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INCREASING THE PRODUCTIVITY OF AN ENTERPRISE BY EFFICIENTLY MANAGING THE POTENTIAL RISKS THAT OCCUR IN THE MANUFACTURING PROCESS

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Abstract: *This paper addresses the topic of increasing the productivity of a company that makes a wide range of products. It is known from the specialized literature that small series production presents the greatest difficulties in production scheduling, because it has a varied nomenclature of products that it makes in small volumes. The organization of this type of production is done according to the method of homogeneous groups of machines and involves many risks in achieving the objectives. The paper highlights an efficient method for counteracting the potential risks in the production activity to obtain a high productivity.*

Key words: *Production management, Potential risks, Product, Technology, Productivity*

1. INTRODUCTION

In these difficult times, increasing the productivity of an enterprise is the goal of any type of enterprise regardless of the field in which it operates.

Labor productivity can be considered a basic indicator that highlights the efficiency of work in a productive system. The acceleration of the productivity growth rate is conditioned by the understanding of its content and significance, of the priority factors of influence and of the way of capitalization. Possible solutions for increasing productivity are the following:

- automation, modernization, or implementation of new equipment.
- reorganization of production equipment.
- implementation of new technologies (policies and software).

Automation, modernization, or implementation of new equipment is a major investment that a company must make to increase productivity. The introduction of modern equipment means a shorter time and lower costs for the respective operations. If a company considers that the equipment it owns is in good working order and can be upgraded, then they will be transformed into high-performance equipment with minimal costs, this being the preferred option.

The implementation of new equipment means not only expenses with their acquisition but also expenses with the commissioning and training of the personnel who use these equipment's plus a period in which they are unproductive.

The reorganization of production equipment is largely influenced by the type of production existing within the enterprise. The organization of production is a set of activities, policies, rules and technical conditions for the establishment, assurance and coordination of production systems and employees to carry out production to achieve maximum efficiency.

Depending on the existing conditions in the production process, enterprises can be classified into three main categories. These types of production organization being highlighted [1]:

- mass production.
- serial production.
- individual or unique production.

Series production consists of three subcategories, depending on the size of the manufacturing batch:

- large series production.
- medium series production.
- small series production.

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The type of production adopted by an enterprise essentially determines: the type of management, the way of organizing the equipment, the conditions imposed by the manufacturing activity and the implementation methods for monitoring and controlling the production. According to what is indicated in [5].

It should be mentioned that from an organizational point of view within an enterprise there is not only one of the three types of production: in series, in mass or unique in pure form. The adoption of the production organization method is done both according to the predominant type of production and according to the existing conditions.

Implementation of new technologies (policies and software). This category can mean major investments for a company due to the costs involved. If we refer to the implementation of an information system such as ERP (Enterprise Resource Planning), it helps us to reduce the time of creation and management of documents within an enterprise, so we will increase productivity in the workplace and implicitly productivity at the organizational level. This category also includes the implementation of new rules and policies through which employees' work begins to be standardized, which means fulfilling a condition for increasing productivity. A team organization method being published in [3].

2. THE PRODUCT AND MANUFACTURING TECHNOLOGY

2.1 Product presentation

The product is a counterweight used on a machine to ensure the balance and stability of the mechanical system.

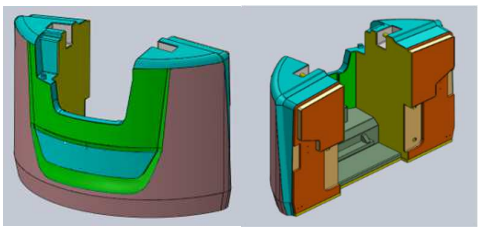

Fig. 2.1. Counterweight model

The purpose of counterweights is to make lifting loads faster and more efficient, saving energy and requiring less machine lift. This is added to the opposite end of the articulated arm to counteract the weight that the machine will lift.

The manufacture of the counterweight components is made of sheet metal with a thickness of 5 millimeters and after their assembly is filled with concrete.

2.2 Product manufacturing technology

The manufacturing technology represents a succession of activities necessary for the transformation of the raw materials into parts and which in the end will be assembled to obtain the finished product. The technology will be defined according to the available equipment and the necessary resources (e.g.: operators, raw materials, energy, tools, etc.) to obtain the parts or finished product that an enterprise owns.

The first step is to cut the metal parts that make up the counterweight shown above on a numerically controlled machine. After cutting, the processed parts must be cleaned through the grinding process and their flatness is checked. If some parts show rust, they must be sandblasted

In the second step, cold deformation operations take place (eg: bending, stamping, etc.) which are supported by the cut parts

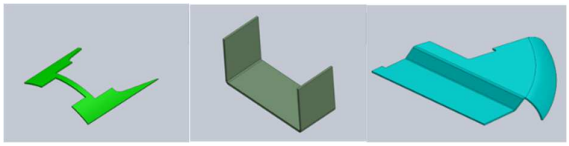

Fig. 2.2. Component parts

Step three is assembly - to move on to the assembly stage, the existence of the cut parts will be checked, including their number and the bent parts as well as the virulated ones. All parts are assembled using screws.

The step four is filling the counterweight - to fill the counterweight, the housing shall be placed on a retaining tray used to protect against accidental leaks in the filling composition. The gaps left over from the housing assembly must be filled in with paste. Inside the counterweight, a honeycomb metal structure will be made, after

which a paste composed of slag, cement and water will be poured.

The last step is packaging and storage - the counterweight is placed with the lower plate on a pallet made of hardwood, beech or oak to have a contact surface as large as possible.

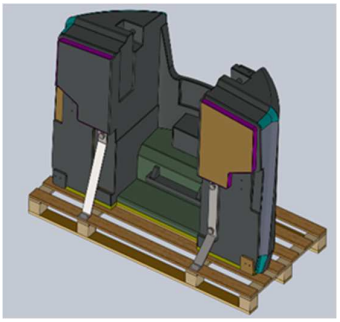

Fig. 2.3. Counterweight storage

It is supported on the lower plate, and the counterweight is fixed through the two brackets, thus avoiding lateral or front-rear movement.

3. IMPROVING MANUFACTURING TECHNOLOGY AND PRODUCTION ORDERING

Increasing the productivity of the enterprise can be achieved in two ways: by automating or implementing new equipment in the manufacturing process and / or by ordering production, which means that there is a mathematical planning for production. These elements being addressed in [4, 5].

Following an analysis of the manufacturing technology of the product presented above, the company wants to improve the times for the fourth step which is the filling of the counterweight with mixture. This activity was performed manually by two operators without any mechanized equipment and had a very long and tiring duration for employees.

The mixer works on the principle of the mixing arms, which rotate around the inner axis of the static mixing vessel at a high speed. The homogenization is performed by these arms which, at the same time, ensure the taking over of the mixture from the edges but also from the bottom of the container. The equipment consists of five main subassemblies, namely: assembled tank, funnel with funnel, assembled shaft and motor mixer support.

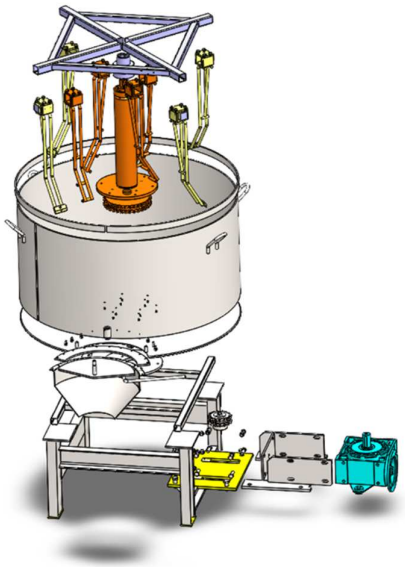

Fig. 3.1. Mixer

According to the principle of continuous improvement, an attempt was made to streamline the manufacturing process by implementing a mixer. This equipment has been implemented to reduce the filling time of the counterweight. Before this operation was done by two operators, one who made the composition of the material in certain containers and the other who filled the counterweight with a shovel, the filling time being about 2 hours.

Table 1

Technology comparison.

Criteria	No equipment	With equipment
Counterweight filling time	2 hours	1 hour
Human resource required	2 operators	1 operator
Filling accuracy	Small	High

Production scheduling is performed using mathematical models and its main purpose is to minimize production costs by orderly allocation of parts according to the sequence of operations imposed by the manufacturing technology and the availability of equipment. The parts are distributed on operations in optimal quantities to streamline the manufacturing process.

The objective function for the production ordering process is to minimize costs by complying with the following conditions [7]:

- compliance with the order of operations imposed by the manufacturing technology.

- compliance with the conditions of non-interference of operations.
- optimal loading of production capacities.

$$Z_0 = \sum_{t=0}^{p-1} f[v(t)] \cdot P[v(t)] + c_s \sum_{t=0}^{p-1} [P(t) - C(t) + S(o)] \cdot P[C(t)] + \\ + c_p \sum_{t=0}^{p-1} [C(t) - P(t) + S(o)] \cdot p[C(t)] + p_n \cdot p_0 \cdot I_0 \quad (1)$$

and

$$Z_0^{'} = \{\int_0^t f[v(t)]P[v(t)]d[v(t)] + c_s \int_a^b [P(t) - C(t) + S(o)]P[C(t)]dC(t) + \\ + c_p \int_a^b [C(t) - P(t) + S(o)]P[C(t)]dC(T) + [p_n \cdot p_0 \cdot I_0]\} \quad (2)$$

where:

f(v) - represents the production function.
P(t) - resources.
C(t) - demand.
S(o) - initial stock.
c_s - storage cost.
c_p - the cost of scarcity.
p[v(t)] - probability of production.
p - number of calculation steps.
P[C(t)] - the probability of the demand.
P_0 - the probability of making the investment.
a, b, c, d, T - the limits of the variation of the stock shortage and of the production function.

Based on the relationships described above, the objective function for production scheduling is as follows [7]:

$$\min Z_0 = \min\left[\sum_{i=1}^{a_1}\sum_{j=1}^{a_2} p_{ij} \cdot X_{ij} + p_n \cdot I_0\right] \quad (3)$$

with next restrictions:

$t_j - t_i \geq t_{ij}$ - for the sequence of operations.

$t_j - t_i \geq t_{ij} \cdot V(t_i^C - T_j^C) \geq t_i$ - for non-interference. of operations

$t_j - t_i^c \geq t_i - T_{cj}$ - for the working period.

$T_c \geq t_i^c + t_i - t_j^c$ - for the duration of the production cycle.

$x_j > 0 \quad x_i > 0$ - for non-negativity.

where:

t_i, t_j - represents the execution time of the operation "i" and "j".
T_c - the duration of the manufacturing cycle.

4. MANAGING POTENTIAL RISKS IN THE MANUFACTURING PROCESS AND PRODUCTION ORDERING

Risk management is the process of identifying, analyzing, and counteracting potential risk factors, with the aim of reducing or avoiding their manifestation. The risk analysis process focuses on all possible scenarios to maximize the probabilities and consequences of positive events, as well as to minimize the probabilities and consequences of negative events.

Risk is the element encountered in any production process, often being difficult to detect or anticipate. It is mainly defined by the negative aspects or the potential to negatively influence the progress of the project in achieving the objectives.

There are various methods of quantitative and qualitative analysis for risk estimation, but in general, the analysis is based on two factors, namely: the probability of occurrence and the impact it has on the process.

The risk can occur in various situations:

- when an event occurs, but the result is uncertain.
- when the effect of an event is known, but the occurrence of the event is uncertain.
- when the event and its effect are uncertain.

The performance of the risk management process is given by the ability of the manager and the team involved to obtain positive results in risk management.

Effective risk management involves the performance of specific activities, such as: risk identification, risk analysis and the development of risk response measures. After performing the activities mentioned above, we move to the stage of monitoring and control of risks in a production process to reduce the effects, if certain identified risks are manifested.

The probability and impact matrix are one of the most used methods of qualitative assessment in risk management. The method is based on the two components of risk, namely: the probability of occurrence and the impact of the risks on the process. The risk matrix can be defined as a two-dimensional network that is characterized by the probability of occurrence of risks and their effect on production activities.

The notion of Risk Score represents the level or degree of risk that is calculated by multiplying the two factors of the matrix.

$$RS_i = I_i \times P_i \quad (4)$$

where:

RS_i - risk score for activity "i"
I_i - the impact of the risk on the activity "i"
P_i - Probability of occurrence for activity "i"

Because impact and probability can be described in a relative and numerical manner, the risk score can be determined. The higher the combined ratings, the higher the score and therefore the level of risk. These ratings are generally defined from low to high or from very low to very high. Organizations need to define their risk tolerance. Creating these definitions of impact and probability levels can help reduce the influence of prejudice. The result of these risk matrices is used to prioritize risks, plan risk response, identify risks for quantitative assessment and allocate guidance resources.

Table 2

The importance of risks.

Risk factors	Impact (1÷5)	Probability (1÷5)	Risk score
Risk of damage to the mixer	4	1	4
Wrong operation of the mixer	1	1	1
The risk of injury in the use of the mixer	5	4	20
The risk of electric shock when using the mixer	4	2	8
The risk of incorrect production planning	4	4	16
Delays in manufacturing production orders	3	3	9

According to Table 2, a common scale from 1 to 5 was used to calculate the score, for the evaluation of each component. The value 1 for Impact is an insignificant effect, and the value 5 implies a disastrous effect. The same for Probability, the value 1 means very low chances of manifesting the risk, and the value 5 represents very high chances of manifesting the risk.

Table 3

Risk classification.

		Risk score				
Probability	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5

High risk (16-25) Moderate risk (6-15) Low risk (1-5)	1	2	3	4	5
	Impact				

Following the risk classification activity identified by the person in charge of production planning, he must define contingency measures to counteract the risks that have a moderate and high degree of manifestation.

Table 4

Contingency plan.

Risk factors	Impact	Contingency measures
The risk of injury in the use of the mixer	High	Before using the mixer, operators will be trained to use it safely. The trainings will be periodic.
The risk of incorrect production planning	High	The person in charge of the production activity will monitor daily if the quantity of products obtained is in accordance with the schedule of production
The risk of electric shock when using the mixer	Moderate	Taking protective measures so that no water reaches the electric motor
Delays in manufacturing production orders	Moderate	Monitoring and maintenance of production equipment in order not to accidentally break down and cause delays in the production flow

Efficient risk management in the production process is very important for increasing the productivity of an enterprise. To obtain the expected results, the company must provide working conditions, high-performance equipment, tools for the most accurate production planning to eliminate or reduce potential risks.

5. CONCLUSION

Increasing productivity is a permanent objective for an enterprise regardless of the field in which it carries out its activity and the conditions imposed by the economic environment.

Regardless of the type of production adopted by a company, it must quickly adapt to the changes occurring both in the internal and external environment by implementing new

machinery and equipment to increase the company's productivity.

Also, the increase in productivity can be achieved with lower investments, such as: reorganizing the equipment in the production hall, modernizing the existing ones, implementing some software for a more efficient management, staff qualification, etc.

In any activity that is planned to take place in the future, there is the possibility of the appearance of disruptive factors that influence the quantity and quality of the expected results. That is why risk management applied in the activity of manufacturing products is very important because it helps us to eliminate or minimize the effects caused by risks. Through the defined contingency measures, employees will know how to react when a potential risk manifest itself.

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Creșterea productivității unei întreprinderi prin gestionarea eficientă a potențialelor riscuri care apar în procesul de fabricație

Rezumat: Lucrarea abordează tema creșterii productivității unei întreprinderi care realizează o gamă largă de produse. Din literatura de specialitate se cunoaște că producția în serie mică prezintă cele mai mari dificultăți în procesul de programare a producției, deoarece are o gama variată de produse pe care le realizează în volume mici. Organizarea acestui tip de producție se face după metoda grupelor omogene de mașini și implică multe riscuri în realizarea obiectivelor. Lucrarea evidențiază o metodă eficientă de contracarare a potențialelor riscuri în activitatea de fabricație pentru a obține o productivitate ridicată.

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