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IMPROVING OPERATIONAL PERFORMANCE THROUGH OVERPRODUCTION ANALYSIS

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***Abstract*—**The overproduction is one of the main problem which manufacturing companies confront with, because it generates additional costs that can be saved for other strategic decisions which may have a significant and a long-term impact on its overall activity. The organizations, who reduce the negative effects of the overproduction and still do everything possible to meet their client needs, represents a model for all organizations to follow. This paper presents a solution which provides important insights for managers in terms of reducing the overproduction as a case of study and at the same time it represents an important contribution to the literature in the field. This process involves a complex assessment of the production process and causes that generate the overproduction. The results obtained attest that the proposed solution can reduce the overproduction, enhancing the operational performance of the company.

***Keywords*—** overproduction, quality, activity-based costing, waste reduction

I. INTRODUCTION

IN order to be more efficient and competitive on the market, many companies have become more focused on increasing demand from customers for higher quality and service. The achievement of competitive advantage through offered services comes from a combination of carefully thought-out strategy for service and the development of appropriate delivery system [1]. There are diverse methods and approaches, such as statistical analysis, computer simulation, and learn tools for improving the operational performance by establishing the best combination of resources in production lines, energy, services and supply chains [2].

Lean manufacturing represents the most efficient management system of a company. Over the time were identified the following main problems that can occur in a production system: waste, instability, and variability. These causes led to system performance decrease and negatively impact the cost and quality provided [3]. In order to maintain their competitiveness in a rising global market, the main goal of the organizations is cost reduction by decreasing non-value activities [2]. Non-value activities or waste represents any activity that does not add value to the process and to activities that the customer would not pay for [4]. There are eight types of waste: overproduction, defects, waiting, non-utilized talent, transportation, inventory, motion and extra-processing [5].

The main purpose of this paper is to present the main generation causes for the overproduction from a large manufacturing industry during two months of this year in Romania and propose a solution in order to improve the operational performance of the company as a case of study. The beginning of the research is focusing on the determination of the product families which generate the most of overproduction using the activity-based costing (ABC) method. The next section determines the causes that generate overproduction. The next section presents a solution for decreasing the overproduction and, at the same time the saving of costs achieved by applying the proposed solution is shown. Lastly, the conclusion is presented.

II. CASE STUDY

This study took place in a large manufacturing industry during two months of this year in Romania. The organization has a good reputation in understanding the client requirements in order to provide fast delivery by scheduling production in advance. The materials are delivered on time and defect-free, where the customer needs them.

For the manufacturing company, in time delivery is one of their most important key performance indicators, due to the fact that they committed to deliver 100% of the end products with no delays. In this case, the company manufactures additional amount of products, besides those ordered by the client, because they can not accurately forecast the quantity rejected due to the quality defects.

In order to estimate the additional quantity needed to be produced, the analyzed company sets a standard budget throughout the year, specifying a value for each month, and then introduces it in the production system.

The standard budget is used for calculating the exact

quantity needed to be manufactured so that the clients order can be closed.

The order can be closed in three situations:

1) *With negative tolerance – which means that the client has agreed to receive smaller amount than in his order (e.g. 10% less than the quantity ordered);*
2) *With nominal value – the quantity delivered is equal with quantity ordered;*
3) *With positive tolerance – the client agreed to receive larger amount than in his order (e.g. 5% more than the quantity ordered).*

However, there are situations in which for different reasons, the company produces more than it is necessary, so all the products remained after delivery are categorized as overproduction.

The remained products generate additional costs, which can be reduced. To achieve this goal, an overproduction analysis was conducted, based on two stages:

1) *Determination of the product families which generate the most overproduction using ABC method – the products of the company were grouped in product families based on the chemical composition of the material, technical measures and the presence of quality tests.*

The overproduction generated was calculated for each product family and in this stage only the first three of them were submitted for the analysis. The product families chosen by applying ABC method generate almost 80% of the total overproduction and are presented in Table I.

TABLE I
PRODUCT FAMILIES THAT GENERATE THE MOST OVERPRODUCTION

Product family	Overproduction [kg]	ABC [%]
X	131.357	29,18
Y	121.768	27,05
Z	90.555	20,12

2) *Determination of the causes that generate overproduction – after analyzing all the orders received by the company during the analyzed period (two months), there were identified four causes that generate overproduction:*

a) *Quality – rate rejection is lower than standard budget (quality defects of the products manufactured are lower than the quality defects forecast for these products);*

b) *Launching – after the production system returned the exact quantity needed to be manufactured, in order to avoid possible delays, it was decided to add another quantity, just to be sure that all the products are delivered in time;*

c) *Re-rolling – there are some cases in which rate rejection is greater than standard budget, therefore it is necessary to launch additional material in order to obtain the products needed to close the client's order. Because of the equipment's limitation, the quantity re-rolled is greater than the one needed to close the order, resulting overproduction.*

d) *Other causes - which include misunderstandings regarding the quantity that needs to be launched or re-rolled. This happens when it is possible to use the in-stock products for another order, but, for example the products are not found in time and the material is already used for the work in progress.*

Each cause generates overproduction, which is illustrated in fig. 1, but the Quality is responsible for over 50% of the total overproduction, so this cause is the subject for the overproduction analysis conducted in this study.

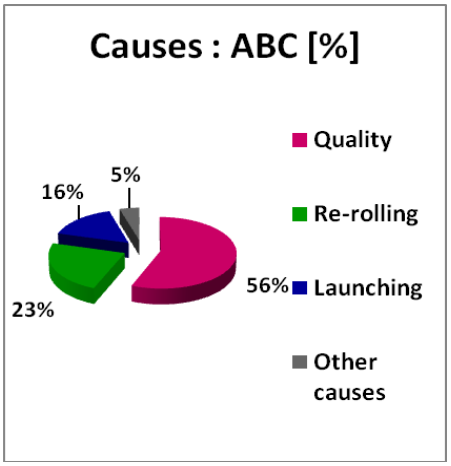

Fig. 1. Causes that generate overproduction

The solution identified for reducing the overproduction was the standard budget decreasing, which aims the reduction of achieved production simultaneously with the overproduction. The standard budget represents the additional amount that has to be produced to cover the qualitative failure from production lines, in order to deliver in time the required mix of products. The standard budget is proposed before the production process begins and it is calculated as a percentage of the amount ordered by the client, being determined based on last year rejection rate. The established standard budget for the analyzed two months was 1,64.

The real budget is a component of the standard budget and it is calculated when production process ends. It represents the precise additional amount that has to be produced in order to cover qualitative failure from technological process. The real budget is calculated as ratio between the products that had qualitative failure and the products that were inspected. For the analyzed two month, the calculated values for the real budget were 0,74 and 0,61.

In order to study the overproduction tendency, for the analyzed two month, the proposed values for the standard budget were 1,63 and 1,62. Whereas the standard budget is directly proportional to the achieved production, along

with its reduction the production will decline too. This will cause re-rolling at some orders, because some of them were closed either with negative tolerance or with nominal value (the amount ordered by customer).

For determining the overproduction and the amount that has to be re-rolled when a reduction of standard budget took place, the minimum amount that has to be produced for each order was determined by applying the equation (1).

$$\mathbf{Q_{min} = T_{neg} - Q_{rej} = (Q_{ord} - Q_{neg}) + (Q_{prod} - Q_{liv} - Q_{extra})} \quad (1)$$

where:
Q_{min} – the minimum amount that has to be produced (the amount before being processed on production line);
T_{neg} – the minimum amount by which the order can be closed (the amount being processed on production line);
Q_{rej} – qualitative failure;
Q_{ord} – the ordered amount;
Q_{neg} – negative tolerance accepted by customer;
Q_{prod} – the amount being processed on production line;
Q_{liv} – the delivered amount;
Q_{extra} – overproduction.

For determining the quantity that would be produced in case of reducing the standard budget (Q_{prod1}), the amount of production (Q_{prod}) was multiplied with the new standard and it was divided by the old standard budget. The delivered amount to each customer was determined by applying the equation (2).

$$\mathbf{Q_{liv1} = Q_{prod1} - Q_{rej}} \quad (2)$$

where:
Q_{liv1} – the delivered amount to the customer where a reduction in standard budget took place;
Q_{prod1} – the amount being processed on production line where a reduction in standard budget took place.

After the delivered amount to each customer was determined there are the following cases:
1) $Q_{liv1} \geq Q_{liv}$, the order can be closed and overproduction is generated;
2) $Q_{liv1} \geq T_{neg}$, the order is closed with negative tolerance or to nominal value. No overproduction is generated and no re-rolling is needed;
3) $Q_{liv1} \leq T_{neg}$, the order can not be closed because re-rolling is needed.

The overproduction is calculated only for the orders that did not need re-rolling, by applying the equation (3).

$$\mathbf{Q_{extra1} = Q_{prod1} - Q_{liv1} - Q_{rej}} \quad (3)$$

where:
Q_{extra1} – the overproduction due to the new standard budget.

The re-rolling is determined only for the orders which needed re-rolling to be closed, by applying the equation (4).

$$\mathbf{Q_{rel1} = T_{neg} - Q_{prod1}} \quad (4)$$

where:
Q_{rel1} – the amount that has to be re-rolled so that the order can be closed.

The results of the analysis are compared with standard budget, being presented in Table II.

TABLE II
FINAL RESULTS OF THE OVERPRODUCTION ANALYSIS

Standard budget [%]	Overproduction [kg]	Diminished overproduction [%]	Re-rolling [kg]	Re-rolling [%]
1,64	44.737	0	1.581	0,45
1,63	38.592	14	9864	22
1,62	32.907	26	18423	41

Overproduction and re-rolling tendency are illustrated in fig. 2. The analysis reveals that if the standard budget decreases, then the re-rolling will increase at a higher pace than overproduction decrease. This means that are many orders that have been closed either with negative tolerance or to nominal value.

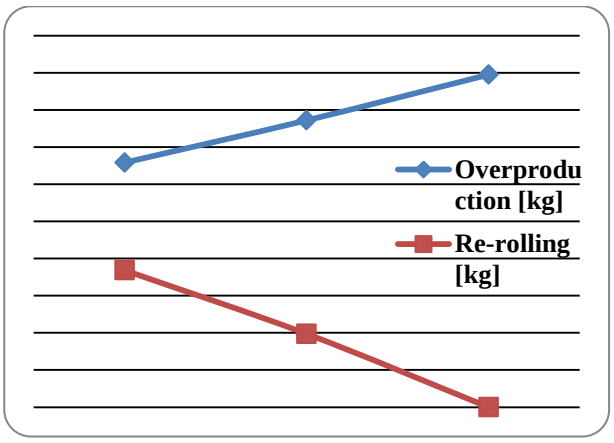

Fig. 2. Overproduction and re-rolling trend

Once the standard budget decreases, the production also declines, so the orders can not be closed with the first time rolled amount. Therewith, this analysis shows that many orders present restrictive tolerance and, due to the instability of the system (qualitative failure from production lines can not be accurately predicted) either overproduction is generated or re-rolling is required for an order to be closed.

In order to determine the cost of an overproduction ton, the first two representative orders, for every product family, from overproduction (Q_{extra}) point of view were identified. The inefficiency generated by overproduction (the added value by the company for the manufactured products) is calculated for every order, by applying the equation (5).

$$\mathbf{I = C_f - C_d} \quad (5)$$

where:
I – the inefficiency (the added value by the company);
C_f – the manufacturing cost of a finished product ton;
C_d – the cost of a waste ton.

The product family inefficiency represents the arithmetic mean of the two representative orders. The overproduction cost for each product family is presented in Table III.

The saving of costs achieved by overproduction reduction is determined as a product between the overproduction amount that was diminished by applying the proposed solution and the cost of an overproduction ton for the analyzed product family. The saving of costs achieved by applying the proposed solution was 106.200 lei at the end of the analyzed months.

TABLE III
THE OVERPRODUCTION COST FOR EACH PRODUCT FAMILY

Product family	***The order***	**Q_{extra}** ***[t]***	**C_f** ***[lei/t]***	**C_d** ***[lei/t]***	**I** ***[lei/t]***	**I_{fam}** ***[lei/t]***
X	35829	24.612	4.124	1.188	2.936	3.780
	85746	14.430	5.812	1.188	4.623	
Y	25478	9.902	3.865	1.188	2.676	2.806
	35845	9.756	4.124	1.188	2.936	
Z	68574	7.904	3.190	1.188	2.002	1.998
	58785	4.476	3.181	1.188	1.993	

III. CONCLUSION

This paper represents a research on the main generation causes for the overproduction and proposes a solution to improve the operational performance of the company. By diminishing the standard budget, the finished products are insufficient for closing the client orders and is necessary the re-rolling of an additional amount. Nevertheless, it can be noticed an important improvement by diminishing the standard budget. More than 106.000 lei were saved by applying the proposed solution. This practical application is focused on preventing the overproduction, in order to identify the benefits which can be provided by this aspect for the managers.

REFERENCES

[1] C. Cristea, "The allocation of customers to warehouses optimization using genetic algorithms", *Acta Technica Napocensis*, vol. 56(I), pp. 89-94, 2013.
[2] J. M. Rohani and S. M. Zahraee, "Production lines analysis via value stream mapping: a lean manufacturing process of color industry", *Procedia Manufacturing*, vol 2, pp. 6-10, 2015.
[3] G. Negru-Strauti, A. P. Pugna, "Improving process performance through lean manufacturing", *Annals of the Oradea University, Fascicle of Management and Technological Engineering*, vol. 1, pp. 237-240, 2013.
[4] M. L. George, *Lean Six Sigma: Combining Six Sigma Quality with Lean Speed*, MsGraw-Hill, New-York, 2002.
[5] C. Cristea, *Production System Management*, (*Managementul sistemelor de producţie)*, Editura Todesco, Cluj-Napoca, 2013.