The Analyse of the Production Areas of the Industrial Enterprises

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Abstract
An actual issue is represented by the efficient utilization of the production areas. The literature of specialty sets at the disposal of the specialist methods and techniques of study and analysis of the production process. Even there is the theoretical support for the exact sizing of the production areas, of the emplacement of the machines and of the equipment and of the necessary facilities, rarely can be found complete solutions for the following up of valorisation of the built up areas. The existence of the land necessary for the construction of some areas of production, their designing for the developing of the industrial activities requires the existence of some important financial resources, which are amplified due to the recent evolution of the real estate field. As a result it is an imperative an optimal valorisation of these areas.

Keywords
production areas, industrial enterprises, analysis methods, valorisation, production surfaces

1. The Identification of the Issue

In case of the new built systems of production, their correct sizing leads, implicitly, to a valorisation of the created production areas. Not the same thing can me mentioned about the old systems of production relocated in already existent buildings or the industrial enterprises which function in old buildings. The literature of specialty offers more methods of sizing the areas of production. Calculations are made frequently which lead to the sizing of the number of machines, equipment and installations and of the areas necessary for each of them [2, 6]. Finally are added the areas covered by each group of equipment through multiplying the normative of the area by the number of equipment of the same type. Also, based on the same regulations are established the necessary areas for the access of the operators, of the means of transport, for the storage of the raw materials, materials or of the technological devices. The total area of production is obtained by adding to the production area all the other areas for the auxiliary activities and for the management of the enterprise. The issue is more acute in case of big cities where the lands have higher level of prices or in the crowded zones, where the available areas are limited.

The problem of the utilization of the production areas is settled in practical activity by using the machines and the equipment at their maximum capacity of production and this obviously based on the existence of demand on the market for the obtained commodities [9]. Since every machine, equipment or warehouse use a part of the total area of the production system, the problem of the utilization of the areas is settled by the valorisation of the existing production capacities. The production areas resulted after a better organization or after an investment effort will be allotted to the narrow places which determine the limitation of the production capacity [8]. But, such an approaching of the problem does not make reference to the areas for the roads of access or for the auxiliary activities. Also, another question is: for the narrow areas having a similar production capacity, to whom of them will be allotted supplementary areas of production? More than this, the expressing of the production capacity is done in physical units, without having a real control from the value point of view.

2. The Objectives of the Research

Such objectives have their contribution to the gradual settlement of the issues mentioned above:

- the changes of the total area and of its structure;
- the quantitative analyse of the valorisation of the production areas;
- the establishing of some models of quantitative analyse;
- the exemplification of applying some model;
- the influence of the modification of the areas of production upon the financial –economic indicators;
- the efficiency of the utilization of the production areas;
- the connection between the utilization of the production area and the volume of production;

- the finding of some solutions for some of the negative situations that may appear in the practical activity concerning the subject.

3. Modalities of Analysis of the Production Areas

For the organization of the research are presented the main modalities of analysis of the production areas in the order of the rising of their complexity and of their informational content. The indicators used for the following up of the utilization of the areas which are in the patrimony of the enterprise are:

- A_b = built up area;
- A_t = total area;
- A_p = production area;
- A_{tj} = the total area occupied by the workstation *j*.

Among the listed indicators, the research is focused on the production areas since these have a decisive contribution to the obtaining of the production.

3.1. The analysis of the dynamic and structure of the production areas

The dynamic of the production areas represents an internal aspect of the enterprise which refers mainly to two aspects:

- the aim of the investment effort;
- the effects of the increasing of the production areas.

The indicators for the characterization of the dynamics of such objectives follow up the evolution in time of the production areas. Such indicators can be:

a) The change of the absolute value of the production area established for the total or for the categories "*i*" of the areas:

$$\begin{aligned} \Delta A_p &= A_{p1} - A_{p0}, \\ \Delta A_{pi} &= A_{pi1} - A_{pi0}, \end{aligned} \tag{1}$$

in which A_{p0}, A_{p1} represent the area at the beginning and at the end of the period;

b) The index with fix base, in chain or average ones calculated per total or per categories of areas:

$$\begin{aligned} I_{A_p} &= \frac{A_{p1}}{A_{p0}}, \\ I_{A_{pi}} &= \frac{A_{pi1}}{A_{pi0}}; \end{aligned} \tag{2}$$

c) The relative deviation of the fixed means:

$$\Delta I_{Ap} = \frac{A_{p1} - A_{p0}}{A_{p0}} \cdot 100. \tag{3}$$

The structure of the production areas follows up the way in which is segmented the area which is in the patrimony of the enterprise. Among the category of relative unit measures the most appropriate for the expression of such an aspect are the relative unit measures of structure having the sense of share or of specific weight. Obviously such unit measures present the property of addition. The indicators for the following up of such an aspect can be:

a) The share of the category of areas in the total of the area:

$$g_i = \frac{A_{ti}}{A_t} \cdot 100; \tag{4}$$

where A_{ti} – are the categories of areas of the production system.

It is calculated the share of each category of area by forming some relative unit measures of structures. Then it will be proceed to a research of the structural changes of the areas. The total area can remain unchanged but, by using measures of replacement or by making investments, the total area can increase.

b) The share of the categories of areas in the total of the production area:

$$g_i = \frac{A_{pi}}{A_p} \cdot 100; \tag{5}$$

c) The report between the built up area and the total area covered by the system of production:

$$k_c = \frac{A_b}{A_t} \cdot 100; \quad (6)$$

d) The report between the surface of the access roads and the total area of production:

$$k_{ar} = \frac{A_{ar}}{A_t} \cdot 100; \quad (7)$$

e) The report between the area of the workstations and the total area of production:

$$k_w = \frac{A_w}{A_t} \cdot 100. \quad (8)$$

3.2. The analysis of the efficiency of the utilization of the areas of production

The analysis of the efficient utilization of the area of production can be performed using the models of factorial type. For their configuration several directions of action can be followed up. One of them starts from the way is segmented the total area of the enterprise: productive area, administrative area and non-productive area, designed for some auxiliary activities, which conditions the good development of production, according to the relation:

$$A_t = A_p + A_a + A_n. \quad (9)$$

The formula of calculation can be used as model of the analysis. Using the balance method can be evaluated the contribution of each type of area to the modification of the total area, expressed based on absolute or relative unite measures. The solutions will be oriented to the better capitalization of the productive area or to its increasing.

Another modality of identification of some models of analysis starts from the adding of the areas necessary for all the labour places of the fabrication system with those necessary for the access roads, according to the relation:

$$A_p = \sum_{j=1}^{n} A_{tj} + A_{ar}, \quad (10)$$

in which "*n*" is the number of the workstations, mounting and heat treatments [10].

The relation of calculation is in the same a model of analysis which can be adjusted by the balancing method. The application will lead to the study of the modification of the production area during the current period in comparison to the precedent period, depending on the areas occupied by each workstation and on those designed to the access road. The solutions will take into consideration the proper sizing of the access roads and the allotment of some areas specific to each workstation. The obtained supplementary areas will be occupied with those machines or equipment whose efficiency increased during the analysed period.

Depending on the level of the detailing and of the degree of complexity, it can be passed to the detailing of the area of production using the relation:

$$A_{tj} = A_{sj} + A_{gj} + A_{ej}, \quad (11)$$

where A_{sj} = static area, it is the rectangular area necessary for each machine [1];

A_{gj} is the gravitation area for maintenance and exploitation established depending on the number of sides on which is performed the supplying with half – finished products, the adjustment and the control for the machines;

A_{ej} is the surface of evolution designed to some activities as: acceptance and storage of the materials and of the production during fabrication, the storage of the materials, tools, devices and instruments of measurement.

Also in this case the relation of calculation is a model of analysis which can be applied based on balancing method. The results of the application are more restrictive since they are dependent on the construction of the machines and of the equipment and on the way they are supplied. Better results can be obtained in the zone of the areas of evolution. The solutions will target the improvement of some aspects as: the acceptance and the storage of the materials, the administration of the running production, the storage and the inter-operational transport, the proper utilisation of the devices, tools and of the instruments of control [4, 7].

The areas of the access roads, designed in order to increase the efficiency of the flux of material and

of the human flux, rise up special issues from the point of view of an exact calculation, especially in the phase of designing of the system of fabrication. They can be calculated indicatively as a *k* percent applied to the total areas of production:

$$A_{ar} = k \cdot \sum_{j=1}^{n} A_{tj}, \tag{12}$$

where *k* depends on the sizes of the half –finished products which are in the fabrication process.

The application of the model can lead to avoiding some road access too narrow or too wide or to the avoiding of the crowding of the system of fabrication.

The efficiency of the utilisation of the production area can be investigated based on a series of indicators which observe the general form of each indicator of efficiency, effect /effort. In the category of effects can be mentioned the intermediary balance of management or other indicators of value and the efforts can be composed of the total area of the production system or of the component elements of it, the relation being:

$$\frac{T,\ Q_s,\ Q_e,\ AV, EBIT,\ RE,\ P_n}{A_t,\ A_p}, \tag{13}$$

where T = turnover;

Q_s = sold production;

Q_e = production of the exercise;

AV = added value;

$EBIT$ = earnings before interest and tax;

RE = result of exploitation;

P_n = net profit.

Such a model notices if the enterprise observed the degree of utilisation of the areas of production and the implications of these non-observances upon the obtained production, as a factor with direct as well as indirect action. Each indicator designed like this has its own informational content which may be analysed. This is the reason why any model becomes an exercise of routine for a practitioner with experience in this field.

a) $Q_{sa} = \frac{Q_s}{A_p} = \frac{N \cdot t \cdot r}{S}$, where:

- Q_{sa} = production per unit of area;
- t = time of equipment functioning;
- N= number of equipment;
- r = medium output per hour.

Such a model emphasizes not only the fact if the enterprise observed the degree of utilization of the production areas but also the implications upon the quantity and quality of the obtained production. Similarly can be issued the indicators of value, reported to the unit of area, as:

- turnover per unit of area;
- production of the exercise per unit of area;
- added value per unit of area;
- earnings before interest and tax per unit of area;
- the result of exploitation per unit of area;
- net profit per unit of area.

b) $Q_{sa} = \frac{Q_s}{A_p} = \frac{N}{A_p} \cdot \frac{T}{N} \cdot \frac{Q_s}{T}$, where:

N/A_p is the degree of covering with equipment of the production areas;

T/N – time of operating for machines and equipment;

$Q_s/T = r_h$ – average hourly yield.

c) $AV_s = \frac{AV}{A_p} = \frac{Q_e}{A_p} \cdot \frac{AV}{Q_e}$, where:

AV/A_p – added value per unit of area;

Q_e/A_p – production of the exercise per unit of area;

AV/Q_e – added value for one monetary unit production of the exercise.

For example, the author considers the model of the analysis of item b). The object of the analysis becomes the variation of the manufactured production per unit of area during the current period in comparison with the previous period. The analysis of the phenomenon can be performed using absolute values or relative values.

a1. The analysis of the phenomenon using absolute values

Using the values of the base of the comparison $\left(Q_s/A_p\right)_0$ and the effective ones $\left(Q_s/A_p\right)_1$, the modification of the phenomenon is expressed as follows: $\Delta\left(\frac{Q_s}{A_p}\right)=\left(\frac{Q_s}{A_p}\right)_1-\left(\frac{Q_s}{A_p}\right)_0$. Forwards is proceeded to separate the influence of the factors upon the modification $\Delta\left(Q_s/A_p\right)$ as follows:

1. The influence of the degree of covering with equipment of the area:

$$\Delta^{\frac{Q_s}{A_p}}_{\frac{N}{A_p}}=\left[\left(\frac{N}{A_p}\right)_1-\left(\frac{N}{A_p}\right)_0\right]\cdot\left(\frac{T}{N}\right)_0\cdot\left(\frac{Q_s}{T}\right)_0 \tag{14}$$

2. The influence of the time of operating of the equipment:

$$\Delta^{\frac{Q_s}{A_p}}_{\frac{T}{N}}=\left(\frac{N}{A_p}\right)_1\cdot\left[\left(\frac{T}{N}\right)_1-\left(\frac{T}{N}\right)_0\right]\cdot\left(\frac{Q_s}{T}\right)_0 \tag{15}$$

3. The influence of the hourly manufactured production:

$$\Delta^{\frac{Q_s}{A_p}}_{\frac{Q_s}{T}}=\left(\frac{N}{A_p}\right)_1\cdot\left(\frac{T}{N}\right)_1\cdot\left[\left(\frac{Q_s}{T}\right)_1-\left(\frac{Q_s}{T}\right)_0\right] \tag{16}$$

Finally the variation in absolute values of the analysed indicator must be found by adding the influences exerted by the factors considered by the model:

$$\Delta\left(\frac{Q_s}{A_p}\right)=\Delta^{\frac{Q_s}{A_p}}_{\frac{N}{A_p}}+\Delta^{\frac{Q_s}{A_p}}_{\frac{T}{N}}+\Delta^{\frac{Q_s}{A_p}}_{\frac{Q_s}{T}} \tag{17}$$

a2. The analysis of the phenomenon using relative values

The index of the analysed phenomenon is established based on the relation:

$$I_{\frac{Q_s}{A_p}}=\frac{\frac{i_N}{A_p}\cdot\frac{i_T}{N}\cdot\frac{i_{Q_s}}{T}}{100^2} \tag{18}$$

where $\frac{i_N}{A_p},\frac{i_T}{N},\frac{i_{Q_s}}{T}$ represent the index of the factors which influence upon the indicator.

The modification into the relative units of the phenomenon can be written as follows:

$$\Delta I_{\frac{Q_s}{A_p}}=I_{\frac{Q_s}{A_p}}-100 \tag{19}$$

The influences of the factors taken into consideration can be explained as follows:

1. The influence of the degree of covering of the area:

$$\Delta_{\frac{N}{A_p}}^{\frac{Q_s}{A_p}} = i_{\frac{N}{A_p}} - 100 \quad (20)$$

2. The influence of the equipment time operating:

$$\Delta_{\frac{T}{N}}^{\frac{Q_s}{A_p}} = \frac{i_{\frac{N}{A_p}} \cdot i_{\frac{T}{N}}}{100} - i_{\frac{N}{A_p}} \quad (21)$$

3. The influence of the hourly manufactured production:

$$\Delta_{\frac{Q_s}{T}}^{\frac{Q_s}{A_p}} = \frac{i_{\frac{N}{A_p}} \cdot i_{\frac{T}{N}} \cdot i_{\frac{Q_s}{T}}}{100^2} - \frac{i_{\frac{N}{A_p}} \cdot i_{\frac{T}{N}}}{100} \quad (22)$$

Among the factors taken into consideration in the model of the analysis from now on we shall take into consideration only the degree of occupying with equipment of the area. The rest of the factors make reference to the qualitative aspects which are of the same importance but which do not make the object of the present article.

The solutions contribute to the valorisation of the existing areas of production or of the recent built ones and are implemented only in the areas which are not properly valorised. Such solutions can be:

- the construction of the areas of production taking into consideration their destination. Frequently it was noticed the construction of some systems of production depending on the area of the available land or their zonal placement. Like this it results systems of production with a certain surface which require the sizing of the production process depending on the available areas [5]. In such situations the normative of the areas are not observed and this fact leads to issued of safety in the labour and in the operating. A limited area of production leads to a certain capacity of production. A rising of the demand over the maxim production capacity is accompanied in most of the cases by organizational solutions (as the work in shifts) or by building some other areas.
- the identification of some solutions for the optimization in case of the areas occupied by machines and equipment of the same type [3].

In case of a group of machines not all the surfaces are used in the same manner. By using some simple relations, as they were previously presented, can be identified the areas which are insufficiently used, for which can also be found some other utilizations.

- the analysis of the yield of each surface based on the volume of production which is generated. Among the areas there are differences of production. Such measurements can lead to the allotment of areas for the groups of machines which have increases of the yield;
- a better organization of the production starting from the analysis of the utilization of the surfaces. In this way appear the possibilities of optimization of the areas of circulation, storage and control.

4. Conclusions

Actually many systems of production are built up in too small areas, which embarrass the development, the parking, the providing of green areas and the development of some services in open spaces. In the production systems the compressed areas are usually the warehouses, the offices and the areas of flexible services and less the production areas or those on which are placed fixed equipment. The article set at disposal some indicators of analysis whose complexity increases gradually, which can be used at a better sizing of some existent production areas or of some which were recently built up. The rational utilization of the area is a source of increasing the production capacity without

supplementary investments. A solution which is frequently adopted in such situations is the allotment of such areas for the increasing of the capacity of production. But, such an approach has some limits, which were emphasized at the beginning of the article. Hence it results the necessity of a parallel demarche to complete the production capacity for the most efficient settlement of such issues which are frequently met in the practical activity.

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