# Determination of the Average Quality of a Company Based on the Obtained Results

Nicolae Dobrițoiu

***Abstract*—**The average quality of a company is the most complex indicator of the activities of a company because it depends on all these activities. In determining this indicator, a qualitative failure of a function can not be compensated with qualitative achievements of other functions or activities of a company. The average quality of a company is expressed best in points, and when it tends toward maximum score indicates a high economic efficiency of the company. We present in this paper a method for determination of the average quality of a company based on the obtained results. Finally, a practical example is given.

***Keywords*—**Quality, total quality, average quality, method, qualitative characteristics, planned production, achieved production, moisture content, ash content.

## I. THE CONCEPT OF QUALITY

A given product can be technically perfect, it can be manufactured out of adequate materials and through an effective technological process and yet, it may be rejected by target customers proving to be unsuccessful on the market. This means that technologist's opinion concerning the concept of quality does not always match that of consumers. The products that meet the standards are not necessarily successful from a commercial point of view. Well, then what is the use of quality if, despite it`s complying with standards, the product is not accepted thus being unable to yield the profit needed by the company to hold out ? Should the concept of quality be revised and then redefined ?

The idea of quality viewed only as adjustment to standards was useful within a background where the ratio demand / capacity was higher than the unit. This situation held through in the fifties and sixties.

But as the balance between these two terms became more obvious, selling also became more difficult, others strategies being necessary. Therefore marketing underwent an important development as a means of selling products facing greater competition (in the seventies).

At present, one can find saturated markets and ever more demanding consumers. It is already no longer enough to manufacture well. What is needed is to facilitate what consumers do expect, to adjust products to their needs, demands and expectations.

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For this reason, it is necessary to devise a new conception concerning quality which is expected to take into account the target customer for the product or service and even more than that, to place the customer on the central axis of organizational activities. In order to best point out the concept of quality, several definitions that go beyond the classical meaning of quality will be introduced further on.

- Predictable degree of uniformity at low cost, adequate to market needs (Deming).
- Designing, producing or providing goods or services that are useful as economically as possible, as well as satisfactory to the beneficiary (Ishikawa).
- Quality: the extent to which a set of intrinsic characteristics (distinctive feature) meeting the demands (need or expectation which is declared, generally implicit or compulsory), ([8]).
- "Extension through which a product or service fulfils a customer's specifications and is in compliance with its use". (U.S.A., Administration and Budget Department, 1988).

In the foregoing definitions, it can be noticed that the reference to customer and to meeting his needs is a common element. If a choice were to be made, then probably it would choose Juran's definition (1993):

"Quality is the set of characteristics of a product meeting the customers' demands and consequently, makes the product be satisfactory."

In conclusion, quality can be said to possess a dynamic in space, time and in the customer's level of education.

## II. THE CONCEPT OF TOTAL QUALITY

Quality consists in creation of products or services that are satisfactory for the customer; consequently, one has to incorporate into it all the activities through which this satisfaction is received, irrespective of the place or type of company where the process is performed.

This implies ensuring: the quality of products and services; the quality of resources; the quality of processes; the quality of both technical and human resources; the quality of administrative activities (see [5] and [7]).

This conception comprising all of the organization and all of the activities is called total quality. However, total quality is not only a way of thinking but mainly a set of principles and methods aiming at satisfying the customer at the lowest cost. In order to fully understand the total quality notion, it must be mention a set of fundamental concepts.

The total quality implies:

- Orienting the organization toward the needs of the customer. Meeting of demands is the main issue. With this objective, the company is expected to focus on important processes which bring added value and make possible the achievement of this aim.

- The broadening of the customer`s concept. The organization can be conceived as a system integrating providers and customers. Applying the quality also means meeting the needs of the inside customer.

- Holding the leading position as far as prices are concerned. Quality is costly but non-quality is even more costly. Centring attention on customer needs and expectations, they will be better achieved if the costs transferred to customer will be lower.

This cut in costs ensures a competition on the market with genuine chances of success. It is therefore necessary for the costs of non-quality to be quantified.

- Prevention-based management. The underlying idea is that of doing things well from the first time and each and every time. It is better than in the case of the classical operations of detection and correction. The need to resort to control is reduced thus minimizing costs. This is the meaning that Crosby gave to phrase zero-faults.

- Improvement of the human factor. Quality is not to be controlled; it is achieved by the people belonging to the organization concerned, by all of them, without exception. Therefore, the establishment of a human resources management is necessary, starting with motivation for quality and participation.

- Continuous improvement. The quality must be conceived as being a horizon rather than a goal. Total quality is not achieved, but it is aimed at a horizon which expands as it progresses. This implies the idea of the continuous improvement of quality. It is always possible for products and services to be of higher quality and better adjusted to the needs and expectations of the customer which, on the other hand are dynamic.

## III. EXPRESSION OF QUALITY

Companies producing and providing products or services have as beneficiaries: various organizations (companies, cultural, religious, political or legal organizations etc.); segments of population within a certain geographical area such as: age groups, professional groups, groups of the population from a certain level of education, political groups, social groups, etc.

For a company to operate and to develop, it must, first and foremost, produce and provide products or services demanded by society. In other words, these products or services must meet, to a high degree the needs, requirements and expectations of the population (beneficiaries).

The existence of a fraction of inadequate products and services produced within a certain period of time and the possibility of taking a wrong decision concerning the quality of the products or services provided require the fixing of the following quality indicators:

1. Average quality after control (*AOQ*) - is an indicator of the efficiency of a certain plan of control and it represents the average quality of the products and services provided after the control of a certain number of batches.

Within the sequence of control operations, apart from the accepted batches there will be rejected batches which will be checked up wholly and the inadequate products and services will be corrected.

If the sample, in the case of the accepted batch, has been reintroduced into the accepted batch without the inadequate products or services being corrected, the average quality after control will be:

$$AOQ = P \cdot P_a + 0(1 - P_a) = P \cdot P_a$$

If, however, the sample is "filtered out" of the inadequate products or services before its being returned to the batch after the control operation, then the indicator is determined as follows:

$$AOQ = P \cdot P_a \left(1 - \frac{n}{N}\right) .$$

Both the beneficiary and the provider are interested in knowing the *AOQ* indicator; the first is interested in benefiting from batches of products or services of an average quality after control corresponding to his flow of achievement of products or services, while the latter is interested in having an average quality after control very much like the quality of the batches he presented on the taking of delivery to avoid having to sort out a large number of rejected batches.

2. The limit of average quality after control (*AOQL*). It represents the maximum value of indicator *AOQ*, being the lowest level of the accepted average quality, i.e.:

$$AOQL = \max_{0<P<1}(P \cdot P_a) = \max_{0<P<1}\left[\sum_{d=0}^{A} C_n^d \cdot P^d \cdot (1-P)^{n-d}\right].$$

3. Acceptable quality level (*AQL*). It represents the maximum percentage of inadequately solved situations or the maximum number of inadequate solutions out of one hundred situations (number of inadequate services/100 situations) for which the batch of products or services is considered to be acceptable from the point of view of the average quality of products or services.

The *AQL* value is fundamental to the application of the standards of quality statistic control, providing the real basis for the acceptance of a number as large as possible of adequate batches and the rejection of a number as large as possible of batches inadequate from a qualitative point of view.

Reference literature as well as control standards recommend that the fixing of the value *AQL* should be done at the level agreed upon by the contract concluded between the partners.

If there is a great number of characteristics to be controlled and if there is a distinct *AQL* for each of them ($AQL_1$, $AQL_2$, …, $AQL_n$) and of distinct admissible faults respectively ($A_1$, $A_2$,…, $A_n$) then the global $AQL_g$ level is determined by means of the formula:

$$AQL_g = \sqrt[n]{AQL_1 \times AQL_2 \times \cdots \times AQL_n}$$

and

$$A_g = \sqrt{A_1^2 + A_2^2 + ... + A_n^2} \quad \text{respectively.}$$

*AQL* represents, also, in the standards for quality control one of the invariable elements of identification of a control plan.

## IV. SIMULATION FOR ESTABLISHING THE AVERAGE QUALITY OF A COMPANY

The establishing of the average quality of a company is done by the following methods:

1. *Determining the average quality at level of organizational structure* ([2])

This method requires knowledge of the following information:

- the structure as types and number of organizational subdivisions; at the level of organizational subdivisions must knew the following information: functions, activities, responsibilities, tasks and operations which must be carried;
- the structure as types and number of execution and management positions; at the level of post, the job description must be known in detail.

To determine the average quality at level of organizational subdivision or execution post and management (functional and of execution) must be known the obtained results and qualitative characteristics that describe these results.

Each quality characteristic that describes an outcome is quantified by a measured value or conferring value.

*Example*: To determine the average quality of an operation is needed to identify the following issues: the result, qualitative characteristics that describe the result and values of each qualitative characteristic, separately.

For the values that quantify the qualitative characteristics is necessary to know the programmed (planned) values and the achieved values.

2. *Determining the average quality for a function or activity performed in a company* ([3])

This method requires knowledge of the following information:

- the name of functions or activities performed in a company;
- the intensity at which it is performed a function or activity in a company, from point of view of programming (planning) and achievement;
- the results obtained by exercising a function or an activity performed in a company;
- the qualitative characteristics that describe each result from a qualitative point of view;
- the values (planned and achieved) of each qualitative characteristic, separately.

3. *Determining the average quality for a result obtained in a company*

This method requires knowledge of the following information:

- the list of results obtained in a company (products, services);
- the programmed values (planned) and achieved for each result;
- the amount of work required to obtain of one result within each type of result obtained in the company;
- the consumption norms and specific consumptions made per unit of product from each type of obtained result;
- the qualitative characteristics and their values (planned or achieved) that describe each type of result, obtained in the company.

*Remark*. The databases used for determination of the average quality values in the company, by the three methods, are different, but the results obtained by the three methods will be about the same.

## V. PRACTICAL EXAMPLE

In the practical example presented below, we use the method "*Determining the average quality for a result obtained in a company*".

The mining company (E.M.C. ...., belonging to mining basin Oltenia) for which it will determine the average quality, aims the capitalization of a lignite deposit through opencast mining ([5]).

The mining company's activities are evidenced by the following results:

a) production of coal extracted and delivered to beneficiaries. Making coal production requires the following activities:

- digging and loading of coal from working face with rotor excavators;
- transport of coal, using the continuous haulage system (conveyor belt), to the coal yard or to charging stations railroad;
- storage of coal in coal yard or direct loading in railway wagons;
- determining the quality of coal delivered to power plants.

b) stripping of dead rock located in the roof of the coal seam. This activity includes the following complex of works:

- excavation and loading of dead rocks from the roof of the coal seam using the rotor excavators;
- transport of dead rocks to the point of dumping using the continuous transport system (conveyor belt) and deposit of the dead rocks using the barren rock adjustable stacker;
- cleaning the stripped coal seam stripped of covering dead rocks.

c) the type of ancillary activities (maintenance, transport of materials and personnel, administration, electrical power feeding, financial, accounting, commercial, personal, etc.).

### *A. Determining the Average Quality of Achieved production*

The achieved production must provide the following quality features:

- calorific power Q=1924 Kcal/kg;
- ash content A=35,4%;

- moisture content W=42,3%.

The values of the quality parameters for the coal production obtained in a period of one month, in 2011, are shown in Appendix 1.

Determining the qualitative characteristics of the products supplied, shown in Appendix 1 is made in the activity "determining the delivered quality" that includes the following works:

- collect of coal samples during loading railway wagons, according to standards of making samples developed at the level of mining basin;
- processing of collected coal samples, to obtain the tests of coal samples (three tests of samples) with the following purposes: a test of sample is sent to beneficiary's lab, a test of sample is sent to the mining company's lab and a test of sample is kept as a blank sample;
- the values of quality characteristics are established in the laboratories and they are presented in Appendix 1;
- if, between the values of quality characteristics resulting from analyses made by the two laboratories, there are significant differences, then it resort to blank sample to determine the values of the quality characteristics for the disputed sample in this case. The test of blank sample will be analysed by a neutral laboratory.

Depending on the values of the quality characteristics obtained in laboratory tests, the following parameters are calculated:

1. The average values of moisture content $U_r$, and of ash content $A_r$, are determined by the relations:

$$U_r = \frac{\sum_{i=1}^{n} U_i \cdot Q_i}{\sum_{i}^{n} Q_i} = 42.9\,\% \quad \text{and}$$

$$A_r = \frac{\sum_{i=1}^{n} A_i \cdot Q_i}{\sum_{i}^{n} Q_i} = 36.66\,\%$$

where:

$U_i$ is the average moisture content in %, as determined in the laboratory for the quantity of coal transported by a trainset;

$A_i$ represent the average content of ashes, in %, determined in the laboratory for the quantity of coal transported by a trainset;

$Q_i$ is the quantity of coal in t, transported by the trainset i

*i* the number of trainset.

2. Calculation of run-of-mine output recalculated and delivered $P_{br}$ is made with the relation:

$$P_{br} = Q_b \frac{100 - U_r}{100 - U_p} \cdot \frac{100 - A_r}{100 - A_p} \quad , \quad \text{i.e.}$$

$$P_{br} = 170509 \frac{100 - 42.9}{100 - 42.3} \cdot \frac{100 - 36.66}{100 - 35.4} = 165444.8 \text{ t}$$

3. The gain or the loss of production, $P_{pc}$, due to unfulfillment of values of quality parameters is done with the relation:

$P_{pc} = P_{br} - P_b = 165444.8 - 170509 = -5064.19$ t .

But not achieving the two parameters by the mining company lead to a loss of a coal quantity of 5064.19 t.

The beneficiary shall pay to the company, only $P_p$=165,444.8 t.

The daily productions, have different periods of storage (column 6 of Appendix 1), and this leads to additional heat loss, due to the coal oxidation phenomenon.

The amount of heat that would have delivered is calculated by the relation:

$Q_l = P_p * Q_P = 165444.8 * 1924 = 318315795$ Mcal ,

where: $Q_P$ is planned calorific power.

In fact, the mining company delivers 312768420 Mcal that is calculated value (column 7 of Appendix 1).

The lost or gained heat, $Q_{pc}$, is:

$Q_{pc} = Q_l - Q_r = 312768420 - 318315795 =$

$= -5292599$ Mcal $= -5292.599$ Gcal,

and in this case, heat is lost.

This loss is given by the coal storage periods in coal yard. During the storage from the mass of coal a percent of volatile substances is emitted and at the same time begins the process of oxidation.

The process of oxidation is directly proportional to the storage period and the environmental temperature of coal yard.

Average quality of delivered production in the analysed period (one month) is determined by the following parameters:

-the amount of lost or gained coal due to tracked quality parameters: moisture content and ash,
$P_{pc} = -5064.19$ t;

- amount of heat lost due to storage duration,

$Q_{pc} = -5292.599$ Gcal.

For the analysed period the average quality of production is determined following the next steps:

Step 1. For each quality characteristic describing the delivered production, it calculates the following indices:

- for lost or gained production, it determine the achievement index of sold production, $i_{Pv}$, with the relation:

$$i_{Pv} = \frac{P_p}{P_l} \cdot 100 = \frac{165444.8}{170509.0} \cdot 100 = 97.02995\% \quad ,$$

where: $P_l$ is the delivered production, t,

$P_p$ is the paid production, t;

- for the quality characteristic "lost or gained heat", the achievement index of sold heat, $i_{Qv}$,, is determined by the relation:

$$i_{Qv} = \frac{Q_p}{Q_l} \cdot 100 = \frac{312768420}{318061019} \cdot 100 = 98.33598\% \ ,$$

where: $Q_p$ is the amount of paid heat, Gcal,

$Q_l$ is amount of heat to be delivered, Gcal;

- for the characteristic "unit cost of production" is determined the achievement index of production cost, $i_c$, by the relation:

$$i_c = \frac{c_p}{c_r} * 100 = \frac{58.73}{55.18} \cdot 1000 = 106.433490\%$$

where: $c_p$ is the planned unit cost, lei/t

$c_r$ is achieved unit cost, lei/t.

Step 2. It is calculates the average quality of the delivered production, $Q_{m1}$, by the relation:

$$Q_{m1} = \sqrt[n]{\prod_i^n i_i} \cdot 10 = \sqrt[3]{i_{pv} \cdot i_{Qv} \cdot i_c} \cdot 10 =$$

$$= \sqrt[3]{97.02995 \cdot 98.33598 \cdot 1000} \cdot 10 =$$

$$= 984.47815 \text{ points.}$$

*Remarks*

1. In the calculus of average quality of the delivered production, $Q_{m1}$, it will take only the values lower or equal to 100 for the achievement indices, since overcome these indicators, more than 100%, does not compensate for failures of indicators that have values less than 100%.

2. We consider that the expression of average quality by points (maximum 1000) is more suggestive than the expression in per cent.

According to the planned information, on the analysed month, the mining company has not obtained the planned quality, to the product "delivered coal", but it has the possibility to achieve the average quality in the coming months by improving the quality characteristics "lost or gained production" and "heat lost due to storage periods".

*B. Determining Average Quality of Overburden, Transport and Deposit of Dead Rocks in Waste Dump*

Stripping a layer of coal consists of the following types of work:

- cutting and loading of dead rocks in face line;
- transport of dead rocks to waste dump onto the conveyor belt;
- the deposit of dead rocks in waste dump;
- arrangement of the waste dump.

Regarding the cutting activity it may follow the operations below:

- cutting of the dead rocks and its loading into the transport equipment;
- cleaning the coal layer`s surface of dead rocks.

The work of cleaning the contact surface between the layer of coal and the massif of rocks located in the roof of layer has a special importance for the quality of delivered coal; an improper cleaning allows increasing the ash content of extracted coal by increasing the content of dead rocks in coal extracted. Artificial growth of ash content of mining production leads to additional costs in the use of coal at electricity production, namely:

- the cost of loading and transporting dead rocks in coal yard;
-the cost of loading and transport of dead rocks from coal yard to power plant;
- the cost of dead rocks storage in warehouse of power plant;
- the cost of loading the dead rocks on belt conveyors, transporting at grinding mills, grinding and transporting at outbreaks of burning of boilers for the production of thermal energy;
- the fuel consume cost achieved by outbreaks of burning of boilers for passing dead rocks through boiler furnaces, (as shown, when the dead rocks, pass through outbreaks of boilers of thermal energy production, not produce energy, but on the contrary it consumes a significant amount of energy);
- the cost of ash disposal resulting from passage of dead rocks through outbreaks, transport and storage of ash in the ash dumps;
- the cost of transforming the ash heaps in farmland.

The cost of passing a ton of dead rocks through the above circuit is quite significant, because it produces only loss, by energy consumption: rock ramming, loading, transport, storage, grinding and passing through by the outbreaks of burning of boilers for the production of thermal energy, transport of ash to ash heaps and its dumping. All this energy consumptions represent for the mining company and for the power plant a significant loss, which leads to increased cost of production of a kilowatt of energy.

Of all the overburden works performed in a quarry, the cleaning activity of the contact surface between the seam of coal and massif of rocks which cover the seam has a significant importance in achieving a high quality of mining production; it is the activity that most influence the quality of coal. In practice, this activity is not assigned due to importance.

To achieve the two main groups of activities, are required a range of services and works performed by various activities performed in a quarry.

For the company, considered as example, the result of the dumping is the amount of cubic meters of unrocked sterile, loaded, transported and deposited in waste dump and, also, construction of waste dump.

Of financial documents (budget of revenue and expenditure) in 2012, we took the values of overburden, achieved and programmed, in thousands of cubic meters that are presented in Table 1.

Table 1
Planned and achieved values of overburden in 2012

| Specifications | Planned | Achieved |
|---|---|---|
| Amount of dead rocks (thousands mc) | 31300.0 | 31522.0 |
| Unit cost of dead rock from overburden (thousands mc) | 8.23 | 8.88 |

Regarding the quality of waste dump construction, there are no information, but some of the information, necessary to determine the quality of waste dump will be determined over time. Example: Information relating to transforming the ash heaps in farmland, or information concerning the stability of the waste dump.

The calculus of achievement indicators of the quality characteristics:

1. Achievement indicator of overburden ($i_1$), is determined by the relation:

$$i_1 = \frac{V_r}{V_p} \cdot 100 = \frac{3152.2}{3130} \cdot 100 = 100.7092652\%$$

where: $V_r$ is the achieved volume of overburden
Vp is the planned volume of overburden.

According to this indicator is recorded as exceeding of the overburden achievement to 0.709%, which, in terms of quality, is good.

2. Achievement indicator of unit cost of stripped dead rock ($i_2$), determined by the relation:

$$i_2 = \frac{c_p}{c_r} * 100 = \frac{8.23}{8.88} \cdot 100 = 92.6802\% .$$

In this case, the value of achievement indicator of unit cost of dead rock, must be greater than or equal to 100%, so that the overburden activity to be considered acceptable from qualitative point of view.

As shown, the achieved unit cost for dead rock from overburden, is greater than planned value, which leads to an additional cost of 0.55 lei/mc (cubic meters), and the achievement indicator is exceeded with 100-92.6802 = 7.3198%, which is considered qualitatively negative.

Qualitative characteristics, such as the cost of filing of dead rocks in waste dump and its arrangement are unknown. In this situation, the average quality of dead rock volume is determined depending on these two quality characteristics.

Average quality of stripping results, $Q_{m2}$, is determined by the relation:

$$Q_{m2} = \sqrt[n]{\prod_j^n Q_j} \cdot 10 = \sqrt{i_1 \cdot i_2} \cdot 10 =$$

$$= \sqrt{100 \cdot 92.682} \cdot 10 = 962.7056 \text{ points}$$

When we know all the values of the qualitative characteristics that describe, from qualitatively point of view, the results of the stripping activity, the model of establishing the average quality of these results is identical to that presented in Section 5.1.

*C. Model for Determining the Average Quality of the Company*

The average quality of the company, based on the quality of results obtained by the company is determined following the steps:

Step 1. The average quality is determined for each type of product, service and performed work, by the relation:

$$Q_{ji} = \frac{V_{ip}}{V_{ir}} \cdot 10 \text{ points} \quad \text{or} \quad Q_{ji} = \frac{V_{ir}}{V_{ip}} \cdot 10 \text{ points},$$

where:

$V_p$ and $V_r$ are the values of the planned production and of the achieved production, respectively;

10 is a conversion factor from per cent to points

j is the type of result (product, work and service)

i is the number of products, services or works.

Step 2. It calculates the average quality, $Q_{mj}$, for each type of result (products, services and works done by the company), by the relation:

$$Q_{mj} = \sqrt[n]{\prod_i^n Q_{ji}}$$

where:

i represent the number of products, services and works, respectively,

j represent the type of result (products, services and works done by the company).

Step 3. It calculates the value of the average quality of the company, $Q_{mf}$, by the relation:

$$Q_{mf} = \sqrt[n]{\prod_j^m Q_{mj}} \ .$$

For the considered example, the average quality of the company is:

$$Q_{mf} = \sqrt[n]{\prod_i^n Q_{mi}} = \sqrt[2]{Q_{m1} \cdot Q_{m2}} =$$

$$= \sqrt{984.47813 \cdot 962.7056} = 973.531 \text{ points.}$$

## VI. CONCLUSION

To better express the average quality produced by a company it is proposed its expression in points. In the example solved, the maximum score you can get the average quality of a company is 1000 points.

Quality done by mining company, in the month that is reviewed, may be considered satisfactory, since it approaches the maximum score 1,000 points.

The work undertaken in mining company, in terms of quality, can be improved by reducing ash percentage of coal delivered and by reducing coal storage period.

Also, the quality of delivered production is influenced by the quality of all activities carried out at mining company. The not achieving of quality of an activity contributes with a number of points, minus, to quality of delivered production.

An achievement or an exceedance of planned quality for a certain activity does not contribute to the quality improvement of another activity that did not achieve the planned quality.

By this model of establishing the average quality for a company, one can identify the non-quality results, and therefore the company's management can take technical and organizational measures to address these failures in the field of average quality.

Research studies show that the efforts of a company to achieve the maximum score are high. As we approach an average quality having the value 1000, the efforts made by the company to increase the quality with a point, are growing.

The manager of a company should not be satisfied, ever, with the average quality of company, even if it tends to 1000 points because there are always possibilities for improvements of activities.

Finally, it should be noted that all the references constituted an important and vast scientific research material that was useful in preparation of this paper.

## APPENDIX 1

The quality parameters of the production achieved by a mining company in October 2011

| No. crt. | Measured parameters | | | | | | | Calculated parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A coal transport | Measured Moisture $W_t$ [%] | Measured Ash Aanh [%] | Determined calorific power $Q_{im}$ [Kcal/Kg] | Delivered Production [tons] $P_{im}$ | Age [days] | Delivered heat $Q_{il}$ [Mcal] | Delivered production - recalculated $P_{ir}$ [t] | Delivered production, lost or gained $P_{ipc}=P_{ir}-P_{im}$ [t] | Heat to be delivered $Q_{ic}=P_{ir}*1924$ [Mcal] | Lost or gained heat $Q_{il}$ - $Q_{ic}$ [Mcal] |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1 | 1 | 41.9 | 40 | 1750 | 2639 | 45 | 4618250 | 2468.076 | -170.924 | 4748577 | -130327 |
| | 2 | 40.9 | 40 | 1800 | 2727 | 45 | 4908600 | 2594.272 | -132.728 | 4991380 | -82779.7 |
| | 3 | 40.6 | 44.2 | 1640 | 3144 | 45 | 5156160 | 2795.728 | -348.272 | 5378980 | -222820 |
| 2 | 1 | 42 | 37.8 | 1830 | 3018 | 45 | 5522940 | 2920.985 | -97.0153 | 5619975 | -97034.6 |
| | 2 | 43.1 | 32.6 | 1980 | 1416 | 45 | 2803680 | 1456.891 | 40.89108 | 2803058 | 621.5566 |
| 3 | 1 | 41 | 40.6 | 1770 | 2662 | 40 | 4711740 | 2502.869 | -159.131 | 4815521 | -103781 |
| | 2 | 42.2 | 38.7 | 1800 | 2388 | 40 | 4298400 | 2269.94 | -118.06 | 4367364 | -68963.8 |
| | 3 | 42.4 | 41.1 | 1690 | 1480 | 40 | 2501200 | 1347.073 | -132.927 | 2591769 | -90568.6 |
| 4 | 1 | 42.7 | 39.6 | 1740 | 3133 | 40 | 5451420 | 2908.999 | -224.001 | 5596915 | -145495 |
| 5 | 1 | 42 | 31.3 | 2080 | 2910 | 20 | 6052800 | 3110.781 | 200.7806 | 5985142 | 67658.03 |
| | 2 | 44.2 | 43.9 | 1515 | 2948 | 45 | 4466220 | 2475.804 | -472.196 | 4763446 | -297226 |
| | 3 | 41.8 | 33.3 | 2015 | 2215 | 15 | 4463225 | 2306.823 | 91.82271 | 4438327 | 24898.11 |
| 6 | 1 | 42.4 | 34.5 | 1950 | 3532 | 15 | 6887400 | 3575.001 | 43.00083 | 6878302 | 9098.4 |
| | 2 | 38.6 | 46.5 | 1625 | 2910 | 45 | 4728750 | 2564.524 | -345.476 | 4934145 | -205395 |
| | 3 | 42.4 | 47.6 | 1405 | 1701 | 45 | 2389905 | 1377.367 | -323.633 | 2650055 | -260150 |
| 7 | 1 | 43.3 | 44 | 1540 | 2707 | 45 | 4168780 | 2305.956 | -401.044 | 4436659 | -267879 |
| | 2 | 41.5 | 33.6 | 2025 | 2260 | 15 | 4576500 | 2355.18 | 95.17972 | 4531366 | 45134.21 |
| 8 | 1 | 41.6 | 43.8 | 1620 | 3199 | 50 | 5182380 | 2816.794 | -382.206 | 5419511 | -237131 |
| | 2 | 45.4 | 47.9 | 1325 | 730 | 50 | 967250 | 557.1151 | -172.885 | 1071889 | -104639 |
| 9 | 1 | 47.4 | 31.6 | 1830 | 2617 | 40 | 4789110 | 2526.023 | -90.9774 | 4860068 | -70957.5 |
| | 2 | 45.4 | 32.2 | 1895 | 1571 | 40 | 2977045 | 1560.236 | -10.7644 | 3001893 | -24848.3 |
| 10 | 1 | 44.8 | 32 | 1930 | 1372 | 30 | 2647960 | 1381.636 | 9.636413 | 2658268 | -10308.5 |
| 11 | 1 | 44.7 | 35.5 | 1815 | 2930 | 30 | 5317950 | 2803.781 | -126.219 | 5394475 | -76525.2 |
| | 2 | 44.4 | 30.5 | 2005 | 1266 | 15 | 2538330 | 1312.457 | 46.45666 | 2525167 | 13163.39 |
| 12 | 1 | 42 | 32.7 | 2020 | 3156 | 15 | 6375120 | 3305.002 | 149.002 | 6358824 | 16296.23 |
| 13 | 1 | 41.7 | 34.6 | 1975 | 2043 | 20 | 4034925 | 2089.808 | 46.80777 | 4020790 | 14134.86 |
| 14 | 1 | 43.8 | 39.5 | 1700 | 2146 | 30 | 3648200 | 1957.551 | -188.449 | 3766328 | -118128 |
| | 2 | 40.1 | 42.6 | 1720 | 3265 | 30 | 5615800 | 3011.713 | -253.287 | 5794536 | -178736 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1 | 37.8 | 36 | 2095 | 3222 | 15 | 6750090 | 3441.023 | 219.0229 | 6620528 | 129561.9 |
| | 2 | 43.5 | 37.7 | 1780 | 2234 | 45 | 3976520 | 2109.654 | -124.346 | 4058975 | -82455.2 |
| 16 | 1 | 44.3 | 28.3 | 2100 | 3034 | 10 | 6371400 | 3250.735 | 216.7352 | 6254415 | 116985.4 |
| 17 | 1 | 42.8 | 31.9 | 2030 | 2730 | 10 | 5541900 | 2852.972 | 122.9717 | 5489117 | 52782.54 |
| | 2 | 42.3 | 30.9 | 2100 | 873 | 10 | 1833300 | 933.8127 | 60.81269 | 1796656 | 36644.38 |
| 18 | 1 | 44.9 | 27.6 | 2090 | 2858 | 10 | 5973220 | 3058.751 | 200.7505 | 5885036 | 88183.97 |
| | 2 | 42.3 | 30.8 | 2100 | 1450 | 10 | 3045000 | 1553.251 | 103.2508 | 2988454 | 56545.51 |
| 19 | 1 | 42.6 | 33.2 | 1990 | 2936 | 15 | 5842640 | 3020.203 | 84.20259 | 5810870 | 31770.23 |
| | 1 | 43.3 | 37 | 1810 | 1691 | 15 | 3060710 | 1620.537 | -70.4632 | 3117913 | -57202.7 |
| 20 | 1 | 41.8 | 38 | 1845 | 3125 | 15 | 5765625 | 3025.216 | -99.7842 | 5820515 | -54890.3 |
| | 2 | 42.1 | 37.2 | 1860 | 2129 | 15 | 3959940 | 2076.852 | -52.1481 | 3995863 | -35923.1 |
| 21 | 1 | 42 | 37.7 | 1805 | 2878 | 15 | 5194790 | 2789.963 | -88.0366 | 5367889 | -173099 |
| | 2 | 42.5 | 42.9 | 1625 | 3117 | 40 | 5065125 | 2745.569 | -371.431 | 5282476 | -217351 |
| 22 | 1 | 44.5 | 41.3 | 1570 | 2955 | 40 | 4639350 | 2582.737 | -372.263 | 4969187 | -329837 |
| | 2 | 41.9 | 36.7 | 1890 | 2987 | 40 | 5645430 | 2947.18 | -39.8195 | 5670375 | -24945.3 |
| | 3 | 40.8 | 30.2 | 2100 | 876 | 10 | 1839600 | 971.12 | 95.12001 | 1868435 | -28834.9 |
| 23 | 1 | 46.9 | 27.4 | 2000 | 3370 | 10 | 6740000 | 3485.401 | 115.4007 | 6705911 | 34089.09 |
| | 2 | 46.1 | 29.9 | 1950 | 2313 | 10 | 4510350 | 2344.629 | 31.62874 | 4511066 | -715.702 |
| 24 | 1 | 43.5 | 38.5 | 1750 | 2901 | 30 | 5076750 | 2704.35 | -196.65 | 5203170 | -126420 |
| | 2 | 43.9 | 37.9 | 1760 | 3068 | 30 | 5399680 | 2867.487 | -200.513 | 5517045 | -117365 |
| | 3 | 43.1 | 34.4 | 1925 | 3132 | 20 | 6029100 | 3136.386 | 4.386154 | 6034407 | -5306.96 |
| 25 | 1 | 42.2 | 40.5 | 1730 | 3284 | 40 | 5681320 | 3029.979 | -254.021 | 5829680 | -148360 |
| | 2 | 42.8 | 37.9 | 1800 | 3222 | 30 | 5799600 | 3070.47 | -151.53 | 5907584 | -107984 |
| | 3 | 42.9 | 42.8 | 1600 | 3575 | 40 | 5720000 | 3132.563 | -442.437 | 6027052 | -307052 |
| 26 | 1 | 45.9 | 26.7 | 2080 | 2791 | 10 | 5805280 | 2969.291 | 178.2909 | 5712916 | 92364.34 |
| | 2 | 42.5 | 30.5 | 2100 | 3757 | 10 | 7889700 | 4027.963 | 270.9634 | 7749802 | 139898.5 |
| 27 | 1 | 40.5 | 30.8 | 1940 | 3398 | 15 | 6592120 | 3753.515 | 355.5145 | 7221762 | -629642 |
| | 2 | 45.6 | 24.7 | 2100 | 3118 | 10 | 6547800 | 3426.586 | 308.5862 | 6592752 | -44951.8 |
| | 3 | 41.3 | 38.6 | 1840 | 3195 | 15 | 5878800 | 3089.363 | -105.637 | 5943935 | -65135.3 |
| 28 | 1 | 38.5 | 37.5 | 2000 | 2966 | 10 | 5932000 | 3058.567 | 92.56665 | 5884682 | 47317.77 |
| | 2 | 42.6 | 38 | 1810 | 3315 | 20 | 6000150 | 3165.037 | -149.963 | 6089531 | -89381.1 |
| 29 | 1 | 43.8 | 36.8 | 1800 | 2711 | 20 | 4879800 | 2583.298 | -127.702 | 4970266 | -90466.2 |
| | 2 | 41.2 | 46.8 | 1525 | 3796 | 30 | 5788900 | 3185.714 | -610.286 | 6129314 | -340414 |
| 30 | 1 | 44.2 | 39.1 | 1700 | 3068 | 20 | 5215600 | 2797.039 | -270.961 | 5381503 | -165903 |
| | 2 | 48.1 | 35.9 | 1650 | 3313 | 30 | 5466450 | 2956.913 | -356.087 | 5689100 | -222650 |
| | 3 | 47.9 | 31.9 | 1815 | 3036 | 20 | 5510340 | 2889.87 | -146.13 | 5560109 | -49769.4 |
| | Total | 42.9 | 36.7 | 1834 | 170509 | 20 | 312768420 | 165312.4 | -5196.62 | 31806019 | -292599 |

## References


[1] Baron, T., (coordinator), *Quality and Reliability*, Tehnică Publishing House, Bucharest, 1988 (in Romanian).

[2] Dobritoiu, N., Quality Assessment for a Company, University 1 Decembrie 1918, Alba Iulia, *Proceedings of the International Scientific Conference "Challenges of Contemporary Knowledge-Based economy"*, November 16-17, 2007.

[3] Dobritoiu, N., Quality Assessment for a Company 2, *Magazine of Management and Economic Engineering*, Vol. 6/No. 4(25), 2007.

[4] Dobrițoiu, N., Research contract No. 534/10.05.2010 - Technical and economic analysis of operating systems used by EMC for their optimization in case of new technical, economic and social conditions, code CPV71241000-9, University of Petroșani, 2010 (in Romanian).

[5] Drăgulănescu, M., Drăgulănescu, N., *The Management of Services Quality*, AGIR Publishing House, Bucharest, 2003 (in Romanian).

[6] Juran, M., *The Quality of Products*, Tehnică Publishing House, Bucharest, 1973 (in Romanian).

[7] Rusu, C., (coordinator), *Manual of Economic Engineering - The Foundations of the Management of Quality*, Dacia Publishing House, Cluj-Napoca, 2002 (in Romanian).

[8] EN ISO 9000:2005 - *Quality management systems. Fundamentals vocabulary*.

[9] EN ISO 90012:2008 - *Quality management systems*.

[10] EN ISO 9004:2009 - *Managing for the sustained success of an organization. A quality management approach*.


## Brief Biography of the Author:

**a) Studies**

**Educational background:**

1976 - 1981 - Mining Faculty, Mining Institute of Petroșani, Romania.

1990 - 1998 - Ph.D. on science department "Technics", specialization "Production Processes Engineering"

1993 - 1994 - Refresher training "CESTEMIN" within "TEMPUS" program at "ÉCOLE NATIONALE SUPÉRIEURE DES MINES DE NANCY", France.

1998 - 1999 - Post-universitary courses "The Management of Human Resources" organized by the Faculty of Science, University of Petrosani, Romania.

January 2006 - The course "Specialist in quality management systems" organized according to the requirements of nr. V10 ale TÜV Rheinland

InterCert, of the department of personnel certification of TÜV Akademie Rheinland GmbH in Köln, Germany.

Jun.2006-Sept.2006 - The course “The Assessment and the Financing of the Real Estates” organized by ANEVAR (National Assessors Association from Romania) in Tg-Jiu, Romania.

**Professional experience:**

- sept.1981 - dec.1983 - trainee engineer for E.M. Paroşeni, Romania
- jan.1984 - jul.1985 - technologist engineer as part of the Endorsement Bureau of the Development Service of C.M. Jiu Valley, Petrosani, Romania

**b) Academic Positions**

- jul.1985 - oct.1990 - assistant at Management Department
- oct.1990 - oct.2001 - lecturer at Management Department
- oct.2001 - present - associate professor at Management Department

I conducted the courses and seminars for:

- Mathematical modelling for mining design
- Economic analysis and informational systems
- The management and the organisation of companies
- Modeling of the deposits of useful minerals substances
- The design of production systems
- Quality engineering.

**c) Scientific Activities** (research, publications, projects, etc….)

- 72 articles published in speciality journals and volumes of national and international scientific speciality conferences;
- 25 papers done relying on the contracts with the production lines or the research - design divisions;
- 3 didactic books and books of problems;
- 10 manuals and courses;
- 1 treatise: “The management and the quality assurance”.

**d) Others:**

- Permanent member of “The managers and economist-engineers association from Romania”.

**My research area** include the following topics:

- data mining
- mining engineering
- modeling of the deposits of useful minerals substances management
- the design of production systems
- quality engineering.