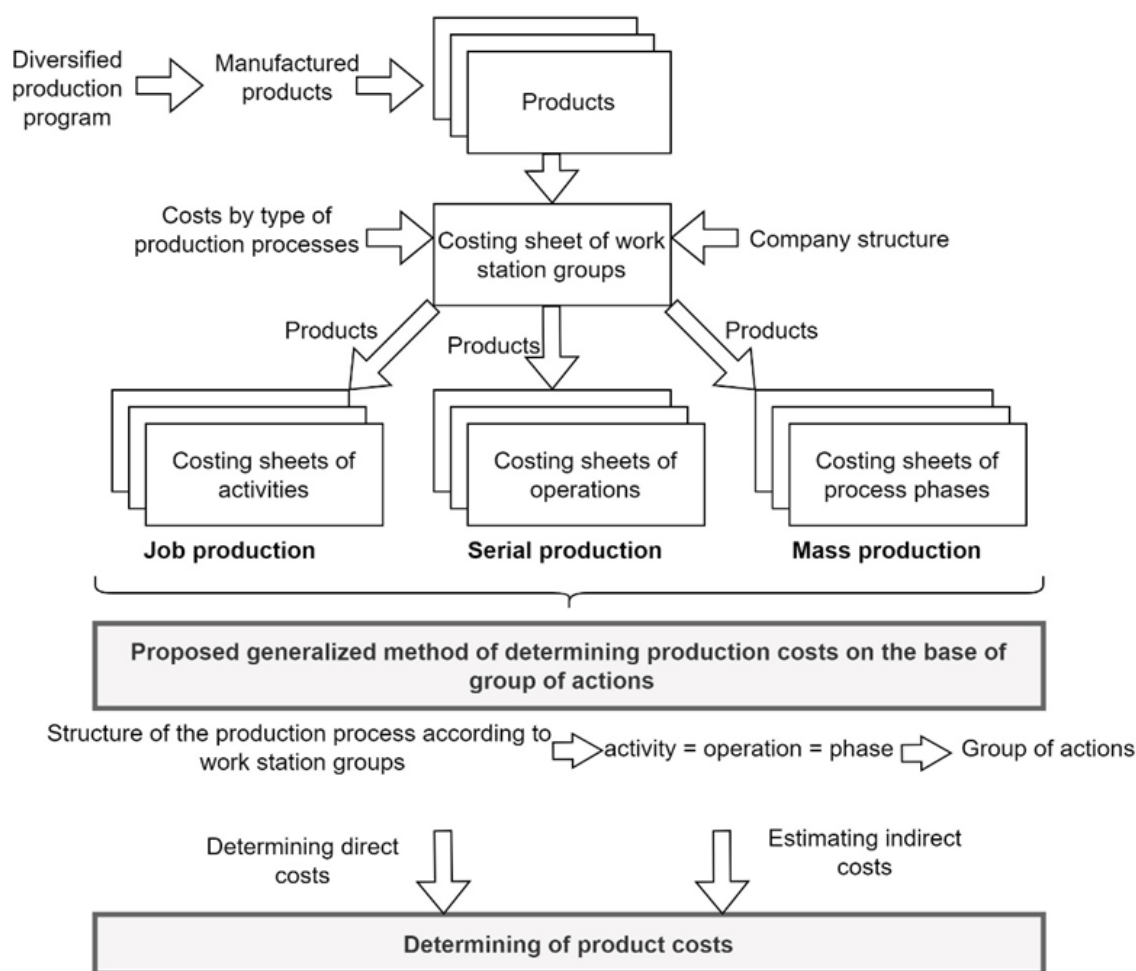


Figure 2. Model of determining production costs.
(Source: Authors' own research)

3 Generalized method for determining production costs

3.1 Method model

Technical progress, the development of planning and implementation methods of production processes, and the use of advanced IT management systems enable effective obtaining of more and more cost information. The model of the proposed cost calculation method is shown in Figure 2.

3.2 Costing sheet

Determining production costs is associated with obtaining information on the value of costs that were incurred at the design stage and the execution of various production processes at a given time. The source

is the costing sheet (CS) (Kaczmar and Matuszek, 2020).

The company CS is an array in which the lines contain individual costs by type, while the columns contain cost centers. At the intersection of the appropriate column and the row, the values of specific generic costs are given, incurred by the appropriate cost center - Figure 3. Cost centers can be considered as entire enterprises, groups of work stations, or individual work stations.

Mark the cost values as c , the next type of cost as I , and the number of the next organizational unit (costing center, group of work stations, etc.) as n . The CS can be written in the form of a matrix (1).

$$[CS] = \begin{bmatrix} C_{11} & \dots & C_{1n} & \dots & C_{1N} \\ \vdots & & \vdots & & \vdots \\ C_{i1} & \dots & C_{in} & \dots & C_{iN} \\ \vdots & & \vdots & & \vdots \\ C_{I1} & \dots & C_{In} & \dots & KC_{IN} \end{bmatrix} \quad (1)$$

where: C_{in} – value of the i -th indirect type of cost incurred in the n -th organizational unit in a given period of time.

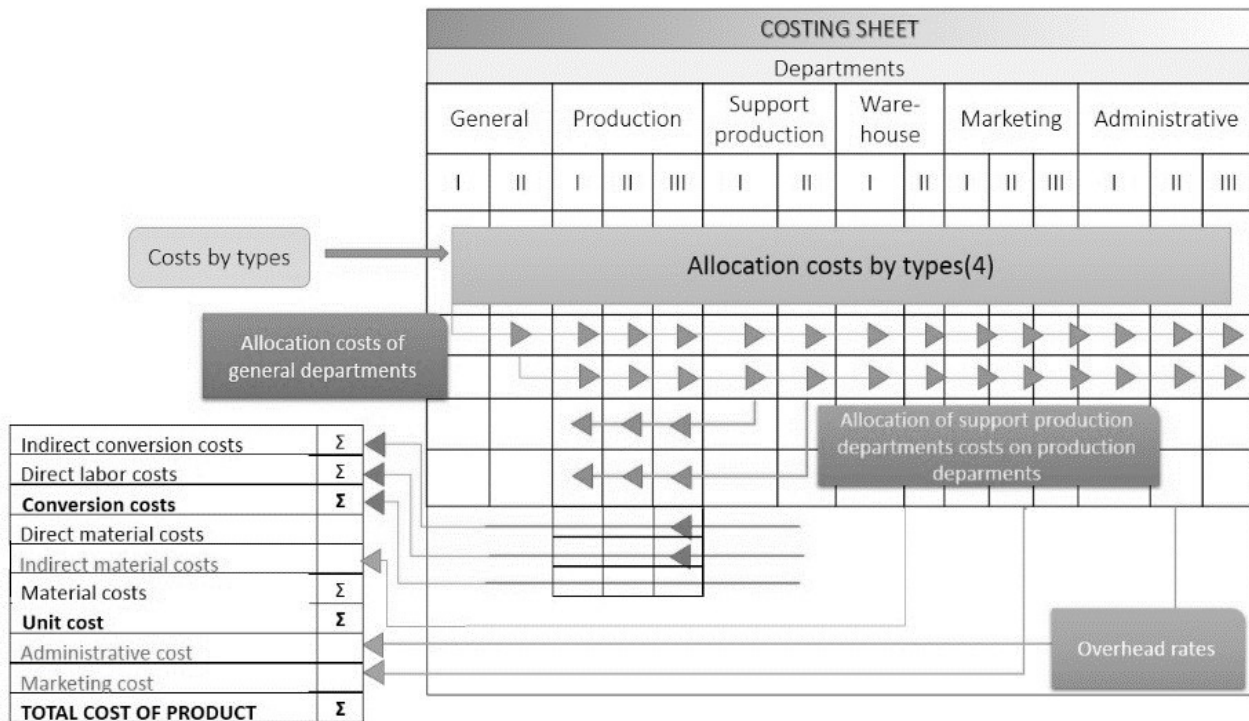


Figure 3. Model of determining production costs.
(Source: Authors' own research)

A CS can be used to determine indirect costs related to cost centers in various settlement periods - month, quarter, year, and so on.

3.3 Costing sheets of group of production process actions (activities, operations, phases)

The costing sheets of action groups (CSA) (activities, operations, phases) of the production process is in the form of a table in which the lines contain individual costs by type (similar to the CS of the entire enterprise), and while in the columns there are activities, operations, or phases (in appropriate cost centers) related to the implementation of individual production processes in enterprises and they are assigned individual cost values by type, created in a given accounting period. If the activities, operations, or phases will be hereinafter referred to as "action groups," the CSA

for the given production process can be written in the form of a matrix (2).

$$[CSA] = \begin{bmatrix} C_{11}^1 & \dots & C_{1m}^n & \dots & C_{1M}^N \\ \vdots & & \vdots & & \vdots \\ C_{i1}^1 & \dots & C_{im}^n & \dots & C_{iM}^N \\ \vdots & & \vdots & & \vdots \\ C_{I1}^1 & \dots & C_{Im}^n & \dots & C_{IM}^N \end{bmatrix} \quad (2)$$

where: C_{im}^n – the value of the i -th indirect type of cost incurred for the m -th activity in the n -th organizational unit in the considered period of time.

Each of the CSA can be linked to a given cost object. The production process, but also a production order, a production batch, a single product, or a group of products can be assumed as the cost object, which consists of actions performed in the CSA.

The set of CSA for the entire production program is the CS for the considered period. This relationship is described as follows using the formula (3).

$$[CS] = \sum_{p=1}^P [CSA^p] \quad (3)$$

where: $[CSA^p]$ – costing sheet of group actions of the p -th manufacturing process,

p - number of the manufacturing process, $p = 1, \dots, P$.

In the CSA worksheet, each activity distinguishes between two types of costs—direct and indirect. Determining direct costs for individual groups of activities does not cause major difficulties. In production practice, time data for calculations can be relatively easily obtained from ERP (Enterprise Resource Planning) software databases. This applies to the costs of direct work, costs of workstations, tools, and so on (4), (5).

$$Cl_d = R_w \cdot t_a \quad (4)$$

$$C_{ws} = C_{ws}^c + C_{ws}^v + C_{tools} \quad (5)$$

where:

Cl_d - direct labor costs,

R_w - the rate of work of an employee working in a given position,

t_a - unit time of performing a group of activities at a given position,

C_{ws} - work station costs,

C_{ws}^c - constant work station costs,

C_{ws}^v - variable work station costs,

C_{tools} - costs of tools.

Determining indirect costs requires the use of indicators appropriate for given production conditions for groups of indirect type of costs - Figure 4.

As indicators of indirect costs, they may be taking into account the traditional methods of cost calculations - cost factors (division calculations), indirect costs overheads (additional calculations), and costs drivers (activity-based costing). In the conditions of modern production practice, not only the scheduling of production tasks but also the determination of production costs in companies and the times of performed groups of actions (activities, operations, phases) of production processes are determined. Therefore, it can be assumed that in each of the abovementioned cases, the labor intensity of a given group of activities can be taken as an indicator (6).

$$Cp_i = \frac{L_d}{\sum L_d} \cdot \sum Cp_{it} \quad (6)$$

where:

Cp_i - indirect processing costs,

L_d - labor intensity of direct work for the analyzed product, order, and so on,

$\sum L_d$ - the sum of the labor intensity of direct work of all activities carried out in a given period of time in a given cost center,

$\sum Cp_{it}$ - sum of indirect costs for all activities carried out in a given period of time at a given cost center.

4 Algorithm of the generalized method for determining the costs of production

The developed algorithm for determining production costs following the previously made assumptions was presented with the formulas (7) to (13). When developing the model, it was assumed that the general course of calculations is based on the most frequently used additional calculation by cost centers. The algorithm, however, has the features of a hybrid calculation combining in some parts the features of other calculations—activity-based costing or division calculation method. The proposed cost calculation algorithm may be subject to various modifications, for example indicators may also take into account other cost factors, administration, and sales costs may be determined by the traditional method based on the overheads. This approach can be used in enterprises characterized by the diversity of the manufactured assortment, low serialization, and the uniqueness of the products produced. In such enterprises, more and more often, the scope of work related to the precise determination of manufacturing costs is taken over from financial and accounting departments by engineers in production engineering departments. The choice of the calculation method depends on the needs of the accuracy of the calculations, the possibility of obtaining cost information, or the time that the company can spend on creating a product cost estimate (Matuszek and Kaczmar-Kolny, 2022).

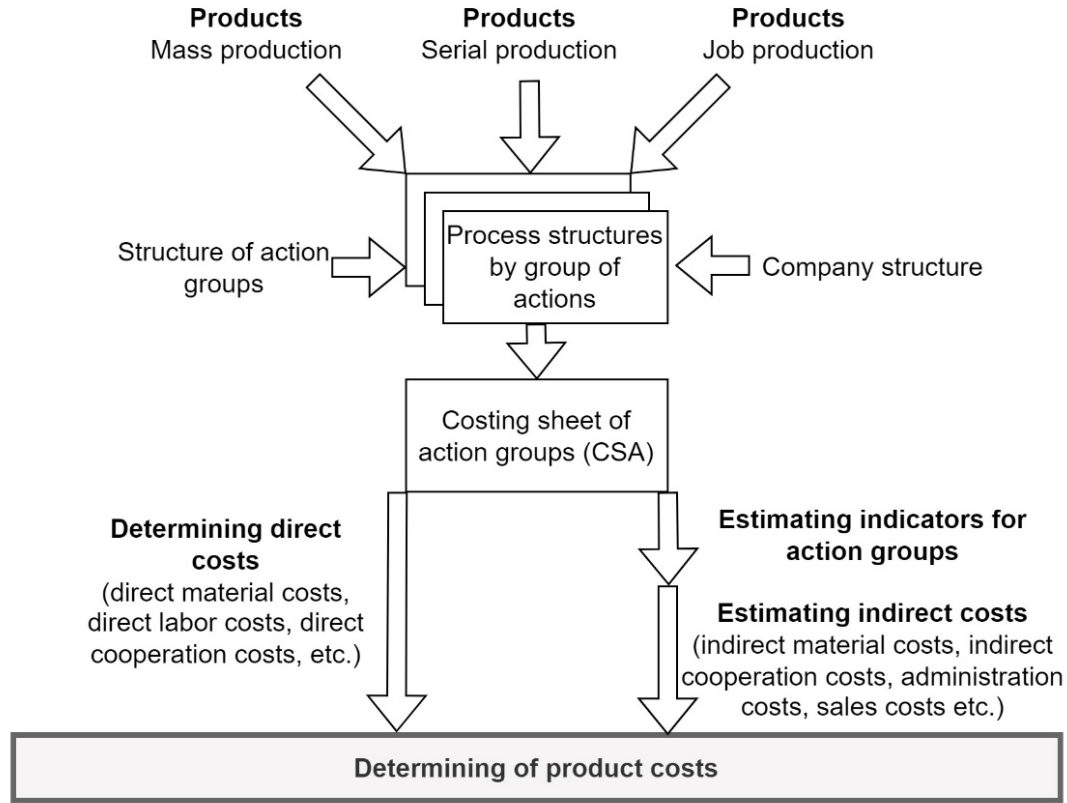


Figure 4. Method of determining the costs of implementing a group of activities in the CSA
(Source: Authors' own research)

$$Cm = Cm_d + Cm_i = Cm_d + \frac{L_s}{WT_s} \cdot \sum Cm_i \quad (7)$$

$$Cc = Cc_d + Cc_i = Cc_d + \frac{L_c}{WT_c} \cdot \sum Cc_i \quad (8)$$

$$Cp = Cl_d + C_{ws} + Cp_i \quad (9)$$

$$Cmf = Cm + Cc + Cp \quad (10)$$

$$Ca = O_a \cdot Cmf \quad (11)$$

$$Cs = O_s \cdot Cmf \quad (12)$$

$$Ct = Cmf + Ca + Cs \quad (13)$$

where:

Cm - material costs,
 Cm_d - direct material costs,
 Cm_i - indirect material costs,
 L_s - labor intensity of supply process (in hours or in % concerning the total working time of an organizational unit/team dealing with supply),
 WT_s - the total working time of the organizational unit/team dealing with supply,

Cc - cooperation costs,
 Cc_d - direct cooperation costs,
 Cc_i - indirect cooperation costs,
 L_c - labor intensity of cooperation process (in hours or in % about the total working time of an organizational unit/team dealing with cooperation),
 WT_c - the total working time of the organizational unit/team dealing with cooperation),
 Cp - processing costs,
 Cl_d - direct labor costs,
 C_{ws} - workstation costs (determined by formula (5)),
 Cp_i - indirect processing costs (determined by formula (6)),
 Cmf - manufacturing costs,
 Ca - indirect administration costs,
 O_a - overhead of administration costs,
 Cs - indirect sales costs,
 O_s - overhead of sales costs,
 Ct - total costs.

5 An example of the method's application in production practice

5.1 Presentation of the problem

The example relates to a medium-sized company where three groups of products are produced as part of its diversification. The first group includes cutting tools made on a large scale, the second group is the sale of power tools and serial production of attachments for them, and the third group is sports equipment (ski lifts) made in small-series production conditions. The organizational structure of this company is presented in Figure 5.

It was assumed that the subject of determining the cost of production will be one of the sports equipment manufactured - "Carousel-Rotor" Figure 6. Figure 6 shows the elements manufactured in the company, the remaining elements included in the carousel

are commercial components, and the costs of their purchase are included in the costs of supply.

The production costs of the "Carousel-Rotor" include the groups of actions presented in Figure 7.

Figure 7 lists the following groups of activities: PZ-order acceptance, PD-documentation design, ZA-supply, W-manufacturing, KJ-quality control, SP-product sales, OB-Machining, KO-Cooperation, MO-assembly. Additionally, the following supervision activities were included: NW-production supervision, NT-technical supervision, NF-financial supervision, NK-personnel supervision and NO-general supervision.

For example, the carousel arm number 10 was chosen as the subject of further cost considerations.

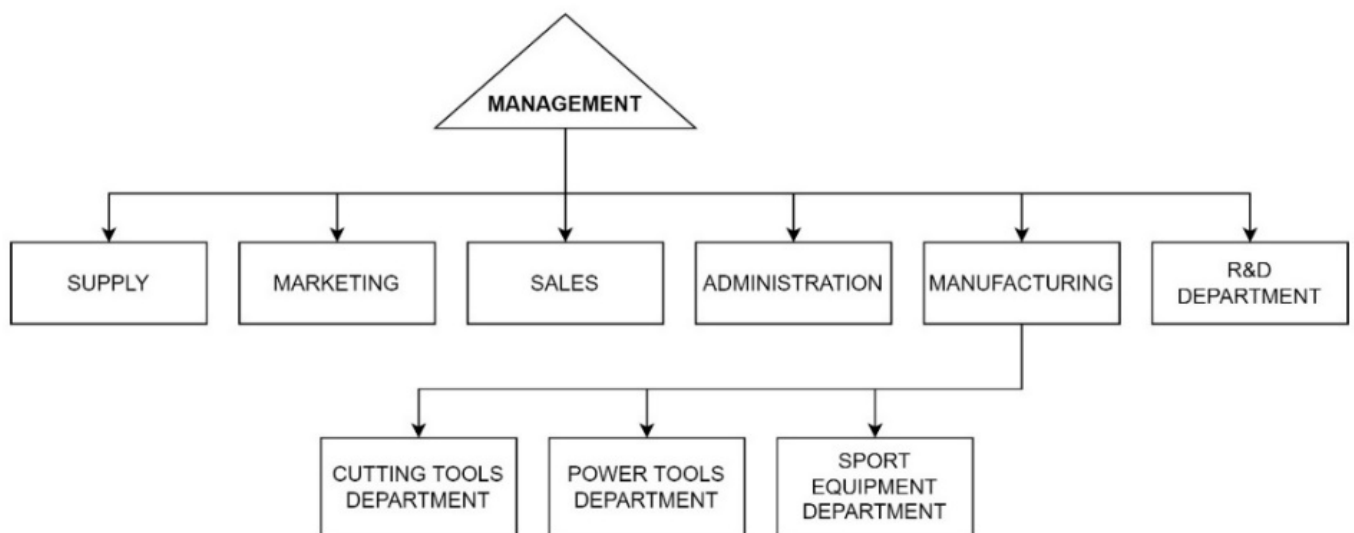


Figure 5. Structure of considered company
(Source: Authors' own research)

Table 1. Company's costing sheet
(Source: Authors' own research)

Costs by types	Work stations of cutting tools production process	Work stations of sport equipment production process	Work stations of power tools production process	R&D department	Supply	Administration	Marketing and sales department
Indirect processing costs	2.5 million PLN/year	3.5 million PLN/year	3.0 million PLN/year	2.5 million PLN/year	0.5 million PLN/year	2.5 million PLN/year	1.5 million PLN/year
Direct costs by types	3.5 million PLN/year	4.5 million PLN/year	3.0 million PLN/year	4.0 million PLN/year	1.75 million PLN/year	1.5 million PLN/year	1.25 million PLN/year
The sum of costs by types (including direct labor costs)	6.0 million PLN/year (1.6 million PLN/year)	8 million PLN/year (2 million PLN/year)	6.0 million PLN/year (1.4 million PLN/year)	6.5 million PLN/year (1.5 million PLN/year)	2.25 million PLN/year (0.5 million PLN/year)	4.0 million PLN/year (1.8 million PLN/year)	2.75 million PLN/year (1.2 million PLN/year)
Number of employees	16	20	14	10 + 3 + 2 = 15	5	18	12
Total number of employees:				100			
Total costs:				35.5 million PLN/year			

5.2 Costing sheet

In the company's CS, cost centers were distinguished by the organizational chart – Figure 5. The CS was created in Microsoft Excel. In the CS, the costs generated by general company positions for positions listed in table 1 were settled.

The CS shown is a simplified sheet. In the full CS, more detailed breakdowns can account for costs by type - for example, energy costs billing, water consumption, and so on.

5.3 Costing sheet of action groups

An example of determining production costs is illustrated in the example of the arms manufacturing process - Figure 8. In the abovementioned example,

following the proposed generalized method of determining costs, the manufacturing costs C_{mf} will be determined, while the remaining costs, that is administration C_a and sales costs C_s , will be calculated according to the traditional additional calculation additive (using overheads).

The course of the rotor arm manufacturing process is presented in the process sheet – Figure 9. Table 2 shows the CS for groups of actions in enterprises. The table shows the costs of direct labor, labor consumption in performing groups of actions at work stations, work station costs, and total labor consumption in the production of all products at given work stations.

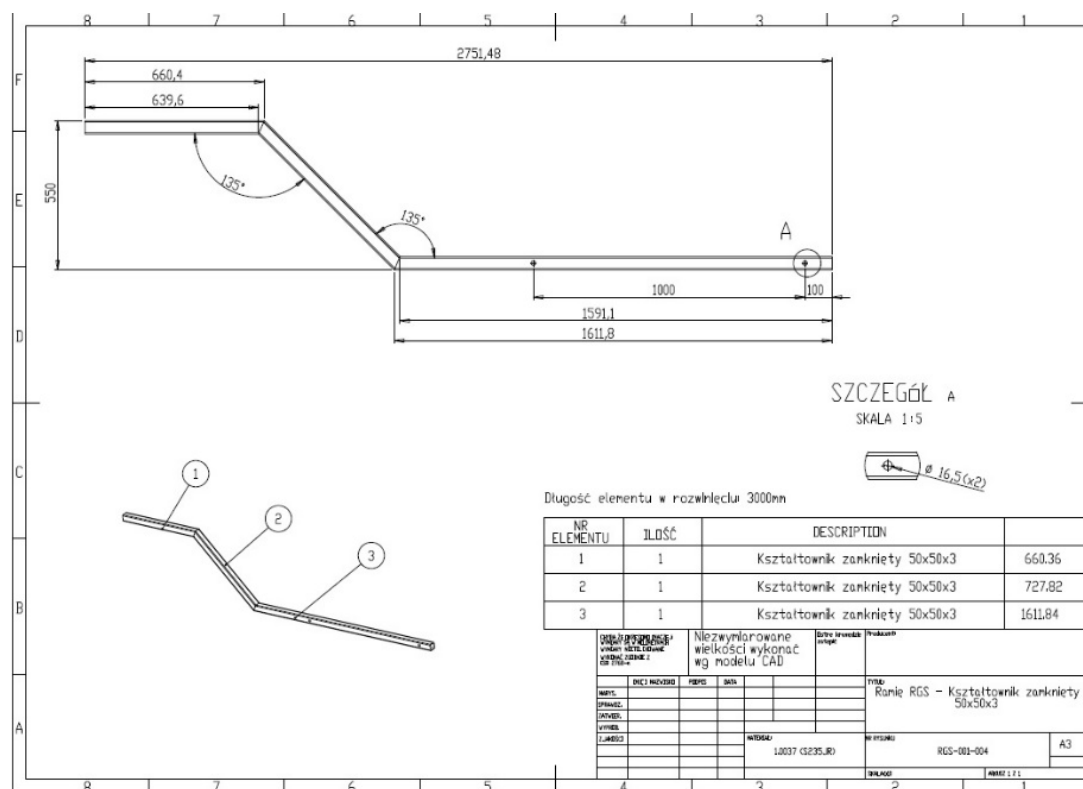


Figure 8. Rotor arm (of rotor shown in fig. 6)
(Source: Authors' own research)

PROCESS SHEET NO. KT/14/2021						
Product		Part name	Fig. Number	Order number		
RGS		Carousel arm	RGS - 000 - 004	ZK - 25/01/2022/DT		
Material type		Form and dimensions of the material [mm]	Quantity per product	Weight of 1 piece	Total quantity per order	
S235JR		Closed structural section 50 x 50 x 3	4	12.8 kg	4	
Operation no.	Work station	Description of the operation	Tools	Tpf	Tu	ΣT
10	PR300	Cutting material to a specific length	Band-saw 34 x 1.1	0.1	0.2	0.9
20	WS300	Drilling holes φ16,5	Drill φ16,5	0.2	0.25	1.2
30	SM250	Welding of structural sections	Welder MIG-MAG 250	0.5	1	4.5
40	SKJ1	Visual control VT	Welding gauge, flashlight, luxmeter, caliper	0.5	0.5	2.5
50	-	Hot-dip galvanization	-	-	-	-
60	LP10	Powder coating	RAL 5010	0.3	0.3	1.5
70	SKJ1	Quality control	Caliper, linear ruler	0.5	0.5	2.5
				Total order time [h]: 13.1		
Comments						
Drawn up:						

Figure 9. Carousel arm process sheet
(Source: Authors' own research)

The proposed method of calculation was related to the determination of indirect costs using the labor intensity of the groups of activities performed at workplaces:

$$Oa = \frac{Ca}{Cmf} \quad (14)$$

$$Os = \frac{Cs}{Cmf} \quad (15)$$

The following values of cost parameters were adopted in the calculations:

- direct labor costs of the employee in operations no. 10 and 20 is 40 PLN/h, in operations no. 30, 40, 50, and 70 is 60 PLN/h, operation 60 is performed in cooperation, which costs 20 PLN per item so $Cc = 80$ PLN/order,
- unit workstation costs: $C_{ws10,20} = 80$ PLN/h, $C_{ws30,40,50,60,70} = 100$ PLN/h,
- production of one sports equipment, 4 pieces of arms: $n = 4$ pieces/order.

Direct labor costs were calculated using formula (16) and workstation costs by formula (17):

$$\begin{aligned} Cl_d = & \left\{ \left[\left(\frac{0.1}{4} + 0.2 \right) \cdot 40 \right] + \left[\left(\frac{0.2}{4} + 0.25 \right) \cdot 40 \right] + \right. \\ & \left[\left(\frac{0.5}{4} + 1.0 \right) \cdot 60 \right] + \left[\left(\frac{0.5}{4} + 0.5 \right) \cdot 60 \right] + \left[\left(\frac{0.3}{4} + 0.3 \right) \cdot 60 \right] + \left[\left(\frac{0.5}{4} + 0.5 \right) \cdot 60 \right] \right\} \\ & = 0.9 \cdot 40 + 1.2 \cdot 40 + 4.5 \cdot 60 + 2.5 \cdot 60 + 1.5 \cdot 60 + 2.5 \cdot 60 = 774 \text{ PLN/item} \quad (16) \end{aligned}$$

$$\begin{aligned} C_{ws} = & 4 \cdot \left\{ \left[\left(\frac{0.1}{4} + 0.2 \right) \cdot 80 \right] + \left[\left(\frac{0.2}{4} + 0.25 \right) \cdot 80 \right] + \left[\left(\frac{0.5}{4} + 1.0 \right) \cdot 100 \right] + \left[\left(\frac{0.5}{4} + 0.5 \right) \cdot 100 \right] + \right. \\ & \left[\left(\frac{0.3}{4} + 0.3 \right) \cdot 100 \right] + \left[\left(\frac{0.5}{4} + 0.5 \right) \cdot 100 \right] \right\} = 0.9 \cdot 80 + 1.2 \cdot 80 + 4.5 \cdot 100 + 2.5 \cdot 100 + 1.5 \cdot 100 + 2.5 \cdot 100 = 1268 \text{ PLN/item} \quad (17) \end{aligned}$$

The data relating to the calculation of indirect costs are given in Table 2. The table includes the part in which the costs were determined according to the proposed method—columns 2, 3, 4, and 5. In columns 2, 3, and 4, indirect costs were determined based on the labor intensity obtained from the process sheet presented in Figure 9. In the case of the R&D department and the supply department (columns 5, 6), the costs are defined as the effort involved in the design, material supply, and components for the entire

product. The data on the labor intensity was obtained based on the costs of using the working time fund of these organizational units. For example, the processing costs in accordance with Table 2 is:

$$\begin{aligned} Cp &= Cl_d + C_{ws} + Cp_i = \\ &= (84 + 420 + 240) + (168 + 700 + 400) + \\ &= (84.75 + 288.25 + 166.75) = 2551.75 \text{ PLN/order} \quad (18) \end{aligned}$$

According to the traditional cost calculation method, Cp_i costs were determined using the formula:

$$Cp_i = O_p \cdot Cl_d \quad (19)$$

According to Table 1, the Cp_i and Cl_d costs are as follows:

$$Cp_i = (2.5 \text{ million} + 3.5 \text{ million} + 3.0 \text{ million}) = 9 \text{ million PLN} \quad (20)$$

$$Cl_d = 1.6 \text{ million} + 2 \text{ million} + 1.4 \text{ million} = 5 \text{ million PLN} \quad (21)$$

$$O_p = \frac{Cp_i}{Cl_d} = \frac{9 \text{ million}}{5 \text{ million}} = 1.8 \quad (22)$$

For such an overhead rate for the Cl_b value given in Table 2, the Cp_i costs for the carousel arm would be (the value of the Cp_i overhead includes C_{ws} costs):

$$Cp_i = O_p \cdot Cl_d = 1.8 \cdot (84 + 420 + 240) = 1339.2 \text{ PLN/order} \quad (23)$$

$$Cp = Cp_i + Cl_d = 744 + 1339.2 = 2083.2 \text{ PLN/order} \quad (24)$$

The difference between the two calculation algorithms is approximately 469 PLN. The difference results from various approaches to determining the indirect costs of processing. In the traditional approach, Cp_i costs were determined concerning Cl_d costs, that is it was assumed that the higher the salary costs of employees, the greater the share of indirect costs in the process implementation costs (which in production practice often resulted from the traditional assumption that expensive jobs are served by highly qualified employees).

Table 2. Costing sheet of action groups
(Source: Authors' own research)

Costs by types	Work stations of cutting tools production process			R&D department	Supply	Administration	Marketing and sales department
	Cutting material, drilling holes	Welding, Visual control	Powder coating, quality control				
Indirect processing costs	84 PLN	420 PLN	240 PLN	-	-	-	-
Work stations costs	168 PLN	700 PLN	400 PLN	-	-	-	-
Labor intensity of rotor arm manufacture	2.1	7	4	270	75	-	-
The sum of labor intensity on work stations	62 600	85 500	72 000	25 500	8 500	-	-
Indirect costs by types	2.5 million PLN/year	3.5 million PLN/year	3.0 million PLN/year	2.5 million PLN/year	0.5 million PLN/year	2.5 million PLN/year	1.5 million PLN/year
Indirect costs	84.75 PLN	288.25 PLN	166.75 PLN	24 500 PLN	4 400 PLN	-	-

Technical progress, the introduction of production automation, resulted in filling expensive workplaces with employees with lower qualifications and therefore lower wages; moreover, the time of execution (labor intensity) of the process, for example related to technical and organizational support (especially in low-volume production conditions), has a significant impact on indirect costs qualified employees). Technical progress, the introduction of production automation, resulted in filling expensive workplaces with employees with lower qualifications and therefore lower wages; moreover, the time of execution (labor intensity) of the process, for example related to technical and organizational support (especially in low-volume production conditions), has a significant impact on indirect costs.

6 Summary

Owing to the development of automation and robotization applications in the implementation of production processes, the share of direct costs in production costs is constantly decreasing, while the department of indirect costs is growing in them.

Many companies, adapting to market requirements, diversify their production program, and depart from the mass production strategy in favor of a strategy tailored to individual customer wishes. This state of affairs has a different cost structure. The share of costs of intellectual contribution to manufactured products in the form of order handling, documentation development, production preparation, supply, storage, control, distribution, marketing, and sales are growing. In addition, the product life cycle is shortened, which emphasizes the need for continuous development of the production program, increasing production preparation costs (Bolfek and Vujcic, 2009). In such a situation, when using standard methods of cost calculations, costs are often obtained that differ from their actual values, which means that enterprises operate on distorted information about the profitability of orders, products, or customers (Kaplan and Anderson, 2008; Seal, et al., 2019).

A large number of publications related to the calculation of production costs shows that this is an extremely important topic that still requires development. The aim of this article was to create

a new, generalized method of calculating production costs, which, however, can be adapted to the individual needs of specific enterprises. The concept of determining costs presented in this article allows for more accurate determination and assignment of indirect costs to a given group of activities in the production process and obtaining cost data when making cost decisions in the enterprise, improving the knowledge of the reasons for generating costs, shaping the course of production processes. In addition, the developed concept of cost determination meets new tools and techniques for shaping production processes, such as:

- enabling the design of the product by the customer himself—using the rapid manufacturing technique RM (Pride, Hughes and Kapoor, 2014),
- management information modules in ERP class software,
- process visualization and animation software.

In the CS, the costs are settled into groups of activities related to groups of workstations. To increase the accuracy of the calculations, it is possible to perform calculations for individual workstations and even for individual workplaces. The CS for groups of actions can be created separately for each of the production processes occurring in the enterprise. The proposed example of the procedure, based on the cost accounting of action groups, enables effective cost calculation, especially in the case of the unit and small-lot production. Thanks to the settlement of costs into groups of actions occurring in the production process, it is also possible to identify activities that generate high costs, which in turn provides the basis for reducing production costs, thanks to decisions to eliminate or reduce the consumption of resources in activities that do not create added value in the product manufacturing processes. There is no correlation between the labor intensity of the work performed in a given production cell (a separate group of workstations) and other cells. In the cost estimate sheet (Table 2) in line 4 (total labor intensity of works in a given cell)-the times of making elements (work items) in a given production cell were summed up. Other workpieces may be executed in other work cells. Therefore, according to the developed model, it is possible to determine

the production costs for each separate group of stations separately.

The presentation of the principles of the building CSs in the form of formulas (1), (2) and (3) is the basis for the development of ERP class software modules, supporting the determination of production costs.

7 References

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