Differences in the Cost Calculation for Construction Work, Road Transport and Water Supply

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Abstract. This paper presents a method of cost and price calculation of construction work, road transport and water and sewerage charges in the Czech Republic. Costs represent an important economic category that is closely related to the price. Each company must perfectly manage costing, especially absorption costing, which consists of budgeting overhead costs on the production (performance, products and services). Absorption costing is characterized by including indirect (overhead) costs together with direct costs of production into the calculation, i.e. it must absorb them completely into the costs. The absorption method is represented by the surcharge calculation. However, creating the calculation formula for absorption costing and the procedure of cost and price calculation have their specifics in various branches of the economy. Differences can be seen in examples of selected case studies. They deal with the representative cost and price calculation of construction work on a particular construction, cost and price calculation of the road transport and one-component and two-component cost and price calculation of the water and sewerage charges. All types of calculation must reflect the economic situation of the company marketing of a new product. The diversity of the product types mentioned above indicates the need for other inputs in the calculation and different calculation procedures. Without mastering absorption costing, it is not possible to introduce more accurate calculation methods, such as the Dynamic Calculation with Contribution Margin or in the next step implement the Balanced Scorecard. Correct absorption costing can be checked by the fact that the sum of all company production costs must correspond to the sum of the financial accounting cost accounts. However, cost control is not the subject of this article.

1. Introduction

One of the company's main tasks is to set the price of the product (performance, product, service) in order to reliably cover the costs, generate a reasonable profit, and at the same time, remain convenient and affordable for the customers. The easiest way to determine the right price of performance, products or services is the cost-oriented pricing. However, in this type of price determination, it is necessary to distribute the total costs of the company to the individual products. This brings the issue of how to make this distribution. The usual method is the cost calculation.

The calculation represents the cost determination for a cost unit. The cost unit is not unified for all the calculations; it always depends on the type of company and the goal for which the calculation is carried out. Most often, cost units such as m, m², m³, piece, etc. are used. The calculation always depends on the specific conditions, and the calculation formula is chosen depending on them. The
general calculation formula in the Czech Republic does not have a fixed structure. Each company, therefore, sets its calculation formula according to its own needs [1].

The calculation can take a variety of forms, namely dynamic and absorption, which are dealt with in this article. The absorption costing is characterized by including the indirect (overhead) costs together with the direct production costs into the calculation, i.e. it must entirely absorb them into the costs.

2. Methodology
The basic costing approach for any industry branch is as follows. First of all, it is necessary to define the cost types for the monitored production. In the next step, it is necessary to distinguish whether the costs can be directly attributed to the cost unit (direct costs) or cannot be determined in this way (indirect costs). Subsequently, it is necessary to create a certain structure of cost items that will enter the calculation formula. In the penultimate step, costs are calculated in the individual cost items based on calculations from normative and valuation documents. At the end of the process, the costs are summed up, which represent the so-called full own costs. After adding the profit, a cost-oriented price has been stated.

In various sectors of economic activity, the generalized calculation formula needs to be adjusted based on the individuality of each product. Therefore, the following chapters provide both theoretical and practical calculations in the field of civil engineering, road transport and water-supply engineering.

2.1. Calculation of cost and price of construction work
In the case of calculation of cost and price of construction work, it is not possible to unambiguously determine the cost unit, since the cost units depend on the type of construction work. Most often, however, $m^3$, $m^2$ or $t$ are used. The calculation formula does not have a unified form for construction work. However, the formula shown in Table 1, from which its individual components can be determined, is usually used. It also explains the term direct processing costs.

Table 1. Calculation formula for construction work price [2]

| CONSTRUCTION WORK PRICE |
|--------------------------|
| **DIRECT COSTS** | **INDIRECT COSTS** | **PROFIT** |
| MATERIALS | WAGES | MACHINE | OTHER DIRECT COSTS | MANUFACTURING OVERHEAD | ADMINISTRATIVE OVERHEAD | PROFIT |
| MATERIALS | DIRECT PROCESSING COSTS | **INDIRECT COSTS** | PROFIT |
| MATERIALS |  | PROCESSING COSTS | **PROFIT** |

For the purposes of clarity and easier understanding, the individual items of the calculation formula are explained on a specific example of the construction work price calculation (Table 2). It deals with performing the concrete C16/20 strength class strip footing. The cost unit, in this case, is 1 m³.

Normative and valuation documents are always required to calculate direct cost items. The normative document is the so-called consumption standard, which, according to the type of direct
costs, determines the amount of material consumption (MCA), the working time of the production human force (HCHT) or the production machinery (MCHT) on the execution of the unit of measure of construction work. This consumption standard shall be multiplied by the relevant valuation base, thus determines the cost of individual direct cost item. The valuation base specifies the price or rate in CZK. For materials, this is the so-called acquisition price stated in CZK/unit of measure of material (AP). This price includes the purchase price and material acquisition costs (e.g. shipping and storage). In the case of wages, the valuation base is the hour tariff in CZK/standard hour, which is contractually agreed (HT). The last standard component is machines that are expressed in CZK/machine hour (MCHH). This rate includes the cost of acquiring and operating with the machine.

As regards the calculation of indirect cost items, these are cost items that cannot be directly related to the cost unit and are therefore determined by means of an individual additional charge (tariff rate), expressed as a percentage. The amount of the additional charge on the manufacturing overhead (o_M), administrative overhead (o_A) is determined by the supplier based on the economic situation of the company.

Similarly, the profit is calculated when the selected base, which is usually the processing cost, is multiplied by the surcharge (s) in per cent. The amount of this rate depends only on the supplier. The resulting calculated price of construction work per unit of measure is then the sum of all the calculation formula items.

### Table 2. Calculation of the specific construction work price

| Item                        | Abbreviation | Price       |
|-----------------------------|--------------|-------------|
| Material                    | M            | CZK 2,439.64|
| Wages                       | W            | CZK 71.19   |
| Machinery                   | MCH          | CZK 6.64    |
| Other direct costs (34%)    | ODC          | CZK 24.21   |
| Total direct costs          | TDC          | CZK 2,541.68|
| Administrative overhead (38%) | AO          | CZK 38.78   |
| Manufacturing overhead (65%) | MO          | CZK 66.33   |
| Total indirect costs        | TIC          | CZK 105.11  |
| Profit (17%)                | P            | CZK 35.22   |
| **TOTAL PRICE**             |              | **CZK 2,682.01** |

Procedure for calculating the individual items of the calculation formula:

\[
M = \text{MCA} \times \text{AP} = \text{CZK 2,439.64} \\
W = \text{HCHT} \times \text{HT} = \text{CZK 71.19} \\
MCH = \text{MCHT} \times \text{MCHH} = \text{CZK 6.64} \\
\text{ODC: } 34\% \times W = \text{CZK 24.21} \\
\text{TDC: } M+W+MCH+\text{ODC} = \text{CZK 2,541.68} \\
\text{TIC} = \text{AO}+\text{MO} = \text{CZK 105.11} \\
\text{AO} = (W+\text{ODC}+\text{MCH}) \times o_A = \text{CZK 38.78} \\
\text{MO} = (W+\text{ODC}+\text{MCH}) \times o_M = \text{CZK 66.33} \\
P = (W + \text{ODC} + \text{MCH} + \text{AO} + \text{MO}) \times s = \text{CZK 35.22} \]
2.2. Calculation of cost and price of water and sewerage charges

Water charge refers to the payment for drinking water supplied from the public water supply and for the services related to its delivery. It is charged when water flows into a pipe connected behind the water meter. The sewerage charge is paid for the wastewater discharged by the public sewer, its cleaning or another way of disposal. The sewerage charge can be charged when the wastewater discharged through the sewer connection flows into the public sewerage [1].

The price of water is determined according to the calculation formula set out in Act No. 274/2001 Coll., On Public Water Supply and Sewerage Systems as amended (Act on Water Supply and Sewerage Systems, as amended) which enables to calculate water and sewerage charge as a one-component or two-component. One-component form applies both at the calculation of the amount of water charge rate as well as at the calculation of the sewage charge rate. Customers pay the water charge in an amount, which is determined as the product of the unit price and the quantity of the water used. The amount of sewage charge is determined as the product of the unit price and the amount of discharged wastewater and rainwater. The amount of the used, discharged or rain water is measured in a way defined by the Act on Water Supply and Sewerage Systems together with the implementing Decree to this Act [3]. The two-component form has two components, variable and fixed. The variable component depends on the amount of water (used, discharged, or rainwater) and the unit price. The calculation of the variable component is the same as the one-component price calculation, i.e. it is the product of the unit price and the quantity. The fixed component does not depend on the amount of water used and the customer pays it even at zero water amount used or discharged. The fixed component can be called a flat rate and its amount is most often determined depending on the capacity of the water meter. The calculation of the fixed component is governed by Decree No. 428/2001 Coll., as amended, pursuant to Annex No. 17. The Ministry of Finance of the Czech Republic further limits the amount of the fixed component in the Price Bulletin [3].

Water and sewage charge calculation is carried out in three steps. In the first step (Table 3), the total own costs (line 10) are calculated as the sum of the previous nine lines. Lines 1, 2, 3, 4 and 5, i.e. lines called material, energy, wages, other direct costs and operating costs, so-called direct costs, which amount is determined from the number of measurement units used and the unit cost in CZK/unit of measure. Line 6 shows the financial costs associated with interest on loans that are paid when the infrastructure assets are transferred into use. Line 7 represents the other revenues that are assigned with a minus sign. These are revenues generated by the services provided related to water infrastructure, however, the costs are not set off. Examples can include revenues from wastewater cleaning which are taken to the wastewater treatment plants from septic tanks. Lines 8 and 9 represent indirect costs that cannot be directly attributed to the cost unit, which is m³.

Table 3. Calculation formula for water and sewerage charge calculation – cost items [1]

| Line | Cost items | Unit of measure |
|------|------------|----------------|
| 1    | Material   | mil. CZK       |
| 1.1  | - raw groundwater + surface water | mil. CZK |
| 1.2  | - drinking water used + waste water delivered for cleaning | mil. CZK |
| 1.3  | - chemicals | mil. CZK |
| 1.4  | - other material | mil. CZK |
| 2    | Energy     | mil. CZK       |
In addition to the cost item group forming part of the price calculation for water and sewerage charges, there is another group of items that enter the final calculation of the water and sewerage charge calculation. These items are identical for both the water charge calculation and the sewerage price calculation. The following table (Table 4) shows the items including the unit of measure in the same structure as listed in the implementing Decree of the Act on Water Supply and Sewerage Systems.

**Table 4. Items entering the final water and sewerage charge calculation [1]**

| Line | Cost items | Unit of measure |
|------|------------|-----------------|
| A    | Value of infrastructure assets according to SDPR (Selected Data from Property Records) | mil. CZK |
| B    | Purchase price of related operating tangible assets | mil. CZK |
| C    | Number of employees | persons |
| D    | Drinking water invoiced | mil. m³ |
Calculation of the customer price for water and sewerage charge itself is carried out in the following table (Table 5) called Calculated price for water and sewerage charge. The table clearly shows the calculations performed on each line. The price for water charge is calculated in the column called Drinking Water and the price for sewage charge in the Waste Water column. The result of the whole calculation, i.e. the price for water and sewerage charge, can be found in lines 18 and 19. In line 18 the calculated price is in CZK per m³ of drinking or waste water and in the line 19 there is the calculated price in CZK per m³ of water including VAT, which is currently at 15% for both water and sewerage charge [1].

### Table 5. Calculated price for water and sewerage charge [1]

| Line (L) | Text                                           | Unit of measure | Drinking water | Waste water |
|----------|------------------------------------------------|-----------------|----------------|-------------|
| 11       | Unit costs including restauration resources    | CZK/m³          | L.10 / L.D     | L.10 / L.(F+H) |
| 12       | Full own costs including restauration resources| mil. CZK        | L.10           | L.10        |
| 13       | Calculation profit                             | mil. CZK        |                |             |
| 14       | - share of calculation profit on full own costs (indicative indicator) | % | (L.13/ L.12)*100 | (L.13/ L.12)*100 |
| 15       | - from L.13 to develop and restore infrastructure assets | mil. CZK        |                |             |
| 16       | Total full own costs including restauration resources + profit | mil. CZK | L.12 + L.13 | L.12 + L.13 |
| 17       | Drinking water, waste water + rainwater invoiced | mil. m³        | L.D            | L.F+ L.H   |
| 18       | Price of water, sewerage charge               | CZK /m³        | L.16 / L.17    | L.16 / L.17 |
| 19       | Price of water, sewerage charge + VAT         | CZK /m³        | L.18 + VAT     | L.18 + VAT |

2.3. Calculation of cost and price of road transport
In road transport, 1 kilometre and 1 hour of waiting or operation are usually considered as cost units. At the same time, it is necessary to notice that a bus with a driver can be seen as one inseparable
whole; however, in fact, the bus and drivers are used in a different way (e.g. more drivers drive the bus or the driver does work without the need for a bus). This implies that both the bus and the driver have to be seen only as part of a transport whole moving along the road. Therefore, the cost of a bus ride is calculated as the sum of the bus costs (riding costs + waiting costs) and the cost of all the drivers, while the performance of each part of the transport whole (a bus and a driver) is being measured in different units (kilometre of ride and an hour of waiting for a bus and an hour of work for the driver) [4].

Cost units have been defined and now the costs have to be divided in more detail. For this purpose, a calculation formula that divides the costs into direct and indirect (Table 6) is used. Direct costs are clearly linked to the cost unit (e.g. fuel, tires, etc.). The indirect costs (overhead) are the costs that cannot be directly attributed to the cost unit, however, must be spent. The next step is the division of the costs into those not dependent on the volume of production or the extent of the transport performance, so-called fixed costs and the costs that depend on the performance (km, hr), so-called variable costs.

### Table 6. Calculation of road transport cost [4]

| Line | Item of calculation formula |
|------|----------------------------|
| 1.   | Operation substances (fuel + fuel oil) |
| 2.   | Rubber hoops |
| 3.   | Wage |
| 4.   | Depreciation |
| 5.   | Repairs and maintenance |
| 6.1  | Health and social insurance |
| 6.2  | Subsistence allowances |
| 6.3  | Other direct costs |
|     | **Total direct costs (DC)** |
| 7.   | Manufacturing overhead |
| 8.   | Administrative overhead |
|     | **Total overhead costs (OC)** |
|     | **Total costs (TC)** |

After the cost division, the conversion of the fixed costs to the so-called cost tariffs, i.e. the recalculation of costs on the cost unit, follows. For easier understanding, this recalculation is explained on a specific example (Table 7). In the first step of the calculation, the variable costs are entered in the columns for tariff calculation (e.g. CZK 6.74/km for operation substances is entered in the column for km or 150 CZK/hour for (direct) wages in the column for hours of waiting). In the second step, it is necessary to divide the fixed costs by the operating time, which is in 2,300 hours in the case study (e.g. depreciation of CZK 520,000 is divided by the operating time of 2,300 hours = 226.09 CZK/hour). In the third step, the data in the tariff (hour of waiting) column is then divided by the
average speed, which is, in this case study, set at 60 km/h. In the case of depreciation, i.e. 226.09 CZK/hour/60 km/hour = 3.77 CZK/km.

| Table 7. Calculation of cost tariffs [5] |
|----------------------------------------|
| **Line** | **Item of a calculation formula** | **Cost calculation** | **Tariff calculation** |
|          |                                |     Variable Costs |     Fixed costs |     Tariff costs |
|          |                                |      CZK/km |     CZK/hr |      CZK |     CZK/km |     CZK/hr |
| 1.       | Operation substances (fuel + fuel oil) | 6.74 | 6.74 |
| 2.       | Rubber hoops | 0.80 | 0.80 |
| 3.       | Wage | 0.50 | 150.00 | 3.00 | 150.00 |
| 4.       | Depreciation | 520,000 | 3.77 | 226.09 |
| 5.       | Repairs and maintenance | 0.58 | 0.58 |
| 6.1      | Health and social insurance | 0.18 | 52.50 | 1.05 | 52.50 |
| 6.2      | Subsistence allowances | 130.43 | 2.17 | 130.43 |
| 6.3      | Other direct costs | 120,000 | 0.87 | 52.17 |
| **TOTAL DIRECT COSTS (DC)** | 8.80 | 332.93 | 640,000 | 18.98 | 611.20 |
| 7.       | Manufacturing overhead | 100,000 | 0.72 | 43.48 |
| 8.       | Administrative overhead | 200,000 | 1.45 | 86.96 |
| **TOTAL OVERHEAD COSTS (OC)** | 300,000 | 2.17 | 130.43 |
| **TOTAL COSTS (TC)** | 8.80 | 332.93 | 940,000 | 21.16 | 741.63 |
| Profit | 50,000 | 0.36 | 21.74 |
| **Cost tariff including calculation profit** | 21.52 | 763.37 |

This is carried out for all items and the resulting cost tariffs are the sum of direct and indirect costs. Thus, in this particular case, the price calculated per 1 km of the ride is 21.16 CZK/km and the price calculated per an hour of operation is 741.63 CZK/hour. The total cost of bus operation can be determined after the total mileage and hours of operation have been determined. The total price includes profit.

3. Results
The structure of all calculation formulas mentioned above is identical. However, there are some differences. The first one is a cost unit, which is diverse for the construction work, it is 1 m³ of the drinking water or the wastewater for water and sewerage charge rates and there are 2 cost units for transport, 1 km and 1 hour. The calculation formula for water and sewerage charge rates is binding and given by the relevant legislation, the calculation formula for construction work is traditional which
means usually an absorption costing with the division of costs into the direct and indirect ones. There are no calculation formulas for the transport given by the corresponding legislation. It is based on the traditional concept of the absorption costing formula complemented by dynamic calculation with variable and fixed costs. This article brings all calculation examples, based on the referred publication sources.

4. Conclusions
It can be concluded from the above-stated results that the creation of a legal standard with the recommended calculation formulas for individual fields of the national economy would be appropriate. Such a comprehensive methodology and related law regulation would certainly help to improve the quality of cost calculation and consequently to establish more transparent production prices. It can be assumed that the quality and the credibility of prices in both private and public sectors in the individual fields of the national economy in the Czech Republic would increase.

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