

## **ANALYSIS OF MAINTENANCE COSTS IN METALLURGICAL ENTERPRISE**

SIKOROVÁ Andrea, LAMPA Martin, SAMOLEJOVÁ Andrea

*VŠB - Technical University of Ostrava, Faculty of Metallurgy and Materials Engineering, Ostrava, Czech Republic, EU, [andrea.sikorova@vsb.cz](mailto:andrea.sikorova@vsb.cz), [martin.lampa@vsb.cz](mailto:martin.lampa@vsb.cz), [andrea.samolejova@vsb.cz](mailto:andrea.samolejova@vsb.cz)*

### **Abstract**

The article describes the current way of reporting of the annual maintenance costs in a metallurgical enterprise. It analyzes fixed, overhead and total company costs focusing on maintenance. The conclusion of this article is to evaluate the current cost management and to make proposals and recommendations that could lower the company maintenance costs.

**Keywords:** Analysis, costs, maintenance, reduction

### **1. INTRODUCTION**

In the current competitive times the market position of the company is affected by a number of factors. One key factor is cost. If an enterprise wants to succeed in these difficult times, its costs must be carefully analyzed and effectively managed. The costs affect the company's financial performance. If the company fails to keep costs at an acceptable level and they will exceed the revenues, the company starts to generate loss. As a result of this situation, businesses are forced to use modern management methods. Part of these methods is the regular performance analysis. [1]

Modern metallurgical enterprise is saturated with a large variety of instruments and equipment, with acquisition value of tens of millions of CZK. The significance of maintenance increases with the technical development of the equipment. Maintenance has significant influence over the company economy. Time of repairs and maintenance predetermines the time utilization of production capacity. The quality of repairs and maintenance determines the technical use and performance of facilities.

Maintenance costs weigh heavily on the company economy. Maintenance costs are charged to production costs. The duration of repairs directly affects time utilization of equipment. The quality of repairs determines the performance, but also the time utilization and thus the volume of production. The usual share of maintenance costs to total production costs is 8-15 %. The maintenance staff of metallurgical works amounts to 1/5 - 1/3 of the workers, which negatively affects productivity. [2]

This article aims to analyze the costs of maintenance of a metallurgical enterprise, and to propose measures to reduce these costs.

### **2. OPERATION OF MAINTENANCE**

Maintenance of technical systems, devices and equipment is a set of activities to ensure their operational condition or rapid recovery in case of failure. Maintenance is used to prevent system failures. [3] There are four basic approaches to maintenance: reactive maintenance, preventive maintenance, predictive maintenance, and proactive maintenance.

#### **2.1. Reactive (Corrective) maintenance**

Reactive maintenance approach is "leave it to operate until it breaks". It is a correction in case of fault or after, while there is no preventive maintenance. Fault is corrected when it is discovered or when it occurs. Practice shows that thanks to the pressure of customers on the production, producers are increasingly resorting only

to reactive maintenance, and that one that demonstrably saves money from lost production and significantly affects the long-term risks, is neglected or deemed unnecessary. [3]

## 2.2. Preventive maintenance

The essence of preventive maintenance is to make a correction in anticipation of its actual need. It follows on preventive examinations, inspections and diagnostics. Replacing parts is commanded by a plan regardless of whether it was physically exhausted. Preventative maintenance on one hand increases the cost of parts that are changed more often, but on the other hand reduces the operation costs, since the downtime is kept to a minimum. Additionally, standard dates and scope of maintenance work enables accurate planning of maintenance for a long time ahead. [4,5,6]

## 2.3. Predictive maintenance

During introduction of predictive maintenance the data that affect the operation are analyzed statistically. The maintenance and parts replacement before the end of their service life are scheduled according to the findings of correlations and causalities between the various factors. An example might be a device on which the staff notices changes during operation, leading to malfunctions. Based on this information, it is possible to evaluate, for example, the need for replacement of some components before the end of their life. [4,5,6]

## 2.4. Proactive maintenance

Proactive maintenance surpasses the orientation only on experience. Currently, the technically sophisticated testing is capable to identify the fault on the monitored equipment, including its causes. This way the proactive maintenance facilitates the corrective actions for improvement within the construction, design and technology departments, and other technical departments involved in innovation.

## 3. ANALYSIS OF MAINTENANCE COSTS IN METALLURGICAL ENTERPRISE

This chapter analyzes the maintenance costs of a manufacturing company that is engaged in industrial energy focusing on the needs of the metallurgical industry. It produces high pressure steam which is transformed into electricity, heat and compressed/blast air and process steam. The basis for this analysis is mainly internal materials and the final report of the company. Given that this is a relatively sensitive data it had been adjusted in order to protect the company interests.

The operation maintenance operates continuously, i.e., in three shifts. All major accidents and random faults must be removed as soon as possible to avoid delays and not to disrupt the operations. Usually all is fixed within a day. Standard repairs and routine maintenance are reported and solved operatively. Specific repair jobs have their own maintenance personnel that possess the adequate expertise and/or licenses. For highly specific repairs for which the maintenance lacks facilities, external companies are hired. For major repairs the required financing is sought after, or co-financing is used. **Table 1** provides a detailed breakdown of costs for repairs and maintenance in 2013-2015.

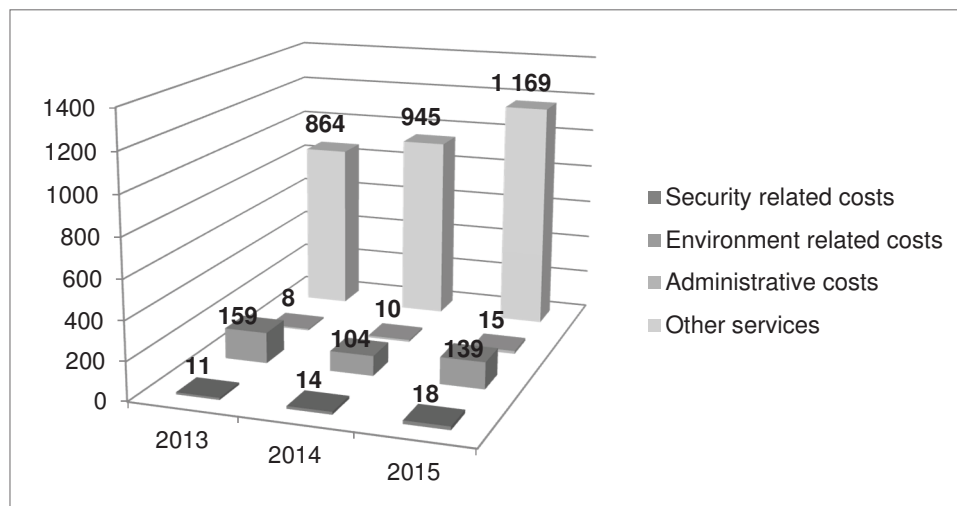
A substantial part of the funds was spent on maintenance of the generating units for the production of steam and electricity. For the enterprise, steam and electricity are the main products therefore the maintenance is consistent and consumes most of the funds. The maintenance costs for equipment for heating and compressed/blast air constitutes rather negligible percentage. The maintenance is subject to manufacturers' recommendations and operating hours. The repair cost of repairing turbo-generators and repairs to the boiler room obviously exceed any other repair costs. "Other repairs" include, for example: turbo-compressor repair, repair of distribution pipes for drinking water, repair of lifts - remedy of safety defects, repair of roof. Expenses grow from year to year because of increasing number of operating hours and increasing frequency of repairs and maintenance.

**Table 1** Maintenance and repair costs 2013 - 2015 (thousands CZK)

Item	2013	2014	2015
Power generation	367	523	791
Steam generation	682	896	988
Heat generation	37	43	42
Production of compressed and blast air	29	38	43
Other	171	205	233
<b>Maintenance total</b>	<b>1,286</b>	<b>1,705</b>	<b>2,097</b>
Repairs of turbo-generators	1,233	864	1 123
Boiler room repairs	29	660	1 431
Control and repairs of chimneys	0	300	487
Repair of steel structure	0	250	513
Other repairs	62	396	612
<b>Repairs total</b>	<b>1,324</b>	<b>2,470</b>	<b>4,166</b>
<b>Maintenance and repairs total</b>	<b>2,610</b>	<b>4,175</b>	<b>6,263</b>

### 3.1. Analysis of overhead costs

Overhead costs in the metallurgical enterprise are divided into the costs associated with security, the environment, as well as the administrative costs and other services, see **Figure 1**.



**Figure 1** Maintenance overhead costs 2013 - 2015 (thousands CZK)

The data in **Figure 1** shows that the highest proportion of maintenance overhead costs are other services that are further comprised of the cost of information systems and information technology, insurance, security and fire protection, and property and land taxes.

### 3.2. Analysis of fixed costs

Fixed costs are costs that remain unchanged with a change in the production volume. The company has to spend those regardless of production volume. Fixed costs generally can not be changed within short periods of time. [7] The total amount of the fixed costs of maintenance is captured in **Table 2**. Fixed costs are costs of repairs and maintenance, energy and tooling costs, other and labor costs.

**Table 2** Total fixed maintenance costs 2013 - 2015 (thousands CZK)

Item	2013	2014	2015
Repairs and maintenance costs	2 610	4 175	6 263
Energy and tooling costs	337	364	328
Other overhead costs	1 042	1 073	1 341
Labor costs	2 318	2 782	3 338
<b>Total fixed costs</b>	<b>6 307</b>	<b>8 394</b>	<b>11 270</b>

The table shows that in all reporting periods the cost of repairs and maintenance represent the highest portion of the fixed maintenance costs. The second highest proportion consisted of labor costs; other overhead costs also represent a relatively large part. In 2013, the costs of repair and maintenance were 41.38 % of the total fixed costs and in 2015 these costs amounted to 55.57 % of the total fixed costs. The tendency to reduce the maintenance costs is entirely understandable.

### 3.3. Total repair and maintenance costs

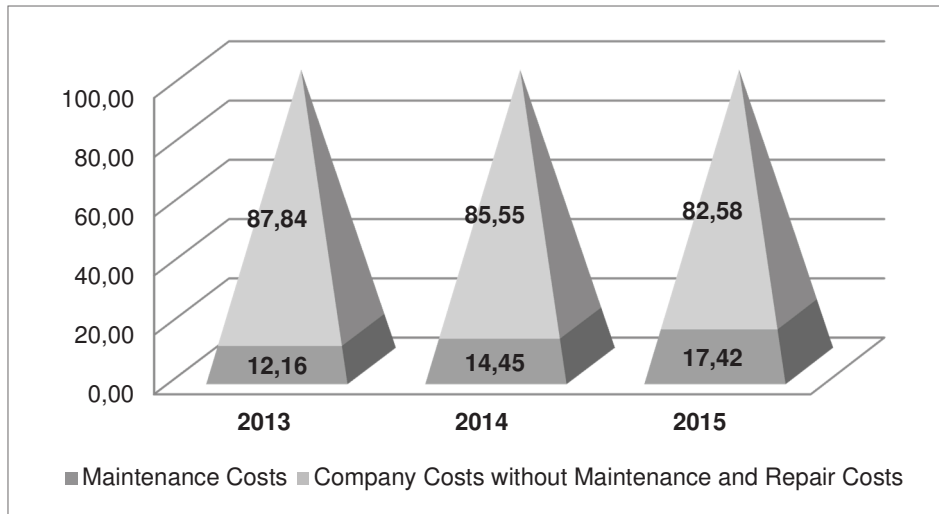
It is interesting to compare how the maintenance costs and repair and maintenance costs participate in the company's total costs. This situation is documented in detail in **Table 3**. Note that these costs represent a substantial proportion of fixed costs, and their total is not negligible.

**Table 3** Total repair and maintenance costs 2013 - 2015 (thousands CZK)

Item	2013	2014	2015
<b>Variable costs</b>	<b>25 737</b>	<b>32 309</b>	<b>36 711</b>
- steam	14 360	18 523	20 668
- power	8 560	9 636	10 564
- blast air	1 369	1 864	2 390
- compressed air	428	769	1 206
- heat	894	1 125	1 368
- demineralized water	126	392	515
<b>Fixed costs</b>	<b>6 307</b>	<b>8 394</b>	<b>11 270</b>
- of which repair and maintenance costs	2 610	4 175	6 263
- of which maintenance costs	1 286	1 705	2 097
<b>Total costs</b>	<b>32 044</b>	<b>40 703</b>	<b>47 981</b>

From the above table it is quite clear that the maintenance costs make up over half of the fixed costs of the metallurgical enterprise and in variable costs the major share is related to high pressure steam and power. **Figure 2** shows the percentage of maintenance costs compared to total company costs.

From the data in **Figure 2** it is evident that in 2013 the maintenance costs accounted for 12.16 %, in 2014 14.45 % and in 2015 rose to 17.42 %. One might argue that currently the maintenance costs represent roughly a sixth of the total costs of the company.



**Figure 2** Share of maintenance costs in total company expenses in %

#### 4. RECOMMENDATION FOR IMPROVEMENT OF CURRENT COST MANAGEMENT

From the above analyses the costs with the largest share in total costs and their development over three years have been determined. The largest portion of the costs is spent on maintenance of the generation units for the production of steam and power, repair of turbo-generators and repairs in the boiler room. Therefore I recommend focusing on these cost groups and identify cost savings opportunities there. The following paragraphs will present proposals that can, in my opinion, help the company to reduce some of the costs.

In terms of cost, the most efficient is the preventive maintenance carried out according to schedule of regular repair and maintenance. For each part of the technology or technological unit, this plan should take into account the age and frequency of use. If the maintenance is provided in this way, it eliminates unexpected outages, emergency situations or unplanned downtime. Timely identification and removal of possible failure maintains if not increases the efficiency of production capacity. To perform only reactive maintenance does not pay off because of the losses in production and shutdowns which have an adverse effect on the operation of the entire enterprise. Also knowledge of the technical condition of the individual production units acquired during inspections, diagnostic measurements and reviews can help with the specific maintenance interventions.

For specific materials, spare parts and services the metallurgical enterprise holds tenders. But not all are implemented consistently because they are not given the necessary attention and time. For certain materials and services the same suppliers are being chosen repeatedly. Here a possibility presents itself to try to get another supplier or negotiate a better price with the existing one, which should be the main focus of the company purchase department.

The metallurgical enterprise hires external companies for certain specific repairs which could be quite expensive. It is therefore necessary to consider whether strengthening own maintenance would not be more effective. At least the time would be saved from dispensing with the need for these external companies, the defects would be removed faster using own employees. Also worth considering is the investment in construction of new generation units as the costs of repairs, maintenance and replacement of broken parts are already quite high.

#### 5. CONCLUSION

Due to the ever increasing market competition, companies are searching for opportunities to continue to remain competitive or how to further expand their markets. Most of these companies are looking for new customers

who can increase their turnover of sold products and consequently the profits. Taking this path is important for the future but it is not easy. Therefore, it is important to look for other ways to achieve higher profits. One of them is to reduce company costs and to increase productivity. Any saving measure or process improvement can yield savings in time and finances. [8]

An analysis of maintenance costs in a metallurgical enterprise has been conducted with proposals to reduce these costs. It is proposed to adhere to preventive maintenance, to carry out effective tenders for contractors, to strengthen own maintenance instead of hiring outside companies and to consider investing in the construction of new generation units.

The proposed recommendations could bring the metallurgical enterprise savings of up to 6 % of the total maintenance costs which reached CZK 2 028.6 thousands. It can be concluded that the proposed measures are economically efficient for the enterprise.

## ACKNOWLEDGEMENTS

***The work was supported by the specific university research of the Ministry of Education, Youth and Sports of the Czech Republic No. SP2016/59.***

## REFERENCES

- [1] INSTITUTE OF MANAGEMENT AND ADMINISTRATION. *Cost Reduction and Control Best Practices: The Best Ways for a Financial Manager to Save Money*. New Jersey: John Wiley & Sons, 2012.
- [2] MISRA, K., B. *Handbook of performability engineering*. London: Springer, 2008.
- [3] ŠTURMA, M. Provoz, revize a údržba technických zařízení: elektrická, plynová, tlaková, zdvihací. Praha: Grada Publishing, a.s., 2015.
- [4] KINNISON, H, A., SIDDIQUI, T. *Aviation maintenance management*. New York: McGraw-Hill, 2013.
- [5] LEGÁT, Václav a kol. *Management a inženýrství údržby*. Praha: Professional Publishing, 2013.
- [6] MISHRA, R. C. a K. PATHAK. *MAINTENANCE ENGINEERING AND MANAGEMENT*. New Delhi: PHI Learning Private Limited, 2012.
- [7] MARTINOVIČOVÁ, D., KONEČNÝ, M., VAVŘINA, J. *Úvod do podnikové ekonomiky*. Praha: Grada Publishing, a.s., 2014.
- [8] LENORT, R., KLEPEK, P., SAMOLEJOVÁ, A., BESTA, P. Production paths - an innovative concept for heavy machinery production planning and control. *Metalurgija*, January-March 2014, Vol. 53, No. 7, pp. 78-80.