USE OF THE 80/20 RULE IN METALLURGY

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Abstract

The paper describes practical application of the 80/20 rule (also well-known as Pareto´s rule) in heat treatment processes of metallic materials. The principle of the 80/20 rule is based on the study of Italian economist and sociologist Vilfredo Pareto. At the end of the 19th century, Pareto defined a mathematical formula which reflected unequal distribution of wealth and expressed the fact that about 20 percent of population owned 80 percent of wealth. This idea was further developed by many of his followers and nowadays it is widely recognized as a principle of measuring effectiveness. The 80/20 rule represents a very useful analytical technique which helps to clearly specify key areas of focus. The goal of this paper is to introduce its practical application in heat treatment processes of metallic materials in the chosen company.

Keywords: 80/20 rule, segmentation, customer, product, heat treatment

1. INTRODUCTION

Industrial production is currently undergoing major changes due to the introduction of information technology, cyber-physical systems and artificial intelligence. This trend is known as Industry 4.0 (or the 4th Industrial Revolution). It is a process of gradual digitization and automation of production, which also causes changes in the labour market and blending of the real and virtual worlds. However, the present article is devoted to a simple rule, which in its versatility transcends individual areas or even development stages of industrial production. This is so-called Pareto rule or 80/20 rule. Formula on which the 80/20 rule is based was discovered more than 100 years ago by the Italian economist Vilfredo Pareto. Vilfredo Frederico Damaso Pareto was a famous Italian economist, sociologist, political scientist and a representative of the so-called Lausanne school. Among other things, he is the author of ordinal approach to consumer behaviour and Pareto optimality. However, this article is not devoted to Pareto's study of economic welfare, but to a simple formula which claims that a minority of causes, inputs, or effort usually leads to a majority of results, outputs or rewards. This formula is commonly called the Pareto rule or 80/20 rule and states that there is an inbuilt imbalance between causes and results, inputs and outputs, and effort and reward. Causes, inputs or effort are usually divided into two categories: a) a majority which has a minor influence and b) a minority which has a major influence. Results, outcomes, or rewards are usually based only on a small part of causes, inputs, or effort that are focused on creating such results, outcomes, or rewards. Relationship among causes, inputs or effort on the one hand and results, outputs or rewards on the other hand are usually in imbalance. [1] The 80/20 rule is an illustrative measure of such inequality. Application of the 80/20 rule in the heat treatment processing of metallic materials is the subject of this article. Heat treatment refers to the controlled use of phase and structural changes in the solid state in order to obtain the desired mechanical, technological, or other utility properties of products or semi-finished products. During the heat treatment process, controlled temperature changes (own heat treatment), controlled changes in chemical composition of surface layers and temperature (chemical-heat treatment) or controlled changes in temperature and consequences of plastic deformation (heat-mechanical treatment) are mostly used. [2]

2. APLICATION OF THE 80/20 RULE IN THE HEAT TREATMENT PROCESS

One of the first pioneers of the 80/20 rule was professor of philosophy George K. Zipf in the 1950s who came up with the affirmation that resources are created so as to minimize work so that about 20 - 30 percent of any resource account for 70 - 80 percent of the activity related to that resource. [3] He supported his claim by a statistical analysis of population and industry in the U.S. Another, and probably the most significant follower of Vilfredo Pareto, was an American engineer of Romanian origin, Joseph M. Juran, who was instrumental in using the 80/20 rule to achieve high quality of products. He used this idea in the field of quality control and turned it into a Pareto diagram in the 1950s. He stated that 80 - 95% of problems are caused by 5 - 20% of causes which he identified as a vital minority. It is necessary to be highly focused on this minority in the analysis of a problem, analyse it in detail and select appropriate corrective actions to reduce or completely eliminate it. Further development of the 80/20 rule occurred in the 1970s when it was used for development of computer systems by newly emerged computer manufacturers in the U.S. As stated by Koch [4], in 1963 IBM found out that about 80 percent of computer time was spent on processing approximately 20 percent of operating code. Company immediately transcribed its operating software to make the most used 20 percent easy to access and to make it easy for customers to use. This makes IBM computers more efficient and faster than competing computing. Except quality or computer industry, today the 80/20 rule is also very popular in the field of time management where it is used very often because it allows to find the priorities in problem solving. The above-mentioned development of the 80/20 rule carries a fundamental need to find the most important activities or causes of the problem and focus further on them.

2.1. 80/20 analysis of source data

Every enterprise has information about its processes, customers and products. For the purposes of this article, it was sufficient to differentiate products according to their revenue. The same procedure was applied in the case of individual customers which were allocated a share of total revenue generated within a defined period. The 80/20 analysis is a quantitative method used to determine exact relation between inputs and outputs. Thus, it examines a relation between two rows of comparable data. The first data row always refers to the selected objects of interest (in this case products and customers), usually in a large number, which can be expressed as a percentage. The second data row relates to some interesting characteristics of these objects, which can be measured and also expressed as a percentage (in this case sales). The first step of the 80/20 analysis is identification and selection of source data. The purpose of the analysis must be considered here: why we are doing this analysis and what we are expecting from it. Customers, products, sales, costs, production lines, vendors, inventory, customer complaints etc. are included among the most frequently analysed source data. The next step is to verify suitability and accuracy of the source data. In business practice, a large amount of different data sets is usually available. Therefore, it is necessary to determine which data will be analysed. When the source data selection is complete, this data must be cleaned from outliers (de facto obvious errors). This means that the source data is cleaned from effects such as seasonal fluctuations, one-time orders or special one-time sales. Such identified and purified source data should also have logical coherence and demonstrable rationality related to setup target of analysis. In other words, such source data categories should make sense. As the next step of the analysis in accordance to 80/20 rule, the prepared data is entered into the 80/20 table and divided into columns according to analysed area. Furthermore, the data is sorted by the defined parameters from the most to the least important items (for this purpose cumulative totals are used). The last step of the 80/20 analysis is a visualization of the results in the table (and possible construction of a graph). In other words, the identification of the so-called eighties (thus 20 percent of customers, products or production lines which bring us 80 percent of revenue or profit) and the so-called twenties (80 percent of customers, products or production lines which bring us only 20 percent of revenue or profit). The final table of the 80/20 analysis will have the following form in the case of heat treatment customers of metallic materials.

Customers	Sales (€)	Cum. Sales %	Cust. rating
Customer E	400 000	48.75%	A
Customer B	170 000	69.47%	A
Customer H	75 000	78.61%	A
Customer C	70 000	87.14%	B
Customer D	40 000	92.02%	B
Customer A	28 000	95.43%	B
Customer I	18 000	97.62%	B
Customer J	9 000	98.72%	B
Customer G	6 000	99.45%	B
Customer F	4 500	100.00%	B
Total	820 500		

Figure 1 Customer 80/20 analysis table

The table compiled in this way (see **Figure 1**) provides an overview of individual customers based on sales for a particular period. Looking at the table, it is obvious that the key 78.6% of sales are created by three largest customers: customer E, B and H. Remaining customers bring 21.4% of total company sales, which is a significantly smaller contribution than the above-mentioned ones. However, the final evaluation based on one criterion only would be too short-sighted. Multiple parameters must be analysed for more qualitative assessment. Therefore, products in relation to sales of chosen enterprise were evaluated during next step.

Part No.	Customer	Sales (€)	Cum. Sales %	Product rating
P113	*Customer E*	200 000	24.4%	A
P115	*Customer E*	124 000	39.5%	A
P106	*Customer B*	76 000	48.8%	A
P114	*Customer E*	76 000	58.0%	A
P105	*Customer B*	64 000	65.8%	A
P122	*Customer H*	60 000	73.1%	A
P107	*Customer C*	39 000	77.9%	A
P104	*Customer B*	30 000	81.5%	A
P101	*Customer A*	20 000	84.0%	B
P109	*Customer C*	19 000	86.3%	B
P110	*Customer D*	18 000	88.5%	B

Figure 2 Product 80/20 analysis table

Figure 2 represents a reduced version of the overall product analysis table (due to size of an original file). Nevertheless, it is obvious that the key 81.5% of sales are generated by eight main products and these products are delivered to four customers. Compared to customer analysis, customer C and its product no. P107 joins the customers E, B and H. The remaining products have significantly smaller contribution in total sales than the above-mentioned ones. The performed 80/20 analysis provides an overview of impact of individual data categories (in this case customers and products) on total sales of heat treatment process during monitored period. However, it considers both categories separately, it does not provide a coherent picture. An important follow-up step is to perform a segmentation of the obtained results and create a so-called 80/20 matrix. By segmenting we get a comprehensive overview of customers, products and revenue clearly broken down into individual quadrants.

2.2. 80/20 quad analysis

Classification of the assessed categories in each quadrant is very useful because it provides a unified view of the results from the previous analysis and helps identify strategies contributing to further growth in sales or elimination of costs and effort invested into management of less profitable productions and customers. For segmentation itself, it is very useful to create a matrix based on the 80/20 rule (see **Figure 3**). We build the 80/20 matrix very simply by classifying individual customers and products according to selected criterion into groups A and B based on a significance. In this case, the criterion is a contribution to total sales during monitored period. As a part of segmentation process, we combine these two categories (customers and products) to obtain individual matrix quadrants: AA, AB, BA and BB. The quadrant AA represents the most significant customers with the highest volumes of products (or best valued products) from sales point of view, the quadrant AB represents the most significant customers with low volumes of realized products (or less valued products), the quadrant BA represents less significant customers with high volumes of products from the sales point of view and finally, the BB quadrant represents less important customers with low volumes of products. Quadrant analysis is basically a mathematical organization of data. Therefore, its disadvantage is that it does not take into account factors such as low volumes produced for customers with high future potential, low volumes of some currently realized products with a high potential to increase production in the future, and for example volumes of products that are now considered rather as a service provided to the most important customers buying the key products of the heat treatment process portfolio. Resulting quadrant analysis will have a following form in this model example.

Customers	Parts			
	A		B	
	AA		**AB**	
	Sales		Sales	
A	€	630 000	€	15 000
	% of Total	76.78%	% of Total	1.83%
	Customers:	3	Customers:	1
	Parts:	7	Parts:	2
	BA		**BB**	
	Sales		Sales	
B	€	39 000	€	136 500
	% of Total	4.75%	% of Total	16.64%
	Customers:	1	Customers:	7
	Parts:	1	Parts:	20

Figure 3 Quad analysis based on customer and product 80/20 analysis

The 80/20 matrix of customers and products of heat treatment process shows that 76.78% of sales are generated by three customers and their seven products (the quadrant AA). It is interesting that 4.75% of sales is generated by one customer and its sole product. Moreover, this customer is not ranked among the most important customers (BA quadrant) based on the initial analyses. In contrast, one of the three most important customers in terms of overall sales generates 1.83% of total sales by its two products (quadrant AB). And finally, seven customers and twenty products generate 16.64% of total sales (BB quadrant). Analysis results confirm the initial idea about an unequal distribution of the share of individual customers or their products in total sales. Implemented segmentation allows to manage processes related to individual customers or products more effectively and efficiently. It represents a starting point for defining individual strategies, which is, together with their explanation and implementation inside and outside company, usually the most difficult step. Two basic questions should be asked while designing individual strategies: “what to do and how to do it". Decisions about appropriate strategies must be accepted on a customer-to-customer and product-to-product basis. The following individual strategies could be selected in this model example:

1) Quadrant AA

The sales department should take care of the existing business with key customers, protect and look after the most high-turnover products. It should also offer key customers cooperation on developing new prototypes that should replace existing products in the future. The sales engineers should ensure product diversification and create at least two or three major product portfolios. The R&D department should come up with innovations of existing products, thus offer new and easier solutions to key customers (e.g. product design change or improvement of existing production processes in order to remove auxiliary or finishing manufacturing operations etc.). Production should be able to define production cells, production lines or machines for key customers and their products in order to avoid waste of production capacities, losses and downtimes caused by production changeover to the other, less important, products for less important customers. Production should also focus on creating a clear flow of material that is, on eliminating work in progress, shortening transfer times from one manufacturing process to another and reducing costs due to downtimes, storage or internal scrap.

2) Quadrant AB

The products in this quadrant typically bring lower profits but they are tolerated as a kind of service to meet the needs of the most important customers. In practice, this means that if a company wants to get a significant contract in terms of production volume or profits, it must agree to process less profitable products together with the profitable ones for the same customer. Therefore, producing these less lucrative products is a service or countervalue for getting significant orders. In this case, a company’s main objective should be finding a way to move these products realized for A customers from B products to A products group. Among other things, this can be achieved by reducing overhead calculated on these products by internally setting a minimum production quantity (reducing downtimes and long changeover times), creating no inventory, simplifying production processes, or combining some production operations with others if possible. In addition, the company may try to negotiate with customer a minimum order quantity, an increase in price of these products or, in extreme cases, outsourcing these products.

3) Quadrant BA

The main goal should be to move customers with high future potential into the AA quadrant. Therefore, effort should be made to increase sales of A products to customers with high potential, to negotiate with customer minimum order quantity of a certain level, or to increase prices of these A products. Alternatively, the company may choose to keep product A profitable in case of customer with a low future potential and explore the possibility of savings in manufacturing of this product, or in the customer service provided.

4) Quadrant BB

The company resources should be primarily used to manage products and customers in the AA or AB quadrant. In the case of this quadrant, it should be assessed whether there is any future potential to move some products or customers into the group A. If so, we should use one of the strategies defined above. If not, we should look at these products and customers differently. The goal should not be to eliminate low-frequent products or low-sales customers completely, but to treat these customers or products differently, for example by using outsourcing, distribution channels etc. The customer service and profit can be improved without added cost of complexity or hidden overheads.

From the above outlined options how to further manage portfolio of individual products and customers, it is clear that some steps can meet major obstacles. It is important to lead a clear communication about the intended changes inside and outside company and to define clear criteria for achieving the goals at each step. People inside organization must understand the concept. This means that the most important reasons and steps leading to implementation of specific change should be explained to them. It is very important to involve all the stakeholders in the process of planning changes and then in the process of decision making, organization and change implementation itself. No less important is the communication with customers. The sales department or customer service must be able to clearly explain the requested changes, reasons for these changes and provide a clear plan for implementation of these changes to the customer. Of course, that is in case if there is an agreement with a customer about these changes. Otherwise a company must only resort to internal changes in case of A customers or products. In the case of B customers or products, it must resort to more radical decisions, which may even lead to a termination of cooperation. All these changes or implementation of new strategies must be clearly monitored, measured and evaluated. For this purpose, key parameters of individual processes and their regular evaluation are used.

3. CONCLUSION

The 80/20 rule is very valuable because it is against our intuition. We tend to assume that 50 percent of causes or inputs will represent 50 percent of results or outputs. It seems that everything should be in perfect balance, but in practice, it is often not so. This fact is confirmed by the above presented analysis carried out in the heat treatment process of chosen industrial enterprise. The 80/20 rule is used to analyse a share of customers and products in total volume of sales made by an enterprise during a particular period. In the first step, separate analyses of share of customers or individual products on sales, were performed. It was found out that the key 78.6% of sales were generated by the three largest customers and the key 81.5% of sales were generated due to production of eight major products. In order to avoid any distortions caused by initial results, a segmentation was made. Inclusion of the analysed categories into individual quadrants of the 80/20 matrix is very useful for obtaining a unified view of the results of previous analysis. The result of the segmentation of customers and heat treatment products is a finding that 76.78% of sales are generated by three customers and their seven products. Possible strategies that could serve to further increase in sales or elimination of costs and efforts put into less profitable products and customers were outlined for the individual quadrants of the 80/20 matrix. The goal of the submitted paper was to describe practical application of the 80/20 rule in the chosen heat treatment plant where the core business is processing parts for automotive industry. This goal was achieved by analysing the above-mentioned detailed steps of the 80/20 rule. The data stated in this article was deliberately distorted by an established coefficient, product and customer names were intentionally concealed based on the company request.

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REFERENCES

[1] KOCH, R. Pravidlo 80/20: umění dosáhnout co nejlepších výsledků s co nejmenším úsilím. Praha: Management Press, 2015. 243 p. ISBN 978-80-7261-313-7.

[2] PTÁČEK, L. Nauka o materiálu II. Brno: CERM, 2002. 392 p. ISBN 80-7204-248-3.

[3] KRUGMAN, P. R. The Self Organizing Economy. Cambridge: Blackwell Publishers, 1996. 122 p. ISBN 978-1557866998.

[4] KOCH, R. The 80/20 Principle: The Secret to Achieving More with Less. Reprint edition. London: Crown Business. 1999. 288 p. ISBN 978-0385491747.