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A Model-Based Approach for Optimal Price Calculation of Primary Wood Products

Primjena pristupa zasnovanoga na modelu za izračun optimalne cijene proizvoda u primarnoj preradi drva

ORIGINAL SCIENTIFIC PAPER
Izvorni znanstveni rad
Received – prispjelo: 30. 5. 2025.
Accepted – prihvaćeno: 21. 7. 2025.
UDK: 630*88
https://doi.org/10.5552/drvind.2025.0274

ABSTRACT • *During a period of intensive changes in the market, when profits cannot be increased by raising sales prices, companies focus on improving production processes and reducing costs. Intensified competition and business development demand improved cost tracking within companies and by individual products. Accurate calculation of product costs is crucial because the final product generates revenue and impacts its growth or decline. Introducing a new model for calculating and allocating costs per product unit aims to review the concept of fixed cost distribution in the company and the calculation of product costs to assess the profitability of This model shows that most selected products are profitable to produce. Observing overall profits for selected products, Model E is the only one that ultimately shows a gain. It provides information on the actual cost of each product, enabling the company to decide whether to produce, wait for a price change, or discontinue a product. Model E suggests dividing costs into fixed and variable, then allocating variable costs to each product's cost. The difference between each product's revenue and its variable costs represents the contribution margin used to cover fixed costs. Applying Model E is expected to yield better business results over time by clearly indicating which products should be supported and which should be terminated.*

KEYWORDS: *wood industry; cost price; contribution margin; cost price calculation models*

SAŽETAK • *Tijekom razdoblja intenzivnih promjena na tržištu, kada se profit ne može povećati podizanjem prodajnih cijena, tvrtke se usredotočuju na poboljšanje proizvodnih procesa i smanjenje troškova proizvodnje. Intenzivnija konkurencija i razvoj poslovanja zahtijevaju pažljivije praćenje troškova unutar tvrtki, kao i za pojedinačne proizvode. Točan izračun troškova proizvoda ključan je korak u tom procesu jer konačni proizvod generira prihod i utječe na njegov rast ili pad. Cilj uvođenja novog modela za izračun i raspodjelu troškova po jedinici proizvoda jest preispitivanje koncepta raspodjele fiksnih troškova u tvrtki i izračun troškova proizvoda kako bi se procijenila profitabilnost svakog proizvoda. Testirani su različiti modeli obračuna troškova (od A do E), a model E pokazao*

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se optimalnim. Njime je potvrđeno da je proizvodnja većine ispitivanih proizvoda isplativa. Promatrajući ukupnu dobit za odabrane proizvode, model E je jedini koji je u konačnici potvrdio dobit. Njime se dobivaju informacije o stvarnom trošku svakog proizvoda, što omogućuje tvrtki da odluči hoće li konkretni proizvod i dalje proizvoditi, čekati promjenu cijene ili ga sasvim prestati proizvoditi. Prema modelu E, predlaže se podjela troškova na fiksne i varijabilne, a zatim dodjeljivanje varijabilnih troškova trošku svakog proizvoda. Razlika između prihoda svakog proizvoda i njegovih varijabilnih troškova čini doprinosnu maržu koja je namijenjena pokrivanju fiksnih troškova. Očekuje se da će primjena modela E s vremenom donijeti bolje poslovne rezultate jasnim naznačivanjem proizvoda koje treba podržati, kao i onih koje treba prestati proizvoditi.

KLJUČNE RIJEČI: *drvna industrija; cijena koštanja; kontribucijska marža; modeli izračuna cijene koštanja*

1 INTRODUCTION
1. UVOD

The demand for wood continues to grow steadily, yet the availability and production of wood raw materials remain limited. This situation lowers the prospects for the timber business, as the wood industry struggles to meet market demand, leading to higher prices for wood products.

Costs are the basis for many business decisions. Wood processing companies must constantly strive to improve or at least maintain their market share (Oblak and Glavonjić, 2014). There are several ways to achieve this. Increased costs reduce company profits, i.e. a company that cares about its profits will strictly monitor its costs in order to maintain profitability (Motik, 2004; Muhdi and Hanafiah, 2022). For any business situation, the rule is that the company must be the lowest cost provider in the long term, that its costs must tend to fall and that it must have a complete picture of costs and profits for each product at all times. It is not sufficient to analyse the costs for a single or limited business area, but the entire business process chain, i.e. from the supplier to the customer of products or services (Posavec *et al.*, 2022). In this way, costs are managed throughout the entire business process (Figurić, 2003). In times of difficult economic conditions, managers have to make numerous decisions and take various measures on a daily basis to ensure the long-term profitability of the company and maximise profits at the lowest possible cost. Accordingly, cost management is of central importance, which, according to Belak *et al.* (2009) pursues two fundamental objectives, cost reduction and cost control. It is possible to manage costs in different ways and with different models, but in order to achieve a positive outcome of the cost management process, it is important to know the existing structure of the organisation's total costs. This should be the first step towards cost management and towards achieving the company's goals. The most effective cost management is reflected in the management of business processes. Therefore, improving the methods of collecting and reporting financial cost data is critical to support management decision-making (Zimmerman, 2011). In today's fast-paced and dynamic market, knowing how to manage costs appropriately and to a high standard is a complex process that requires the application of modern methods. For a long time, cost management was carried out using traditional methods and the resulting allocation key. However, due to major market changes in the forestry and wood processing industries, there was a need to develop new methods and business models whose cost allocation keys are more appropriate and precise than those of traditional methods (Kajanus *et al.*, 2019).

The wood-based sector development strategies include modernising production and increasing the proportion of end products with higher added value (Posavec and Vuletić, 2004). The industry in Europe has called for better recognition of its potential as a driver for sustainability in key EU policies, including the EU Industrial Strategy, the EU Green Deal, and the EU Bioeconomy Strategy (European Economic and Social Committee, 2024). In 2020, the share of wood processing and furniture manufacturing in the GDP of the Republic of Croatia was around 1 %. Wood processing (C 16) (according to the National Classification of Activities – NKD2007) accounted for 0.7 %, and furniture production (according to NKD C 31) for 0.3 %. In total, there were around 2,000 business entities that, together with forestry, employ around 53,000 people. Additionally, wood processing accounted for 66.40 % of the total annual revenue of both activities and 73.88 % of total foreign trade, while furniture production accounted for 33.60 % and foreign trade for 26.12 %. The average monthly net wage per employee in wood processing was EUR 662.15. The activities provided the supply of goods to the European Union market and exports to third countries to the value of 957 million euros, and at the same time the value of the acquisition and import of goods amounted to 672 million euros, resulting in a surplus in foreign trade of 285 million euros (GoC, 2023). However, in 2022 there were more than 1340 companies operating in the Republic of Croatia, registered according to their main economic activity (NKD 2007) in the sector Processing of wood and wood products (C 16). According to the Croatian Bureau of Statistics and Croatian Financial Agency, in 2022 wood

processing generated an income of 2.1 billion euros employing around 18,000 people. The average monthly net wage per employee in wood processing was 770 euros. The activities provided the supply of goods to the European Union market and exports to third countries to the value of 981 million euros.

Although new wood-based materials have entered the market, coniferous sawn wood remains the most significant solid wood product in terms of both production volume and economic importance (Andersch *et al.*, 2013).

A similar situation is observed in the Croatian market, where the competitiveness of primary wood processing is a key challenge. In line with this, the main aim of this paper is to explore possibilities for reducing the cost price in the manufacturing process of primary wood products, as a means to increase competitiveness. Using a selected medium sized wood processing company as a case study, the research has two specific objectives:

i. to analyse the current system of cost calculation and overhead allocation, and
ii. to present and compare alternative costing models — full costing, partial costing, and direct costing — in order to identify which model best supports business success.

The development of models and the proposal for the application of an appropriate method for calculating the cost price will contribute to the improvement of the business activities of companies in the field of primary wood processing. On the example of the selected wood processing company, the cost price will be determined and calculated using different cost calculating methods (division calculation, additional calculations, and calculations of by-products).

2 THEORETICAL BACKGROUND
2. TEORIJSKA PODLOGA

The accounting system is one of the most important foundations for the success of any company, as the correct and efficient application of the accounting system contributes to enhancing the economic efficiency of the company, reduces the excess costs, and reduces the risks that the company may encounter (Kamal, 2015).

Costs are an integral part of any business, including manufacturing companies. In the context of manufacturing, costs are incurred in order to achieve useful effects, i.e. the production of finished products. Many costs are incurred in the production process (product costs, direct labour costs, general production costs, material costs, depreciation costs, etc.). It is necessary for the management of a production company to know how to recognise costs, in which phases costs arise and which products cause these costs. We need to know the costs in order to determine the cost price and thus the selling price of the product and to see how it behaves in relation to competitive prices on the domestic and foreign market (Škrtić, 2015).

The goal of every company is to produce as much as possible with as few costs as possible, i.e. to generate as much profit as possible (Škrtić, 2015).

Prices are exogenous factors when viewed from the perspective of a company's business policy. Price is a consequence of the relationship between supply and demand, but it is also the cause of supply and demand and has its own constituent elements. The relationship among the elements within the price represents the structure of the price.

Although the specific costs estimated vary among fields, the generic categories of costs are often similar (e.g. equipment, human resources, and consumables (Brunetti *et al.*, 2013). Other disciplines also provide lessons on how to report costs in a transparent manner, such as capturing generic units (e.g. person hours or days) rather than monetary estimates due to context dependence (e.g. geographic and temporal variation) of costs (Baltussen *et al.*, 2003).

Some elements of the cost price structure of a manufacturing company are production materials, depreciation, unit labour costs, external services, general management and distribution costs, i.e. production costs. Cost calculation starts with calculating the direct material cost (Andersch *et al.*, 2013).

Similarly, the structure of the selling price is influenced by the utility of a product, the costs of transportation, trade, capital and distribution, and the influence of the state through taxes, customs duties, surcharges and various fees may also be present.

As it is not possible to avoid costs in the production process, it is necessary to plan, identify, manage and correctly allocate them to the products and services in which the costs were incurred. In order for the company to better manage costs in the future and achieve higher profits, management must plan costs well. For successful cost planning, it is important that the same conditions prevail in the future business as in the past, and management also needs to know how the increase (decrease) in production will affect the change in cost levels. Management often requests cost reports that are classified in such a way that they serve the purpose most effectively, i.e. that they are most suitable for management when making important decisions for the company as a whole.

The weighting coefficient for analysing the contribution of jobs in the creation of added value makes it possible to control the cost price of products. Activities related to labour costs are important signals for the competitiveness of traded goods, as labour costs account for a significant proportion of the cost price of

products (Stutely, 2011). Products inevitably have a significant impact on competitiveness, and this means that the correct calculation of cost price is crucial (Kourdi, 2011). Managers often overlook rising indirect costs and tend to focus almost exclusively on direct costs. The introduction of sophisticated information technology (IT) systems and automated processes lowers direct costs but increases indirect costs as extensive maintenance and computer programmers are required to prepare the production lines on the machines (Porter, 2008). Profitable companies are aware of the simple fact that there are costs wherever production takes place and that every unit of money in unnecessary costs reduces the company's profit by exactly that amount (Samuelson *et al.*, 2021).

Cost management is defined as the achievement of business goals on the basis of optimised costs under certain corporate conditions. This definition is based on the observation of the relationship between costs and benefits, i.e. on the so-called COST – BENEFIT philosophy, which is the fundamental approach in the field of cost management (De Rus, 2021).

3 MATERIALS AND METHODS
3. MATERIJALI I METODE

3.1 Research polygon
3.1. Istraživački poligon

The research polygon represents a medium sized company in which the following products are manufactured as part of its production programme: fir and beech sawn timber, fir elements for pallets, pallets, interlayers for parquet and panels for building formwork, various wall panelling and flooring (panelling, mouldings, decking, and farmhouse floorings), and pellets. The production facility of the polygon is divided into six departments (work units): Raw Material Preparation, Sawmill, Cutting (Decimating), Refining, Finishing, and Pellet Mill, in which 86 people are employed. The data collection for the selected business year company report was 2021 and data were processed in 2022.

In the production process, 90 % of fir and 10 % of beech raw material is processed. The raw material is classified into three classes of technical roundwood and three thickness classes. The production programme is based on fir raw materials of the second and third class of technical roundwood, while wall panelling and flooring are made from the first class, and joinery work is carried out separately. The beech raw material is mainly supplied in the third class of technical roundwood and is used for the production of blocks for pallets. The production plant is an integral part of the polygon, as well as the maintenance department and management. Eight people are employed in the management. The maintenance department is composed of electrical maintenance (with three employees), mechanical maintenance (three employees), the grindery (two employees), and the boiler room (five employees). In the department for the preparation of raw materials, a raw material warehouse and a debarking unit are located. Six workers are employed in this department. The debarked logs are transported to the sawmill, where they are sawn into timber of different thicknesses depending on the work order. For special orders related to roof construction, prisms are produced directly during sawing on a band saw. The sawn timber is transported by side forklifts to either the material warehouse or for further processing to the cutting department, where two prism production lines are installed, consisting of a multi-blade circular saw and a double-sided profiler. Eighteen workers are employed in this department across two shifts.

The waste generated during timber sawing is transported, along with low-grade timber, to the Refining and Finishing Department by a side loader. First-class raw materials are used for the production of joinery, wall panelling, and flooring, depending on market demand. The joinery production process is initiated in the sawmill, where timber with a thickness of 25 mm and 50 mm is sawn from first-class raw material. After drying, the material is transported to the Cutting Room, where it is processed into cants, packaged, and dispatched to the end customer. The production process for wall panelling and flooring is also initiated in the sawmill with timber sawing. Timber of 175 mm, 150 mm, and 120 mm thickness is sawn. The prisms are arranged into packages, which are then transported to the dryers by loader. Once dried, the packages are transported by forklift to the four-sided milling machine, where wall panelling and flooring are produced in accordance with market requirements. In the Pellet Mill, the process is started with the loading of sawdust into the dosing bunker. From the dosing bunker, the sawdust is conveyed via a screw conveyor to the inclined rubber conveyor, which is used to dose the large mill. Woodchips and sawdust are fed into the mill through a sieve with 7 mm diameter holes and are transported by ventilation into the large sawmill silo. The material from the silo is dosed into the dryer. The dried material is separated and fed into the pellet-making machine. The final product is packed into 15 kg bags. The Pellet Production Department is staffed by eight workers who work in shifts.

3.2 Data collection
3.2. Prikupljanje podataka

Primary and secondary data sources were used for the research. Secondary data was collected within the research polygon from business, financial and accounting reports. Primary data was collected in the research

area by observing the production process in order to obtain information on the quantity produced, capacity utilisation, price of raw materials with transport, material costs of production, production time and all unit costs, so that the cost price of a single product could be determined as a result. The monetary values expressed in the national currency, the Croatian kuna (KN), were converted into euros (1 EUR = 7.53450 KN).

In the first phase of the research, the following basic factors influencing production and the cost price were defined: the cost of raw materials with transport, percentage utilisation of raw materials, production time, hourly labour rate, total wage costs for the product, labour cost per m^3 and proportion of fixed costs per work unit in relation to the total cost.

The prices of sawn logs and the prices of their transport are given for the types of wood (raw materials) processed in the research polygon (beech and fir with spruce). For each type of sawn log, the number of sawing days and the total number of working days in the current year are given, the monthly data are summarised, and the monthly and daily average of sawing work and the corresponding monthly and daily costs of raw materials and transport costs are calculated. Utilisation is calculated by daily monitoring of the amount of input and output of raw materials in production by the individual work unit. Utilisation is monitored from the log to the finished product. When a new dimension is introduced in production, the recordings of the working day are made and the production time for each product is calculated. As not all products place the same burden on each work unit, a table was created in which the production time of an individual product was recorded by each work unit, as well as the total time required to manufacture the product. For each product, the time required to produce 1 m3 of the final product is calculated for all production stages, i.e. for all work units. In the accounting programme, the workers of the research polygon are deployed across the production departments. Employees in the maintenance and management departments are categorised according to a specific key. Monthly data on salary payments were collected and a table of total salaries per month was created, in which the gross hourly value was calculated for the entire research polygon. In another table, the total salary and the hourly value were calculated by production department.

In the course of consumption, non-current assets (fixed assets) transfer part of their value to the products, which is why depreciation is calculated as the cost of the obtained product and is included in its cost price. The research polygon is divided into four work units, and the work machines with their monetary values are also grouped in this way. Depreciation was calculated separately for each work unit, while the depreciation costs of the other parts of the research polygon were allocated to the work units according to a specific key. This is based on the distribution of workers in each unit.

The share of fixed costs in total costs was calculated on the basis of accounting data. For the sawmill, cutting, refining and finishing work units, it is 25 %, while in the pellet mill it is 30 %.

3.3 Product selection
3.3. Odabir proizvoda

When a new dimension is introduced in production, the footage of the working day is recorded, and the production time is calculated for each product. As not all products place the same burden on each work unit, a table was created in which the production time of an individual product was recorded for each work unit and the total time required to manufacture the product. For each product, the time required to produce 1 m^3 of the final product is calculated for all production stages, i.e. for all work units. Due to the large number of different products in the production process, fourteen different products were selected for the purpose of this work, which best represent the production process in the sawmill and cutting work unit. At the same time, most of the finished products in the research area are manufactured in these work units. The selected products account for 40 % of the total number of products manufactured in these work units.

Table 1 shows the selected products (pure dimension – length × width × thickness):

- unedged board/sawmill 4000 × 98 × 23 mm (P1),
- scantling/sawmill 5000 × 120 × 120 mm (P2),
- edged board/cutting unit 5000 × 150 × 25 mm (K1),
- scantling/cutting unit 5000 × 80 × 80 mm (K2),
- fixed board/cutting unit 3985 × 74 × 25 mm (K3),
- scantling/cutting unit 3985 × 59 × 59 mm (K4),
- scantling/cutting unit 3985 × 60 × 36 mm (K5),
- scantling/cutting unit 3980 × 73 × 73 mm (K6),
- scantling/cutting unit 4000 × 74 × 7 mm (K7),
- scantling/cutting unit 3980 × 76 × 76 mm (K8),
- scantling/cutting unit 3980 × 78 × 36 mm (K9),
- scantling/cutting unit 3980 × 86 × 43 mm (K10),
- edged prism/cutting unit 3980 × 100 × 24 mm (K11),
- and edged prism/cutting unit 3980 × 150 × 48 mm (K12)

with details of the volume, number of pieces per cubic metre, number of pieces in the finished package, quality, construction price and production quantity.

The production time and utilisation of logs for the production of individual (selected) products was determined by monitoring production and recording the working day, as shown in Table 2. Prisms with a thickness of 19 to 25 mm (K3, K11 and K12) have the longest production time in the cutting unit, which is due to both the number of pieces processed and the production time,

Table 1 Products selected for analysis
Tablica 1. Proizvodi odabrani za analizu

	V_1, m³/piece	Q_1, piece/m³	V_2, m³/piece	GQ	Pc_1, EUR/piece	Pc_2, EUR/m	Q_{pc}, piece	Q_m, m³	Pc, EUR
P1	0.00902	111	1.3000	III	1.05	116.45	35001	315.567	36746.45
P2	0.07200	14	1.0000	II	12.04	167.23	332	23.934	4002.50
K1	0.01875	53	2.5000	II	2.85	151.97	6167	115.625	17571.26
K2	0.03200	31	4.1600	II	5.39	168.56	4728	151.296	25502.15
K3	0.00737	136	2.3000	II/III	1.84	249.56	9359	69.000	17219.41
K4	0.01387	72	1.8778	II/III	2.45	176.57	31416	435.792	76947.99
K5	0.00861	116	2.2010	II/III	2.32	269.46	4091	35.216	9489.42
K6	0.02121	47	2.2060	II/III	5.01	236.09	36612	776.512	183329.13
K7	0.02190	46	2.2670	II/III	5.23	238.71	21527	471.536	112560.21
K8	0.02299	44	2.2070	II/III	6.00	261.21	29185	670.928	175251.88
K9	0.01118	89	2.2800	II/III	3.17	283.25	22849	255.360	72331.90
K10	0.01472	68	2.2670	II/III	3.97	269.46	2464	36.272	9773.98
K11	0.00955	105	2.8217	čpč – II	2.38	248.86	4333	41.392	10300.62
K12	0.02866	35	2.7269	čpč – II	7.42	258.81	10802	309.534	80110.33

Legend: V_1 – volume; Q_1 – quantity, V_2 – volume; GQ – group quality; Pc_1 – price; Pc_2 –price; Q_{pc} – produced quantity; Q_m – producted quanitity; P_c – total price
Legenda: V_1 – volumen; Q_1 – količina; V_2 – volumen; GQ – grupna kvaliteta; Pc_1 – cijena; Pc_2 – cijena; Q_{pc} – proizvedena količina; Q_m – proizvedena količina; Pc – ukupna cijena

Table 2 Production time and percentage utilisation of the selected products by work unit and in total
Tablica 2. Vrijeme proizvodnje i postotna iskorištenost odabranih proizvoda prema radnim jedinicama i ukupno

	I_p, %	I_k, %	I_{uk}, %	H_p, min/m³	H_k, min/m³	H_{uk}, min/m³	H, h/m³
P1	75.0 %	-	75.0 %	37.00	0.00	37.00	0.617
P2	40.0 %	-	40.0 %	50.00	0.00	50.00	0.833
K1	75.0 %	47.0 %	35.3 %	32.00	0.00	32.00	0.533
K2	70.0 %	61.0 %	42.7 %	20.00	17.84	37.84	0.631
K3	75.0 %	50.0 %	37.5 %	20.00	37.67	57.67	0.961
K4	66.0 %	63.0 %	41.6 %	22.00	21.30	43.30	0.722
K5	66.0 %	58.0 %	38.3 %	21.00	25.40	46.40	0.773
K6	66.0 %	65.0 %	42.9 %	20.00	17.29	37.29	0.622
K7	66.0 %	66.0 %	43.6 %	20.00	17.40	37.40	0.623
K8	66.0 %	63.0 %	41.6 %	21.00	18.30	39.30	0.655
K9	66.0 %	58.0 %	38.3 %	20.00	23.76	43.76	0.729
K10	66.0 %	66.0 %	43.6 %	20.00	20.64	40.64	0.677
K11	75.0 %	47.0 %	35.3 %	37.00	59.13	96.13	1.602
K12	75.0 %	55.0 %	41.3 %	30.00	27.33	57.33	0.956

Legend: I_p – sawmill capacity utilisation; I_k – cutting capacity utilisation; I_{uk} – total capacity utilisation; h_p – manufacturing time, sawmill; h_k – manufacturing time, cutting; h_{uk} – total manufacturing time; H – manufacturing time.
Legenda: I_p – iskorištenost kapaciteta pilane; I_k – iskorištenost kapaciteta krojačnice; I_{uk} – ukupna iskorištenost kapaciteta; h_p – vrijeme proizvodnje, pilana; h_k – vrijeme proizvodnje, krojačnica; h_{uk} – ukupno vrijeme proizvodnje; H – vrijeme proizvodnje

as the time for passing through the machine must be reduced because of the load on the machine.

3.4 Choice of methods for calculating the cost price of the product
3.4. Odabir metoda za kalkulaciju troškova proizvodnje

In the research polygon, there is no standardised end product. The end products are similar but differ in terms of type, dimensions, shape and quality, and they also differ in the production stages, i.e. not all products place the same burden on the production departments. In this paper, the cost price is calculated using the full cost price, i.e. using the division, the additional calculation and the calculation of the related products. Since it is not possible to track how much each product contributes to covering fixed costs with the existing methods, the cost price is also calculated using the direct cost method.

3.4.1 Division calculation with equivalent numbers
3.4.1. Djelidbena kalkulacija s ekvivalentnim brojevima

For this type of calculation, it was necessary to determine the production stages for each product and group them in such a way that equal equivalent numbers could be used for equal stages. The production time was measured for each product per production stage, as were the associated costs. Production wages are used as an equivalent number as they can be calculated for all products. It was also necessary to determine the product on the basis of which the equivalent

figures are calculated separately for each production stage (Figurić, 2003). In order to determine the cost price, it was necessary to calculate the amount of production by types and production stage, then to multiply the amount of production by the corresponding equivalent numbers, and the equivalent amounts thus obtained had to be added up separately for each production stage (Blaško, 1980). By multiplying the cost price of a product unit by its equivalent number, the amount of costs incurred separately for each product unit at each stage of production is obtained. By adding the amounts received per product unit for each product separately, the total cost price of each product unit by production stage is calculated.

3.4.2 Additional calculation
3.4.2. Dodatna kalkulacija

In the research polygon, the costs per work unit are monitored daily. For each work unit, depreciation costs, labour costs, energy costs and overhead costs were monitored and added to the direct production costs according to a specific key. This is exactly what is required with this method – to group overhead costs by work units. The key for calculating overheads is calculated separately for each work unit and the individual products are charged proportionally with the overheads of the labour unit in which the product was processed. First, the direct costs are incorporated in the products pricing, then the overhead costs are added to the price of the product according to the appropriate key. When using this method, the cost calculation is carried out in several steps: 1. determination of costs relating to all work units and all products; 2. determination of costs relating to only some cost centres of the basic activity, which are unevenly represented; 3. determination of costs of the basic activities successively in the order of production phases by work units up to the last cost centre. In this procedure, the costs of the first and second step only represent overheads that are allocated according to a specific key. The costs of subsequent steps are made up of direct costs and overheads. The overheads of these steps are transferred to the following cost centres on the basis of the same key, up to the last one, where the final price of all products is formed.

3.4.3 Calculation of by-products
3.4.3. Kalkulacija vezanih proizvoda

In the research polygon, by-products are created in addition to the main products, so that the cost price is calculated using this method. In the first phase, the products are divided by work units into the main and by-products. There are several main products and several by-products, and the main products are even produced from some by-products through further processing. In the second phase, a calculation is carried out using the subtraction method for individual work units. Woodchips and sawdust are by-products that are common to all work units. In the work units of the sawmill, refining and finishing, it is a by-product, while in the work unit of the pellet mill it is the raw material from which the main product, pellets, is made. The by-product in the cutting unit is, apart from sawdust, useful waste. During further processing in the refining unit, the useful waste from the cutting unit is used to produce elements for pallets, which are the main product in this work unit, the finished pallets. In the pellet mill unit, in addition to the main product, pellets, a by-product in the form of briquettes is produced, which is used as fuel for the boiler room in the research polygon. The by- products are not sold in the research polygon but are used in further production. The market prices for the individual by-products are therefore used to determine the cost price using this method.

3.4.4 Direct costing method
3.4.4. Metoda direktnih troškova

When applying this method, it was necessary to distinguish between fixed and variable costs. Financial cost data are valuable on their own and can contribute to a full economic costing of an intervention when paired with nonmonetary costs, such as opportunity costs (Drummond *et al.*, 2005). In order to apply this method, the costs are first divided into direct and overhead, i.e. fixed costs. Since only the direct costs are included in the cost price, the following is calculated for each product: production materials, salaries of employees in production, direct external services and the variable part of overhead costs. In the direct cost method, the difference between the selling price of the product and the variable costs is called the contribution margin and is the basic indicator of how much a product contributes to covering the fixed costs in the research polygon. When calculating the cost price, the main and by-products are defined by work units, as material costs, production wages and other variable costs are not included in the by-products.

4 RESULTS AND DISCUSSION
4. REZULTATI I RASPRAVA

4.1 Choice of model for the cost price calculation
4.1. Izbor modela izračuna cijene koštanja

Due to the large number of different products in the production process, fourteen different products were selected for the purpose of this work, which best represent the production process in the sawmill and cutting work units. At the same time, most of the finished products are also manufactured in these work units.

The depreciation values were determined from the accounting data of the fixed assets for the research year. Data on total depreciation costs per work unit and

data on the total number of hours per work unit were used to calculate depreciation costs per hour. Machinery, buildings and vehicles are divided into work units, and the depreciation costs can be accurately calculated separately for each work unit. For buildings and machines that are not located within the production units, the depreciation costs are allocated to the production units according to a specific key. The key is determined according to the needs of the individual work units or their utilisation. Production operations are conducted on all machines.

The values of the total salaries of the workers amounting to 931.107.45 EUR were taken from accounting data. The hourly value for the selected products was calculated by dividing the sum of the total gross hours of the sawmill department and the total gross hours of the cutting department divided by the sum of the total hours of the sawmill department and the total hours of the cutting department. It amounts to 5.57 EUR/h (594618.52 EUR / 106760.66 h = 5.57 EUR/h).

Furthermore, the average raw material price including transport for the selected products P1 to K10 is 56.94 euros, while the average price per m3 for products K11 and K12 is 84.94 euros.

Table 3 shows the products selected from the sawmill and cutting work units. Table 3 will be the base table for most models, and additional columns will be added depending on the type of calculation.

4.2 Model A and Model B
4.2. *Model A i model B*

Cost monitoring in the polygon is based on the Traditional Product Costing (TPC) Model. This means that the costs for direct materials and direct labour are included in the accounting – direct costs, while the overheads – indirect costs – are added to the direct production costs according to a specific key. The profit and loss account is prepared monthly. In terms of accounting, the polygon is divided into two production units: Sawmill (in which there are departments for raw material preparation, sawmilling, cutting, refining and finishing) and Pellet Mill. Such a division is acceptable for accounting purposes, but in this way, it is not possible to track costs per product. At the end of each month, the average cost price for each unit is calculated using the full cost price. For the Pellet Mill production unit, which has only one product, the calculated price represents the actual cost price of this product, while for the Sawmill production unit this price represents only the break-even point of all products manufactured in this production unit. Such a cost tracking model for calculating the cost price has not proven to be effective as it is of limited use in production decisions. A major problem is that the cost price is not calculated per product, so it is not possible to determine which product is profitable for further production and which should be removed from the production process. The sales price in the research polygon is determined by the market and cannot be influenced, but it is also not possible to react quickly to its change, as a certain amount of time must pass before all production costs are calculated. Average production costs are monitored by each department. The average daily costs per department are calculated on the basis of previous years. Production is entered daily in the tables, and the results can be compared with the sales price on the basis of the daily

Table 3 Products selected from sawmill and cutting work units
Tablica 3. Odabrani proizvodi iz pilane i pogona za rezanje

	$Q_{I/P}$ m³	I_{UK} %	Q_m m³	$Pc_{I/P}$+tran EUR	*MC* EUR/m³	*H* h/m³	H_{price} EUR/h	*SC* EUR	*Sc* EUR/m³
P1	420.76	75.00 %	315.57	23957.04	75.92	0.62	5.57	1083.73	3.43
P2	59.84	40.00 %	23.93	3406.89	142.35	0.83	5.57	111.07	4.64
K1	328.01	35.25 %	115.63	18676.50	161.53	0.53	5.57	343.42	2.97
K2	354.32	42.70 %	151.30	20174.48	133.34	0.63	5.57	531.38	3.51
K3	184.00	37.50 %	69.00	10476.61	151.83	0.96	5.57	369.34	5.35
K4	1048.08	41.58 %	435.79	59675.71	136.94	0.72	5.57	1751.45	4.02
K5	92.00	38.28 %	35.22	5238.07	148.74	0.77	5.57	151.67	4.31
K6	1810.05	42.90 %	776.51	103060.85	132.72	0.62	5.57	2687.64	3.46
K7	1082.50	43.56 %	471.54	61635.35	130.71	0.62	5.57	1636.88	3.47
K8	1613.58	41.58 %	670.93	91874.35	136.94	0.66	5.57	2447.36	3.65
K9	667.08	38.28 %	255.36	37982.52	148.74	0.73	5.57	1037.19	4.06
K10	83.27	43.56 %	36.27	4741.18	130.71	0.68	5.57	136.82	3.77
K11	117.42	35.25 %	41.39	9974.31	240.97	1.60	5.57	369.32	8.92
K12	750.39	41.25 %	309.53	63739.69	205.92	0.96	5.57	1647.10	5.32
Total	8611.30		3707.964	514613.55	2077.36			14304.39	60.89

Legend: $Q_{I/P}$ – quantity input; Q_m – produced quantity; I_{UK} – total capacity utilisation; P_{cl}/P+tran – input raw material price including transport; *MC* – material costs; *H* – production time; H_{price} – the value of working hours; *SC* – total salary costs; *Sc* – salary cost per product
Legenda: $Q_{I/P}$ – količina ulazne sirovine; Qm – proizvedena količina; I_{UK} – ukupna iskorištenost kapaciteta; P_{cl}/P + tran – cijena ulazne sirovine uključujući transport; MC – trošak materijala; H – vrijeme proizvodnje; H_{price} – vrijednost radnog sata; SC – ukupni trošak plaća; Sc – trošak plaće po proizvodu

Table 4 Model A – Existing and Model B – Divisive calculation
Tablica 4. *Model A* – postojeći model i *model B* – djelidbena kalkulacija

	Model A				Model B					
	Ck EUR/m³	***p*** EUR/m³	***Pf*** EUR	***e***	***Qe*** m³	***Tm*** EUR	***tm*** EUR/m³	***Ck*** EUR/m³	***p*** EUR/m³	***Pf*** EUR
P1	224.53	-108.08	-34107.76	0.94	297.10	27878.63	88.34	167.70	-51.25	-16172.96
P2	224.53	-57.30	-1371.40	1.27	30.45	2857.35	119.38	266.37	-99.14	-2372.81
K1	224.53	-72.56	-8390.01	0.81	94.15	8834.46	76.41	240.90	-88.94	-10283.13
K2	224.53	-55.97	-8468.32	0.96	145.68	13669.63	90.35	227.21	-58.65	-8873.35
K3	224.53	25.03	1726.85	1.47	101.25	9501.17	137.70	294.89	-45.33	-3127.71
K4	224.53	-47.96	-20900.32	1.10	480.15	45055.24	103.39	244.34	-67.77	-29534.42
K5	224.53	44.93	1582.38	1.18	41.58	3901.54	110.79	263.84	5.63	198.15
K6	224.53	11.56	8979.02	0.95	736.80	69138.31	89.04	225.22	10.87	8442.33
K7	224.53	14.18	6686.31	0.95	448.74	42108.00	89.30	223.48	15.23	7179.98
K8	224.53	36.68	24608.53	1.00	670.93	62957.38	93.84	234.42	26.79	17972.78
K9	224.53	58.72	14995.96	1.11	284.34	26681.39	104.49	257.29	25.97	6630.80
K10	224.53	44.93	1629.83	1.03	37.51	3519.68	97.04	231.52	37.94	1376.29
K11	224.53	24.33	1006.88	2.45	101.25	9500.65	229.53	479.42	-230.57	-9543.67
K12	224.53	34.28	10610.72	1.46	451.54	42370.98	136.89	348.13	-89.32	-27647.44
total			-1411.31		3921.45	367974.42				-65755.14

Legend: *Ck* – cost price; *p* – profit; *Pr* – profit; *e* – equivalent number; *Qe* – equivalent quantity; *Tm* – total other costs of selected products; *tm* – average other costs of selected products
Legenda: Ck – cijena koštanja; p – dobit; Pr – profit; e – ekvivalentni broj; Qe – ekvivalentna količina; Tm – ukupni ostali troškovi odabranih proizvoda; tm – prosječni ostali troškovi odabranih proizvoda

costs. This method of cost monitoring helps to manage production by department as it shows when production is positive and when it is not, but it still does not show the profitability of the product itself and the cost price of an individual product.

In Model A, the cost price is presented according to the existing method for calculating the cost price in the research polygon. According to the existing method, the average cost price for all products produced in the research polygon, with the exception of the pellet mill unit, is calculated using the full cost price and amounts to 224.53 EUR/m³ in 2021.

Table 4 was created by adding to Table 3 a column with the cost price according to the existing model, which is the same for all selected products and amounts to 224.53 EUR/m³ regardless of the actual material cost per product, recognising that for a single product the material costs are higher than the cost price for this product. It is evident from the table that products P1, P2, K1, K2 and K4 do not generate a profit but a loss and that the profitability of their production is questionable, while products K3, K5, K6, K7, K8, K9, K10, K11 and K12 generate a profit. The table also shows that the products that generate a profit do not compensate for the loss of the other products, so the overall result is negative.

In Model B, the cost price for the selected products was calculated using a divisive calculation with equivalent numbers. The production wages were used to allocate the other costs to the products. The basis for the calculation of the equivalent numbers is the production wages, and the product K8 was selected as the reference product for the calculation of the equivalent numbers as it is produced most frequently in the research polygon. The price of one equivalent unit is 102.11 EUR (Tm = 367974.42 EUR; Qe = 3603.82 m³). The table also shows that products P1, P2, K1, K2, K4, K11 and K12 do not generate a profit but a loss and that the profitability of their production is questionable, while products K5 to K10 generate a profit. It is evident from the table that products that generate a profit do not compensate for the loss of the other products, so the overall result is negative.

4.3 Model C
4.3. *Model C*

Model C shows the cost price for selected products calculated with the help of additional calculation (Table 5). The basis for the distribution of overheads are the production wages. For the first two selected products, the depreciation value was taken only for the Sawmill, while for the other products the depreciation values of the Sawmill and the Cutting unit were added together ($Am = QI/P$ – quantity used (m³) × H – production time (h/m³) × value of the depreciation hour (EUR/h)). The distribution coefficient for the production costs is calculated by dividing the total production costs by the total production wages (production wages – see Table 3; column SC (in ERU) = 14304.39 EUR), and it amounts to 10.110. Table 5 shows that products P1, P2, K1, K2, K3, K4, K11 and K12 do not make a profit but a loss and that the profitability of their production is questionable, while products K5, K6, K7, K8, K9 and K10 make a profit. On the other hand, the

Table 5 Model C – Additional calculation
Tablica 5. *Model C* – dodatna kalkulacija

	t_{am} EUR/h	*Am* EUR	*am* EUR/m³	T_I EUR	t_i EUR/m³	T_{up} EUR	t_{up} EUR/m³	*Ck* EUR/m³	*p* EUR/m³	*Pf* EUR
P1	0.57	110.88	0.35	11009.25	34.89	15255.39	48.34	162.95	-46.51	-14675.74
P2	0.57	11.26	0.47	1117.62	46.70	1548.68	64.72	258.86	-91.63	-2192.66
K1	1.13	69.54	0.60	3448.42	29.82	4778.44	41.33	236.23	-84.26	-9743.00
K2	1.13	108.17	0.71	5363.57	35.45	7432.24	49.12	222.14	-53.58	-8107.01
K3	1.13	75.17	1.09	3727.30	54.02	5164.88	74.85	287.14	-37.59	-2593.40
K4	1.13	356.06	0.82	17655.67	40.51	24465.26	56.14	238.42	-61.85	-26952.19
K5	1.13	30.77	0.87	1526.00	43.33	2114.56	60.04	257.27	12.19	429.47
K6	1.13	546.32	0.70	27090.26	34.89	37538.67	48.34	220.11	15.98	12411.32
K7	1.13	331.76	0.70	16450.71	34.89	22795.56	48.34	218.10	20.61	9719.25
K8	1.13	502.50	0.75	24916.99	37.14	34527.19	51.46	229.96	31.25	20964.78
K9	1.13	211.54	0.83	10489.39	41.08	14535.03	56.92	251.63	31.62	8075.22
K10	1.13	27.99	0.77	1387.81	38.26	1923.08	53.02	226.55	42.91	1556.28
K11	1.13	75.15	1.82	3726.40	90.03	5163.63	124.76	466.49	-217.63	-9007.70
K12	1.13	337.20	1.09	16720.47	54.02	23169.36	74.85	341.23	-82.42	-25511.43
total		2794.30		144629.85		200411.97				-45626.80

Legend: t_{am} – value of depreciation hour; cost of depreciation; *Am* – total cost of depreciation; *am* – cost of depreciation; T_I – production cost; t_i – production cost (EUR/m³); T_{up} – management and distribution cost; t_{up} – management and distribution cost; *Ck* – cost price; *p* – profit; P_r – profit
Legenda: t_{am} – vrijednost sata amortizacije; trošak amortizacije; Am – ukupni trošak amortizacije; am – trošak amortizacije; T_I – trošak proizvodnje; t_i – trošak proizvodnje (EUR/m³); T_{up} – trošak upravljanja i distribucije; t_{up} – trošak upravljanja i distribucije (EUR/m³); C_k – cijena koštanja; p – dobit; P_r – profit

products that make a profit do not cover the loss of the other products and the overall result is negative.

4.4 Model D – additional calculation
4.4. *Model D* – dodatna kalkulacija

Model D shows the cost price for the selected products, which is calculated based on the related products. This calculation method assumes the production of a by-product alongside the main product, i.e. a by-product is also manufactured, which cannot be influenced. In this model, the subtraction method is used, in which the value of the by-products is subtracted from the costs incurred in the production process that resulted in the related products, and which cannot be directly allocated to each product individually, so that the remainder is the costs attributable to the selected products. By-products generated in the production process in the Sawmill work unit are woodchips with sawdust and residues, and in the Cutting department, these are wood chips with sawdust, and useful waste is defined as residues in this paper. The basis for calculating the equivalent numbers is the production wages, and the product K8 was chosen as the base product for calculating the equivalent numbers because it is most often produced in the research polygon. The total revenue from by-products (UPs) amounts to 41122.84 euros. The distribution coefficient is obtained by deducting the revenue from by-products (UPs) from the other costs of the selected products (they amount to 40 % of the total other costs of the Sawmill and Cutting department) (see Table 4; column Tm) and dividing it by the total equivalent production. The distribution coefficient is 83.35.

Table 6 shows that products P1, P2, K1, K2, K4, K11 and K12 do not make a profit but a loss and that the profitability of their production is questionable, while products K3, K5, K6, K7, K8, K9 and K10 make a profit. It is evident from the table that the products that make a profit do not compensate for the loss of the other products, so the overall result is negative.

4.5 Model E – calculation of the cost price using the direct costing method
4.5. *Model E* – izračun cijene koštanja metodom izravnih troškova

The main advantage of the direct cost method is that only the variable costs is considered when calculating the cost price of the individual products, i.e. the costs that are incurred as production increases. The product with the highest contribution margin (the difference between the revenue and the variable costs) is the most useful, not the one whose sales price is higher than the full cost price, because the product with the highest contribution margin largely compensates for the fixed costs and thus contributes to a more successful business. When calculating the cost price, the main and by-products are defined, as material costs, production wages and other variable costs are not included in by-products. By-products (woodchips with sawdust, residues and useful waste) are created as a product of the main products, but they generate revenue on the market, therefore their market value is added to the contribution margin of the main products and the total contribution margin for this group of products is obtained. The total revenue of the by-products in the sawmills and cutters department (UPs) is 41.122,84 euros. The fixed costs amount to 30 % of the total costs. The

Table 6 Model D – Application of the related calculation with equivalent numbers
Tablica 6. *Model D* – primjena vezane kalkulacije s ekvivalentnim brojevima

	e	Q m³	$T_{m\text{-}s}$ EUR	$t_{m\text{-}s}$ EUR/m³	C_k EUR/m³	p EUR/m³	P_f EUR
P1	0.94	297.10	26945.62	85.39	164.74	-48.29	-15239.95
P2	1.27	30.45	2761.72	115.39	262.38	-95.14	-2277.19
K1	0.81	94.15	8538.80	73.85	238.35	-86.38	-9987.47
K2	0.96	145.68	13212.15	87.33	224.18	-55.63	-8415.87
K3	1.47	101.25	9183.20	133.09	290.28	-40.72	-2809.74
K4	1.10	480.15	43547.39	99.93	240.88	-64.31	-28026.56
K5	1.18	41.58	3770.97	107.08	260.13	9.33	328.72
K6	0.95	736.80	66824.47	86.06	222.24	13.85	10756.17
K7	0.95	448.74	40698.78	86.31	220.49	18.22	8589.20
K8	1.00	670.93	60850.40	90.70	231.28	29.93	20079.77
K9	1.11	284.34	25788.44	100.99	253.79	29.46	7523.74
K10	1.03	37.51	3401.89	93.79	228.27	41.19	1494.09
K11	2.45	101.25	9182.70	221.85	471.74	-222.89	-9225.71
K12	1.46	451.54	40952.95	132.31	343.55	-84.74	-26229.41
		3921.45	326851.46				-53440.20

Legend: C_k – cost price; p – average profit; P_r – profit; e – equivalent number; Q_e – equivalent quantity; $T_{m\text{-}s}$ – other costs of the selected products minus the revenues of the by- products; $t_{m\text{-}s}$ – average other costs of the selected products minus the revenues of the by- products (eur/m³)
Legenda: C_k – cijena koštanja; p – prosječan profit; P_r – profit; e – ekvivalentni broj; Q_e – ekvivalentna količina; $T_{m\text{-}s}$ – ostali troškovi odabranih proizvoda umanjeni za prihod sporednih proizvoda; $t_{m\text{-}s}$ – prosječni ostali troškovi odabranih proizvoda umanjeni za prihod sporednih proizvoda (EUR/m³)

data used to calculate the other variable costs are the depreciation costs, energy costs and other costs (maintenance and management costs and distribution costs). They were calculated by multiplying the quantity produced (Qm) by the production time (H) and the value per hour (Hprice). In addition, the total variable costs per unit were calculated by adding the raw material price per product unit (Pc2), the labour costs per product unit (sc) and the other variable costs per product unit. The contribution margin (Cm) was calculated by subtracting the total variable costs (V) from the total value produced (see Table 1; column Pc), while the contribution margin per unit of product (km) was calculated by dividing the contribution margin for the product (Cm) by the quantity produced (Qm). The profit gained for each selected group of products was calculated by de-ducting the fixed costs for this product (F) from the contribution margin of the selected product (Km).

Table 7 shows that products K1 and K11 do not generate a profit but a loss and that the profitability of their production is questionable, while products P1, P2, K2, K3, K4, K5, K6, K7, K8, K9, K10 and K12 generate a profit. The table shows that the products that make a profit cover for the loss of the other products and that the overall result is positive, amounting to 259.666,02 euros.

However, the total contribution margin for all selected items ($\Sigma\ Cm = Cm\ P1 + Cm\ P2 + Cm\ K1 + Cm\ K2 + Cm\ K3 + Cm\ K4 + Cm\ K5 + Cm\ K6 + Cm\ K17 + Cm\ K8 + Cm\ K9 + Cm\ K10 + Cm\ K11 + Cm\ K12$) is increased by the realised revenue of by- products (UPs). The total contribution margin increased by the realised revenue of by- products ($\Sigma\ Cm + UPs$) amounts to 313554,87 euros, and the total profit of the selected products (($\Sigma\ Cm + UPs$) – F) in this case amounts to 300788,87 euros.

4.6 Comparison of cost prices in selected models
4.6. Usporedba cijena koštanja u odabranim modelima

As depicted in Figure 1, Model A illustrates the cost price according to the existing method for its calculation in the research polygon. According to the existing method, the average cost price is calculated using the full cost price for all products manufactured in the research polygon, except for the pellet mill department, and it amounts to 224,53 EUR/m³ in 2021. In the existing model, the cost price is the same for all products and shows that it is worthwhile to produce only the products whose selling price is equal to or higher than the average cost price. It is evident from the table that products P1, P2, K1, K2 and K4 do not make a profit but a loss and that the profitability of their production is questionable, while products K3, K5, K6, K7, K8, K9, K10, K11 and K12 make a profit. In addition, according to Table 3 (MC column) and Table 4 (*Ck* for Model A), 9 of 14 selected products have a higher selling price, but if the Material cost column is considered, it can be seen that the material cost of some products is higher than the cost price, while according to the existing model, they make a profit, thus giving a false picture of the profitability of that product. Looking at the total profit for the selected products, Model A shows a loss of 1411,31 euros.

In Model B, a division formula with equivalent numbers was used to calculate the cost price. Of 14

Table 7 Model E – Calculation of the cost price using the direct costing method
Tablica 7. *Model E* – izračun cijene koštanja metodom izravnih troškova

	V_o EUR	v_o EUR/m³	*V* EUR	*Ck* EUR/m³	*Cm* EUR	*cm* EUR/m³	*F* EUR	*Pf* EUR
P1	1269.70	4.02	26310.47	83.38	10435.98	33.07	544.19	9891.79
P2	130.13	5.44	3648.10	152.42	354.40	14.81	55.78	298.63
K1	743.65	6.43	19763.57	170.93	-2192.32	-18.96	318.71	-2511.03
K2	1150.66	7.61	21856.52	144.46	3645.62	24.10	493.14	3152.48
K3	799.77	11.59	11645.72	168.78	5573.69	80.78	342.76	5230.93
K4	3792.58	8.70	65219.74	149.66	11728.25	26.91	1625.39	10102.86
K5	328.42	9.33	5718.15	162.37	3771.27	107.09	140.75	3630.52
K6	5819.79	7.49	111568.28	143.68	71760.85	92.41	2494.20	69266.65
K7	3544.49	7.52	66816.71	141.70	45743.50	97.01	1519.07	44224.43
K8	5299.51	7.90	99621.22	148.48	75630.66	112.73	2271.22	73359.44
K9	2245.94	8.80	41265.65	161.60	31066.25	121.66	962.54	30103.71
K10	296.27	8.17	5174.28	142.65	4599.70	126.81	126.97	4472.73
K11	799.73	19.32	11143.36	269.22	-842.74	-20.36	342.74	-1185.48
K12	3566.62	11.52	68953.41	222.77	11156.92	36.04	1528.55	9628.37
			558705.19		272432.03		12766.00	259666.02

Legend: V_o – other variable costs of a specific production stage; v_o – other variable costs of a specific production stage; *V* – total variable costs; *Cm* – total contribution margin; *cm* – contribution margin; *F* – fixed costs; *Pr* – profit
Legenda: V_o – ostali varijabilni troškovi određene faze proizvodnje; v_o – ostali varijabilni troškovi određene faze proizvodnje; V – ukupni varijabilni troškovi; Cm – ukupna kontribucijska marža; cm – kontribucijska marža; F – fiksni troškovi; Pr – profit

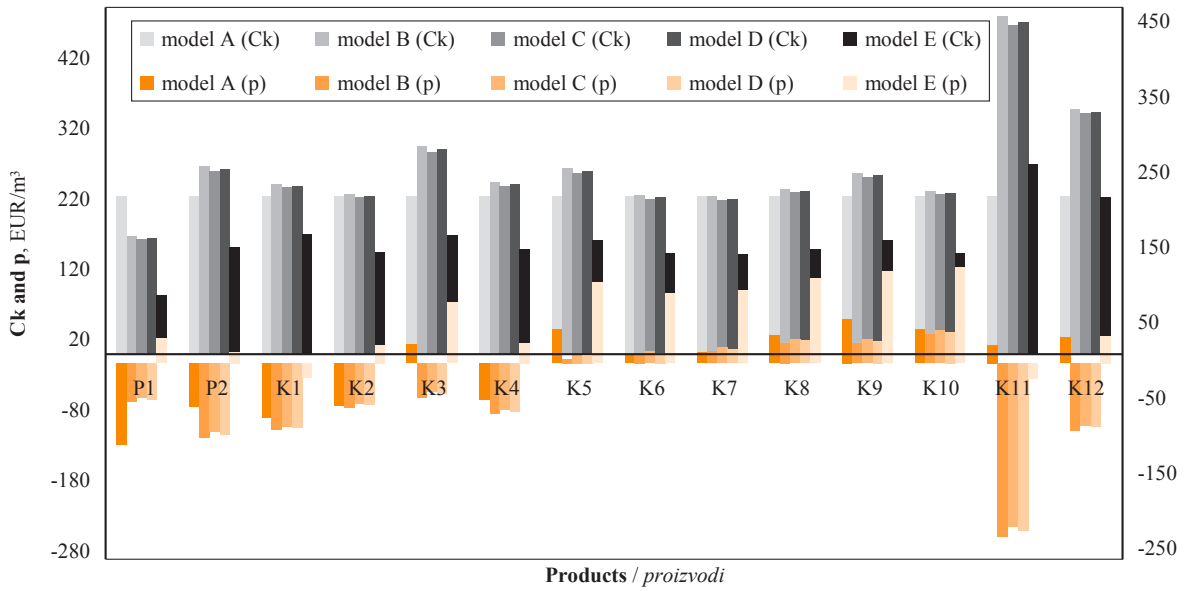

Figure 1 Cost prices and realised profit/loss of products P1, P2, and K1 – K12
Slika 1. Cijene koštanja i ostvarena dobit/gubitak proizvoda P1, P2 i K1 – K12

selected products, only 5 generate a profit. According to this model, it turns out that most of the selected products are not worth producing, and when looking at the total profit for the selected products, Model B results in a loss of 65.755,14 euros.

In Model C, the cost price for selected products is calculated with the help of an additional calculation. The production wages are the basis for the distribution of general costs. The total profit for the selected products according to Model C is negative, i.e. a loss is realised as 9 products out of 14 selected products make a loss, and the cost price is higher than the sales prices. According to this model, it turns out that the seven selected products are not worth producing. Looking at the total profit for the selected products, Model C results in a loss of 45.626,80 euros.

In Model D, the cost price for the selected products was calculated using the calculation of related products. It is based on the fact that in addition to the main product, by-products whose manufacture cannot be influenced, are also produced. The subtraction method is used here. This means that the value of the by-products is subtracted from the costs incurred in the manufacturing process that generated the by-products, and which cannot be directly allocated to each product individually, so that the remainder is the costs attributable to the selected products. The total profit for the selected products according to Model C is negative;

out of 14 selected products, 8 products make a loss, i.e. the cost price is higher than the selling price. According to this model, it turns out that most of the selected products are not worth producing. Looking at the total profit for the selected products, Model D results in a loss of 53.440,20 euros.

In Model E, the cost price of the selected products was calculated using the direct co-sting method. When calculating the cost price of the individual products, only the variable costs are considered, i.e. the costs that are generated when production increases. The most profitable product is the one with the highest contribution margin, not the one whose sales price is higher than the cost price, because the product with the highest contribution margin mostly covers the fixed costs and therefore contributes to a more successful business.

Figure 1 shows that out of 14 products, only 2 do not achieve a positive result. In addition, the total revenue for products selected according to Model E is positive. According to this Model, products K1 and K11 are not profitable, while products K6, K7, K8 and K9 achieve the highest contribution margin, showing that they are most profitable and contribute to a more successful business in the research polygon. According to this model, it turns out that most of the selected products are worth producing, and when looking at the total profit for the selected products, Model E is the only one that shows a profit of 259,666.02 euros. Model E provides the company with information on the actual cost price of an individual product and, in view of the change in the sales price over the course of the year, it helps determine which product is worth producing, which is better suited to waiting for a change in the sales price and which is not worth producing at all.

4 CONCLUSIONS
4. ZAKLJUČAK

If the company uses the full cost price when calculating the cost price in the production of primary wood products, it will probably not be able to dynamically monitor the production costs of a particular product. In addition, when using this method, all fixed and variable costs are included in the cost price of the product, with the cost of raw materials being considered a variable cost and allocated directly to the product, while all other costs are allocated to products according to specific keys. In this case, the company cannot know which product contributes most to a positive business result. In this way, completely wrong conclusions are often drawn and products that are not the most profitable are promoted, while products that contribute significantly to the company's success are removed from the production programme.

The aim of this article was to emphasise the importance of choosing the right method for calculating the cost price of products in the production of primary wood products. When considering the cost price and profit in all five selected models, it becomes clear that both the cost price and the profit change depending on the distribution of costs.

By analysing and processing the data obtained from the research polygon and using the example of five selected models, the results have shown that Model E is optimal, while the most acceptable costs are to be divided into fixed and variable costs and then the variable costs are to be included in the cost price of each product. The difference between the revenue of each individual product and the variable costs of these same products is the contribution margin, which covers the fixed costs of the research polygon.

The other selected models A, B, and C used for the calculations generate negative business result (loss) for most of the selected products in wood processing company. The reason for that could be input of different fixed and variable costs or market influence on sales prices for selected products or assortments during the analysed year.

Model E used in this work follows the cost prices of the products and is the most acceptable in the research polygon. Therefore, it can be concluded that a well-chosen cost price calculation model can determine which product makes the greatest contribution to cost recovery. It is expected that the application of Model E in the research polygon will lead to better business results in the coming period, because by applying this model the company receives clear information about which products should be developed, and which should be removed from the production programme. By investing in the modernisation of production, it is expected that product quality will increase, new products will be introduced, the cost price and the cost of manual labour will decrease, as well as the total cost of production.

Research limitations are related to the inputs, such as input costs of raw material, services and salaries, which could influence the result of different model-based calculations. The research is based on a sample of 14 products, which cover approximately 40 % of total production, and does not cover all production departments or the entire product range. All models were tested within one business year. Business seasonality and market changes over a longer period were not considered.

It is necessary to continue the research in this area, i.e. to apply Model E to the entire production process and, based on calculations, to develop computer software that monitors the production process on the basis of various purchase prices for raw materials and planned sales prices on the market determined by supply and demand. This would enable long-term planning of the product range, with greater added value or profit in the wood processing market. The innovative

application of new raw materials, products and calculation models (Kropivšek et al 2021) can also improve the company's business results.

In the Republic of Croatia, there are more than 800 small or micro companies engaged in a similar production programme that monitor production and process costs as the analysed company after the past period (ex post). By applying the proposed method for calculating the cost price, these business entities can improve their work processes in the production of wood products with higher added value. Future research should be focused on implementing the calculation model in more small and medium sized wood production companies to adapt this model to different production contexts.

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