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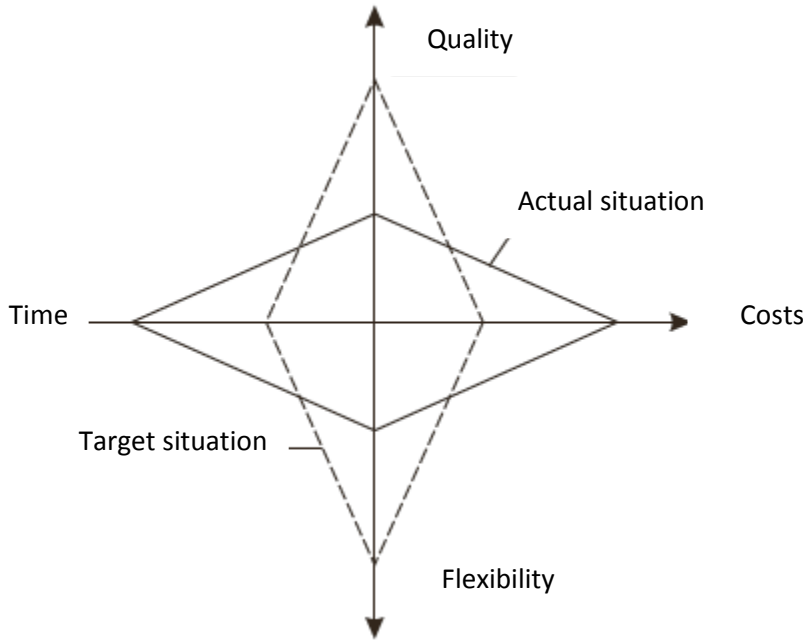
1. INTRODUCTION

All companies are under pressure at all times both in terms of costs and price. It is necessary to combine many factors to create goods and services and implement the corporate goals. These goals vary greatly from company to company but they all have one thing in common: maximizing profit. There might also be other objectives, such as keeping or the improving market share, reducing costs, reducing losses, etc. The economic requirements come up again and again. These are represented in the following diagram, which should represent the actual and planned situations:



The production process is carried out by a combination of production factors: human and other resources, work pieces and information, in many production stages.

The task of operational accounting is to monitor what is happening the in the production process numerically to ensure the smooth running of the operation and thus success. Operational accounting is numerically understanding the company's operations.

Accounting is done for two different purposes:

a) External interests

The public interest is documented by the rules found in the German Commercial Code (HGB), Stock Corporation Act (AktG), Law on Limited Liability Companies (GmbH-Gesetz) and Cooperative Law (GenG). In addition to this, every businessman is obliged to account for their commercial transactions and financial position through proper accounting. Also, the applicable tax law prescribes an orderly breakdown of the costs from these accounts. Since 1936 there have been regulations containing cost accounting principles and accounting policies in force in Germany. These organize accounting methods uniformly and make it possible to compare costs, prices and performance.

In addition to the tax authorities, external investors also have an interest in the company's information in order to assess the surety of interest and repayments. Owner who are not involved in the board of management, such as small shareholders, are informed about the economic situation due to the provisions described above.

b) Internal interest

The accounts show what has happened in the past and also allow conclusions to be drawn for future business policy. This data is the basis for all the management's business decisions. Employees also want to know the economic situation of the company as their own future prospects are affected.

The scope of the accounting system depends on the number of product types, the quantity of products, production processes and methods, and the company's size. The accounting system's raw data is usually recorded automatically today.

In accordance with the law and as a result of business needs, business accounting has two main tasks:

- Keeping chronological and numerical records of all economic and legal operations which change the company's assets or capital.
- The periodic collection and appropriate structuring of the business data collected.

1.1 Accounting structure

To fulfill these two tasks, the accounting system is organized into the following fields:

(a) External accounting (annual accounts)
(b) Internal accounting (master summary sheet)
(c) Cost accounting (calculation of costs)
(d) Business statistics (tables, graphs, figures)
(e) Budgeting (forecasting)

a) External accounting

The task of external accounting is to numerically record, verify and process all the company's transactions with the outside world (for example with customers, suppliers, banks, authorities, the tax office, etc.).

On top of this, financial statements are created periodically (monthly statements or annual statements), i.e. the balance sheet and the profit and loss account. Other important areas of financial accounting are financial and investment planning and monitoring.

b) Internal accounting

The job of internal accounting is to follow and make accounts for the production process pursued by the company's individual departments right up to the finished product. It records, reviews and processes the internal operations. In particular, the following tasks arise:

- Recording all costs incurred.
- Organizing the costs recorded by cost element.
- Booking the costs, broken down by cost element.
- Assigning the costs elements to the places (cost centres) where they were created.
- Matching up cost elements to the goods and services created.
- Establishing costing surcharges.
- Evaluating the numbers collected statistically (by calculating correlations, distributions and trends).
- Creating short and medium-term preliminary cost planning and cost specification for budgeting.

c) Cost accounting

The job of cost accounting is to supply management with the findings they need to bring costs and revenues into an appropriate balance and thus provide satisfactory results.

Cost accounting therefore:

- Monitors the efficiency and profitability of the business
- Determines of the cost price of individual products. Evaluates the earning capacity of individual products by comparing the costs with the prices (pre and post calculations)
- Compares in-house production and external procurement
- Prepares documents for production planning and control
- Analyses weak points in the production and detects key areas for rationalization
- Identifies the most profitable products
- Carries out economic and systematic comparisons between different manufacturing options
- Enables cost comparisons between plants

Cost accounting helps to evaluate stocks of finished and unfinished products in the balance sheet.

Cost accounting takes place in three steps:

1. Recording costs	for cost elements
2. Allocating costs	cost centres and cost units
3. Using cost data	to measure the operating activities / to control of the operating behaviour / for scheduling

d) Business statistics

Business statistics covers everything which is important for the implementation of internal measures in the form of tables of figures, graphics and graphs, and metrics. In addition, market statistics are playing an increasing role to support business operations.

Analysis and interpretation of data from the company and external sources (business associations, statistical offices) are used with statistical tools and methods for the planning and control necessary. Comparative calculations over time, plant and the actual and nominal situations find application in statistics so that
different developments over particular time periods become visible and thus also assessment can be made. This results in: performance, quality, cost and personnel statistics.

e) Budgeting

Budgeting tries to make randomness as small a factor as possible in economic management and to ensure systematic monitoring of the operating behaviour. It gives advance statistical accounts and requires an accurate observation of the market or a business plan. The basis of budgeting is the data held in the operating statistics.

The objectives of the company are set out in a plan with a specific for a time period (e.g. a year). The overall plan contains the target figures (= planned figures) arranged into sections (for example sales plan, financial plan, costing, purchasing plan, production plan). At the end of the planning period, the figures which are actually achieved (actual figures) are compared with the planned figures and the difference is calculated and analyzed. This analysis is the basis for the studying the causes of deviation from the plan. It can be recognize whether errors were made in estimating while creating the plan or whether there were defects in the planning process.

This accounting are for internal use: Management use them to control business processes in all areas impinging on achieving future results. It is, however, not bound to legal requirements.

The calculation of public contracts is an exception here, which have to comply with special requirements (Regulation on Pricing for Public Contracts (VOB)).

The future of successful business activities, coming from corporate decisions, is calculated in budgeting. To do this, time-related (past, present and future related) data from all areas of accounting is processed. Starting from the sales plan right up to the shop order, budgeting is carried out retrogradely (on production programs, product lines, production processes and other things) to optimize the interlinking of production and exploitation in all areas.

Summary

The job of accounting is to monitor the various events of the production process numerically. It is divided into internal and external accounting, cost accounting, business statistics and budgeting. Production of goods and services causes expenditure, effort and costs. What is important is to know the cost elements, the cost centres and the cost units.

1.2 Planning, recording, analyzing and evaluating the function–field related costs according to the planned data

We define the term "cost" as "the monetary value of the consumption of goods and services for the creation of operational performance". This makes the main task of cost accounting the collecting, arrangement according to various characteristics, and evaluation and monitoring of all the company's individual tasks. Therefore, the main function is to influence the processes creating and selling goods and services in the following areas:

- The convenient organization of the actual costs incurred in conjunction with optimal organization and techniques, and
- achieving a positive operating profit (income > expenses).

Cost are characterized by these three points:

- They must be linked to goods or services, for example using up materials, the use of equipment, the use of a human workforce.
- The goods or services need to be consumed when creating operational performance.
- The goods or services consumed must be assigned a monetary value. For example, when using up materials it would be the cost price; when using equipment, the depreciation and amortization of the equipment and interest; when using a human workforce, their pay.

Cost and performance accounting matches costs with the associated performance. The focus of cost and performance accounting is the preparation of documents by the following two criteria:

- Pricing, price assessment, price controls
- Investigating/planning and controlling efficiency

Operating policy decisions are made according to the priorities of the planning calculations mentioned above.

1.3 Standard costing – Part of planning for the future

The objectives of the company require the activities of the management to be realized. An example is increasing sales and extending the sales area through affecting the company's cost situation and decisions made on the basis of prepared planning documents (e.g. in-house manufacture or external procurement).

Standard costing is an important basis for the actions of the management. This importance is increasing because standard costing, as part of cost accounting, is a medium-term calculation oriented on the future (one year or more).
The determination of future costs is contained in the cost element, cost centre and cost unit calculations.

Term	Question	Examples
Cost elements	What costs are incurred?	Material costs, labour costs, energy costs
Cost centres	Where are the costs incurred?	Turning shop, assembly line, production preparation
Cost unit	Why are the costs incurred?	Crane X, product A

1.3.1 Cost elements, cost centres, cost units

1. Cost elements

The large number of operational processes and the value consumption associated with them cause a great number of individual costs. Without a corresponding breakdown, they would not be understandable.

All the costs in a company can be assigned to certain cost elements, depending on which aspects of the costs are used to break them down.

A cost element includes all costs which can be traced back to the same factors.

The following are important aspects:

- The type of goods and services consumed (material, personnel, services costs, investment-related costs, implicit costs).
- Accounting aspects: Direct costs (construction materials, wages for manufacturing employees) and overheads (for materials, manufacturing, construction, administrative and sales).
- According to how the costs can be influenced: Fixed costs and variable costs.

2. Cost centres

Cost centres are those nodes in firm which caused the costs and to which these costs can be attributed.

They are operational areas which can be separated as far as cost accounting goes. Calculations can be made for them individually.

According to the nature and size of the company, cost centres can be departments, workshops, machine groups, and possibly also individual workplaces.

3. Cost unit

Cost units are what is produced (goods, services), to which the costs they have caused are attributed.

The costs incurred in the individual cost centres are associated with cost units.

Cost units can be assigned to both goods and services for the outside world and also to in-house services.

The planned costs are obtained from the required quantity of the product and the planned price. By periodically comparing the planned and actual costs, conclusions can be made about the efficiency or inefficiency of the company. Different comparisons require different data and relate to:

- Comparison of costs from various periods (such as from the same month last year, or this month and last month)
- Comparisons of cost elements and cost centres over time and
- Cost trends in the light of various degrees of activity (levels of activity)

The numbers required are, therefore, the actual costs from the cost centre accounts and/or the cost element accounts, collected and properly assigned. Variance analyses can provide information about the causes of (in)efficient processes. The person responsible for the cost centre has to justify it if the centre exceeds the planned or target costs. This is only possible if the planned costs are feasible and can be influenced.

A certain amount of determination of data is a prerequisite for using cost planning.

Past experiences can be used to make forecasts. For this, a precise knowledge of the processes is needed, so that they do not set any unrealistic goals for a cost centre. Should savings be the goal, optimal processes are assumed.

In order to focus planning data on cost centres, the following steps are required:

- The creation of operational units (OUs), here cost centres. These can be assigned, for example, via function or responsibility, or spatially (one can look at the organization of the company and its processes for help here).

- The establishment of measurements for the respective cost centres. Here it is important to remember that the cost centre groups must be able to be compared later. For example volume (lot size), manufacturing hours, engine running hours, etc. can be set up as reference values. The quantitative setting of reference values for a planning period of a cost centre (planed reference value) is the measure for the planned degree of activity. The most important planning parameters are the capacity of people and resources of the company considered as a basis for production and sales.

If the planned costs for an activity plan, i.e. a plan of the degree of activity is to be determined, it is necessary for the consumption and the handling and processing times needed to be determined for each cost element and cost centre.

Planned quantity • planned price	=	planned total price (kg • EUR/kg = EUR)
Planned time •rate of pay	=	planned total pay (h • EUR/h = EUR)
		Grand total (EUR)

- Organizing the costs into activity-independent and activity-dependent costs and thus in fixed (independent from the reference activity degree) and variable costs (dependent on the reference activity degree).
- Calculating the documents necessary for the accounts (cost unit accounting) by dividing the planned costs by the planned reference size for the cost centre. The results of standard costing give rise to, among other things, cost centre plans for centres (sections, divisions, machines) for periods (months).

Cooperation between those from departments which prepare cost accounting (such as work preparation, technical business administration, and the manager) and those responsible for cost centres (such as an industrial master craftsman) is necessary so that those responsible accepts the planned costs. Only cost planning coming from cooperation of these parties has a positive impact on costs. It is important to know about how costs can be influenced.

Standard costing is used in companies that mass produce things if a stable production program is kept for a longer period of time (at least a year). All partial plans, such as sales, procurement, production, profit, are then coordinated into the planning process.

The data for the target/actual comparisons, as well as time-based and operating comparisons is taken from the cost accounting done and statistics.

The basis for effective standard costing is correct data processing and the optimal organization of the company and its processes in conjunction with economic production scheduling.

1.4 Standard costing in different types of company

1.4.1 Actual cost accounting

Actual cost accounting covers the consumption of goods and services over a period in the past. It has two forms: period accounting and unit accounting. Changes in the cost of goods, employment fluctuations, shifts in the composition of orders, inefficient production, and other random factors fully affect the costs calculated. These are passed from stage to stage and grouped together.

The principle of making costs transparent according to the costs-by-cause principle is thereby bypassed and precise control is lost. Different influences affect the costs at different times in different amounts. This makes a comparison of different products over period or unit impossible or at least questionable. It is simply the result of overall operation, not that of parts, departments or cost centres.

Representation of the actual costs for various periods:

	January	February	March	April	May	June
Materials	€ 10,000	€ 9,500	€ 9,800	€ 10,300	€ 10,800	???
Total cost per item	€ 9.60	€ 9.80	€ 9.70	€ 9.40	€ 9.20	???

The actual costs are determined as follows:
Actual cost = actual quantity • actual price

For example: Flooring 135 m² • € 48/m² = € 6,480

Pure actual cost accounting cannot include time necessary or costing boundaries and thus normal or plan values must be used in these areas.

1.4.2 Normal cost accounting

Normal cost accounting works with fixed internal pricing to leave out random fluctuations in the cost factors and to simplify the on-going accounting using normalized overhead costs.

Normal costs are not scheduled costs, which are of course standardized, but average costs calculated from several actual past periods.
They are based on the normal, i.e. average consumption of goods.

From the actual values from the past, the additional costs of poor decisions are also taken into account. So they are an average of favourable and unfavourable values.

The reliability of normal cost accounting can be increased by taking account any changes now occurring.
The normalization of the costs does not need to cover all cost components, but can be very different and, for example, focus only on the use of fixed internal prices for material costs, fixed pay, fixed overhead surcharges, and fixed internal prices for services.

Normal cost accounting was developed before standard costing.

Two procedures that relate to overheads are distinguished in normal cost accounting:

- rigid normal cost accounting
- flexible normal cost accounting

Rigid normal cost accounting

Rigid normal costing is valid only for a fixed level of activity and works with only two variables:
- the price and
- the quantity.

The advantage of this is that it is valid longer and is a simplification of the accounting system.

The price discrepancy is the difference between the normal prices and the actual costs for raw materials, consumables and supplies.

A quantity discrepancy or consumption discrepancy occurs when the actual quantities consumed in the cost centre (department) are not the same as the average amounts. Working with the average level of activity or capacity utilization means there are differences when the actual levels are different. The significance of the differences with regard to excess or shortfall is therefore diminished.

Reminder:
Excess: actual capacity > target capacity
Shortfall: actual capacity < target capacity

The normal overheads are calculated from the total overheads divided by the production hours.

The deviation is the difference between the actual overheads and the normal overheads.

For example the metal cutting cost centre:

Total overheads: € 104,000/period
Production hours: 1,300 h/period

Normal rate: $\frac{104{,}000}{1{,}300}$ = € 80/h

The accounts show the following:

Total overheads: € 114,000/period
Production hours: 1,500 h/period

€ 80/h • 1,500 h/period = € 120,000/period => normal costs
€ 114,000/period – € 120,000/period = - € 6,000 => difference

In other words too much has been charged, the actual hourly rate is lower (€ 76 per hour).

The advantages of normal costing are the simplification and acceleration of cost accounting and the use of the normal cost rate.

The disadvantages are the static average values based on the past and the fact that changes in the level of activity are not taken into account.

Flexible normal cost accounting

Flexible normal cost accounting on the other hand, also takes into account changes in the level of activity and attempts better cost control by splitting the volume deviation into consumption and activity deviation. This is done by adapting the normal cost rate to changing capacity utilization. This separates normal overhead costs for each cost centre into their fixed and their variable components.

This gives two tasks to flexible standard cost accounting, a qualitative and a quantitative task. The first is to divide the total cost into fixed and variable costs. The second is to determine the costs for each cost group.

The level of response can be used to determine how costs change when the level of activity changes.

R = response level
K = cost change => change in cost as a percentage
B = activity change => change in activity as a percentage

$R = \frac{K}{B}$

$K = \frac{K_2 - K_1}{K_1} \cdot 100\ \%$ $B = \frac{B_2 - B_1}{B_1} \cdot 100\ \%$

for example:

K_1 = € 11,500 K_2 = € 12,880
B_1 = 450 units B_2 = 540 units
R = $\frac{12}{20}$ = 0.6

60 % of 11,500 = 6,900 k_v (variable costs)
60 % of 12,880 = 7,728 k_v
40 % of 11,500 = 4,600 k_f (fixed costs)
40 % of 12,880 = 5,152 k_f

The result says that a change of activity of 1% changes the costs by 0.6%. In addition, the proportion of costs which are fixed and which are variable can be read off directly. Here the response level corresponds to the variable costs, and 1 minus this is the fixed costs.

1.4.3 Accounting with mixed costs

Most cost elements are neither completely fixed nor completely variable. These elements are known as mixed costs, because they have fixed and variable elements. Mixed costs are indirect labour costs, costs for auxiliary materials, maintenance costs, energy costs, etc.

Mixed costs can be split into their fixed and variable cost components.

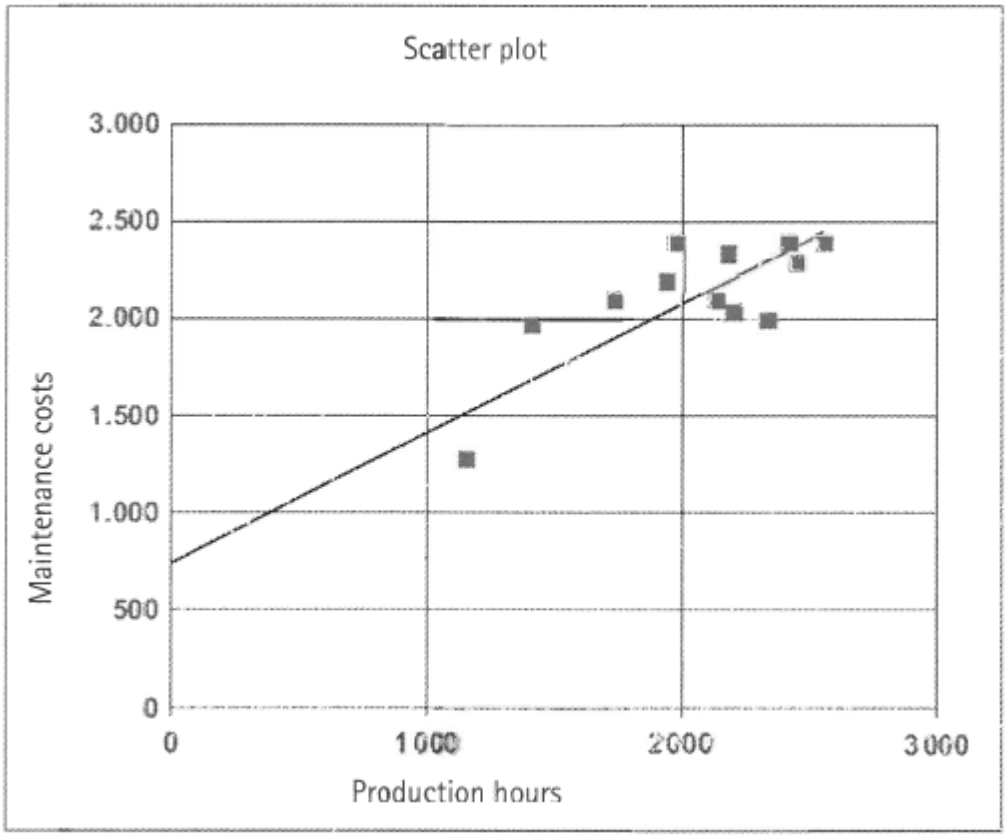
The following methods are helpful here:

Estimation
The proportion of the two types of costs is estimated. So, for example, that the energy costs are 75% fixed to 25% variable. This allocation is inaccurate, however the accuracy achieved is often good enough.

Graphical procedures
(splitting costs using a scatter plot) Related readings of costs and levels of activity are plotted on a chart. A line of best fit is drawn through the points, its intersection with the vertical axis is the amount of the fixed costs.

The following maintenance costs have been accrued by a cost centre (machine group) over a year alongside the following production hours. The proportion of fixed costs of the maintenance will be calculated.

Month	Production hours in h/month	Maintenance costs in €/month
January	2 140	2,100
February	1 980	2,400
March	2 450	2,300
April	2 180	2,350
May	1 940	2,200
June	1 740	2,100
July	1 410	1,980
August	1 150	1,280
September	2 200	2,050
October	2 420	2,410
November	2 560	2,400
December	2 340	2,000
Total	24 510	25,570



1.4.4 Flexible normal cost accounting

The procedure for flexible normal costing is carried out in a number of steps. The following example illustrates the procedure. It is derived from the data in the section on rigid normal costing (p. 10).

1. Calculation of actual overheads, e.g. € 104,000

2. Distribution of actual overheads into a variable and a fixed part according to the cost analysis: 62.5% variable and fixed 37.5%

This means:

62,5 % = 65,000 € k_v
37,5 % = 39,000 € k_f

3. Variable normal costs

$$\frac{k_v}{normal\ level\ of\ activity} = \frac{65{,}000}{1{,}300} = 50\ €/h$$

4. Fixed normal costs

$$\frac{k_f}{normal\ level\ of\ activity} = \frac{39{,}000}{1{,}300} = 30\ €/h$$

5. Normal overhead rate (normal activity)

= k_v-part + k_f-part
= 50 + 30
= 80 €/h

6. Calculated normal overhead costs

80 • 1,500 = €120,000

7. Excess/shortfall

Difference = 114,000 – 120,000
= - €6,000

8. Normal overheads

Fixed overheads + (variable overheads rate • actual activity)
39,000 + (50 • 1,500) = 114,000

9. Variation due to the difference in activity level

Actual overheads – normal overheads
114.000 – 114.000 = 0

10. Variation due to the change in activity level

Normal overhead costs – calculated normal overhead costs
114,000 – 120,000 = - 6,000

The advantages of flexible normal costing is the inclusion of changes in capacity or activity and improved cost control.

The disadvantage is the complex process and costs which come from it.
As a result, rigid normal costing is more frequently used.

1.4.5 Standard costing

Standard costing is a cost accounting system suitable for this purposes.

Full cost accounting (all costs are charged to the cost object) is performed as standard costing in the form of:

- rigid standard costing – the cost centre's cost planning is carried out for a period, such as one year, based on a particular average activity plan for this period. The planned costs can be compared to actual values regardless of a differences in planned activity.
- flexible standard costing – this takes account of the difference between the planned activity level and the actual one by adjusting the planned (nominal) costs. The costs are allocated here as fixed costs (activity-independent costs which do not change as activity changes so long as capacity remains the same) and variable costs (performance-related costs).

The use of standard costing as partial cost accounting, in which only the variable costs are associated with the cost units, is possible with direct costing.

Flexible standard costing is common on a full cost basis. Within this, the actual and nominal cost centres, cost units and cost element calculations are compared.

Flexible standard costing can only realize its objectives for the future the company, if certain conditions are met for its introduction and implementation. For example:

- the organization of the company and its processes are tailored to the system in question;
- there is a functioning accounting system, in which the data required for the actual accounts and the statistics can be found;
- cost centres have independent areas of responsibility, according to the needs of standard costing;
- reference values are determined at the cost centres to determine the planned costs

In the conditions mentioned previously, one can see that the cost accounting system depends on the order position, business organization and production program.

The application of standard costing on the basis of a production program that is stable for at least a year can be in undertaken in companies which do mass production and batch production, if there is customer and market orientation. As a further condition, one need a constant cost structure and constant cost centres over the period planned for.

The individual costs are assigned to the relevant products or services based on design documentation (such as parts lists and drawings) and data on work preparation. To account for overheads, what is known as standard costing rates are set up.

Small orders, short working processes, as well as large price fluctuations on the market restrict the use of the flexible standard costing, or can even make it impossible.

In production, where the goods or services are produced only once or in small numbers, i.e. only a few products of the same design and order-driven manufacturing, flexible standard costing is not suitable. This is because of an insufficient order situation for the period and/or multiple changes in cost structure.

The following problems which arise in individual and small-scale production show why the use of standard costing is not possible in these areas:

- Often, not all details are known in the estimate and changes may be necessary due to customer orientation.
- According to the quantity of the production factors, manpower, machines, materials, required, the processing of the quotation will have to rely on the total cost, for example hourly rates for manpower and machines or cost per amount of material. This is fraught with inaccuracies, since the actual cost is not known.
- Overheads are not related to the amount of product or service created, which prevents the formation of standard costing rates.

1.5 The structure of standard costing relating to function field

In industrial companies, the structure often takes into account location and typically uses areas such as: general area, materials, production, sales and administration. It is therefore necessary to break-down these areas further into cost centres. This structuring fulfills the requirements for standard costing according to function fields.

The breakdown by cost centres as places of production of goods or services where costs arise, makes it possible to give responsibility to the head of the cost centre for variables that can be influenced. Planning per cost centre makes it possible to directly assign the direct costs of creating goods or services, and the overheads to the respective cost centres via the cost centre accounts.

In addition to costing cost units, comparing nominal and actual values, and cost centre accounting, cost element accounting plays an important part of standard costing. Cost element accounting collects together all costs expected in the period, divided according to cost element (costs with equal reference values) and thus provides data for the cost centre and cost unit accounting.

1.5.1 Characteristics of the structure of costs elements

To be able to provide the basis for planning the costs of a period, the amount produced at a workstation in a cost centre must be evaluated alongside the costs for the production factors. The cost, structured according to different features, can as shown as follows:

Type of goods used:

- Material costs, consisting of direct costs and overheads;
- Production costs consisting of wages and overheads or, alternatively,

- Production costs consisting of wages, residual production overheads and machinery costs (depreciation, interest) costs for space, energy costs, maintenance costs, machine dependent tooling costs etc.);
- Special direct costs of production.

Goods and services consumed:
- Primary costs: Goods and services sourced outside of the company, and resulting costs such as materials, personnel, capital and external service costs;
- Secondary costs: Goods and services sourced from a different cost centre within the company.

For example, costs for repairs by craftsmen employed by the company.

Cost depending on the level of activity:
- Fixed costs (activity-independent)
- Variable costs (activity-related)

These, and similar structures can be found in all areas of cost accounting and they form the basis for different calculations, depending on the purpose.. A more detailed description of cost elements is included in the relevant place in the teaching material.

Flexible standard costing on the basis of full costs is not possible without resolving the planned costs into fixed and variable cost components. The following structures can be used:

Resolution to cost unit:
- Individual costs, directly charged, such as construction materials and wages
- Overheads, indirectly through overhead rates in cost centre accounting

Methods of compilation:
- As basic costs, which are the operating expenses, or
- As additional costs, the calculated costs,

According to operational functions:
- Costs according to spatial structure, such as cost centres in the areas materials, production, management and distribution.

1.5.2 The structure of standard costs for an example cost centre in terms of cost manufacturing

This outline shows a possible structure for the costs elements in the cost centre:
Costs for:

Staff
- Direct labour costs for production as piecework, incentives and hourly rates
  Characteristics: The services are directly assignable to the order (e.g. through time tickets) and as such are direct costs.

- Indirect labour costs
  Characteristics: These are overhead costs, i.e., they are indirectly charged to the product. It is common to differentiate between direct and indirect labour costs (such as designers, foreman).

- Salaries
  Characteristic: Salaries for employees, are considered overheads, i.e. direct association to the individual order is not possible. For example the salary of a master craftsman, or staff working in preparation.

- Social security contributions
  Characteristics: The direct labour pay-related social costs are direct costs, such as statutory social expenses: employer contributions to the health insurance, care insurance, accident, unemployment and pension insurances. Voluntary social costs on the basis of works agreements are overheads, such as grants for staff canteens, costs for libraries, for celebrations etc..

- Other personnel costs
  Characteristics: Costs associated with hiring and firing of employees are overheads, such as job advertisements, interview costs, employees' severance pay.

Materials

- Construction materials (material expenses)
  Characteristics: Construction materials are calculated directly as part of the cost unit (production).
- Material overheads for auxiliary materials
  Characteristics: The substances which only occur in small amounts in the products or services (minor components), are considered overheads for economic reasons, e.g. nails, screws, electrodes, glue.
- Supplies
  Characteristics: Supplies are not directly part of the cost unit, but are required for the production and will be charged as overheads, such as electricity, gas, compressed air, fuel and others.

Resources

- Characteristics: Resources are all material goods which are necessary for production but which are not possible to order under special individual costs, for example land, buildings, machines, operating equipment.

- Costs for resources
  - Wear on equipment due to use or time results in a lowering of its value, which is placed here and is called depreciation.
  - Maintenance of equipment which must be continuously available to ensure production (according to DIN 31051 Sheet 1, the tasks are the maintenance, inspection and repair of resources), is designated as maintenance costs.
  - Buildings' depreciation and maintenance costs are considered occupancy costs.
  - Energy used in the drives of machines and equipment and for lighting.
  - The use of tools and devices for automatic and / or manual production. Low-value assets (tools with low value) can be considered supplies and put in the overheads. For high-quality tools and devices, the depreciation is to be determined.

Imputed cost

- Imputed depreciation
  Characteristics: Imputed depreciation is due to the impairment of tangible and intangible objects (buildings, machines, patents, licenses etc.).

- Imputed interest
  Characteristics: Imputed interest is related to the total assets required by the company (internal and external capital) and are thus the fee for the use of capital in the company. Only the company's borrowing costs are considered neutral for tax purposes whereas the imputed interest also

includes the scheduled cost of lost interest on internal capital. The amount is determined as follows: Imputed interest = (necessary operating capital • interest rate)

- Imputed risks
  Characteristics: Costs of unforeseen events that consume things working towards the company's aims, lead to loss of employed capital. All such risks are taken into account if they are not specific risks covered by insurance.

The imputed risks are:

1. General business risks to the entire enterprise (such as technical progress or changes in market conditions) which are not reflected in the profit. They are not predictable and as such cannot be calculated in advance. Insurance for this is not possible.
2. The direct risks relating to individual operational areas, or individual cost centres. On the basis of experience, these risks are predictable and can be insured against if necessary. Individual risks are summarized in the following table.

Risk	Examples	Calculated on the basis of	Documentation
Development risk	Failed development or research	Development costs in the period accounted for	Documents detailing the development
Manufacturing risk	Materials, manufacturing or design errors	Production costs in the relevant area	Production documents such as rework tickets
Investment risks	Write off's, total losses	Purchasing or net book value	Company data
Stock risks	Shrinkage, ageing	Value of the stock	Inventory lists
Sales risks	Currency fluctuations, bad-debts	Sales, inventory of receivables	Accounting documents
Warranty risk	Warranty claims, product recalls	Manufacturing costs	Sales records

- Imputed operator's income
  In sole traders and partnerships, the proprietor(s) do not receive salaries, instead they are compensated from the profits, this money is the imputed operator's income.

- Imputed rent
  If the sole trader or partner of a partnership makes their own buildings and/or rooms available for business use, the imputed rent is calculated for this purpose based on normal local rents. These costs shall be disregarded if depreciation for the rooms and building, imputed interest, costs for maintenance etc. have already been charged.

Third-party services

- The costs for services carried out externally such as telecommunications services, external repairs, services for patents, tests etc. are determined here.

Cost centres

- According to ability to assign the costs to the cost centres (direct or indirect), one differentiates here between direct costs and overheads at a cost centre. The cost accounting is based on documents, invoices or material sampling certificates or also on the use of various types of energy. The overheads in the cost centres are calculated pro-rata using an allocation formula.

1.6 Standard costing

Standard costing is a suitable means of preparing data relevant for decision making for controlling operational processes. It is carried out as

- Full cost accounting (the cost units are directly or indirectly associated to all costs, direct costs and overheads, fixed and variable costs via cost centre accounting.
  - In rigid standard costing or
  - In flexible standard costing and
- Partial cost accounting
- Direct costing (the cost units are only associated with the variable costs directly or indirectly through cost centre accounting).

1.6.1 Rigid standard costing

The requirement for the sensible application of "rigid" standard costing is that the level of activity is almost constant, which means that it only changes within very narrow limits. These fluctuations occur in practice, but one can set the nominal and actual activity levels to be the same without big mistakes. The cost differences calculated are always consumption or price differences in "rigid" standard costing. Since there are no activity changes, resolving the fixed and variable costs units is not required. Here, one must calculate the following:

$$\text{Degree of activity} = \frac{Actual\ activity\ level}{Nominal\ activity\ level} \cdot 100\ \%$$

$$\text{Degree of activity} = \frac{Actual\ performance}{Nominal\ performance} \cdot 100\ \%$$

$$\text{Standard cost rate} = \frac{Standard\ costs}{Standard\ activity\ level}$$

$$\text{Degree of activity} = \frac{Actual\ activity\ level \cdot 100}{Reference\ activity\ level} \cdot 100\ \%$$

1.6.2 Flexible standard costing on a full cost basis

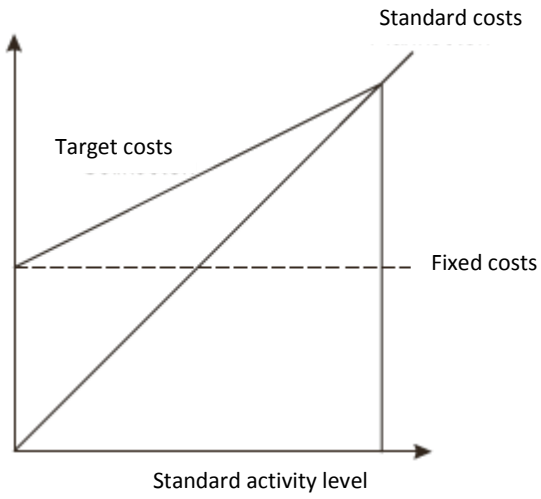
Flexible standard costing on a full cost basis is designed to enable the setting of target costs for different levels of activity by resolving cost. The target costs form the basis of more nuanced analysis of any cost differences. The flexibility of the actual target costs tailored to the activity level for each cost element and the sum of the costs of all cost categories are determined following the adoption of the planned activity level including the planned costs on the basis of the production program for each cost centre. A leverage ration calculation is often used to determine the ratio of variable to fixed costs of a cost element or cost total with a certain planned level of activity.

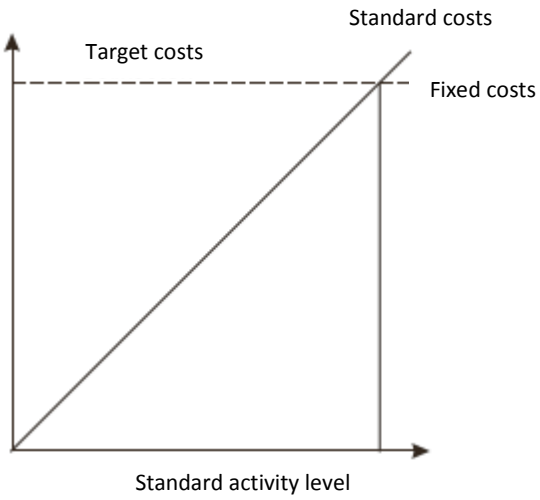
$$k_v = \frac{Leverage\ ratio}{10} \cdot \text{standard costs} \qquad \text{or}$$

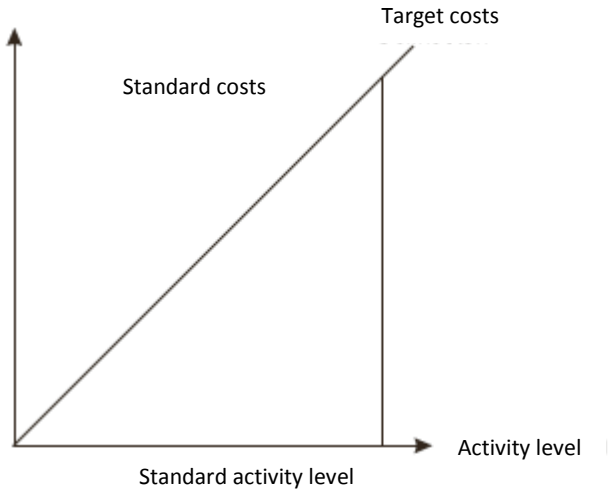
$$\text{Leverage ratio} = \frac{k_v}{Standard\ costs} \cdot 10$$

The leverage ratio describes the relationship between the fixed and variable costs for linear cost functions. It determines the percentage change in costs when the level of activity changes by 10%.

A leverage ratio of 8 says that with a 10% change of activity, 80% of the total costs will be variable and 20% fixed.
Examples: Standard costs € 10,000 and leverage ratios of 5, 0 or 10:







In first case, a leverage ratio of 5, the standard costs are 50% variable. In the second case, leverage ratio 0, the standard costs are 100% fixed costs. Finally, in the third case, leverage ratio 10, the standard costs are 100% variable costs.

The leverage ratio is used to determine the variable part of the target costs for activity levels differing from the planned activity level. When the activity level changes 30% and the leverage ratio is 6, the change to the planned costs is:

3 • 6 % = 18 %

The leverage ratio can be determined using past experience of costs.

The following variables help to determine the costs in variable cost accounting:

Analyses are carried out to detect the causes of variations:

- Price variations
- Variations in activity level
- Variations in consumption

Flexible standard costing is aimed at controlling the efficiency of the company. The influences of the market are eliminated by evaluating the quantities of goods both in the plan and in the actual accounts using standard or actual prices.

The variance in the level of activity coming from the difference in the target costs and the standard costs are caused by the fixed cost parts of the respective cost elements and arise through the actual activity level being different from that planned.

An excessive use of goods results in positive variance and could be the responsibility of the person in charge of the relevant cost centre,

Negative variance is caused by specifications in the plan which are too high.

Cost analysis is carried out for variances of 10% or more, which form the basis of measures to rule out future cost variances. The causes of higher consumption vary. This is because many different elements need to be made available for the organization of processes, the spacial and temporal coordination of the workforce and machines, for example production materials, information, documents (drawings, instructions) and the capacity of workforce and resources necessary.

Making the wrong materials available can change the actual volumes. Consumption deviations also arise through the use of unplanned resources. Design changes lead to modified procedures and to process variations.

Example

The total cost of a metal working cost centre is € 170,611 for a planned activity level of 1680 hours.

Resolving the costs gives us fixed costs of € 71,913 and variable costs of € 98,698. For the planned activity level about 58% of the total costs are variable (leverage ratio = 5.8).

The actual costs amount to € 133,600 for an actual activity level of 1008 hours.

1.6.3 How to determine standard costs

Step 1: Separate cost centres and name cost centre managers.

Cost centres are separated according to various criteria. Some of these are: function, location, organization. The depth of the nesting of cost centres depends on the depth required in later analysis.

Step 2: Set performance measurements

A measure (or perhaps several) needs to be found with which to express the performance of cost centres and to which the costs of the cost centres are proportional. Reference sizes are often based on time. Hours of production per year is often used. According to the company, other performance references are available, such as quantity per year.

Step 3: Set reference performance levels

In standard costing, the level of activity planned is particularly important. There have been a number of different models developed to plan this, however the same must be true here as for standard costs. It must be a true and fair measure of the future activity level. Maximum or optimum activity

levels are usually far from the actual conditions. The most appropriate approach is likely to be to consider all internal and external bottlenecks. The value obtained from this is defined as the planned activity level of 100%.

Step 4: Analyze the time and quantity structure

Analysis of the time and quantity structure of the individual costs elements, such as staff costs, energy costs, etc.

Step 5: Plan the time and quantity structure

The time and quantity structure is oriented solely on the cost elements of the company's production program. This is compiled from the sales and inventory plan. The scheduled times and amounts can be determined by calculation or lump-sum value mappings. The principle of efficiency also applies to this step.

Step 6: Evaluate time and quantity structure

The cost price or the internal price can be used as the planned price. The use of internal pricing which stays constant over the entire period makes sense. Since both the standard costs and the actual costs are determined with these constant internal prices, a variance in the cost only points to a variation in consumption. When establishing the actual costs using actual prices, any variance in price must be taken into account before determining the difference in consumption.

Case study of cost planning

The controlling department of a medium-sized business is given the task of creating standard costing for their cost centre 9708 (metal working). After discussions with the sales, manufacturing and production scheduling departments, they have collected the following data:

Step 1: Delimiting cost centre

This step has already been completed via the existing actual cost accounting. It is the cost centre 9708 (metal working). You are managing the cost centre as an industrial master craftsman.

Step 2: Set performance measurements

The performance measures are defined in "production hours/month". No other measures like "pieces/month" or "kg/month" are used.

Step 3: Set reference performance levels

Based on the number of work stations, 1680 production hours/month is set as the reference level. In accordance with the production scheduling, this value is set as 100% (planned activity level = 100%).

Step 4, 5 and 6: Cost planning

In order to determine the costs/month planned, the following data sheet is worked out together with the production scheduling and the controllers:

Determination of standard costing for different cost elements

No.	Cost element	Basis for calculation (time and volume expected and planned price)	Leverage ratio	Standard costs in €/month
1	Manufacturing wages	12 workplaces 35 h/week = 140 h/month 140 h/month • 12 employees = 1680 h/month at € 20.90	1	
2	Indirect labour costs	The use of transportation services etc. 200h/month at € 17.50/h (not including social costs)	0.1	
3	Salaries	1 Industrial foreman 1 Area manager (1/4 of time)	0	5,000 2,000
4	Social costs for wage earners	95%	0.85	
5	Social costs for salary earners	95%	0	
6	Auxiliary and operating material	Value obtained relative to experience gained in neighboring department	0.75	8,500
7	Electricity	27 kWh per production hour (at € 0.15/kWh) Fixed costs € 756/month	0.9	
8	Tooling	Value obtained relative to experience gained in neighbouring department	0.8	12,600
9	Maintenance costs	Calculated as 4% of the purchase price of the fixed assets (see No 11)	0.2	
10	Occupancy costs	700m2 at € 25/month including environmental protection equipment	0	
11	Imputed depreciation	Fixed assets: 2.4 million euro 10% lin.	0.33	
12	Imputed interest (fixed assets)	2.4 million euro/2 = 1.2 million euro average capital tied up, 10% interest	0	
13	Imputed interest (current assets)	200 thousand euro, of which 1/2 tied up = 100 thousand euro, 10% interest	0.75	
	Total			

Determination of the basic standard costing according to REFA (Organisation for work design, industrial organisation and company development).

Cost centre cost plan			Cost centre 9708 Sheet metal processing 12 workplaces		Valid in each month of the coming year		
					Planned reference volume		
					Planned activity level		
Cost element			Leverage ratio	Standard price in €/production hour	Standard costs in €/month		
No.	Description				Total costs	Variable costs	Fixed costs
1	Personnel costs	Manufacturing wages					
2		Indirect labour costs					
3		Salaries					
4		Social costs for wage earners (95%)					
5		Social costs for salary earners (95%)					
6	Direct manufacturing overheads	Auxiliary and operating material					
7		Electricity					
8		Tooling					
9		Maintenance costs					
10		Occupancy costs					
11	Imputed costs	Imputed depreciation					
12		Imputed interest (fixed assets)					
13		Imputed interest (current assets)					
Basic standard costs in €/h							
Standard cost rate in €/h							

Solution to determine the basic standard costing according to REFA.

Cost centre cost plan			Cost centre 9708 Sheet metal processing 12 workplaces		Valid in each month of the coming year Planned reference volume Planned activity level		
Cost element			Leverage ratio	Standard price in €/production hour	Standard costs in €/month		
No.	Description				Total costs	Variable costs	Fixed costs
1	Personnel costs	Manufacturing wages	1	20.9	35,112	35,112	
2		Indirect labour costs	0.1	2.08	3,150	3,500	350
3		Salaries	0	4.17	7,000		7,000
4		Social costs for wage earners (95%)	0.85	19.86	33,356	28,353	5,003
5		Social costs for salary earners (95%)	0	3.96	6,650		6,650
6	Direct manufac-turing overheads	Auxiliary and opera-ting material	0.75	5.06	8,500	6,375	2,125
7		Electricity	0.9	0.79	7,560	6,804	756
8		Tooling	0.8	7.50	12,600	10,080	2,520
9		Maintenance costs	0.2	4.76	8,000	1,600	6,400
10		Occupancy costs	0	10.42	17,500		17,500
11	Imputed costs	Imputed depreciati-on	0.33	11.9	20,000	6,600	13,400
12		Imputed interest (fixed assets)	0	5.95	10,000		10,000
13		Imputed interest (current assets)	0.75	0.50	833	625	208
Basic standard costs in €/h					170,611	98,699	71,912
Standard cost rate in €/h					102	59	43

The figures have been rounded for clarity.

In the following, there is a target/actual comparison with previous data to determine the actual deviations.

Actual/target comparison Cost centre 9708 Sheet metal processing 12 workplaces		Standard reference value: 1680 production hours Planned activity level: 100% Actual reference level: 1008 production hours Actual activity level: 60%	Actual costs in €/month for the actual reference value of 1008 h/month		
Cost element			Total costs		Variance
No.	Description		Target	Actual	
1	Personnel costs	Manufacturing wages	35,112	21,067	-14,045
2		Indirect labour costs	3,500	3,400	-100
3		Salaries	7,000	7,000	---
4		Social costs for wage earners (95%)	33,356	20,014	-13,342
5		Social costs for salary earners (95%)	6,650	6,650	---
6	Direct manufacturing overheads	Auxiliary and operating material	8,500	5,100	-3,400
7		Electricity	7,560	4,536	-3,024
8		Tooling	12,600	7,560	-5,040
9		Maintenance costs	8,000	8,000	+2,000
10		Occupancy costs	17,500	17,500	---
11	Imputed costs	Imputed depreciation	20,000	20,000	---
12		Imputed interest (fixed assets)	10,000	10,000	---
13		Imputed interest (current assets)	833	833	---
Total			170,611	133,660	-36,951
€/h			102	133	31

Comparing the hourly rates of the target € 102 to the actual costs of € 133, it is not hard to see that the hourly rate calculated is too low.

1.6.4 Flexible standard costing on a partial cost basis: Direct costing

The disadvantage of flexible standard costing on a full cost basis is that the fixed costs are calculated to be proportional to changes in the level of activity.

In partial cost accounting, only variable costs are assigned and the fixed costs are disregarded when comparing the target and actual figures. Partial costs accounting contains cost element, costs centre and costs unit accounting.

The following are determined for the target/actual comparison:

The standard costs for each cost element for each cost centre as well as the share of fixed and variable costs in the planned costs.

There is a variance of 0 in the level of activity, since the target costs and calculated costs are the same.

Leaving out variation in activity levels means that partial cost accounting is much clearer for the controller of the cost centre and so easier to manage.

1.7 Methods of function-field related cost determination

In cost accounting, all costs from all cost elements for a specific period are assigned in the cost element plan, using the documents available and according to the company's cost element structure. Then the amounts are determined for each cost element.

Which cost elements are used depends on the size and type of the company and the aim of the cost accounting. Sorting patters are used like the accounting systems, the Joint Standard Accounting System (GKR) or the Industry Standard Accounting System (IKR). Tailoring the organization of the internal records to that of the company is helpful for determining the costs.

Cost element accounting is also the basis for analyzing the costing structure in which the build up of costs and their development over time is displayed using time and cost centre comparisons. Data is made available from the cost element accounting for the cost centre accounting, cost unit accounting and quotation costing, and later for the profit and loss account. The unambiguous determination and professional organization of costs serves many purposes.

Below we show how consumption is represented in function-field related cost determination:

Material costs

Material costs arise due to the consumption of raw materials, equipment, retail products, components and third-party services, such as surface treatment carried out in a different company.

Three methods are used to determine the consumption rates:

1. **Continuous inventory**
In this process the consumption rates are determined by keeping track of goods coming in and out. This is done by warehouse bookkeeping using material withdrawal slips.

2. **The inventory method:**
Delivery notes show what goods have come in, withdrawals are not noted. At the end of the period, an inventory is carried out to determine the goods held and the difference determined.

3. **Retroactive accounting:**
In retroactive accounting, the planned usage quantities per piece are determined from documents, such as bills of materials or formulations, and set against the number of pieces created and in progress. The documents must take account of all the individual parts and assemblies as well as planned waste (offcuts, rejects, scraps). There are disadvantages in retroactive accounting such as inaccuracies in the consumption rates; assignment of overheads; differences in amounts of material due to shrinkage, spoilage, etc.. Thus it can only be used for simple situations and products created from only a few parts.

When assessing the amounts of materials with prices, time plays an important role because one can value the goods either at the purchase price or the cost of replacement.

The purchase price or cost price is the price paid to the supplier taking into account any rebates, discounts etc. and extra costs such as delivery, packing, transport insurance.

When the materials are procured only once within the accounting period, the effective purchase price is determined upon the goods coming in and assigned on the use of the goods.

The cost of replacement (replacement value) is used for goods which are stored over long periods, e.g. wood, or by deliveries or large amounts e.g. coal, crude oil.

The daily-value is the value of the goods on the day they come into the warehouse.

The adjusted price is designed to exclude external influences such as price fluctuations. It is the average value over a long period of time. The adjusted price is used, for example, in just in time procurement.

Personnel costs

Labour costs arise due to the use of staff and are divided into wages (manufacturing wages and overheads wages), salaries, social costs and other personnel costs. The data necessary (such as gross earnings, employer contributions to social security etc.) are taken from the wage and salary accounting. Time tickets, time records, payrolls for the particular workplaces/cost centres contain the information needed to determine this gross charge.
The production scheduling documents such as work schedules and time tickets contain all the important information such as job number, identification number, drawing number, batch size, work sequence, type of pay, pay group, time per piece, setting-up time, cost centre/workstation time needed, date, cost centre executing the work, name and personnel number.

Pay

Pay is divided into direct labour costs directly assigned to the cost units and indirect labour costs, which are assigned as overheads. Bonuses are counted alongside the wages. Wages are divided into:

1. Time wage
The wage level is independent of the performance provided, i.e. it is remuneration based on a specific unit of time (hour, day, week, month) independent of the production. It is determined by the formula:

time wage = wage per time unit • number of time units

Example: In a working week of 35 hours an hourly rate of € 20.76/hour

Time wage = 35 hours • € 20.76/hour = € 726.60

Time wages are used for work requiring high quality, transport work, repair work, monitoring and work with a high risk of accidents.

2. Piecework

This form of remuneration is performance related and based closely on requirements. The employee can affect his or her individual earnings with his or her performance. This type of wage depends upon setting default performance units based on normal human performance. Piecework may be based on individuals or groups. This means that either the performance of an individual or that of a group is used as the basis for payment. There are two types of piecework: money or time.

a) Money piecework:

The fee is determined by a specific amount of money assigned to a performance unit and the number of performance units completed.
Example: If the piecework is paid at € 1.05/piece and 22 pieces are completed per hour, then the pay is computed thus:

Pay for piecework = pay per piece • number of pieces in an hour

Pay for piecework = € 1.05/piece • 22 pieces = € 23.10

The values of money piecework vary with tariff changes.

b) Time piecework:

In time piecework, there is a time allowance set for a performance unit. In many cases, this allowance is determined by the REFA (Organization for work design, industrial organization and company development) procedure. The employee is paid for the time allowed for the production units completed, regardless of the time actually needed. At the end of a billing period, the pay is calculated in the following way:

Pay for piecework = pay per piece • number of pieces • minutes factor

$$\text{Minutes factor} = \frac{Basic\ pay\ according\ to\ tarrifs + piecework\ bonus}{60}$$

$$= \frac{Basic\ pay}{60}$$

For example: The basic wage is € 15, the piecework supplement is 25%, the time allowed per piece is 16 minutes. The gross wage for 6 pieces per hour is:

$$\text{Minutes factor} = \frac{15\ € + 15\ € \cdot 0{,}25}{60} = 0{,}31\ €/\text{min}$$

Time piecework = 16 min/piece • 6 pieces • 0,31 €/min = 29,76 €

3. Bonus pay

There is a performance-independent salary and a performance-based bonus. This can be a bonus for amount, quality, economy, deadlines etc. The performance can be measured here individually or in groups just as for piecework.

4. Salaries

They are determined using the payroll. In terms of cost elements, they are charged as overheads to the cost centres. As far as holiday and pay on public holidays is concerned, they are charged a monthly at a pro-rata rate (1/12) of the planned annual totals.

Social costs such as additional labour costs, wage and payroll costs, i.e. services required by law or tariffs or voluntarily donated (the employer's primary and secondary social costs) are charged as overheads to the cost centres.

Money received by entrepreneurs in sole traders or partnerships is dealt with as the salaries of management undertaking similar activities in capital companies.

Resource costs occur due to land, buildings, machines, tools, vehicles and other means of transport, furniture and the maintenance of these things. Intangible items such as patents licenses etc. may also arise here.

Depreciation costs are calculated according to the tax depreciation tables based on a fixed depreciation period. They determine the loss in value of the equipment caused by its use or wear and tear over time. The depreciation of total non-current assets is included in the balance sheet. Different methods of calculating depreciation are used: the straight line method (depreciation is the same each year, based on the purchase price giving linear depreciation), the declining-balance method (depreciation is a fixed percentage – max. 30% - of the residual value each year, the residual value being reduced by this amount for next year – this gives a geometric depreciation) or the units-of-production method (depreciation is calculated as the purchase price divided by the estimated number of units to be produced in the equipment's lifespan times the actual number produced in the year). Maintenance can help prolong the useful life of equipment. The depreciation calculated is determined by the purchase price of the asset, the residual value at the end of its useful life and the depreciation method used.

The total depreciation should allow the possibility of replacing the resource at the end of its useful life. As prices change during the lifespan of the resource, depreciation in cost-accounting is on the basis of the estimated cost of replacement.

Example
Some equipment costs 35,000 MU (monetary units). Its usual operational life is 6 years. It is estimated that at the end of its useful life it can be sold for 5,000 MU.

Here we will put the calculations from the straight-line method and the declining-balance methods next to each other:

Linear depreciation $= \frac{purchase\ price - end\ price}{usage\ period}$

Linear depreciation $= \frac{35{,}000 - 5{,}000}{6} = 5000$

Geometric depreciation$= 100 \bullet \left(1 - \sqrt[n]{\frac{end\ value}{purchase\ price}}\right)$

Geometric depreciation$= 100 \bullet \left(1 - \sqrt[6]{\frac{5{,}000}{35{,}000}}\right) = 27.7\ \%$

Comparison of annual depreciation via these two methods:

	Straight-line depreciation	Declining-balance depreciation		
Year	Depreciation (MU)	Residual value (MU)	Depreciation (MU)	Residual value (MU)
0	---	35,000.00	---	35,000.00
1	5,000.00	30,000.00	9,695.00	25,305.00
2	5,000.00	25,000.00	7,0049.49	18,295.51
3	5,000.00	20,000.00	5,067.86	13,227.65
4	5,000.00	15,000.00	3,664.06	9,563.59
5	5,000.00	10,000.00	2,649.11	6,914.48
6	5,000.00	5,000.00	1,915.31	4,999.17
Total (MU)	30,000.00		30,000.83	

Below, the depreciation in performance should distribute the costs correctly according to their cause.

The same equipment as above is considered. It is used in with two shifts, and estimated to run for 18240 hours. The hours of operation for each year are:

2940 hours, 3100 hours, 3100 hours, 3000 hours, 3100 hours and 3000 hours.

From this, the following depreciation and residual values are calculated:

Year	Depreciation (MU)	Residual value (MU)
0	---	35,000.00
1	4,835.53	30,164.47
2	5,098.68	25,065.79
3	5,098.68	19,967.11
4	4,934.21	15,032.90
5	5,098.68	9,934.22
6	4,934.21	5,000.01
Total (MU)	29,999.99	

Maintenance costs

Companies need their resources to be available continuously and trouble-free as much as possible. Preventative maintenance is done to ensure this, on top of general care and maintenance. A precise definition of the costs can be determined for some processes here by identifying the expenses. It is more difficult to determine the costs of any repairs to equipment that are necessary. One possibility is to calculate the annual maintenance costs by multiplying the replacement value by a maintenance factor. The maintenance factor depends on the machine and is taken from branch-specific catalogues.

Annual maintenance costs = replacement value • maintenance factor

If there are documents such as orders, time tickets, and material requisition cards, then the maintenance costs can be structured according to the materials used, services obtained from other companies or internally.

The actual costs incurred are determined via documents such as material requisition cards, time tickets and invoices so that they can be assigned to the correct order/machine or cost centre.

Tooling costs

Cost-intensive devices and tools with a long service life are treated in the same way as machines and equipment as far as cost determination, depreciation and maintenance costs are concerned.

Energy costs

Energy costs include all types of energy going into machines. The costs are relatively easy to identify by measurements. However, it is not enough to simply read off the kW numbers from the type plate, as this is the maximum use and the actual energy used is normally much lower. Tests have shown that the average power use of main engines is approximately 60% of the maximum. Energy costs are calculated as the connected load times a usage factor (not to be confused with the factor used to determine the production capacity) times the cost of a kWh. This calculation is only for electrical energy, other types of energy are calculated according to the data to hand.

Example

The installed capacity of the equipment =
16.5 kW, use factor = 0.8, price 0.18 MU/kWh

Energy = power • use factor • price/kWh

Energy costs 16.5 • 0.8 • 0.18 = 2.38 MU/h

or

Energy costs = energy use • price per kWh

Energy costs 13.2 • 0.18 = 2.38 MU/h

Occupancy costs

Occupancy costs are determined from two values: Firstly, the area needed for the equipment including any additional area, area for users, preparation areas, repair areas etc.; and secondly the normal local rent per square meter or the values paid in the past.

Occupancy costs (MU) = space requirements (m2) • imputed rent (ME/m2)

If depreciation, imputed interest, buildings insurance, property taxes and upkeep costs are already associated with the space, then no occupancy costs are determined.

Imputed interest

The imputed interest for resources (depreciable fixed assets) is determined according to the method of average interest. The basis for the imputed interest is, therefore, half the purchase price and the current interest rate for long-term investments.

Imputed interest = $\frac{purchase\ price \cdot interest}{2\ x\ 100}$

Cost of services

Services provided by other companies are registered by invoices and are generally charged as overhead costs to cost centres. Special direct costs are exceptions which can be directly attributed to a cost element.

Tax costs

Tax costs, such as property taxes, vehicle taxes, industrial or commercial profits tax, are determined by financial accounting and charged as overheads to the cost centres (except excise duty).

Imputed risks

We differentiate general business risks arising due to the choice of location, the branches, the market position etc.. It cannot be calculated and is picked up in the profit. Individual risks depend on specific operations for example fire, burglary, default on debt, a decline in prices, machine failure, rejects etc.. They arise irregularly and in differing amounts. If they were charged at the time of the costs, then the products would sometimes have very high and sometimes very low risk losses. Instead, an average value is used as an imputed risk which is meant to cover the risks incurred in the long term. If the risks are covered by insurance, then this calculation is no longer necessary. The insurance premiums are then the costs and can be associated to the cost centres or cost elements.

Decisions can only be made on the basis of carefully determined and collected data resulting from the interplay of the wages, salaries, equipment and materials costing together with accounting by cost elements, costs centres and cost units.

1.8 Assigning cost elements to cost centres in the expense distribution sheet

1.8.1 The development of business accounting

The expense distribution sheet considers the costs which are not directly attributable, the overheads. It is designed to collect them, to assign them to the cost centres, and to determine the supplements for overheads for individual production or batch production.

Expense distribution sheets were developed at the end of the twenties. However, at this time little attention was paid to issues like cost control, supporting management decisions and the design of production programs. Expense distribution sheet have been continually refined and expanded ever since. In many businesses, especially small and medium-sized businesses, the structure and the functions of expense distribution sheets are still unknown, but this knowledge is essential for making decisions to achieve optimal business results.

1.8.2 The task of cost centre accounting

While cost element accounting considers which costs are incurred, cost centre accounting clarifies where the costs are incurred.

Cost centre accounting determines which cost elements arise, to what level and in which centres.

1.8.3 The purpose of cost centre accounting

The purpose of cost centre accounting is to facilitate monitoring via

- permanently monitoring the costs of each cost centre;
- creating areas of responsibility, strengthening the sense of responsibility and thus increasing the motivation to perform within the cost centres;
- creating documentation of the calculations.

The production costs are divided according to the cost elements and assigned to the cost centres. This allows the calculation of rates at which to bill the overheads to the cost objects.

1.8.4 The principles of cost centre structuring

General principles

The following principles have been developed for dividing a company into cost centres:

- The cost centre must be an independent area of responsibility, so that cost control can be effective. It should also be, where possible, a single special unit, to avoid overlapping.
- The causes of costs need to be measurable as accurately as possible for each cost centre; otherwise there is a risk of faulty cost control.
- The documents detailing the costs must be registered exactly and at the same time for each cost centre.

These three principles can contradict each other: the finer the structure, the easier it is to measure the causes of costs exactly and find reference values; on the other hand, there is a greater risk of faulty cost control and calculations. The division into areas of responsibility and special units is not enough so that internal charging takes a great deal of effort.

The second principle in practice is usually means that:

- A deep structure is usually chosen for production. This structure is often as fine as individual machines or work stations (work centre costing). The division of the company into cost centres goes much further than just considering location and responsibility.
- In administration and sales, however, a much rougher classification is used, since in these areas it is very difficult to find reference values for causes.

Breakdown according to invoicing criteria

The following types of cost centres are distinguished, according to the type of invoicing:

- Main cost centres are those cost centres whose costs are not assigned to other cost centres but rather directly to cost units.
- Support cost centres are those cost centres whose costs are not directly related to cost units, but rather to other support or main cost centres.

Companies and establishments which produce consumables, durables or goods for manufacturing, are structured with reference to the main functions into the following cost areas:

1. General area
(Services for the whole operation)
- Real estate and facility management
- Porters
- Security
- Fire service
- Energy facilities
- Social facilities
- Canteen
- Medicine
- Library
- Works council, etc.

2. Production area
(Serves the purposes of the company directly)
- Turning shop
- Milling shop
- Metalworking shop
- Forge
- Foundry
- Plating shop
- Pain shop
- Hardening shop
- Assembly, etc.

3. Production support area
(Provides support services for the production centres)
- Technical management
- Works scheduling
- Machine repair, maintenance
- Equipment design
- Equipment manufacturing, etc.

4. Materials area
(Procures and manages materials for manufacturing and aiding production)
- Purchasing
- Incoming goods
- Inspection of goods
- Storage
- Maintenance and issue of materials, etc.

5. Development and construction sector
- Construction
- Research
- Development, etc.

6. Administration

- Management
- General administration
- Organization
- Legal department
- Human resources
- Accounting
- Payroll, etc.

7. Sales area

- Sales
- Advertising
- Sales warehouse
- Shipping
- Branches and offices, etc.

1.8.5 The importance of expense distribution sheets

The expense distribution sheet is a tool to help businesses carry out combined accounting with cost elements and cost centres. Its main purpose is to collect the data on all cost elements incurred in the company and assign it to the cost centres that caused it.

Expense distribution sheets are used for calculating business figures and for the preparation of statistics to allow the continuous monitoring of individual cost centres and operating areas. In addition, expense distribution sheets are used to calculate overhead rates, to be found in the preliminary and final costing. It is a table; the rows list the cost elements and the columns list the cost centres.

Including recent findings and trends, the tasks of expense distribution sheets can be summarized as:

- Expense distribution sheets give an overview of the cost structure and development of costs within individual cost centres and within the whole company.
- Expense distribution sheets contains the statistics on cost elements, cost centres and cost units enabling comparisons within the company and of times.
- Expense distribution sheets are an important tool for improving efficiency.
- All overheads should be associated with the individual products as accurately as possible in order to identify the correct overhead rates and create the correct documentation for pricing and inventory valuation.
- Expense distribution sheets facilitate the assignments from support cost centres to main cost centres.
- Expense distribution sheets are also essential tools for cost planning and the expansion of conventional cost accounting to standard costing. Thus the target costs can be measured and the behaviour of the individual cost elements as the level of activity changes can also be controlled.
- The documents necessary for controlling the company and important parts thereof can be put together and evaluated by using expense distribution sheets.

Thus, expense distribution sheets create the documents for cost planning, operational and economic control, as well as for supporting business decisions.

1.8.6 A critical look at expense distribution sheets

Criticism of expense distribution sheets, as developed and as still used, focuses on:

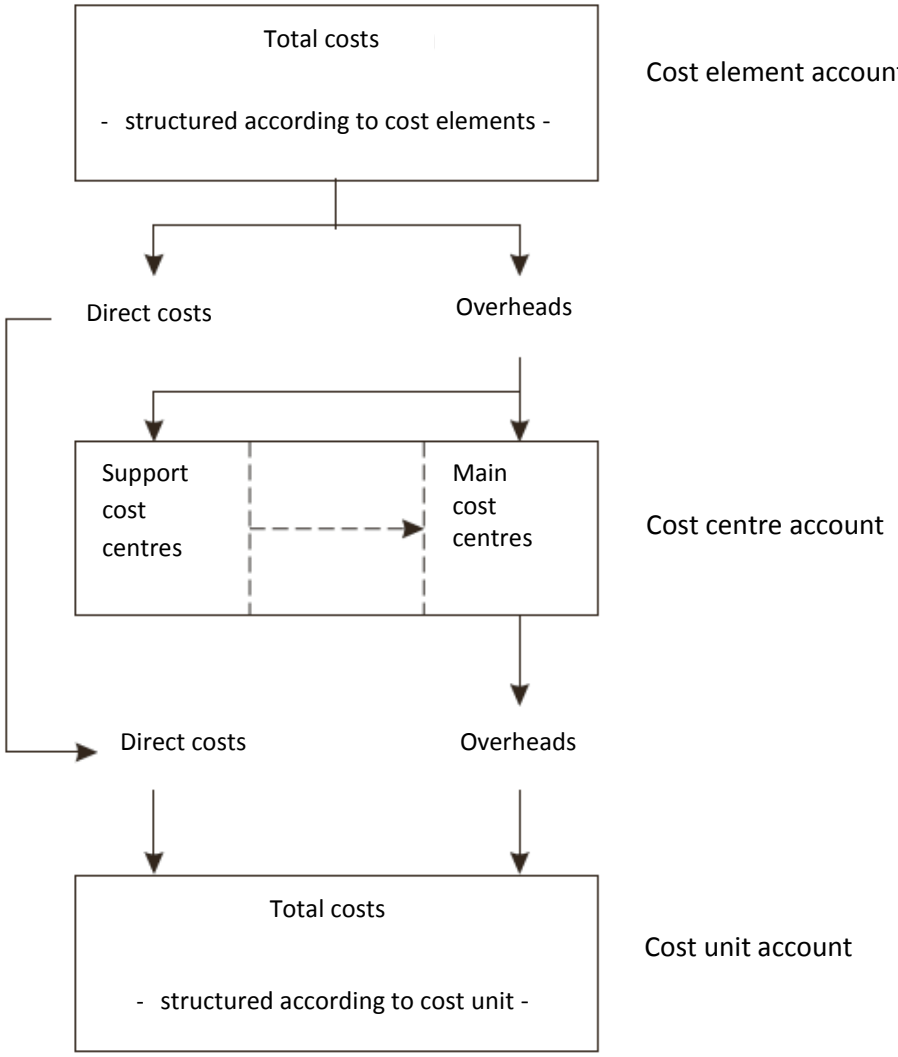
- The assessment of the costs elements, which is mostly based on formulae, whose connection with the organizational business processes needs to be laboriously investigated.
- The division into cost centres is often motivated by purely computational needs and is in no way related to business process.

- The use of direct labour wages to establish overhead surcharges, which are now outdated and should be replaced with manufacturing hours.

1.8.7 Carrying out a master summary by means of expense distribution sheets

Expense distribution sheet only record overheads. This is because the direct costs can be divided correctly to the cost units bypassing the expense distribution sheets. If one sees any parts of direct costs in an expense distribution sheet, this is so that they are available to calculate reference values.

You can see how costs are resolved from cost elements, via cost centres, to cost units in the following Figure.



Cost centre accounting via expense distribution sheets consists of the following steps:

a) Step 1: Determining and distributing costs

The costs within the billing period are recorded according to cost elements and allocated to cost centres using an allocation formula.

b) Step 2: Cost allocation

The costs of the general cost centres are allocated to those following them then the costs of the support cost centres are allocated to the main production centres.

These cost centres are there to provide support and services to the other cost centres and so their costs must be distributed.

c) Step 3: Determine the overhead supplement

The overheads collected at the various main cost centres are correlated with certain reference values, such as the material expenses (materials area), direct labour costs (production area), or the production costs (administration and sales areas). In this way, various surcharge rates are obtained such as the materials surcharge, the manufacturing overhead surcharge, the administrative surcharge and the sales overhead surcharge.

d) Step 4: Identifying further key figures

Key figures can show up changes in how the company is operating. They are useful for internal time comparisons as well as for inter-company comparisons.

Key figures can be:

- Manufacturing hourly rate
- Average wage per hour
- Overhead costs per employee
- Total costs per employee
- Production cost per machine hour
- Total costs per machine hour, etc.

Schematische Darstellung der Vorgehensweise im Betriebsabrechnungsbogen
1. Übernahme der Summe der Kostenarten aus der Geschäftsbuchhaltung oder der Lohnbuchhaltung
2. Umlage der Kostenarten auf die Kostenstellen
3. Umlage der allgemeinen Kostenstellen auf alle nachfolgenden Kostenstellen
4. Umlage der Fertigungshilfskostenstellen auf die Fertigungshauptstellen
5. Berechnung der Gemeinkostenzuschlagsätze

Kostenstellen / Kostenarten	Zahlen der Buchhaltung	Allgemeine Kostenstellen				Fertigungshauptstellen				Fertigungshilfs-stellen			Material-stellen		Verwaltungs-stellen	Vertriebsstellen
z. B. Fertigungshilfslöhne																
	1							**2**								
sonstige Kosten																
Summe Kostenarten																
Umlage der allgemeinen Kostenstellen																
								3								
Summe																
Umlage der Fertigungs-hilfsstellen																
Summe																
Bezugsgrößen für die Ermittlung der Zuschlagsätze						Fertigungslohnkosten							Material-einzelkosten		Herstellkosten	
Zuschlagsätze in %								**5**					**5**		**5**	

Schematic presentation of the procedure for expense distribution sheets

1. Take the sum of the cost elements from the bookkeeping
2. Allocate the cost elements to the cost centres
3. Allocate the general cost centres to the following cost centres
4. Allocate the production support cost centres to the main production cost centres

Calculate the overhead surcharges

Cost centre / Cost element	Values from the books	General cost centres	Main production cost centres	Production support cost centres	Materials cost centres	Administration cost centres	Distribution cost centres
e.g. Indirect labour costs of production							
Other costs							
Total of cost							
Allocation of general cost centres							
Total							
Allocation of support cost centres							
Total							
Reference values for determining surcharges			Manufacturing wages		Direct material costs	Manufacturing costs	
Surcharge in %							

At the end of a billing period, the overheads actually incurred can be compare to those imputed in the overhead costing. If the overheads imputed are higher than those actually incurred, we say the overheads are over-absorbed. The other way around and they are under-absorbed. From this knowledge, the overhead supplement in the next accounting period can be calculated more precisely and the question of rounding the supplements up or down answered more easily.

1.8.8 Creating an expense distribution sheet

The first step in creating an expense distribution sheet is:

Cost centre	Values form the books	General area		Materials area	Manufacturing area					Administration area	Distribution area
Cost elements		1	2		Support centre 1	Support centre 2	Main centre A	Main centre B	Total A + B		
Manufacturing material	20,000			20,000							
Manufacturing wages	12,000						4,000	8,000	12,000		

Recording primary overheads:

> Primary overheads are overheads in the cost centre which are actually incurred as individual cost elements. They are taken from the accounts.

The second step in the expense distribution sheet is then:

Cost centre	Values form the books	General area		Materials area	Manufacturing area					Administration area	Distribution area
Cost elements		1	2		Support centre 1	Support centre 2	Main centre A	Main centre B	Total A + B		
Manufacturing material	20,000			20,000							
Manufacturing wages	12,000						4,000	8,000	12,000		
Axillary and operating material	5,000										
Energy	1,000										
Indirect labour costs	10,000										
Salaries	6,000										
Depreciation	2,400										
Other	4,000										
Total	28,400										

Distribution of primary overheads:

> In the third step of creating an expense distribution sheet, the primary overheads are distributed to all the auxiliary and main cost centres where they are incurred. They are them summed for each cost centre.

A distinction is

- A cost centre's direct costs, which can be exactly determined for individual cost centres because they can be documented, for example, current on the electricity meter or salaries with payrolls; and

- A cost centre's overheads, which cannot be determined exactly for individual cost centres, but must be assigned to each cost centre by means of a particular allocation formula.

An example of the distribution of overhead costs to cost centres: The distribution of the cost element "Energy" is as follows. From the accounts we know that the total figure is 1,000:

Allocation formula: 3: 6: 8: 5: 4: 6: 8: 5: 5

Sum: 3 + 6 + 8 + 5 + 4 + 6 + 8 + 5 + 5 = 50

Unit: 1,000/50 = 20

The costs for each cost centre: 3 • 20 = 60; 6 • 20 = 120; etc.

Thus, there is the following row for "Energy" in the example expense distribution sheet:

Cost centre	Values form the books	General area		Materials area	Manufacturing area					Administration area	Distribution area
Cost elements		1	2		Support centre 1	Support centre 2	Main centre A	Main centre B	Total A + B		
Manufacturing material	20,000			20,000							
Manufacturing wages	12,000						4,000	8,000	12,000		
Axillary and operating material	5,000	100	160	300	600	640	1,020	1,260	2,280	480	440
Energy	1,000	60	120	160	100	80	120	160	280	100	100
Indirect labour costs	10,000	200	300	600	1,100	1,200	1,800	3,400	5,200	600	800
Salaries	6,000	120	140	340	400	560	1,300	1,420	2,720	800	920
Depreciation	2,400	60	80	160	280	320	560	580	1,140	180	180
Other	4,000	120	90	230	400	320	780	780	1,350	600	890
Total	28,400	660	890	1,790	2,880	3,120	5,580	7,390	12,870	2,760	3,330

The distribution of secondary overheads

The costs in the expense distribution sheet go into the cost unit accounts but only allocate costs to the main cost centres. Thus, the

- General cost centres and
- Support cost centres

must be dealt with by charging their costs to the main cost centres. This process is called the distribution of secondary overheads.

The distribution of secondary overheads is done with what is known as the staircase procedure. This makes it possible to redistribute the internal services as secondary overheads step by step to the receiving main cost centre. This redistribution is only possible in one direction.

The distribution of secondary overhead costs using the staircase procedure is carried out using an allocation formula analogously to the distribution of the primary overheads.

The following allocation formula is valid for our example expense distribution sheet:

General cost centre 1: 1: 2: 2: 1: 1: 1: 2: 1

General cost centre 2: 1: 0: 0: 1: 1: 1: 1: 1

Support cost centre 1: 1: 2

Support cost centre 2: 1: 1

This gives us the following numbers for our example:

Cost centre	Values form the books	General area		Materials area	Manufacturing area					Administration area	Distribution area
Cost elements		1	2		Support centre 1	Support centre 2	Main centre A	Main centre B	Total A + B		
Manufacturing material	20,000			20,000							
Manufacturing wages	12,000						4,000	8,000	12,000		
Axillary and operating material	5,000	100	160	300	600	640	1,020	1,260	2,280	480	440
Energy	1,000	60	120	160	100	80	120	160	280	100	100
Indirect labour costs	10,000	200	300	600	1,100	1,200	1,800	3,400	5,200	600	800
Salaries	6,000	120	140	340	400	560	1,300	1,420	2,720	800	920
Depreciation	2,400	60	80	160	280	320	560	580	1,140	180	180
Other	4,000	120	90	230	400	320	780	780	1,350	600	890
Total	28,400	660	890	1,790	2,880	3,120	5,580	7,390	12,870	2,760	3,330
Allocation of general area 1				66	132	132	66	66	132	132	66
Allocation of general area 2				178	0	0	178	178	356	178	178
Total				2,034	3,012	3,252	5,824	7,634	13,458	3,070	3,574
Allocation of support area 1							1,004	2,008	3,012		
Allocation of support area 2							1,626	1,626	3,252		
Total				2,034			8,454	11,268	19,722	3,070	3,574

Creating the overhead surcharges:

The actual overhead surcharges are determined by dividing the overheads of the individual main cost centres by the direct costs of the main cost centres.

The following formulas are for the actual overhead surcharges:

Actual material overhead surcharge = $\frac{Materials\ overheads \cdot 100}{Direct\ material\ costs}$

Actual manufacturing overhead surcharge = $\frac{Manufacturing\ overheads \cdot 100}{Direct\ manufacturing\ wages}$

Actual administration overhead surcharge = $\frac{Administration\ overheads \cdot 100}{Cost\ of\ production}$

Actual distribution overhead surcharge = $\frac{Distribution\ overheads \bullet 100}{Cost\ of\ production}$

Thus the production costs of the turnover are:

	Production materials costs
+	Material overheads
+	Manufacturing wages
+	Manufacturing overheads
=	**Cost of production**
+	Reduced inventory
-	Increased inventory
=	**Cost of the turnover**

This gives us the following actual overheads for our example:

2,034 • $\frac{100}{20{,}000}$ = 10.17 %

8,454 • $\frac{100}{4{,}000}$ = 211.35 %

11,268 • $\frac{100}{8{,}000}$ = 140.85 %

3,070 • $\frac{100}{20{,}000+2{,}034+12{,}000+19{,}722}$ = 5.71 %

3,574 • $\frac{100}{20{,}000+2{,}034+12{,}000+19{,}722}$ = 6.65 %

Cost centre	Values form the books	General area		Materials area	Manufacturing area					Administration area	Distribution area
Cost elements		1	2		Support centre 1	Support centre 2	Main centre A	Main centre B	Total A + B		
Normal surcharge in %				9.70			210.10	143.20		4.70	6.65

Determining the normal overhead surcharges:

In order that our cost accounting can fulfill the correct monitoring function, we need to look at the past values. These give us the normal overhead surcharges.

For our example, we get the following row:

Cost centre	Values form the books	General area		Materials area	Manufacturing area					Administration area	Distribution area
Cost elements		1	2		Support centre 1	Support centre 2	Main centre A	Main centre B	Total A + B		
Manufacturing material	20,000			20,000							
Manufacturing wages	12,000						4,000	8,000	12,000		
Axillary and operating material	5,000	100	160	300	600	640	1,020	1,260	2,280	480	440
Energy	1,000	60	120	160	100	80	120	160	280	100	100
Indirect labour costs	10,000	200	300	600	1,100	1,200	1,800	3,400	5,200	600	800
Salaries	6,000	120	140	340	400	560	1,300	1,420	2,720	800	920
Depreciation	2,400	60	80	160	280	320	560	580	1,140	180	180
Other	4,000	120	90	230	400	320	780	780	1,350	600	890
Total	28,400	660	890	1,790	2,880	3,120	5,580	7,390	12,870	2,760	3,330
Allocation of general area 1				66	132	132	66	66	132	132	66
Allocation of general area 2				178	0	0	178	178	356	178	178
Total				2,034	3,012	3,252	5,824	7,634	13,458	3,070	3,574
Allocation of support area 1							1,004	2,008	3,012		
Allocation of support area 2							1,626	1,626	3,252		
Total				2,034			8,454	11,268	19,722	3,070	3,574
Actual surch-arge in %				10.17			211.35	140.85	164.35	5.71	6.65
Normal surch-arge in %				9.70			210.10	143.20		4.70	6.65

Determining the normal overheads

To compare past values with the actual current costs, it is necessary to determine the deviation in monetary units. This means that the normal overheads must be determined on the basis of the actual direct costs.

For this purpose, the following formulas are valid:

Normal material overheads = actual production material • normal surcharge

Normal manufacturing overheads = actual production wages • normal surcharge

Normal administrative expenses = normal production costs • normal surcharge

Normal sales overhead = normal production costs • normal surcharge

The normal production costs are calculated as follows:

	Actual materials costs
+	Normal materials overheads
+	Actual manufacturing wages
+	Normal production overheads
=	**Normal cost of production**
+	Reduced inventory
-	Increased inventory
=	**Normal cost of turnover**

For our example, this is:

Cost centre / Cost elements	Values form the books	General area 1	General area 2	Materials area	Manufacturing area: Support centre 1	Manufacturing area: Support centre 2	Manufacturing area: Main centre A	Manufacturing area: Main centre B	Manufacturing area: Total A + B	Administration area	Distribution area
Normal overheads				1,940			8,404	11,456	19,860	2,527	3,575

Comparing actual and normal overheads

By comparing the actual and normal overheads, we can see if too many costs have been incurred, i.e. if there is a shortfall, or whether they are over-absorbed.

This completes the creation of the expense distribution sheet.

Note: Surplus / deficit = normal overheads – actual overheads

Thus in our example, the final expense distribution sheet has the following appearance:

Cost centre / Cost elements	Values form the books	General area 1	General area 2	Materials area	Manufacturing area: Support centre 1	Manufacturing area: Support centre 2	Manufacturing area: Main centre A	Manufacturing area: Main centre B	Manufacturing area: Total A + B	Administration area	Distribution area
Manufacturing material	20,000			20,000							
Manufacturing wages	12,000						4,000	8,000	12,000		
Axillary and operating material	5,000	100	160	300	600	640	1,020	1,260	2,280	480	440
Energy	1,000	60	120	160	100	80	120	160	280	100	100
Indirect labour costs	10,000	200	300	600	1,100	1,200	1,800	3,400	5,200	600	800
Salaries	6,000	120	140	340	400	560	1,300	1,420	2,720	800	920
Depreciation	2,400	60	80	160	280	320	560	580	1,140	180	180
Other	4,000	120	90	230	400	320	780	780	1,350	600	890
Total	28,400	660	890	1,790	2,880	3,120	5,580	7,390	12,870	2,760	3,330
Allocation of general area 1				66	132	132	66	66	132	132	66
Allocation of general area 2				178	0	0	178	178	356	178	178
Total				2,034	3,012	3,252	5,824	7,634	13,458	3,070	3,574
Allocation of support area 1							1,004	2,008	3,012		
Allocation of support area 2							1,626	1,626	3,252		
Total				2,034			8,454	11,268	19,722	3,070	3,574
Actual surch-arge in %				10.17			211.35	140.85	164.35	5.71	6.65
Normal surch-arge in %				9.70			210.10	143.20		4.70	6.65
Normal over-heads				1,940			8,404	11,456	19,860	2,527	3,575
Over / under absorption				-94			-54	188	138	-543	1

A selection of some of the basics for recording and distributing of some cost elements and the allocation formulae:

Cost element	Basis for distribution	Apportionment
Salaries	Payroll, employees per cost centre	Direct
Other labour costs	Contracts, employees per cost centre	Direct
Material overheads	Delivery notices	Direct
Energy (electricity etc.)	Consumer measurements	Direct
Depreciation	Account forms, replacement values	Direct
Imputed interest	Capital necessary for operation	Direct
Rent	Space used in m^2	Direct
Social costs (optional)	Wages, salaries (payroll)	Direct
Heating	Room size in m^3	Indirect
Electrical energy	Connected load	Direct
Property insurance	Value of equipment	Indirect
Tax	Capital	Indirect

The direct costs which are associated directly with cost units are taken as reference values for calculating the overheads and overhead supplements in the expense distribution sheet. The direct materials costs are allocated to the materials area and the manufacturing labour costs to the main cost centres of the production area.

1.9 Monitoring of function-field related costs

There are many tasks in cost accounting:

- Creating documents for decision making
- Developing cost and performance targets
- Determining the current costs and performance data
- Performing profitability analyses

This generates up-to-date and meaningful data for cost element accounting. Some important requirements for the data are that it is complete, accurate, up-to-date and collected according to the objectives. Making the costs transparent by differentiating with respect to cost elements is important, as is assigning the value of goods and services according to their cause.

The following costs are among the most important production data:

- **Personnel costs:** the relevant cost centre, attendance time, hourly pay, number of hours worked, order number (cost unit)
- **Materials:** type, amount, price
- **Equipment costs:** Machine no.; performance data such as energy consumption; depreciation costs, interest costs and space costs; maintenance costs and machine-bound equipping costs for tools and devices.

Other structures can be found in the section "Methods of function-field related costs".

Profitability projections allow the comparison of costs within the period. The costs are determined relating to a period, an order and a source. The value of the comparison of the actual and nominal situations depends on how up-to-date and accurate they are.

The comparison of the actual and nominal situations is a way to evaluate the profitability and thus serves to monitor the function-field related costs by comparing the cost elements. These comparisons are performed as:

- Time comparisons, i.e., the costs from comparable periods in the past are compared with each other,
- Operating comparisons, here, the cost of comparable companies are compared,.
- Comparison of the actual and nominal situations, the standard costs for a period and the actual costs of the same period are compared and thus the economic efficiency is calculated as the ratio of the actual and target costs. It must be less than or equal to 1 for economic production.

Target costs
Preference is give to actual/target comparisons over time comparisons. When the target costs are exceeded, i.e. production is uneconomic, the reasons are uncovered by analysis and then measures are planned to eliminate them. Root cause analysis proceeds in the following steps:

- Identification of the amount and frequency of the cost overruns.
- Investigation of the causes by collaboration between design, planning and quality management.
- Action planning with the establishment of deadlines and responsibilities, to stop similar problems occurring in the future.
- Monitoring the measures implemented

Reference method
The reference method is used to investigate variances in costs. Detailed descriptions of the working conditions planned (staffing, processes, resources, etc.) are compared with the variations, documented with descriptions, to uncover possible causes.

1.10 Monitoring and keeping within the allocated budget

Requirements arising from strategic planning must be implemented in day to day activity. The person responsible for costs thus receives differentiated planning data for their area. This contains objectives and background data. In this way, the person responsible receives a budget within which he or she has full access to the resources. The total company budget is divided into partial budgets and allocated to the relevant areas, such as the sales, purchase or production budget. To monitor the data of and compliance with the budget, certain principles must be taken into account right from the start, when it is established:

- The budget must represent a challenge that is also possible because employees are not motivated by demands that are too high or too low.
- By accurately allocating cost centres to the individual operational areas, there will only be one budget and no extra "shadow budget". This is necessary because otherwise neither will be taken seriously.
- The achievement of the budget target has to have priority and not getting below target costs. Otherwise the budget has not been prepared properly.
- Those responsible should be involved with drawing up the budget so that they can identify with it. -Budget planning is done from bottom to top (bottom up), because the lower target is included in the targets above them.

In the following are some points from different budgets to be monitored:

- **Cost monitoring:** monitoring of the materials, supplier evaluations to determine the optimal suppliers, i.e. offer testing, e.g. do the offer and request match, is the offer complete and unambiguous? Or a material check for the price, payment terms, quality or delivery time. This usually accompanies the comparison of offers, and the supplier analysis and assessments.

- **Changes in the production process:** Materials costs can influence readiness to deliver or lead to changes in the production process. Similarly, the decision to produce ones self or buy in, volume changes, changes in the delivery dates, or a different level of vertical integration can to lead to changes in costs.

- **Design changes:** The design of products (such as shape), the solution principle (such as mechanical, electrical, pneumatic), the material (such as metal, plastic, natural materials), the size (e.g. material, supercritical load acceptance) and tolerances (such as tolerances with respect to function) can be realized with very different types of processing and very different costs, and are thus decisive for the level of the materials costs.

- **Control of productivity:** productivity is an index of a process, of equipment, or a material describing its production properties; or work productivity – the relationship between production and hours worked; or machine productivity – the relationship between production and machine hours.

- **Level of activity:** The people and the equipment, as system elements, together with the organization determine the capacity of the working system. There is a difference between quantitative capacity and qualitative capacity. The possible performance of people and of equipment or an establishment generates the qualitative capacity. The number of people and resources generate the quantitative capacity according to the time or deadline and the duration of their use. Level of activity is particularly important. This is supposed to permanently bridge the gap between the actual capacity and that needed.

- Level of activity is measured with the on-going comparison between existing capacity and required capacity so the question is of surplus or deficit. The solutions for shortage (available < needed) include: shift work, overtime, temporary workers. The solutions to surplus (available > needed) include: commissioning orders, extension of the production program.

2. INFLUENCING COSTS, TAKING INTO PARTICULAR CONSIDERATION ALTERNATIVE MANUFACTURING CONCEPTS AND NEED BASED STOCK MANAGEMENT

2.1 Methods of cost control

2.1.1 Optimising the workplace

The basis for an optimum workplace design is knowledge of the work system with its seven system elements:

- Task
- Input
- Capacity for personnel
- Capacity for resources
- Workflow
- Output and
- Environmental impact

The backbone is formed from an optimal combination of human and other resources, equipment and information. The goal is to achieve the task, taking into account the basic requirements for humanization and efficiency. Neither of these is possible without the other. Optimization makes the work better for the workers, i.e. it reduces the strain on them, boosts safety, and improves the efficiency of the operation, i.e. high performance with good quality and low costs (minimization principle).

To create a targeted and methodological approach, the REFA methodology is used. REFA is the Organization for Work Design, Industrial Organization and Company Development. This methodology was previously known as the 6-step method.

Tools and machines
Places of work should be designed and optimized according to ergonomic findings:

- Anthropometric examination of the workplace
  Anthropometry is the study of the determination and application of human body measurements. A systematic approach is required. This can be achieved via asking specific questions during the individual design steps.

  1. Clarify the task: what activities are performed in the workplace, and in which ways? Where possible, adapt the work to the people.
  2. Determine the user group: which employees, women or men, will be used to complete the task? Set up the work place so that 90% of the employees to be used can work there.
  3. Determine the working posture: in which posture is the work done? Sitting, standing or kneeling? Is it possible to change this?
  4. Determine the working height: is the working height individually adjustable for different employees?
  5. Determine the line of sight, distance to object and angle of the head: is it possible to have a right angle between the line of sight and the object?

6. Determine the position of the arm: is it possible to have a right angle between the upper and lower arm, or can armrests or surfaces to rest the arms on be used?
7. Determine the internal and external dimensions: are the dimensions set up for the personnel? Internal dimensions must be checked against the largest people (such as ensuring there is enough room the legs) and external measurements (such as how far one has to reach) to the smallest people.

- Workplace environment
  The following three areas are important here:
  - Numeric variables (according to DIN 33403): air temperature, relative humidity, air velocity and thermal radiation
  - Working conditions: How hard the work is physically, working clothes
  - Individual characteristics: gender, age, acclimatisation and constitution

It must be ensured that the task does not lead to the detriment or harm of the worker's health in the environment designed.

- Noise at work
  If there are sound waves in the company which, due to their amplitude, pitch or length, can stress the human body or endanger or even damage it, we call this noise. The effects of noise on human beings can be mechanical damage (tympanic membrane), hearing loss (noise induced hearing loss), physiological damage (high blood pressure, cardiovascular stress) and psychological damage (concentration, nervousness, irritability).

  Preventative measures are to be taken. The aim of this is that no harmful noise reaches the human ear. The following list shows the options in order of priority:
  1. Prevent noise from developing
  2. Prevent noise from propagating
  3. Spatially separate source of noise and staff
  4. Use personal ear protectors

- Mechanical vibration at work
  Mechanical vibration and the shock and stress is causes disrupts well-being at work, affects performance and endangers health. Here are four measures to prevent or reduce mechanical vibrations:
  1. Design measures to prevent the development of vibration
  2. Design measures to prevent the propagation of vibration
  3. The use of personal protective measures (measures to prevent exposure to the vibration)
  4. Organisational measures (setting break times)

- Lighting in the workplace
  Lighting is particularly important in the workplace, because people take in 80% of their information through the eyes. Lighting must be adapted to the different needs of individual jobs. Only optimum lighting avoids physical and mental stress and enables high performance. There are different types of lighting and, of course, combinations:
  1. General lighting for a whole room at the same lighting level, allowing work stations to be moved and still be lit
  2. General lighting, structured according to the work stations with fixed lights for individual work stations or groups (less flexibility)
  3. Individual lighting, with lighting adapted for the work

- Pollutants in the workplace

  In contrast to the aforementioned influences, exposure to dangerous substances and possible damage is often not noticed and recognized until much later. Under the term "harmful substances" in the workplace, we include all solid, liquid and airborne pollutants. Airborne pollutants such as dusts, fumes, mists, gases and vapours are particularly significant. However, dirt, oils, fats, acids, alkalis and other foreign material hazards can also occur at work. The following measures are possible, and listed here in order of priority:

  1. Technical/technological measures: using a different material, changing the working procedure
  2. Measures against the spread of pollutants: closed processing systems, extraction facilities
  3. Measures against the impact of the pollutant: masks, protective suits, goggles

- Design of the working process

  The organization of work significantly determines the nature and size of the stress placed on workers. The aim is always the optimal interaction of people and resources, in order to complete the tasks quickly, on schedule, under humane conditions, with the maximum efficiency and in the required quality. The type of operation, the products to be manufactured, as well as the machines and equipment affect the design of work processes. The following sequence can be used to design work processes:

  1. Formulate the objective and the task
  2. Breakdown the overall task in subtasks
  3. Schedule the subtasks
  4. Determine the time per unit
  5. Collect the tasks together in the schedule

  The result is then presented as a finished plan for example as a task list, schedule etc.

- Continuous improvement process (CIP)

  CIP should be a "driver" across the whole production process: It is not only a method, but part of company-wide objective, which contributes to the improvement of procedures, processes and products through greater ownership by the employees. Everyone can contribute to lowering costs and thus to securing the future of the company. The participation of all employees in the decision-making process according to their abilities is no longer sufficient, but rather new corporate values must be developed which support these processes, such as:

  - the permanent willingness to learn,
  - the desire to communicate
  - new understanding and behaviour from management
  - the ability to deal with the changes positively.

The staff will only permanent support this when the individual can improve his or her individual work situation or monetary situation by CIP. The company can achieve this goal by agreeing periodic attainable objectives and rewarding improvements with bonuses.

- Optimisation examples

  1. Die casting gears instead of turning and milling them
  2. Deep drawing of hollow bodies rather than shearing, bending and welding
  3. Drop forging of geometrically complex parts instead of sawing, turning, milling, drilling
  4. Electrochemical mould ablation instead of machining
  5. Laser cutting instead of burning and machining
  6. Glueing instead of boring, riveting, screwing or pinning
  7. CNC machines, machining centres instead of universal machines

Processes that do not include machining can have many advantages, including less loss of material, the ability to produce more difficult shapes with less effort, an increase in the strength of the parts, and last but not least shorter manufacturing and lead times.

The use of machining centres makes it possible to run multiple production processes on a machine and complete all the work on a workpiece in one go. Further uses are the monitoring of tool life, automatic measuring, reducing the primary processing time through the use of more powerful tools and the reduction in secondary processing times by the use of automatic workpieces and/or changing tools.

- Training employees
  Training must be based on the business' goals and should be integrated into personnel planning. What qualifications are needed by employees or what educational measures for the future should be planned can be found at an early stage by comparing profiles. On the job training under the guidance of supervisor and colleagues or other employees is a low-cost possibility and should be used extensively. Appropriate measures are training in the workplace, substitution, job enlargement), task delegation, job rotation and participation in workshops. Training increases flexibility and can also increase productivity in addition to providing monetary incentives.

2.1.2 Alternative materials

Material is a generic term including raw materials, working materials and auxiliary materials. Often, using alternative materials saves costs. Reducing the range of parts (use of standardized parts) may reduce costs and an increase in the procurement quantities (lot sizes), taking into account the existing storage capacity, can lead to better prices through volume discounts and lower freight costs. In accordance with the technical requirements, materials and supplies with the lowest costs should be used.

2.1.3 Stock

The inventory in the warehouse should be planned so that supplies are in readiness and capital expenditure is low.

Stock: Low-value and/or low-turnovers materials (c-parts). Cost savings can be achieved by, for example, collective ordering, telephone ordering, monthly billing, simplified inventory accounting by simultaneously booking materials in and out, simplifying stock monitoring by visual inspection etc.

Semi-finished and finished goods: Semi-finished and finished goods, b-parts (medium-value and medium-turnover), and a-parts (expensive and/or high turnover materials). Costs for semi-finished products can be influenced by optimizing the range.

By applying value analysis, finished goods can be treated carefully and extensively. Precise inventory management and control, and accurately setting minimum inventory levels can save additional costs.

Decisions relating to in-house production or external procurement (make or buy)

The decision on whether to produce components one's self or buy them in can only be made after reviewing a number of factors. To achieve a reduction in the cost, cost comparisons are performed, where the variable unit costs of in-house production and the purchase price per piece for external procurement can be used for short-term decisions, i.e.: variable unit costs of in-house production > purchase price per piece for external procurement implies a decision for external procurement. Long-term decisions include the fixed costs for in-house production in the consideration and determination of the volume necessary for in-house production to be worthwhile (procedure comparison or profitability calculation).

Production-synchronized delivery (just-in-time)

If goods are directly received into the production process without significant intermediate storage, we speak of production-synchronized delivery or just in time. The benefit is reduced storage costs.

2.1.4 Change the amounts of vertical integration

Vertical integration should only be reduced if it leads to lower costs, optimization of lead times, reduced stockpiling and/or improved utilization of capacity, improving competitiveness.

Multiprocess systems
Multiprocess systems combine three technical systems: for processing, material flow and information. They allow for the cost-effective production of different pieces in differing orders and different batch sizes. The advantages are:

- low storage costs due to computer-based warehousing and material supply
- batches fitting the production process reducing long and short term storage costs (just-in-time production)
- optimized processing times by complete machining, parallel set-up and editing, improved material flow, automatic process control and thus reducing the set-up and secondary processing times
- using of more effective tools (extension of service life)
- high capacity utilization by bridging the breaks
- low-staff costs for the production and thus reduced unit costs

Production cells
Production cells consist of fully automatic machines in conjunction with industrial robots for handling workpieces and tools. They are computer controlled. The complete processing of a family of parts can be carried out in a production cell.

Outsourcing
Outsourcing usually referring to areas that add peripheral value, to keep crucial know-how within the company. Special areas can be carried out by specialists and are thus best left to them. The portion of outsourcing can be established by portfolio analysis that evaluate the complexity of families of parts.

2.1.5 The influence of logistic costs

Logistics costs are costs for handling materials, consisting of those for ordering, moving and distributing the material used.

The flow of materials

An optimal flow of materials is achieved when the materials have to travel the shortest distance from their arrival until they leave the company, and this travel is done with the appropriate transportation, means of conveyance, handling equipment and storage media. The purchase costs, the potential savings and the operating costs incurred later for conveyance, handling, transport and storage must be examined. Material flow analysis should be done in preparation for optimization. The material flow plan typically includes:

- the step by step representation of the operations of working sequences
- data such as times, distances, means of conveyance, volumes
- transport frequencies, interdependency of tasks etc.

Internal transportation

Workplace transportation is counter-productive, because it does not directly contribute to adding value. Therefore, transportation should be avoided as far as possible or reduced to a minimum. According to the frequency of transportation and volume of materials, aisles and shelves should be arranged so that the minimum transport costs are achieved.

External transportation

External transportation is always linked to costs. Building up one's own transport capacity, however, requires considerable financial resources. Only a long-term and sufficiently good utilization of the means of transport can justify these investments. Often, only large companies meet these requirements. However, internal transportation gives a company a degree of independence in their transport system. Due to the costs and the capital involved, large companies also employ external transport services to which they have links and framework contracts.

2.1.6 The simplification of administrative procedures

Administrative procedures are necessary to combine the factors of production used in the company according to the company's objectives.

Technical administrative procedures
Preparing work plans, testing materials, creating NC programs and bills of material etc.

Organizational administrative procedures
Processing requests, creating invoices, processing of warranty claims etc.

Process-oriented administrative procedures
Human resources, i.e. hiring and releasing employees, currency conversions to the EURO, central purchasing etc.

2.1.7 Time management considerations

Time management is used to plan, manage and control time factors in production continuously. All macro and micro work systems at all levels of the organization are included.

Task integration

Time is the most important indicator for processes. Changing the times means changing the processes. All employees should be included, according to their capabilities, to optimally influence the design of processes and organizational structures. One way is offered by autonomous group work. Only a new, integrated organization and production structure allows the integration of functions completely or partially into the groups. This includes:

- organising work differently
- new process-oriented task structures
- greater freedom of action
- new relationships between the roles of employees and executives

Group payment
Group work requires the individual group members to have a high sense of personal responsibility to achieve the predefined goals of the company vision and also to gain a financial advantage themselves. Semi-autonomous group work can be paid in a new way. This is to add a new component "goal-oriented group bonus", in addition to the basic pay scale and normal incentives. The group gets to influence components of the cost structure directly, such as wages and salaries, costs for operating and auxiliary materials, costs for rejects and reworking.

2.2 Controlling costs using the results of cost accounting

When carrying out cost object accounting, or time unit accounting, cost controls (product costing analyses) are carried out in relation to pieces or contracts. There are different approaches:

- Comparing target costs to actual costs,
- Comparing the preliminary costing and the product costing analysis,
- Correlating the cost of the products and sales
- Monitoring the running costs through concurrent calculation.

The following areas give scope to cost control within the various areas of the company:

- **Distribution and design:** Deadlines, incomplete information, additional customer requests after the contract is finalized, customer's performance and security requirements which differ from one's own, partial delivery to customers, penalties.
- **Construction:** Inadequate drawings, incorrect performance data, incomplete bills of materials, changing bills of materials, incorrect quantities.
- **Materials management:** Additional tools or plate costs, additional costs for accepting materials in framework contracts, partial deliveries from suppliers, necessary in-house production instead of planned third-party purchase (and vice versa), costs caused by supply problems, purchasing costs by modified material planning.
- **Manufacturing and production organization:** Revised lot sizes through collective orders or splitting of orders, unplanned changes in volume due to increased waste, additional tools and devices due to procedural changes.
- **Accounting and organization:** Incorrect bookings, costs from incorrect orders, charges pending, incorrect provisions, missing documents, incorrect evaluation of parts and materials, price changes during the accounting period.

3. INFLUENCING EMPLOYEES COST CONSCIOUSNESS IN DIFFERENT FORMS OF WORK ORGANIZATION

3.1 Representing the manufacturing costs as part of the company´s production

Input costs, production costs, distribution costs and administrative costs are cost elements which are assigned to their functions. Manufacturing costs are incurred for production and the related cost elements for creating the costs objects:

- **Direct production cost** = wages for the time worked, piecework or premium pay as directly billable costs
- **Production overheads** = indirect labour costs; salaries; social costs; auxiliary materials such as welding wire, packaging, electrodes, etc.; supplies, such as lubricants, fuels etc.; capital costs such as imputed depreciation, calculated interest, space costs, maintenance costs, energy costs, tooling costs etc. as indirect costs
- **Production material costs** = When all costs up to distribution are included in the production costs

The cost elements and their assignment to cost centres are listed in a table on the expense distribution sheet. The cost elements (overheads) are mapped to the individual cost centres using allocation formulae.

Showing the link between cost overruns, i.e. planned costs < actual costs and their impact on the profitability of the company is essential. On the basis of the planned values or market prices for the products manufactured, constructive cooperation can be reached to carry out the measures necessary. When there are cost overruns:

- the overruns are analyzed by cost element and level,
- the causes are explored by comparing target and actual processes,
- possibilities for dealing with the causes are worked on
- approaches are developed to solve the problem,
- dates are set for the measures to be carried out and responsibility assigned.
- the measures are monitored,
- the development of the individual cost elements is checked the following periods.

3.2 Participation of all employees in cost assessment

Employees are much more able to understand changes and new features if they have participated in the cost assessment. Barriers and fears are reduced. Inclusion makes employees more willing to make suggestions for changes and to participate in problem-solving. A good manager is one who brings together the expertise of all the employees, coordinates their actions and tries to reach the goals set with them. Objectives must be set high, but realistically. Developing them jointly leads to employee motivation. Motivation is particularly high if the employee know that his or her proposal will be recognized, whether materially or in another way. To access the employees' dormant problem solving skills and put them into practice, they must be encouraged to engage for the greater good of the company. Through open communication between employees and managers, as takes place in staff or group discussions, trust is built up which forms the basis for making full use of the potential of qualified and motivated staff. In addition to these talks, also the participation of the individual in quality circles, quality groups, workshop circles can be used among other things to aid motivation.

4. CREATING AND EVALUATING THE MASTER SUMMARY SHEET VIA COST ELEMENTS, COST CENTRES AND TIME UNIT ACCOUNTING

4.1 Cost element accounting as the basis of cost accounting

In 1971, the use of the Industry Standard Accounting System as a replacement for the Joint Standard Accounting System was proposed by the Federal Association of German Industry. This is an accounting system that is characterized by comparability and standardization and also enables the use of computers.

The Industry Standard Accounting System includes the following ten account classes:

Class 0	Property and equipment, and intangible assets
Class 1	Investments and cash accounts
Class 2	Inventories, receivables and active deferrals
Class 3	Equity, value adjustments and provisions
Class 4	Liabilities and passive deferrals
Class 5	Income
Class 6	Material and personnel expenses, depreciation and value-adjustments
Class 7	Interest, taxes and other expenses
Class 8	Opening and balance
Class 9	Left free for cost and management accounting including accrual accounting

The Classes 0-8 are considered as administrative accounting, while Class 9 is intended for industrial accounting.

From this rough outline, each company can use a finer structure to create a chart of accounts which is suitable for them. The chart of accounts is the overview of the accounts to be done in the company. All accounts are formally divided into the ten groups, the classes. Within the classes, account groups are formed, collecting together the cost types with a common basis. The account groups, again up to ten of them, are marked with a two-digit serial number. Within the account groups, it is again possible to divide into up to 10 account types. They will receive a three-digit serial number. Unlimited accounts can be placed under an account type, they have a four-digit serial number.

Example

Class	4	Cost element accounts
Account group	43	Personnel costs
Account type	439	Salaries
Account	4394	Sales salaries

Industrial class 9:

Class	9	Cost and management accounting
Account group	92	Construction materials
Account type	922	Supplies
Account	9225	Consumables

If one divides up the cost elements based on their behaviour as the level of activity changes, then we have:

- fixed costs (time-dependent costs): these do not change within a period of time or certain activity limits
- variable cost (quantity-dependent cost): these change with the level of production, in practice they are mainly assumed to be proportional, and
- mixed cost: these consist of a mixture of fixed or time-dependent costs and variable or quantity-dependent cost items.

The resolution of mixed costs is necessary but problematic. One uses the computational (analytical) or the accounting method.

The computational method is applied when one can assume that the costs are linear, as is usual in practice.

The accounting method examines each cost element's behaviour under changes of activity level and splits the results into fixed and variable components. This method can only be used for cost elements where the quantitative usages can be determined.

The variable costs (K_{vi}) at a level of employment (B_i) can be determined as follows:

$$K_{vi} = \frac{K_2 - K_1}{B_2 - B_1} \bullet B_i$$

from the ratio of the difference in actual costs (the costs of two past periods K_1, K_2) and the respective difference in the level of employment (B_1, B_2), . Here B_2 is the highest and B_1 the lowest level of employment and K_2 and K_1 the associated costs.

The fixed costs (*Kf*) arise from the difference of the total cost (Ki) and the variable costs (K_{vi}).

Example
Energy costs are as follows:

K_2= € 3,300 / month, with a level of employment of B_2 = 200 h/month

K_1 = € 1,300 / month, with a level of employment of B_1 = 50 h/month, so the variable costs are determined as follows:

The following fixed costs arise for 200 hours per month:

$$K_{vi} = \frac{3{,}000-1{,}300}{200-50} \bullet 200 = 2{,}667\ €/\text{month}$$

Kf = 3,300 – 2,667 = 633 €/month

The proportionality of variable costs to employment changes is necessary for the application of this procedure.

4.2 Cost centre accounting as a tool for distributing cost elements to cost centres according to the areas of causation

An organization geared to economic activity requires billing areas for production and performance evaluation. How these are formed depends on the size of the company. The organizational structure is a hierarchical breakdown of internal management and functional levels. This gives a clear separation of the activities and responsibilities to ensure these activities are carried out smoothly.

Cost centres generate overheads differently and this must be taken into account. It must be made possible to allocate the overheads to the cost units (individual goods or services). This is done using some of their features.

These features are:

- the nature of the task, for example procurement of materials or production of the products;
- the spatial conditions, for example functionally defined units in individual rooms (a turning shop in a Hall);
- the organization of the company, i.e. the defining of areas in which responsibility is carried by a responsible contact person (such as a cost centre manager, head of department or foreman);
- technical accounting criteria, i.e. forming main and auxiliary cost centres

Cost centre areas for medium-sized and large businesses have already mentioned, of course this depends on the task:

- General area
- Materials area
- Production area
- Administration
- Sales area

For smaller businesses, the three areas, operation, sales and administration are often sufficient.

In practice, determining cost centre is not usually based on just one feature, but on a combination of the above criteria.

4.3 The purpose of expense distribution sheets

Expense distribution sheets are the basis of the economic control of the individual cost centres (sections). Today, due to computers, relatively little effort is needed to determine what actual costs have been incurred in a period of time by using goods.

When using normal or standard costing, these costs are adopted as the normal or target costs for future periods.

The need for action when there is waste can be detected by comparing the costs identified in individual cost elements with the costs planned in the cost centre plan.

The overhead surcharges identified in the expense distribution sheet form an integral part of the surcharge calculation and thus offer the ability to assign the overheads in cost unit accounting. The overheads will be added to the direct costs as overhead costing rates, such as materials overhead surcharge, manufacturing overhead surcharge, administrative overhead surcharge and sales overhead surcharge.

The manufacturing costs during a period are calculated as follows:

	Material expenses (construction materials)
+	Material overheads
+	Manufacturing costs
+	Manufacturing overheads
=	Costs

$$\text{Material overhead surcharge} = \frac{\frac{Material\ overheads}{period}}{\frac{Material\ direct\ costs}{period}} \bullet 100\ \%$$

$$\text{Manufacturing overhead surcharge} = \frac{\frac{Manufacturing\ overheads}{period}}{\frac{Manufacturing\ wage\ costs}{period}} \bullet 100\ \%$$

$$\text{Administration overhead surcharge} = \frac{\frac{Administration\ overheads}{period}}{\frac{Production\ costs}{period}} \bullet 100\ \%$$

$$\text{Distribution overhead surcharge} = \frac{\frac{Distribution\ overheads}{period}}{\frac{Production\ costs}{period}} \bullet 100\ \%$$

How the surcharges are determined depends on the cost structure of the cost centre. Thus surcharges as percentages is just one way. Other options are: costing of hourly rates, weighting or via machine operating hours and overheads of the rest of the production.

If:

Normal overheads > actual	= there is a favourable variance
Normal overheads < actual costs	= there is an unfavourable variance
The surplus / deficit	= normal overheads - actual overheads

Changes in price, procedure and employment can all cause variance. An expense distribution sheet created in this way, alongside the data calculated above is suitable for cost control and cost unit accounting. If the individual overheads or the total overheads fall outside permissible tolerances, the cause must be analyzed and operational measures taken in order to stop this.

Example

The following normal surcharges have been calculated for the main cost centre "Assembly":
(a) material overhead surcharge 10 %
(b) manufacturing overhead surcharge 180 %
(c) administrative overhead surcharge 18%
(d) distribution overhead surcharge 12%

After the assessment of primary and secondary overheads for the cost centre, Assembly, the expense distribution sheet has calculated the following overheads:
(a) material overhead € 11,400 / period
(b) manufacturing overheads € 268,500 / period
(c) administrative expenses € 104,481 / period
(d) distribution overhead € 83,585 / period

The direct costs for the period are as follows:

- Production material costs € 120,000
- Production cost € 150,000

The surcharges, normal overheads, and the surpluses/deficits are to be determined.

Solution

	Actual costs		Normal costs	
1 Manufacturing materials	120,000		120,000	
2 Material overheads	11,400	9.5 %	12,000	10.0 %
3 Material costs	131,400		132,000	
4 Manufacturing wages	150,000		150,000	
5 Manufacturing overheads	268,500	179.0 %	270,000	180.0 %
6 Manufacturing costs	418,000		420,000	
7 Manufacturing costs	549,900		552,000	
8 General administrative overheads	104,481	19.0 %	99,360	18.0 %
9 Sales overheads	82,585	15.2 %	66,240	12.0 %
10 Total production cost	737,966		717,600	

Overhead costs	Cost centres			
	Materials	Production	Administration	Distribution
Actual costs	11,400	268,500	104,481	83,585
Normal costs	12,000	270,000	99,360	66,240
Variance				
Surplus	600	1,500		
Deficit			5,121	17,345

The causes of the surpluses in production could be more economical lot sizes, lower wear and tear of tools or better preventive maintenance of the equipment.

The deficits in administration could be due to rationalization or also pay increases. In sales, additional advertising expenses can lead to deficits.

4.4 The purpose of cost unit accounting

The overheads, as we have seen, are assigned on the basis of the direct costs determined by cost element accounting and cost centre accounting for the cost centres. This forms the basis for the assignment of the costs incurred in the course of the production to the cost unit. This assignment is to be carried out alongside the cost centre accounting.

The costs can be assigned to:

- Customer orders or stock order (intended for an unspecified market) or
- Internal services, i.e. capitalisable services for equipment with multiple periods of long life or non capitalisable services which have already been taken into account in the cost centre accounting with the internal activity allocation.

The diverse purposes of cost unit accounting can be met with these conditions, such as:

- Identifying the manufacturing or total production costs per unit/product
- Determining all the direct, indirect and special direct costs in the period and how they map to the services provided (time unit accounting),
- Showing the short-term, periodic success as a result of economic activity with short-term profit and loss account. The same result can be achieved by comparing the profit and loss in a period with the total net sales structured by products or product types (total cost method).

- Providing information for:
  - Decisions on prices and price upper and lower bounds,
  - The decisions affecting a product, such as the removal of negative cost units from a program or a strengthening the activities for cost units which are sure to be successful,
  - Decisions relating to in-house production or external procurement,
  - Identification of stocks of work in progress and finished goods, as well as capitalisable in-house activity.

The production costs and the total production costs are calculated with the direct, fixed and special direct costs, which are separated in the time unit account according to cost unit or cost unit group.

Checking the profitability is made possible by comparing the actual costs with the recorded normal or standard, or target costs.

The results of the comparison of the total production costs and those from each cost object for a period of time with the corresponding revenues (from the profitability analysis) are the basis for operational decisions.

The cost unit time account is therefore extended and becomes a profitability account. The difference between the total costs of sales, the revenue and the total earnings of the company, and the pro-rata production by cost units can be seen.

The determination of operating profit or loss may be done in a table called the cost unit time sheet. This is often carried out monthly. It can also be called the short-term profit and loss account.

We describe the procedure for determining the operating result step by step:

- Take the total manufacturing, materials and special direct costs and the cost units from the cost element account.
- Assign the overheads to the cost units using the normal/standard or target surcharge rates
- Determine the normal costs
- Add the actual costs in a column of the expense distribution sheet to record the surplus or deficit
- Identify the material costs, manufacturing costs, production costs and total production costs
- Complete the cost unit time account
- Carry out the profitability analysis

Evaluation:

Suppose that cost unit A is generating a profit, while cost unit B generates a loss. The following measures could be taken:

- Change the manufacturing process for product B
- Optimize the range of products manufactured, favouring product A
- Change product B

If the costs for a cost unit in a period are determined by cost unit time accounting, then the cost per order-unit calculation is to determine the costs incurred in the production and operating processes per order-unit. This makes it possible to make offers, implement cost control and identify the lower bound on the cost.

We differentiate between the following, depending on when the cost per order-unit calculation is carried out:

- **Preliminary calculation**
  This is carried out in advance on the basis of technical documents such as bills of material, time allowances, work process descriptions etc. Expected changes in the price of the materials are taken into account by assessing the consumption at the price to reorder, to make the assessments of costs as realistic as possible.

  The estimation is used in:
  - order-oriented enterprises to identify offer prices.
  - as a basis for decisions for accepting or rejecting an order.
  - new products and changes to cost planning for products
  - to provide documents aiding the choice of production process and system comparisons (profitability calculations).

- **Intermediate calculation**
  This is carried out during production to continuously monitor costs. It is also called a concurrent calculation. A calculation is performed during the production process by using the actual costs of the goods consumed in the process.

  The intermediate calculation can also be seen as a final costing of unfinished products. Concurrent calculations are used in shipbuilding, power plant construction, bridge construction, and so on.

  The intermediate calculation enables monitoring developing costs before the order is finished. This can be seen by comparing the planned and actual costs. Variations identified can then be handled with appropriate measures.

- Final calculation
  This is carried out after the production of the products. It deals with the actual effective costs in the production and realization processes. It compares the planned / target costs per order-unit with the actual costs showing any deficits or surpluses. The experience gained from the analysis can be used in the future to improve preliminary calculations and find optimal offer prices.

5. CALCULATION

5.1 The calculation method for the cost per order-unit calculation including breakeven analysis

5.1.1 Calculation procedure

One of the main tasks of costing is the calculation of costs per unit for the company's products (cost per order-unit calculation).

The costs calculated are used as a basis for evaluations and decisions in the operational and strategic area of an industrial firm.

Uses:

- Monitoring costs (efficiency)
- Evaluating resources (capital)
- Pricing, price assessment (creating quotes)
- Selecting materials (designing products)
- Choosing manufacturing processes (automation technology)
- Deciding on in-house production and external procurement (vertical integration)

Many calculation procedures have been developed for this purpose. Different ones are used depending on the industry, product range and manufacturing technology.

(a) The principles of assigning costs:
The aim is to allocate the costs as appropriately as possible based on their causes.

- **Causation principle:**
  Used in: Allocating costs and variable overheads.
  Prerequisite: Cause and effect relationships (independent and dependent variables).
  Procedure: Detailed review of the production (target specification, determination of actual situation, documents, feedback, interpretation of the results).
  Problem: Determining the costs is time consuming.

- **Principle of averages:**
  Used in: Allocation of overheads (such as depreciation, rental costs,...).
  Prerequisite: Useful reference values (times, quantities, costs).
  Procedure: Proportional allocation by key statistical data (such as time used, dimensions of rooms).
  Problem: It only allocates the costs to their causes under certain conditions.

- **Principle of financial viability:**
  Used in: Allocation of cost with the coupling calculation.
  Prerequisite: The market prices of the products.
  Procedure: Proportional allocation based on the recoverable revenue or profit margin.
  Problem: Not allocated appropriately to causes.

As the basis of efficiency, the costs and benefits must be in a reasonable relationship with each other. The required clarity, accuracy and timeliness of the values determines therefore how broad and deep the calculative method needs to be.

(b) The impact of the production structure:
The following categorization according to production structure has proved to be useful for the calculation procedure:

Single product manufacturing: A single product is manufactured in large quantities (mass production).
Batch production: A basic product is produced with variations, whereby the raw materials and production processes are similar.
Multi-product manufacturing: Various products are manufactured in single or batch production.

It is therefore often necessary to use different costing methods during the production process of a particular product. Depending on the production, different costing methods are used and then put together to form a complete calculation. For example, in a foundry, the smelting costs per ton may be calculated using output costing, however the casts, casting and cleaning costs are calculated using a surcharge calculation.

Output costing

Output costing the simplest form of costing. The costs from a period are divided by the number of the units produced in the same period. The total costs are thus evenly distributed to all cost units.

(a) One-step output costing:

This is used when a single product is being produced, where each individual unit should bear an equal share of the total costs of the period. The entire company is considered a cost centre, whose entire cost is equally assigned equally to the individual units.

In one-step output costing, we need not even separate direct costs and fixed costs.

A deep cost centre structure in the context of cost centre accounting is also not required.

Areas of application: utilities (electricity, water),
the extraction of raw materials,
the production of standard parts,
the production of semi-finished goods, etc.

Cost per unit: $sk = \frac{Total\ cost}{Production\ volume}$

However, when using this approach there must be no changes to any stocks of finished and semi-finished products (sales or temporary storage facilities); i.e., the amount produced always equals the amount calculated for.

(b) Multi-step output costing:

This is used for single product manufacturing in which individual periods have different production and sales volumes (stocks of finished products) and/or different stocks of semi-finished products at different stages of the production process (intermediate storage).

Two-stage output costing

For single-stage production (or a multi-stage without intermediate storage):

Provided that only production and sales volume of a period vary, two-stage costing is carried out. Here, the production costs and perhaps the production-related share of the administrative costs are attributed to the production volume, while the sales-related administrative costs and the sales costs are attributed to the sales volume. The evaluation of changes in stocks is performed on the basis of the manufacturing costs.

Cost price per unit:

$$sk = \frac{Production\ costs}{Production\ volume} + \frac{Administration\ and\ distribution\ costs}{Volume\ sold}$$

Multi-stage output costing

This applies to multi-stage manufacturing with intermediate storage:

If the quantities of the various stages in the production are different, then multi-stage output costing is done, in which the production costs are allocated to the various stages.

The quantities of unfinished products manufactured in a production stage are then immediately available for the next stage of processing or storage. The amount of goods in stock at the ends of different periods can be higher or lower.

Production costs per unit for each stage:

Step I: $hk_I = \frac{HK_I}{m_I}$

Step II: $hk_{II} = \frac{m_I^* \cdot hk_I + HK_{II}}{m_{II}}$

Step III: $hk_{III} = \frac{m_{II}^* \cdot hk_{II} + HK_{III}}{m_{III}}$

...

etc.

...

Step N: $hk_N = \frac{m_{N-I}^* \cdot hk_{N-I} + HK_N}{m_N}$

m_I..... m_N are the output of the stages;

m_I^*..... m_{N-I}^* are pre-production stocks of the Stages 1 to N-1 which are processed further in Stages II to N;

HK_I..... HK_N the total cost of each stage excluding the costs for the pre-production stocks used.

Cost price per unit:

$$sk = hk_I + hk_{II} + ... + hk_N + \frac{Administration\ and\ distribution\ costs}{Volume\ sold}$$

Example

In a car body factory, which contains, among other things, sheet-metal parts production and a paint shop, the following costs arose last month:

Cost centre (stage)	Pre-production volume m*	Production volume m	Manufacturing costs MC
Rolling	100 tonnes steel	7,000m rolled steel	€ 20,000
Cutting I	6,500m rolled steel	6,300m steel strips	€ 15,000
Cutting II	5,400m steel strips	8,000 pieces	€ 10,000
Shaping A	5,500 pieces	5,400 pieces	€ 12,000
Shaping B	5,000 pieces	4,800 pieces	€ 9,000
Degreasing and painting	4,000 pieces	3,800 pieces	€ 23,000

The material costs per ton of steel used are € 950.

There were no stocks of intermediate products are the start of the month.

In the month considered, 3,500 pieces were sold.

The management and sales costs amounted to € 8,000.

Solution

Rolling $\frac{100 \cdot 950 + 20{,}000}{7{,}000}$ = 16.43 €/m

Cutting I $\frac{6{,}500 \cdot 16.43 + 15{,}000}{6{,}300}$ = 19.33 €/m

Cutting II $\frac{5{,}400 \cdot 19.33 + 10{,}000}{8{,}000}$ = 14.30 €/piece

Shaping A $\frac{5{,}500 \cdot 14.30 + 12{,}000}{5{,}400}$ = 16.79 €/piece

Shaping B $\frac{5{,}000 \cdot 16.79 + 9{,}000}{4{,}800}$ = 19.36 €/piece

Degreasing and painting $\frac{4{,}000 \cdot 19.36 + 23{,}000}{3{,}800}$ = 26.43 €/piece

Cost per piece of sheet metal:

26.43 €/piece + $\frac{8{,}000\ €/month}{3{,}500\ €/month}$ = 28.72 €/piece

(c) Output costing with equivalence numbers (equivalence number calculation)

The equivalence number calculation is often considered part of output costing in the broader sense.

It is used for batch production of a range of similar products. The costs are calculated by assigning equivalence numbers to the variants based on the differences to the basic product. In other words, weightings, proportions, rankings.

The areas of application include:
the food industry (dairies, breweries...),
plastics processing (plastic injection moulding...),
the construction industry (brickyards...)
the paper industry, textile industry etc.

What makes the equivalence number calculation special is that the
variants are related to a basic product via equivalence numbers (sometimes called the reference type). Output accounting is then subsequently applied. The basic product generally receives the equivalence number 1.

The heart of the equivalence number calculation consists of determining the equivalence numbers. To get useful equivalence numbers, relevant operational experience and professional knowledge of the technical processes is essential.

The equivalence numbers are usually determined on the basis of the different materials used (volumes and values) and/or different work (processing time).

The actual output quantities of each of the variants are then converted via their weighting in computationally equivalent quantities called accounting units. Only then is each variant compared to the basic variant in terms of cost causation.

Assessing costs with the equivalence number calculation:

Unit costs of the variant:

$= \frac{Total\ costs}{Total\ of\ all\ accounting\ units}$ • equivalence number of the variant

= production of the variant • its equivalence number

Like simple output costing which we discussed above, output costing with equivalence numbers can also be single-stage, two-stage or multi-stage.

Example

Lighting domes are made out of plastic in different sizes.
The following parts were produced in one period:

Variety (diameter in mm)	Quantity manufactured (pieces/period)	Mass (kg/piece)
300	8,000	0.50
400	12,000	0.75
500	15,000	1.10

The following costs have been determined for this period:

Production materials: € 14,960
Material overhead costs: € 2,000
Manufacturing wages: € 13,600
Manufacturing overheads: € 54,400

The equivalence numbers, ENs, are calculated from the relative masses.
The smallest light dome is chosen as the basic product with EN = 1.
Calculate the production costs for each product!

Solution

Variety	Quantity	Mass	EN	AU	PC in €/piece	PC in €/period
300	8,000	0.5	1.0	8,000	1.440	11,520
400	12,000	0.75	1.5	18,000	2.160	25,920XXXnotewrongorig
500	15,000	1.10	2.2	33,000	3.168	47,520
				59,000		84,960

PC = € 84,960/period

Cost per accounting unit: $\frac{84{,}960\ €/period}{59{,}000\ €/period}$ = 1.44 €/AU

For example for the Ø 400 variant:

PC = 0.75 kg/piece : 0.5 kg/piece = 1.5
AU = 12,000 pieces/period • 1.5 = 18,000 AU/period
PC = € 1.44/AU • 18,000 AU/period = € 25,920/period
PC = € 25,920/ period / 12,000PC/period = 2.16 €/PCs

Surcharge calculation

If products vary greatly in materials, production processes, vertical integration, etc., then the production is generally of individual products. Here, output costing is no longer applicable.

Production is generally divided into small processes in which the material is processed, the resources used and staff deployed. Thus the calculation is refined for the different materials, capital, labour and operating costs. A surcharge calculation is often used because it is applicable to all situations, regardless of whether the manufacturing is done with a flow production system or is discrete or whether it is single, batch or mass production.

Areas of application:

- Mechanical engineering, plant construction,
- home appliances,
- office machinery,
- consumer electronics, etc.

The cost of a product unit can normally be determined with an adequate degree of accuracy by a surcharge calculation.

In this calculation, the direct costs recorded in the cost element account are directly allocated the cost unit.

Overhead costs are only indirectly attributed to the costs units by a percentage surcharge coming from the cost centre account. The overheads determined in the expense distribution sheets for the last accounting period are the basis for calculating the overhead surcharges. The associated direct costs and manufacturing costs are used as a relative reference. Special direct costs are assigned according to product (such as special tools) or order (for example special packaging) in the surcharge costing.

Summary surcharge calculation (one-stage surcharge calculation):

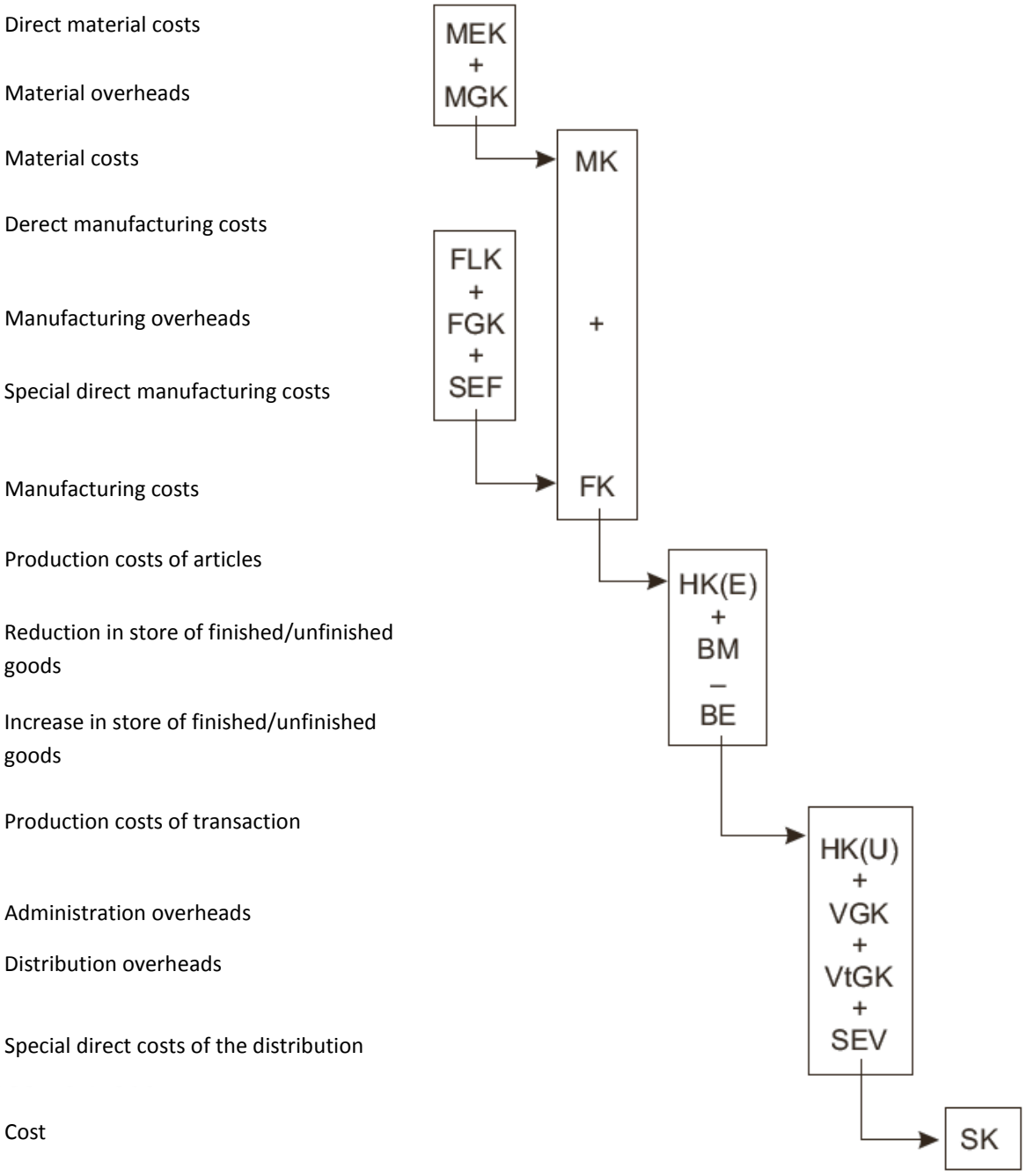
This is a simplified procedure, used only if the fixed overheads are relatively low and therefore the risk of costs being allocated incorrectly is very low (such as craft businesses). Either the manufacturing wages alone (wage surcharge costing) or only the cost of materials (material surcharge costing) is used as basis for the overhead surcharge, depending on whether production is labour-intensive or material-intensive.

Differentiated surcharge calculation (multi-stage surcharge calculation):

This is a more exact form of surcharge calculation compared to summary surcharge calculations, but also takes more time and effort, because cost centre accounting is assumed. The direct costs are determined from the product or manufacturing planning documents (such as bills of materials, work plans etc.). The overheads are charged by using multiple overheads surcharges (one for materials overheads, manufacturing overheads, etc.). These surcharges are to take into account the development of costs and activity level of the next accounting period as well as possible.

a) Surcharge calculation with overhead surcharges:

Calculation scheme:



Material overheads = Material expenses • MS / 100

Manufacturing overheads = Manufacturing cost • PS / 100

Administrative overheads = Cost • AS / 100

Distribution overheads = Cost • SS / 100

Note: In addition to the manufacturing costs, development and construction costs may need to be taken into account as special direct costs or overheads.
If no special direct costs are incurred, SDP and SDC are not needed in this costing.
If no changes to stock have occurred, then:

PC(C) = PC(T) = HK

The major weakness of a surcharge calculation with overhead surcharges lies in the unjustified assumption of the proportionality of overheads and direct costs. But for low overhead surcharges, the relationship is, at least to a large extent, proportional so the errors in the calculation are low.

Example

A part is made in two stages.
The following data is available for a customer's order:

Order quantity	m	= 50 pieces
Material expenses	MDC	= 8.8 €/kg
Use of materials	G	= 4.4 kg/piece
Material overhead surcharge MS		= 24 %
Production Stage A:		
Rate of pay	LS_A	= 19.88 €/hour
Time taken for the order	t_r	= 20 min/order
Time taken per unit	t_e	= 4.50 min/piece
Manufacturing overhead surcharge	FZ_A	= 275 %
Production Stage B:		
Manufacturing costs	FS_B	= 98.28 €/hour
Order Time	T	= 190 min/order
Management and sales overhead surcharge V + VtZ		= 35 %

Determine the cost per piece!

Solution

Direct material costs MEK:	4.4 x 8.8	= 38.72 €/piece
Material overheads MGK:	38.72 • 24/100	= 9.29 €/piece
Material costs MK:		= 48.01 €/piece
Manufacturing wage costs FLK_A:	(20/50 + 4.50 • 19.88/60)	= 1.62 €/piece
Manufacturing overheads FGK_A:	1.62 • 275/100	= 4.46 €/piece
Manufacturing costs FK_B:	190/50 • 97.28/60	= 6.16 €/piece
Manufacturing costs FK:	1.62 + 4.46 + 61.6	=12.24 €/piece
Production costs of articles HK:	48.01 + 12.24	= 60.25 €/piece
Production costs of transaction and Administration and distribution overheads	60.25 • 35/100	= 21.09 €/piece
Cost SK	**60.25 • 21.09**	**= 81.34**

b) Surcharge calculation with machine hour rates (machine hours accounting):

Machine hours accounting is often considered a method of surcharge calculation in a broader sense.

The allocation of production overheads on the basis of the manufacturing wage costs is problematic for highly automated production. In the production cost centres, high labour productivity leads to a low proportion of the costs being due to manufacturing wages and the high level of capital leads to a high proportion of overheads. Thus, the overhead surcharges are extremely high. A minor change in wages would lead a very large change of the production overheads calculated if the overhead surcharge were not modified at the same time.

Also the proportion of fixed costs rises sharply with increasing mechanization. As a result, the proportional relationship between costs incurred and production carried out is no longer valid.

Through the use of machine hours accounting, the manufacturing overheads are assigned, the accuracy increased and the transparency of the costs improved.

The machine hour rate only contains the production overheads directly attributable to a machine. The other production overheads in the cost centre, independent from the machine, are charged separately. These surcharges are therefore reduced accordingly. They are then, however, assigned as a percentage to the respective manufacturing wage costs.

Machine hours accounting is a refinement of the differentiated surcharge calculation because the manufacturing overheads are further divided.

Identification of the production costs:

Manufacturing costs =	= Manufacturing wages	= Manufacturing wages + Machine costs + Other manufacturing overheads

$$\text{Other manufacturing overheads} = \text{Manufacturing wages} \bullet \frac{Other\ manufacturing\ overhead\ surcharge}{100\ \%}$$

Examples of machine costs:

- **Imputed depreciation costs:**
  This depends on the current value, and the lifespan.
- **Imputed interest costs:**
  This depends on the average essential capital bound up in the machine; that is the interest calculated with half the cost and average interest rates.
- **Occupancy costs or imputed rental:**
  This is calculated using the surface area taken up; for example imputed building depreciation. imputed interest costs for buildings and insurance.
- **Energy:**
  This depends on the power installed and usage; e.g. electricity, gas, compressed air.
- **Maintenance:**
  This is proportional to the cost or depreciation of a machine; e.g. maintenance, inspection, repair.
- **Tool costs:**
  Depends on the service life and wear and tear of machine tools.

Examples of the production overheads remaining:

- Indirect labour costs of the production
- Salaries in the production organization (foremen, engineers,...)
- Social costs
- Lighting, heating, cleaning
- Production logistics (transport, interim storage)
- Planning (planning, management)
- Quality assurance, etc.

Example

The following data has been calculated for an injection moulding machine:

Replacement value	270,000 €
Purchase price	250,000 €
Transport costs	1,100 €
Installation costs	3,900 €
Useful life	5 years
Operating time	2,250 hours/year
Imputed interest rate	8 % per year
Maintenance costs	3 % per year relative to cost
Space requirements	24 m²
Occupancy cost	160 €/(m²year)
Power	15 kW
Technical usage	0.8
Energy costs (electricity)	0.18 €/kWh
Air consumption	11 m³/hour
Energy costs (compressed air)	0.05 €/m³

Calculate the machine-hour rate

Solution

K_A = $\frac{270{,}000\ €}{5 \cdot 2{,}250}$ = 24 €/hour

K_Z = $\frac{250{,}000\ € + 1{,}100\ € + 3{,}900\ €}{2} \cdot \frac{0.08}{2{,}250}$ = 4.56 €/hour

K_I = $255{,}000 \cdot \frac{0.03}{2{,}250}$ = 3.40 €/hour

K_R = $24 \cdot \frac{160\ €}{2{,}250}$ = 1.71 €/hour

K_{E-S} = $15 \cdot 0.5 \cdot 0.18$ = 2.16 €/hour

K_{E-L} = $11 \cdot 0.05$ = 0.55 €/hour

Machine-hour rate: **36.35 €/hour**

Joint product costing

Joint product costing is used for joint production. This is where one production process leads to several products. This can be because there is some technical or natural link between them and because it has to be so or because it is economic to do so.

The difficulty of costing joint products is the pro rata allocation of common costs, since allocating according to causation is not possible. The financial viability principle is usually applied to attribute the costs to the individual products. Here residual value accounting and market value accounting are used.

(a) Residual value costing:

Residual value costing (a subtraction method) is applied when the products can be divided into a main product and one or more secondary or waste products.

It is based on the principles of average and of financial viability.

Profit of the by-products = Revenue - processing costs

Remaining costs = Total costs - total profit

Production costs of the main product = $\frac{Remaining\ costs}{Volume\ produced}$

Example

A company manufactures 5000 pieces of the main product, A. The co-products are 2000 pieces of by-product B and 1500 piece of by-product of C. The entire production costs amount to € 60,000. The processing costs of the by-products are € 0.40/ piece for B and € 0.30/ piece for C. The proceeds from the sale of the by-products is € 3/piece for B and € 4/piece for C.

Calculate the cost of the main product.

Solution

Product	Production volume in units	Unit processing costs	Proceeds per piece	Surplus per piece	Total surplus
Main-product A	5,000	----			
By-product B	2,000	0.40	3	2.60	5,200
By-product C	1,500	0.30	4	3.70	5,550
					10,750

Residual costs:
€ 60,000 - € 10,750 = € 49,250

Costs for the main-product A = $\frac{49{,}250\ €}{5{,}000}$ = 9.85 €/piece

(b) Market value costing:

Market value costing (an allocation method) is used when it is not possible to separate the products into main products and by-products. Market value costing is based on the principle of financial viability.

The formal structure of the calculation corresponds to output costing with equivalence numbers. The cost of the joint production of the products is proportional to the revenue obtained from them. The directly attributable special direct costs of production, SDC, are assigned separately to the products.

Example

A joint production process has a total cost of € 42,720. The products A, B and C are produced in varying amounts (3,000; 800 and 1,200 pieces respectively). The directly allocatable special direct costs of production are € 0.40/piece, € 1.20/piece and € 0.55/piece respectively.

The sales price is € 10.80/piece; € 28.80/piece and € 7.20/piece respectively.

Solution

Products	Quantity in pieces	SDC per piece	Proceeds per piece	EN	AU	PC-SDC in €	PC total in €
Product A Product B Product C	3,000 800 1,200	0.4 1.2 0.55	10.8 28.8 7.2	1.5 4.0 1.0	4,500 3,200 1,200	7.20 19.20 4.80	7.60 20.40 5.35
					8,900		

Cost per accounting unit = $\frac{42.720\ €\ €}{8{,}900\ RE}$ = 4.80 €/AU

5.1.2 Breakeven analysis in connection with full cost accounting

The main weaknesses of full cost accounting are:

- the overheads are often not allocated appropriately (according to a key, assessment, direct cost basis,...)
- the calculation rates are incorrect if there are fluctuations (the assumption of proportionality for fixed costs,...)
- decisions on in-house production and external procurement may be incorrect (residual fixed costs...)
- decisions on sales and production programs may be incorrect (product range, bottlenecks...)
- nothing is said about planning business success (profitability, short-term lower price limits...)

(a) Cost elements in full and partial cost accounting

Breakdown of total costs:

Total cost		
Direct costs	Overheads	
Variable costs		Fixed cots
Direct costs	Variable overheads	Fixed overheads

Rules: (1) All direct costs are variable costs
(2) Not all overheads are fixed costs

Direct costs are variable costs (direct material costs and manufacturing wages). Overheads contain both fixed and variable cost elements.

Exact cost resolution

Pure variable costs and pure fixed costs are very rare. Usually, there are what is known as mixed costs. These consist of fixed and variable cost components.

The cost determined in cost element accounting and assigned in cost centre accounting are decomposed into variable (dependent on the activity level) and fixed (independent of the activity level) costs for the purposes of the partial cost accounting. Various mathematical and accounting procedures are employed to do this. Finally, the variable costs are allocated to the cost units (products).

(b) Comparison of full and partial cost accounting

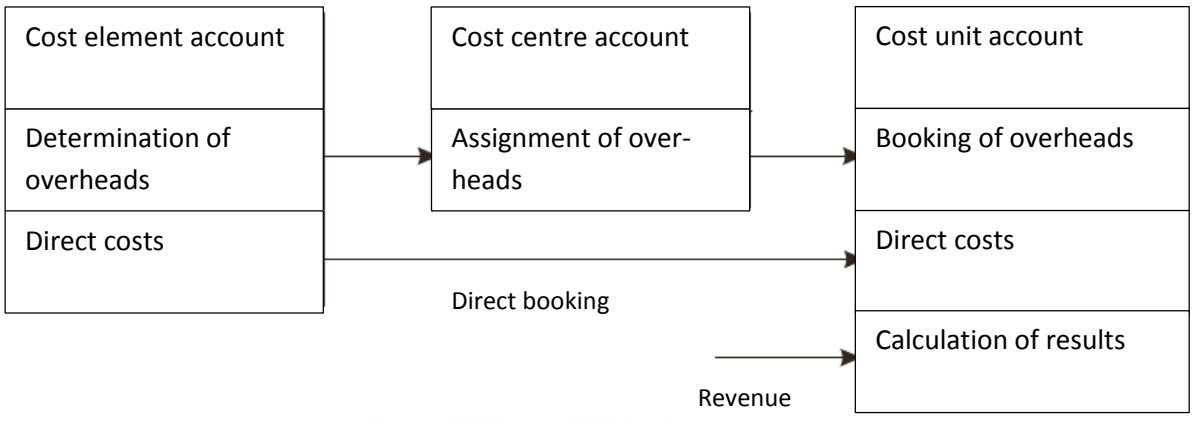
Distinctive features

Partial cost accounting is a logical development of full cost accounting. They are not contradictory or even competing systems, but each is more suitable for considering different problems. All costs incurred within a given billing period are collected in partial cost accounting, just as in full cost accounting.

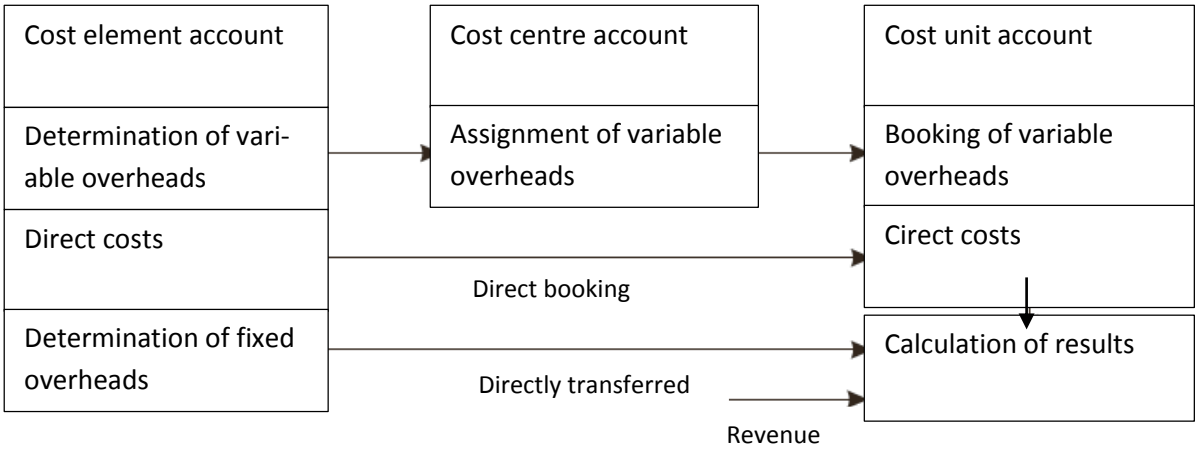
The differences are visible in the assignment of costs to the products produced:

In cost centre accounts, the allocation of overheads, which includes the total fixed costs and part of the variable costs, is performed by using allocation formulae. The direct costs are directly assigned to the products in the cost unit account and these serve as the basis for the surcharges for the overheads determined in the cost centre account.

Full cost accounting assigns all of the fixed costs for what is known as a "normal level of activity", including those not fully attributable to their cause, to the cost units. Decisions based on full costing can therefore be incorrect.



Partial cost accounting assigns only part of the costs (the variable costs) to the cost units, while the remaining costs (the fixed costs) appear as a separate cost item be transferred periodically in the operating results. As a result, partial cost accounting does not omit the fixed costs, but only omits assigning the fixed costs to individual products.



Basic situations:

Different issues arise depending on the problem. These require certain assumptions or conditions and lead to certain consequences:

Full cost accounting	Partial cost accounting
■ no market price given ■ **pricing** required Question: What price should we offer the goods at? ■ the relationship with competitor's price can be compared ■ price is determined according to the full or total costs: price = cost + profit	■ market price known ■ price assessment is required Question: Is the market price acceptable? ■ if there is free capacity, the acceptance of the single orders is to be decided ■ the lower price limit is determined by the partial or marginal costs.

Examples for comparison: Full cost accounting – Partial cost accounting

Situation 1: No market price is available			
Full cost accounting		**Partial cost accounting**	
Cost elements	€/piece	Cost elements	€/piece
Material direct costs	2.00	Material direct costs	2.00
Material overheads surcharge 10%	0.20	Variable part of the material overheads	0.05
Manufacturing wage costs	0.30	Manufacturing wage costs	0.30
Manufacturing overheads surcharge 300 %	0.90	Variable part of the manufacturing overheads	0.20
Special direct costs	0.10	Special direct costs	0.10
Management and sales overhead surcharge 30%	1.05	Variable part of the administrative and sales overheads	0.20
Cost price	4.55		4.55
Profit surcharge 15%	0.68		0.68
Offer price	5.23	Marginal costs	2.85
This means that the offer price is set to € 5.23/piece.		Here, a price cannot be determined. It must, however, exceed the marginal costs of € 2.85/piece.	

Situation 2: The market price is € 3.85/piece			
Full cost accounting		**Partial cost accounting**	
Cost elements	€/piece	Cost elements	€/piece
Material direct costs	2.00	Material direct costs	2.00
Material overheads surcharge 10%	0.20	Material overheads surcharge 10%	0.05
Manufacturing wage costs	0.30	Manufacturing wage costs	0.30
Manufacturing overheads surcharge 300 %	0.90	Manufacturing overheads surcharge 300 %	0.20
Special direct costs	0.10	Special direct costs	0.10
Management and sales overhead surcharge 30%	1.05	Management and sales overhead surcharge 30%	0.20
Cost price	4.55	Cost price	2.85
This means that the total costs identified are € 0.70piece more than the recoverable proceeds. The order is rejected, as otherwise it would lead to a loss.		This means that assuming there is free capacity, the order will be accepted. This is because the recoverable revenue is € 1.00/piece more than the marginal costs. The operating result is improved as a result.	

(c) The basics of breakeven analysis

Marginal costs

Marginal costs are the extra costs of creating one addition unit, or the costs saved when one less unit is created.

If, for practical reasons, we assume the cost function to be linear, then the variable costs are proportional to the level of activity.

Then, at least within certain levels of activity the marginal cost can be regarded as constant and correspond to the variable costs per unit.

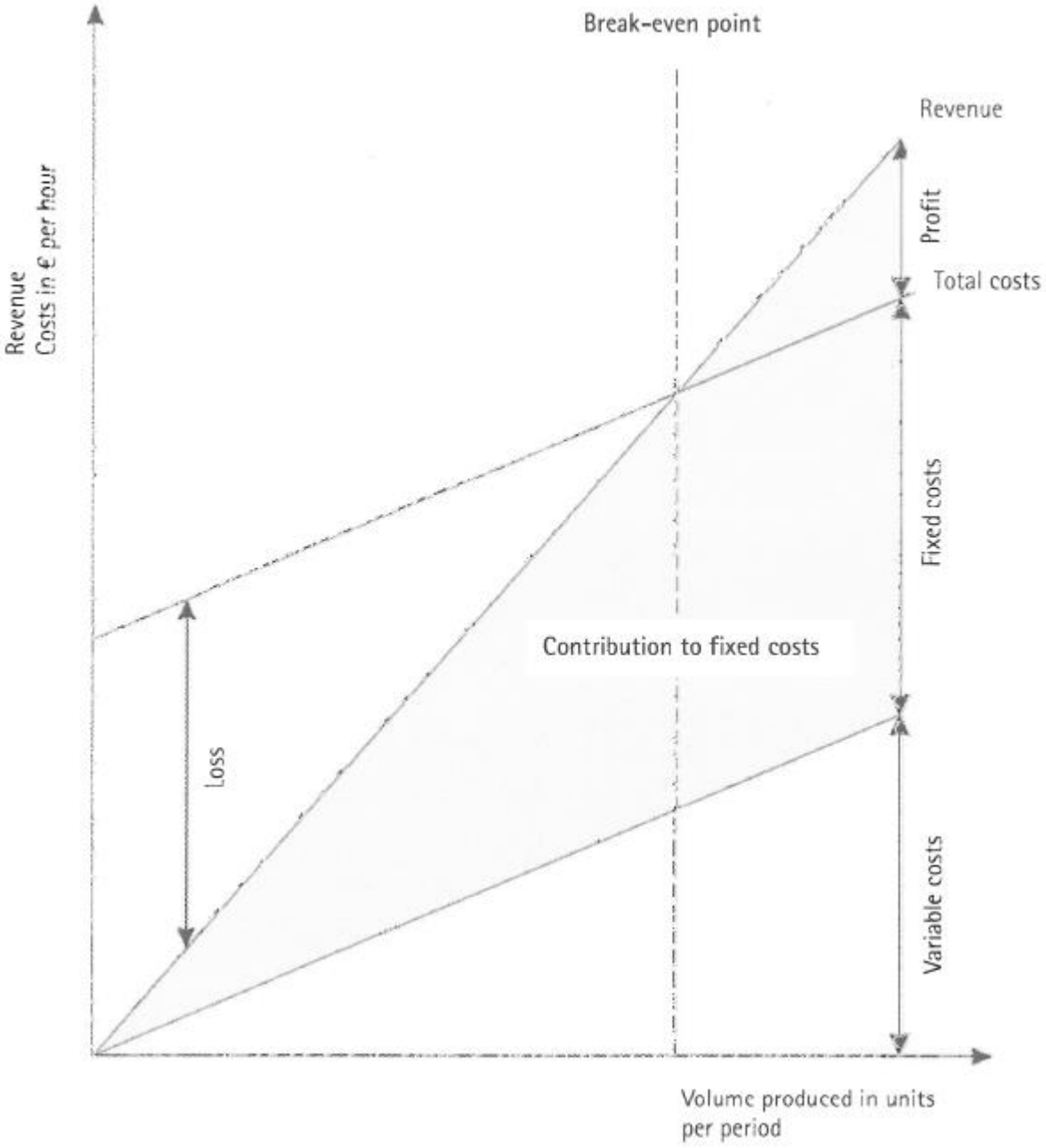
The marginal costs are the absolute lower price limit.

In the long term, a company can exist only if it fully covers its costs with corresponding revenue.

Breakeven point

Breakeven analysis determines the sales revenue needed for a company to make a profit. Falling below this level will lead to a loss.

At breakeven point, the sum of fixed and variable costs equals the sales revenue.



The profits/losses are only the same in the partial and full cost accounts if production volume and sales volume are identical. The breakeven point chart illustrates the impact of revenues, costs, and sales volumes.

Breakeven point:

$$\text{Critical volume} = \frac{Fixed\ costs\ per\ period}{Contribution\ to\ fixed\ costs\ per\ piece}$$

Contribution to fixed costs per piece = Revenue per piece - variable costs per piece

Profit/loss = Revenue - total cost

Profit/loss = Contribution to fixed costs - fixed costs

These basic equations show that the result generated in a period depend on the market price, quantity, variable costs per piece and the fixed costs. The fixed costs are therefore not assigned to the individual product units, but rather compared as a block with the returns.

Example

A company manufactures plastic housings. At a level of activity of 100%, they can make 140,000 pieces per month.

Proceeds	6.85 €/piece
Variable costs	4.35 €/piece
Fixed costs	280,000 €/month

What critical volume and what critical level of activity need to be reached to achieved to fully recover the costs?

Solution

Critical volume = $\frac{280{,}000\ €/month}{(6.85 - 4.35)€/piece}$ = 112,000 pieces/month

Critical level of activity = $\frac{112{,}000\ pieces/month}{114{,}000\ pieces/month}$ • 100 % = 80 %

Contribution to fixed costs

The contribution to fixed costs is the difference between the proceeds and the variable costs (marginal costs). It measures to what extent the fixed costs are covered. The term "contribution" means that each product for which the revenue exceeds the variable costs contributes towards covering the fixed costs. When making short-term decisions, products that deliver at least a positive contribution, should not be taken out of the program, unless better alternatives exist. In the case of free capacity, every product whose costs do not fall below the variable costs is manufactured and sold.

In the short term, each product helps to cover the fixed costs which have already been incurred if the unit revenue (price) exceeds the absolute lower price limit (marginal costs).

Where appropriate, therefore orders are accepted temporarily which do not fully offset the fixed cost coverage, to avoid worse results.

In the long term, however, the price must not be below the total unit costs (full costs).

Therefore dangers to particularly watch out for are:
- The customer getting used to "special conditions"
- The effects of "discounts" on other products and/or other customers

If the sum of the contributions is greater than the fixed costs, the break-even point is exceeded giving a positive result, i.e. profit. The identification and analysis of this contribution is therefore of major importance for making future policy decisions.

Cases:
(1) Positive contribution:

- The contribution covers the fixed costs; i.e. profit.
- The contribution covers the fixed costs exactly; i.e. breakeven.
- The contribution is less than the fixed costs; i.e. loss.

(2) Negative contribution:

- The revenue is lower than the variable costs.

Example

The following situation is predicted by cost and revenue planning for the next billing period:

Product:	A	B	C
Proceeds:	372,000	246,000	314,000
Manufacturing costs: -fixed -variable	Total: 205,000 174,000	 158,000	 166,000
Administrative costs: -fixed -variable	Total: 76,000 3,500	 5,000	 2,000
Sales: -fixed -variable	Total: 36,000 14,500	 16,500	 11,000

The operating results should be determined via the contribution to fixed costs.

Solution

Product:	A	B	C
Proceeds:	372,000	246,000	314,000
Variable costs: -Production costs -Administrative costs -Sales costs	 174,000 3,500 14,500	 158,000 5,000 16,500	 166,000 2,000 11,000
Contribution to fixed costs:	180,000	66,500	135,000
Total contribution to fixed costs:	381,500		
Fixed costs: -Production costs -Administrative costs -Sales costs	 205,000 76,000 36,000		
Profit:	64,500		

Example

The sales volume of a product causes fixed costs of € 360,000/month and variable costs of € 480,000/month. In the same period the contribution to the fixed costs was € 400,000/month.

What was the revenue and how big is the profit or loss?

Solution

Contribution = revenue – variable costs

Thus:
Revenue = contribution + variable costs
Revenue = € 400,000/month + € 480,000/month
= € 880,000/month

Profit or loss = contribution - fixed costs
Profit = € 400,000/month - € 360,000/month
= € 40,000/month

Example

A manufacturing company has a maximum monthly output of 24,000 units (= 100% level of activity) of a particular product. The total costs for
22,200 units are... € 222,600
19,800 units are... € 203,400.

The organizational structure and the production technology remain the same.

We can assume that the variable costs are proportional to the level of activity.

The selling price (unit price) is € 18/unit.

The estimated capacity is 5,000 units per month.

Determine the fixed costs, the contribution per piece, the breakeven point and the profit or loss.

Solution

The change of the total cost at different levels of activity must come from a change in the variable costs.

The variable costs only arise when there is production and are therefore dependant on the quantity or workload.

$$\text{Variable costs} = \frac{Change\ in\ costs}{Change\ on\ production\ volume}$$

$$\text{Variable costs} = \frac{222{,}600\ \frac{€}{month} - 203{,}400\ \frac{€}{month}}{(22{,}200 - 19{,}800)\ pieces/month}$$

= 8 €/piece

Total costs = fixed costs + variable costs

Thus:
Fixed costs = total cost - variable costs/unit • quantity
Fixed costs = € 222,600 - (€ 8/unit • 22,200 units/month)
Fixed costs = € 45,000/month
Contribution per piece = € (18 - 8)/unit = € 10/unit

Critical volume $= \frac{45{,}000\ €/month}{18\ \frac{€}{piece} - 8\ \frac{€}{piece}}$

= 4,500 pieces/month

Profit or loss = contribution per piece • quantity - fixed costs
Profit = € 10/piece • 5,000 pieces/month - €45,000/month
Profit = € 5,000/month

Example

The cost and revenue structure of a company is subject to ongoing changes.
Therefore two possible future situations are calculated from that of a given year to find the possible consequences:

Piece price: € 600/piece

Variable costs per unit:
- Direct material costs € 200/piece
- Variable personnel costs € 150/piece
- Other variable costs € 100/piece

Fixed costs:
- Fixed personnel costs € 7,000,000/year
- Other fixed costs € 5,000,000/year

Situation A: Personnel costs increase by 8% in 2 years.
Situation B: Personnel costs increase by 8% in 2 years. In addition, commodity prices increase by 10% and sales prices by 5%.

	Initial situation	Situation A	Situation B
Price per piece	600	600	630
- Material direct costs	250	200	220
- Variable personnel costs	150	162	162
- Other variable costs	100	100	100
Variable costs per unit:	450	462	482
Contribution per unit	150	138	148
- Fixed personnel costs	7,000,000	7,560,000	7,560,000
- Other fixed costs	5,000,000	5,000,000	5,000,000
Fixed costs	12,000,000	12,560,000	12,560,000
Critical volume	80,000	91,014	84,865

Measures to compensate for the changes to costs and price:
- Reducing fixed costs
  (for example by lowering capital commitment by producing less in-house)
- Increasing the contribution per piece
  (for example by improving the product and so being able to increase the price or reducing the variable costs through productivity improvements)
- Increasing sales
  (for example, by marketing measures)

Example

A company produces a product in three different sizes.

Variant	Quantity produced and sold	Price in €/piece	Costs in €/piece	Variable costs in €/piece
A	20,000	3.20	3.45	2.40
B	55,000	2.85	2.70	2.29
C	90,000	0.90	1.00	0.22
Fixed costs			€ 113,750/period	

All variants can be produced on a single system.

The production times per item are the same for all products.

The management wants to clean up the range.

Therefore one or two variants should be eliminated.

A calculation should be done to aid the decision.

Solution

When using full cost accounting:

Variant	Quantity	Price per unit	Costs in €/piece	Profit in €/piece	Profit in €/variant
A	20,000	3.20	3.45	-0.20	-4,000
B	55,000	2.85	2.70	0.15	8,250
C	90,000	0.90	1.00	-0.10	-9,000
Operating result					-4,750

i.e.: The total loss is € 4,750.

The management decides to stop making A and C to increase the production of B to up to 165,000 pieces if the market is ready for it.

This profit expected from this is € 24,750.

At the end of the accounting period, it turns out, however, that the loss has increased.

When using partial cost accounting:

Variant	Quantity	Price per unit	Variable costs	Contribution per piece	Total contribution
A	20,000	3.20	2.40	0.85	17,000
B	55,000	2.85	2.29	0.56	30,800
C	90,000	0.90	0.22	0.68	61,200
Total operating income:					109,000
- Fixed costs:					113,750
= Operating result:					-4,750

1. Wrong decision: Eliminate A and C, increasing the output of B

B	165,000	2.85	2.29	0.56	92,400
- Fixed costs:					113,750
= Operating result:					-21,350

Result: Ceasing production of A and C would lower the variable costs, but not the fixed costs, which would lead to more losses.

2. Wrong decision: Eliminate A and C, without increasing the output of B

B	55,000	2.85	2.29	0.56	30,800
- Fixed costs:					113,750
= Operating result:					-82,950

Result: A cessation of production of alternatives A and C without compensating by increasing production of B would further increase the loss.

1. Correct decision:
Eliminate B and C if the sales of A can be increased to fill the capacity.

Reason: Variant A has the highest contribution per piece.

A	165,000	3.20	2.40	0.85	140,250
- Fixed costs:					113,750
= Operating result:					26,500

Result: Variant A provides the greatest contribution towards the fixed costs.

2. Conditionally correct decision:

Eliminate A if the volume of each variant cannot be increased and the elimination of at least one variant is mandatory.

Reason for change: B and C have the highest total contribution towards the fixed costs.

B	55,000	2.85	2.29	0.56	30,800
C	90,000	0.90	0.22	0.68	61,200
- Fixed costs:					113,750
= Operating result:					-21,750

Result: The largest contributions towards the fixed costs are provided by B and C.

Note: In the long run, the total fixed costs must be covered completely, because it would otherwise be better to stop production and thereby reduce the associated fixed costs.

Specific contribution:

When there is spare capacity, each product made and sold needs to make a positive contribution towards the fixed costs. When the full capacity is being used, however, this sole criterion of "positive contribution" is no longer enough.

If several products can be produced, and each has a positive contribution to the fixed costs, and capacity is tight, then both the contribution to the fixed costs and the production time need to be taken into account.

Specific contribution to fixed costs = $\frac{Contribution\ to\ fixed\ costs\ per\ unit}{Production\ time\ per\ unit}$

Production should be organized so that the contribution generated is maximal. Priorities may be set by determining the specific contributions. The sales performance of products should therefore be prioritized in the order of their specific contribution. Marketing efforts should therefore be intensified for products with a high specific contribution.

When determining priorities, additional factors must always be taken into account, for example, the stage in the product's lifecycle, market potential, market share, a products place in the range, etc.

Example

Four products are produced at a facility running at its full capacity of 320 hours per month:

Product	Contribution per piece	Production time in min/piece	Rank according to contribution per piece	Specific contribution in €/min	Rank according to specific contribution
A	0.80	0.20	3	4.00	2
B	1.50	0.60	2	2.50	3
C	0.50	0.10	4	5.00	1
D	1.80	0.75	1	2.40	4

Maximum contribution:

- Not taking the bottleneck situation into account:
  Product D, ranked 1 (contribution/piece)!
  1.80 €/ PCs • 320 hours/month • 60 min/hour / 0.75 min/piece
  = € 46,080/month

- Taking into account the bottleneck situation:
  Product C, ranked 1 (specific contribution)!
  € 5/ min • 320 hours / month • 60 min / hour
  = € 96,000/month

Opportunity costs:

Opportunity costs are the costs of a particular choice, resulting from the lost benefits that the best alternative to it would bring. Often, the contributions of the best unrealized usage of capacity are used as opportunity costs.

Opportunity costs =	Specific contribution to fixed costs (displaced)	•	Bottleneck production time (extra)

Example: Displacement in bottlenecks
A customer places a one-time additional order Z, if the complete order can be delivered in the current period. Partial deliveries are not accepted. The order can be fulfilled technically. It would occupy the capacity from Cost Centre K that has a total of 1,400 hours available.

Product	Specific contribution in €/h	Production time in hours
A	72	200
B	45	300
C	65	600
Z	49	800

Total capacity of Cost Centre K: 14,000 hours
- Capacity used already for Products A, B and C: 1,100 hours
- Capacity of the additional order, Z: 800 hours
= capacity that must be freed up: 500 hours

A reduction in the capacity given to the existing products in favour of the additional order Z can be only economically feasible if the capacity of the cost centre is used more successfully.

Solution

Due to the specific contribution rankings, Product B can be economically replaced. However the capacity released by this is only 300 hours which is not sufficient to free up the total required capacity of 500 hours for Order Z. The missing capacity of 200 hours can be obtained by reducing the production of another product. The specific contribution will not help here. If we just looked at that, then the Order Z would have to be rejected because the specific contribution of the other products are higher.

The opportunity costs should be used. This means the contribution lost by displacing the planned production. The products with the least specific contribution are taken out of production until the capacity of 400 hours needed is freed up.

Opportunity cost = € 45/h • 300h + € 65/h • 200h = € 26,500

The additional orders use the capacity freed up to generate:

Contribution = € 49/h • 500 h = € 24,500

Thus, the opportunity costs are higher than the contribution which can be gained.

However, this assessment is only correct about the alternative use of the displacement capacity of 500 hours.

The additional order should be accepted as that would make a contribution of
€ 49/h • 800h = € 39,200
as a further 300 hours of capacity is used in Cost Centre K.

Due to this decision, the additional order is accepted, displacing Product B completely and Product C partially:

Additional contribution = Contribution of additional order - opportunity cost
= € 39,200 - € 26,500 = € 12,700

(d) In-house production or external procurement: The "make or buy" problem
The following table allows one to draw conclusions, at least from an accounting point of view, about in-house production and external procurement.

Decision	In-house production, if	External procurement, if
When there is capacity free	variable costs are less than the purchase price	variable costs greater than purchase price
When capacity is fully used	variable costs + opportunity costs is less than purchase price	variable cost + opportunity costs is greater than purchase price
When there is a bottleneck which is eliminated by investment	Total cost less than purchase price	Total cost greater than purchase price

If there is capacity free, the fixed costs are irrelevant to decision making, because the fixed costs remain the same regardless of the decision. In addition, including fixed costs of not fully utilised cost centres would increases the costs of in-house production strongly. The decision would then be for external procurement and the underemployed cost centre would receive even fewer orders.

If the cost centre is operating at full capacity or above capacity, valuations must be made based on the situation in which, for example, the additional costs of external procurement are compared with the displaced contribution (opportunity cost) of addition saleable production.

Of course, quality, deadline and risk aspects must be taken into account.

Example

Product	Quantity needed in pieces/month	Capacity needed in min/month	Specific contribution in €/min	Rank	Total contribution in €/month
A	6,300	3,150	8	2	25,200
B	5,500	1,650	15	1	24,750
C	8,700	4,350	5	3	21,750
D	4,400	1,760	3	4	5,280
		10,910			76,980

The machine has a capacity of 10,910 minutes/month. Currently, the machine is fully utilized making products A, B, C and D.

A new product, N, could be produced on this machine or eternally procured. 6000 pieces / month are expected to be needed. For in-house production there would be variable costs of € 5/piece. The production time would be 0.6min/piece. The price for external procurement would be € 8/piece.

Solution

Capacity requirements for Product N:

6000 pieces/month • 0.6min/piece = 3600min/month

For in-house production, 3600min/month of capacity would have to be deployed. Due to their low specific contribution, Product D would be fully displaced (1760 min / month) and Product C partially displaced (1840min/month):

Product	Quantity needed in pieces/month	Capacity needed in min/month	Total contribution in €/month
A	6,300	3,150	25,200
B	5,500	1,650	24,750
C	5,020	2,510	12,550
		7,310	62,500

Decision when running at full capacity:

- Variable costs of in-house production of Product N: € 5/piece
- Opportunity cost (displaced contribution) of Product N:
- $$\frac{76{,}980\frac{€}{month} - 62{,}500\frac{€}{month}}{6{,}000\frac{pieces}{month}} = 2.41\ €/\text{piece}$$
- Cost of product N: € 8/piece

Result
Variable cost + opportunity costs < purchase price
€ 5/piece + € 2.41/piece < € 8/piece
i.e.: The decision is to produce N in-house!