CONSISTENT MAINTENANCE MANAGEMENT MODEL

Jan SAILER[1], Tomáš HLADÍK[1]

[1]*Department for Quality and Dependability of Machines, Faculty of Engineering, Czech University of Life Sciences Prague, Czech Republic*

Abstract

A number of asset management models, methodologies and tools are available and well known today. However, various organisational approaches to asset management processes are adopted by companies in industry. In the paper, a number of examples of maintenance process models are summarized and comparison of examples (benchmark) of real maintenance organisational structures is presented. The used examples origin from chemical, petrochemical and automotive industries. On this background, a case study of major maintenance organisation change in Unipetrol, a central-european refinery and petrochemical group (part of PKN Orlen) is presented and analysed.
The goal of the authors is to provide readers an overview of the proposed changes in the organisational structure and asset management processes. Furthermore, to show the significance of their impact on number of management positions (reduction by 25%), roles, competences and asset management process flows with respect to KPIs evaluation.

Keywords: *maintenance; organisational structure; asset management.*

INTRODUCTION

There currently exist a number of asset management methodologies and tools. Even though this term is defined through a set of norms, both national and global ones (*ISO 55000, 2014*; *ISO 55001, 2014*), in the vast majority of cases we see isolated processes and methodologies, even though these are efficient as far as their application and outputs are concerned, they mostly focus only on a s ingle area or sub-process and are not interlinked, they do not form a consistent whole, or do not respect the needs or organisational structure of the production plant (*Leong, 2012*; *Flynn, 1995*). This state is usually caused by the isolated development of individual methodologies, which are often commercial products. An important role is also played by time, since individual methodologies and tools were developed in a certain time frame and thus they logically cannot follow up on each other. As an example, the set of methodologies generally referred to as Risk Reliability Management includes the Reliability Centered Maintenance, Risk Base Inspection and SIFpro© (*Shell Global Solution International, 2003*) methodologies, whose goals are to generate optimized plans for preventive maintenance based on risk assessment. Individual methodologies generate plans for preventive maintenance, but in distinct formats, completely unsuitable for automated or batch transfer to central planning systems for maintenance, where data are still processes within the planning and work implementation sub-process.
A frequent representative of such CMMS is SAP – the preventive maintenance management module (*Valesko, 2010*; *Tan, 2009*; *Mourtzis, 2016*). Another factor which reduces the efficient implementation of modern methodologies for asset management is their low adaptability to the organisational structure of the production plant. The imperfect connection of the asset management to the production area, which in this case represents the customer, and with processes supporting the asset management process such as the purchase of spare parts and consumable material, investments, safety and security, or HR, then leads to imperfect communication flows that reduce the organisation's efficiency and in the end lead to suboptimal asset management costs, reduced availability of production equipment and lower process safety. For instance, this could lead to imperfect adherence to requirements of valid legislature, incorrect usage of residual service life of production equipment, or low coverage by predictive maintenance.
The facts specified above force us to view the asset management process as a consistent unit, integrated within the organisational structure of the production plant in a manner allowing efficient communication and goal sharing, whereas the real needs of the production facility, the medium- and long-term plans as well as the mission and vision of the company all need to be respected.
The proposed solution spans all parts of the asset management process, from the method of entering requests, their approval and prioritization, system of technical preparation of a job, optimal planning, transfer for implementation, feedback on implementation and final acceptance and closure of a job,

whereas emphasis is placed on efficient communication, work quality and utilization of work capacities (*Wireman, 2004*; *Kuda, 2012*).

Organisationally, it is necessary to setup the process in a way ensuring that individual decision steps are carried out on the side of the operator of the device and not on the side of the maintenance. On one hand, this results in an independent approval process with respect to costs management, and on the other this leads to clearly defined priorities by the operator, who is then forced to make decisions not only based on the current operating situation but also based on the costs and indicators for long-term operational availability (*ČSN EN 15341, 2010*). As was mentioned earlier, one of the primary tools to achieve optimal decision-making was the sharing of goals within key indicator assessment for processes, whereas the operator shares maintenance goals such as maintenance costs, mechanical availability of devices, Mean time between failures (MTBF) and/or efficiency of the work of the implementer of maintenance. On the other hand, the maintenance side shares operational goals, such as operational availability, use of production facilities, the energy index, or for instance variable costs (*Abreu, 2013*).

From an organisational standpoint, the solution is based on the structure of a so-called multi-professional team, where a single organisational element has representatives of all key areas required for efficient administration and management of the entrusted production section. In practice, this means that the team includes representatives of production, technologies and maintenance, as well as other areas such as reliability and quality management who are responsible for the efficiency of central specialized bodies in given areas.

One of the key areas that need to be emphasized is the definition of process efficiency indicators for individual management levels, including the definition of key indicators (*ČSN EN 15341, 2010*). This set of indicators contains not only basic items such as the aforementioned fixed costs for maintenance, MTBF, or mechanical availability of equipment, but also indicators monitoring process safety of equipment such as Loss of Primary Containment (LOPC), number of process alarms per time unit, success rate of diagnostics of rotary machines etc.

The structure of monitored indicators is based on a classical pyramid logic, where the number of monitored items becomes smaller in the direction of top management (*Younus, 2003*).

The primary contribution is the creation of an asset management model which will ensure an improvement of mutual communication and coordination between individual company bodies, improvement of availability indicators for production equipment, optimization of costs for the implementation of maintenance activities, improvement of process safety indicators such as LOPC or number of process alarms. The author intends to demonstrate these properties based on a real-life implementation of the proposed process solution.

For creation of such asset management model, it is vital to reflect current problems and trends in maintenance organisational structures. There are two basic forms of maintenance organisational structures: area and central. In an area organisation, work control is delegated to area shops. In a central organisation, all work orders are controlled from a central shop (*Maynard, c2001*). For smaller maintenance organisations it is typical to use central form, for larger organisations central shop concept is widely used. Combination of both concepts (area-central) might be used for multilevel maintenance, where specialists are assigned to specific areas, maintaining the key equipment. Skills which are not needed on a daily basis are dispatched from the central shop when needed.

Organisational structure can be partly described by the Maintenance Organisation Ratio. This is manager to staff ration and ordinarily it is about 15:1. However this ration must be set carefully with respect to the skills and daily agendas of supervisors, machine shop dispositions and to the form of production (*Maynard, c2001*). Thus The goal of this study is to provide an overview of the proposed changes in the organisational structure and asset management processes.

MATERIAL AND METHODS

One of the main factors for the maintenance organisation is the characteristics of the maintenance needs that are generated by the assets.

A possible scenario of a production plant for chemical products can serve as an example.

Originally all the repair work arising out of the maintenance needs (or demand) of the plant was undertaken by local maintenance department personnel. After a major decrease of 40% in production output due to lack of demand was decided by management to reduce the numbers of production and maintenance personnel.

A further investigation resulted in two main options to choose between: either completely outsource the maintenance function, or outsource as much as possible. For practical reasons it was decided that a maximum of 50% of the work had to be done by maintenance department and 10% by operators undertaking first line maintenance work. So 40% of all work was outsourced, in particular all work on building services installations and all the utility equipment (*Zaal, 2016*).

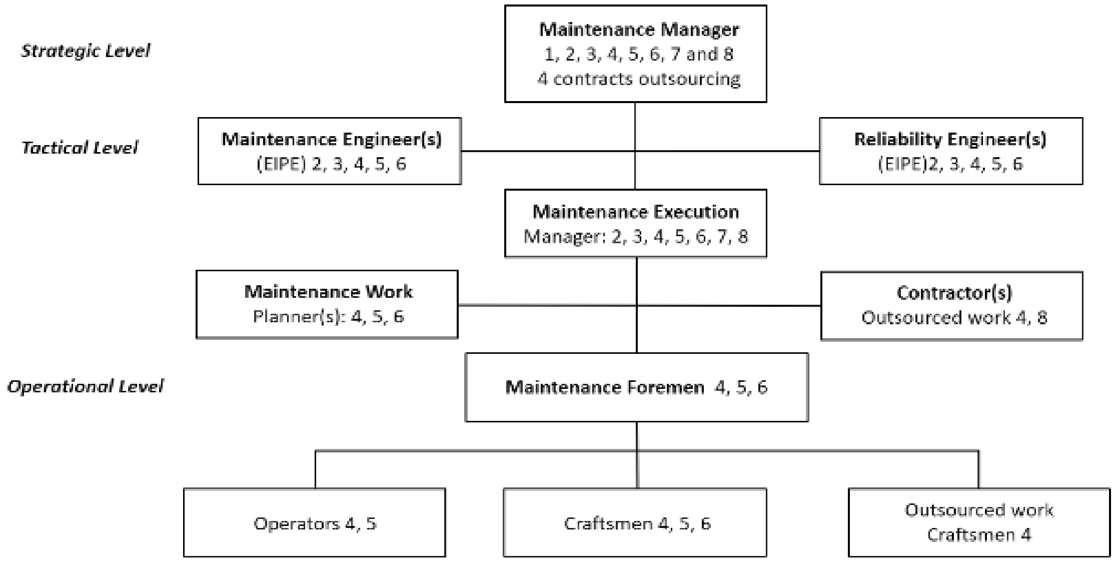
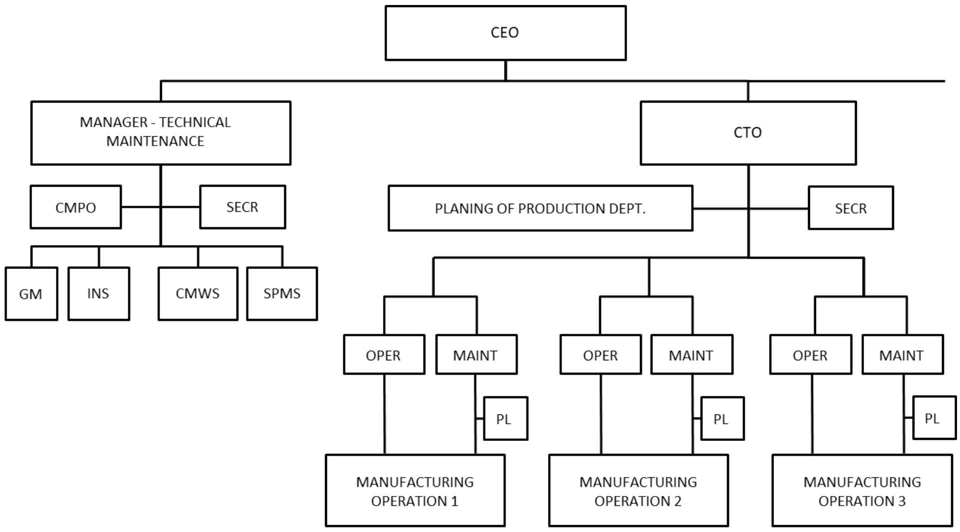


Fig. 1 Possible organisation of the maintenance department for a production plant (*Zaal, 2016*)



CMPO: Central production planning dept.	**SECR**: Secretary	**INS**: Instruments and tooling management
GM: General repairs workshops	**OPER**: Operations manager	**MAINT**: Maintenance manager
CMWS: Central maintenance workshops	**SPMS**: Spare parts procurement and warehouses management	**PL:** Planning

Fig. 2 Example of organisation structure of combined maintenance *(Legát, 2017)*

Regardless of formal structure of the organisation and the position of maintenance within the structure, there are certain generally accepted principles. The employees must know what they are responsible for, and whom they report to. Managers are required to know who is responsible for setting goals and all other activities needed for their success. The organisation structure should represent these responsibilities in the simplest and uncomplicated way. The organisation structure is often clear on the level where business policy is formulated in the organisation, however, it is essential that the organisation structure is clearly understood on the level of work execution (*Legát, 2017*).

RESULTS AND DISCUSSION

The area maintenance model was in the past been used over the long term for individual production plants in Unipetrol. This was during times when the company had its own in-house executive maintenance including workshops and machinery. Change occurred in the nineties, when the company underwent privatisation and almost all servicing activities were split off and from then on used in the form of outsourcing. Changes in the organisational structures of maintenance were also accelerated at that time, when it was necessary to adapt to a different model of operation. Over the next fifteen years, many changes then occurred, when organisation of maintenance settled on the area model with a specific small role played by centralised services which constituted basic service for individual maintenance operations. The central part included technical diagnostics, cost reporting and basic administration of the maintenance process. There was no central technical engineering, no system of uniform strategic management, for example in the field of reliability, inspection, risk management, planning and strategy for preventative maintenance. Connection with the field of production differed for various production units. This model of maintenance management required a large number of management employees and ensured only minimal options for uniform management of maintenance strategy.

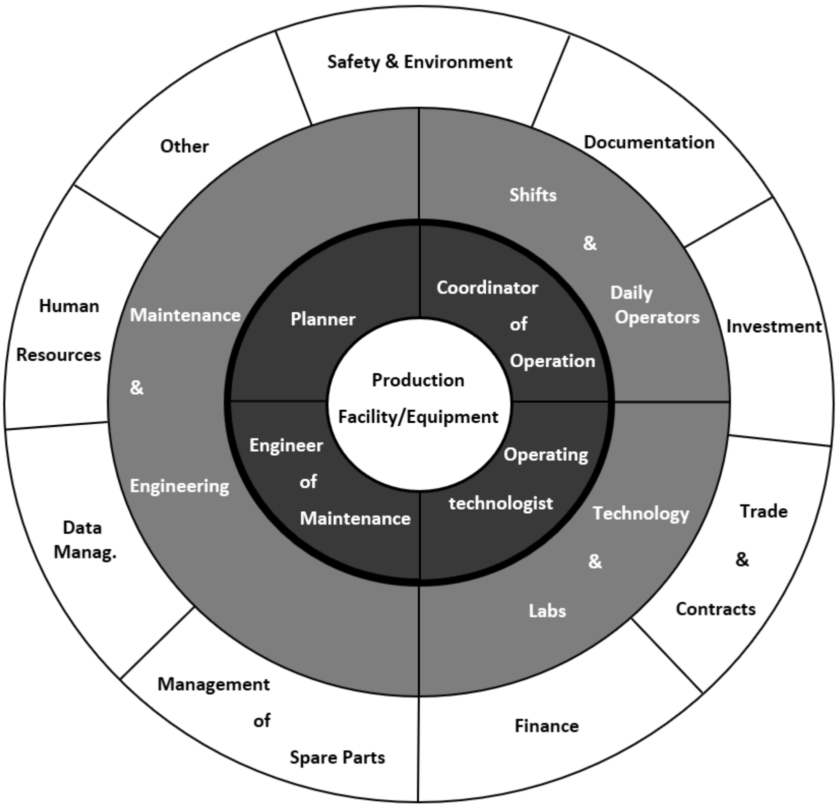


Fig. 3 Roles in production Team

In 2014, the company decided to implement the organisational model of Facility Teams across the board for management in the field of production. This concerns a multiprofessional team which is responsible for comprehensive management of a defined production unit and which also allows for close connection with organisation of maintenance.

Apart from the position of production technologist and energy technologist, the Facility Team is made up of a Reliability Engineer, Main Maintenance Engineer, Operations and Maintenance Coordinator and Scheduler (Fig. 3). It is precisely thanks to these positions that close interconnection with organisation of maintenance and its suppliers is ensured.

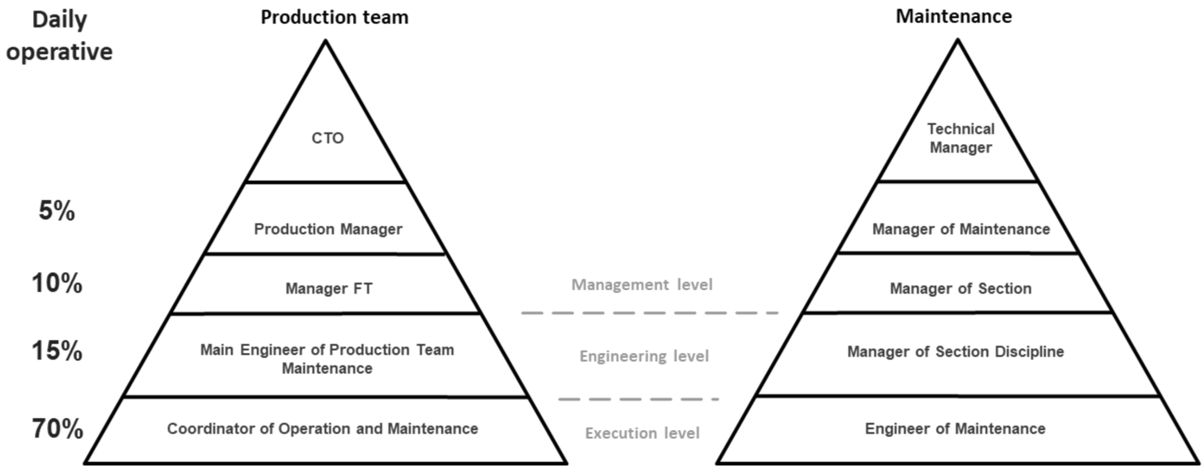


Fig. 4 Organisational Pyramid

So as to ensure that responsibilities and communication between in-house production and maintenance are clearly defined, transition to Facility Teams required change in the organisational structure of maintenance (Fig. 4). These changes were at the same time used to ensure more complex changes in organisation of in-house maintenance, whereas centralization occurred of the executive part of maintenance and the level of technical engineering was created, allocated to departments according to technical expertise (Fig. 5).

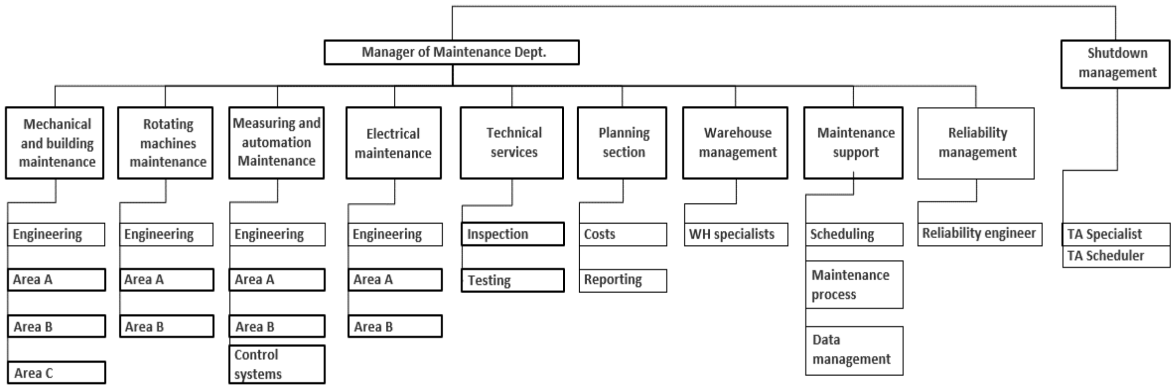


Fig. 5 Organisational chart

CONCLUSIONS

The changes in the organisational structure described above had an impact on the number of employees in management positions, bringing a reduction in their number from 12 to 9, i.e. by 25%.

Tab. 1 Analyzed KPIs

Indicators	Unit	Before the change					After the change		
		2010	2011	2012	2013	2014	2015	2016	2017
Ratio of managerial positions	%	6,9	7,7	7,6	8,4	8,5	6,4	6,3	5,5
Regulatory requirements fulfilment	%	16,5	19,6	15,8	17,2	18,3	7,8	4,7	1,7
High priority works	%	18,3	19,1	19,3	19,7	20,3	15,0	11,5	14,2
Planned vs. unplanned maintenance	%	26,0	25,0	23,5	20,5	21,2	14,0	16,0	14,0
Failure maintenance ratio	%	44,0	56,0	50,5	54,0	51,0	52,0	53,5	52,5

The reason behind these organisational changes was not however reduction of the number of jobs, but increase in the specialist abilities as regards organisation in the field of technical engineering and setup of organisation in such a way that competences and flow of information are clearly defined within the framework of interconnection between organisation of production and organisation of maintenance.For the evaluation, the period of 2010-2017 has been used (Tab. 1), with the year 2014 as the point of change. This period represents a sufficient sample of timeseries of selected KPIs and also avoids impacts of certain historical changes.

REFERENCES

1. Abreu, J., Martins, P. V., Fernandes, S. & Zacarias, M. (2013). Business Processes Improvement on Maintenance Management: A Case Study. In *Procedia Technology, 9*, 320-330. ISSN 22120173.
2. Ales Z, Jurca V, & Legat V. Effectiveness indicators of food processing lines. (2013). In: *Conference Proceeding - 5th International Conference Trends in Agricultural Engineering 2013* (pp. 56-61). Czech Republic: Czech University of Life Sciences in Prague.
3. ČSN EN 15341: Údržba – Klíčové indikátory výkonnosti údržby. (2010). ÚNMZ.
4. Flynn, B. B., Schroeder, R. G., & Sakakibara, S. (1995). The Impact of Quality Management Practices on Performance and Competitive Advantage. In *Decision Sciences, 26*(5), 659-691. ISSN 0011-7315.
5. *Introduction to Risk & Reliability Management*. (2003). Shell Global Solution International. ISBN: 978-80-213-2388-9.
6. ISO 55000: Overview, principles and terminology. (2014). International Organization for Standardization.
7. ISO 55001: Management systems – Requirements. (2014). International Organization for Standardization.
8. Kuda F., Beránková, E., & Soukup, P. (2012). Facility management v kostce: pro profesionály i laiky. Olomouc: Form Solution. ISBN 978-80-905257-0-2.
9. Legat, V., Mosna, F., Ales, Z., & Jurca, V. (2017). Preventive maintenance models – higher operational reliability. In *Eksploatacja i Niezawodnosc – Maintenance and Reliability, 19* (1):134141.
10. Leong, T. K., Zakuan, N., & Saman, M. Z. M. (2012). Quality Management Maintenance and Practices-Technical and Non-Technical Approaches. In *Procedia - Social and Behavioral Sciences, 65*, 688-696. ISSN 1877-0428.
11. Maynard, H. B. & Zandin, K. B. (2001). *Maynard's industrial engineering handbook*. 5th edition (pp. 2248-2250). New York: McGraw-Hill. ISBN 9780070411029.
12. Mourtzis, D., Vlachou, E., Milas, N. & Xanthopoulos, N. (2016). A Cloud-based Approach for Maintenance of Machine Tools and Equipment Based on Shop-floor Monitoring. In *Procedia CIRP, 41*, 655-660. ISSN 22128271.
13. Tan, W. G., Cater-Steel, A., & Toleman, M. (2009). Implementing it service management: A case study focussing on critical success factors. In *Journal of Computer Information Systems*, *50*(2), 1-12.
14. Valesko, S. (2010). CMMS increases efficiency, cuts downtime. In *The National Provisioner, 224*(3), 20-23.
15. Wireman, T. (2004). *Benchmarking best practices in maintenance management*. New York: Industrial Press. ISBN 9780831131685.
16. Younus, J., Fahad, M., & Khan, M. A. (2016). Evaluation and Benchmarking of Maintenance Organization and Planning/Scheduling at Automotive Industries of Pakistan. In *Procedia CIRP, 40*, 711-715. ISSN 22128271.
17. Zaal, T. M. E. (2016). *Profit-driven Maintenance for Physical Assets.* Maj Engineering Publishing. ISBN 9079182419.

Corresponding author:
Ing. Jan Sailer, Department for Quality and Dependability of Machines, Faculty of Engineering, Czech University of Life Sciences Prague, Czech Republic, e-mail: Jan.Sailer@unipetrol.cz