IMPLEMENTING A CMMS: AN INVESTMENT APPRAISAL BASED ON VALUE OF DATA

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Abstract

Optimal asset data management would require assessing the value of the data regarding the technical and business related goals of the organization. However, the value of data, or data as a cost object, has not been extensively researched. This paper presents a case study on evaluating the value of data -based profitability of investing in a Computerized Maintenance Management System (CMMS). The research is conducted in collaboration with a company who manufacture a range of parts for the automotive industry. Currently the company operates without a CMMS, therefore the implementation of the CMMS is included in the analysis as a scenario. The results will measure the time used in asset data management (gathering, transferring, analysing and exploiting the data), and the value of data in asset management decision making under different maintenance strategies.

Key Words: CMMS, Investment, Value, Maintenance data.

1 INTRODUCTION

The digitalization of manufacturing processes has created vast amounts of maintenance and production data available to asset managers [1]. Data plays a significant role in asset management decision making, and thus the increase of data creates new requirements for maintenance management processes (see e.g. [2]). Optimal data-based asset management would require maximizing the value of the used data in terms of resources spent and benefits achieved. However there is a lack of understanding and managerial constructs supporting data-based value creation in asset management. One approach to increasing the value is through eliminating waste in the data management process [3]. This paper discusses decreasing unnecessary processing of data, and making data available for decision-making by changes in Information Technology (IT) systems and the maintenance strategy. The objective is to assess the value of data –based profitability of investing in a CMMS, which is demonstrated through a case study.

The case presented in this paper is part of a larger study aiming to create a specific analytical model for assessing the profitability of maintenance investments from the perspective of data management processes. The case company are a tier one supplier and manufacture a range of parts for the automotive industry. The analysis focuses on a production plant operating in the UK. Currently the case company use manual forms to collect mostly production-led data on their maintenance, and inserts the data into electronic spreadsheets daily. The maintenance managers feel that they cannot use the data for maintenance development, because it is mainly focused on maintenance and breakdown times whereas, for example, the data on failure causes are missing. Accordingly, the maintenance technicians of the production plant are currently using 70% of their time on breakdowns and repairs, as opposed to 2.9% on preventive maintenance tasks. The maintenance managers are examining the need to invest in a CMMS, but are unsure whether it would be profitable. The data used for the analysis includes the selected production plant's maintenance and breakdown times from 1st January to 22nd June 2018. The maintenance manager of the plant was interviewed to gain insight on the maintenance and data management processes.

2 ANALYSIS AND RESULTS

According to [4], in CMMS investment analyses two major cost categories must be included: annual maintenance costs (including labour, inventory, downtime, shutdown and maintenance) and installation costs (including software, hardware, labour, training, consulting and support fees). In this

case study we firstly evaluate the impact on the annual costs, especially the work required from the personnel and the downtime costs. The current (manual) data management process in the case company and the impact of the potential CMMS implementation are shown in Figure 1. For simplicity it has been assumed that the time and resources used in the maintenance work requests and the actual maintenance work remains unchanged. Currently the employees use maintenance report sheets, maintenance shift handover reports, and production data summaries to gather maintenance data. Multiplied by the number of documents and the cost of employees' time (total cost for employer evaluated using payscale.com and stafftax.co.uk to assess the average salaries of maintenance technicians and production supervisors), the documentation in the current process causes costs of £11,542 per year (4,522 + 3,510 + 3.510). In addition, the current process includes inserting the data into electronic spreadsheets once a day. Multiplied by the evaluated cost of time of a production planner, the annual cost for this phase is £3,458. If the case company would implement a CMMS, the data collection would have to include reporting maintenance events into the system, and adding production data from each shift. Using the current amount of maintenance events and production shifts, and multiplied by the evaluated cost of maintenance technician and production supervisor time, the documentation in the CMMS-led process would cause annual costs of £29,146 (27,391 + 1,755).

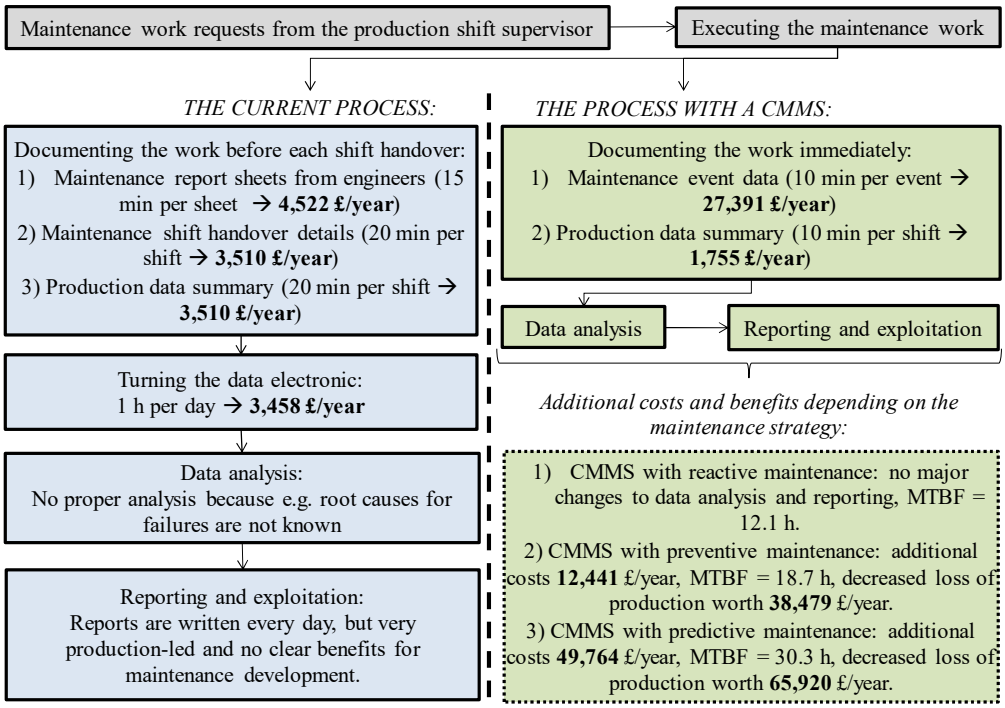

Figure 1: The current and the potential CMMS-based data management process.

Implementing a CMMS would create a change into the data analysis, reporting and exploitation phases of the process. CMMS can be exploited in maintenance data management to eliminate failures, maintenance costs, and quality issues. The benefits could then include having the data available fast and reaching the required data to support maintenance decision making. However, this is highly dependent on the selected maintenance strategy. The different requirements for data and CMMS set by reactive, preventive and predictive maintenance strategies are addressed by [5]. ***With reactive maintenance***, a CMMS could help to ensure the availability of spare parts and maintenance personnel. However the data of the case company did not indicate significant challenges in these areas: the maintenance personnel did not seem to be overworked and had time for breaks, meetings, and development projects. The MTTR (Mean Time To Repair, calculated as the total maintenance time divided by the total number of breakdowns) was 24 minutes, which is not overly long. No significant changes to data analysis and reporting are foreseen as long as the focus would be on reactive maintenance. The MTBF (Mean Time Between Failures, calculated as the plant runtime divided by the number of breakdowns) is assumed to remain unchanged, 12.1 hours. ***With preventive (time-based) maintenance***, the role of CMMS would be to support maintenance schedule planning in terms of availability of spare parts, personnel and planned stoppages. The data required in preventive strategies includes e.g. failure mode and effects analysis, performance and cost rates, reliability measures, system age, degradation times, time to repair, and number of failures [6]. Compared to the

current process, more time (1 additional hour per shift) would be needed for data analysis and reporting. The annual cost of this additional time is evaluated to be £12,441. Naturally, preventive maintenance also has potential to decrease the number of breakdowns. Komonen [7] reported a prevention rate of 34.3% in a sample of three-shift factories operating in various industries in Finland during 1996-1997. Using this as a baseline we have assumed a prevention rate of 35% (35% of the current breakdowns can be avoided with preventive maintenance). This would cause the MTBF to increase to 18.7 h, and the plant downtime to decrease by 1,011 h/year. The value of this decrease in lost production is evaluated to be £38,479 per year, based on public financial information on the case company. ***With predictive maintenance*** (condition-based maintenance) CMMS would provide real-time process data for condition monitoring and maintenance decision support. Even more data would be required, including failure modes and effects, system and component state, cost data, reliability, residual life, degradation variables, etc. [6]. Assuming that an additional 4 hours per shift are needed for data analysis and reporting, the additional costs would be £49,764 per year. Condition-based maintenance can be used to predict most failures, but the resources used in maintenance must be balanced with the demand for cost efficiency. The breakdown prevention rate achievable through predictive maintenance is quite case dependent. In this case example a prevention rate of 60% is assumed, which would cause the MTBF to increase to 30.3 h, and the plant downtime to decrease by 1,732 h/year. The value of this decrease in lost production would be £65,920 per year.

Table 1 Summary of the costs and benefits compared to the current manual process.

SCENARIO	CMMS with reactive maintenance	CMMS with preventive maintenance	CMMS with predictive maintenance
A) Additional costs caused by data collection	£14,146 per year	£14,146 per year	£14,146 per year
B) Additional costs caused by data analysis and reporting	-	£12,441 per year	£49,764 per year
C) Benefits from decreased downtime	-	£38,479 per year	£65,920 per year
D) Budget for annuity of CMMS installation costs *(D = C-A-B)*	**-£14,146 per year**	**£11,892 per year**	**£2,010 per year**

Table 1 summarizes the additional costs and benefits of the case company adopting a CMMS with different maintenance strategies. The bottom row of the table, Row D, shows the additional annual benefits of each scenario, excluding the CMMS installation costs. According to [8], commercially available CMMS packages with data collection and analysis features are generally priced to £10,000+, and those with real-time analysis features to £30,000+. Thus the CMMS scenarios with reactive and predictive maintenance can be seen as unprofitable, but the scenario with preventive maintenance could be feasible with £11,892 for the annuity of the investment costs.

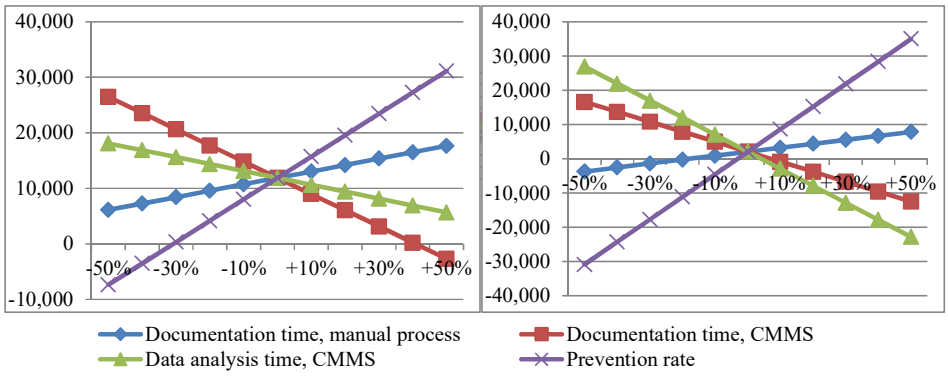

Figure 2: Sensitivity analysis with preventive (left) and predictive (right) maintenance strategy.

A sensitivity analysis was conducted to assess the impact of the assumptions and uncertainty. The studied variables included the time used for documenting the maintenance work both in the current process and in a CMMS-driven scenario, the additional time needed for data analysis, reporting and exploitation with CMMS, and the breakdown prevention rate in the CMMS scenarios with preventive and predictive maintenance. The variables were varied from -50% to +50%, compared to the original

value assumed in the analysis above. The sensitivity analysis concluded that the scenario of adopting a CMMS with reactive maintenance would not be profitable even if the variables were changed to more beneficial values. As depicted in Figure 2, the profitability of a CMMS with preventive maintenance is particularly sensitive to changes in the amount of time used for documentation and data collection in the CMMS-based maintenance process, as well as changes in the breakdown prevention rate. Regarding the CMMS scenario with predictive maintenance, the investment would become profitable if the time required by the CMMS-led data management process would decrease from the assumptions made in the analysis above, and if the breakdown prevention rate would significantly exceed the assumed 60%.

3 DISCUSSION AND CONCLUSION

This paper contributes to the discussion on optimal data-based asset management through assessing the value of data –based profitability of a CMMS investment. The case study concluded that adopting a CMMS with the current (reactive) maintenance strategy would not be feasible. However using the CMMS to implement preventive maintenance could be profitable, as the investment appraisal resulted in an annual budget of approximately £12,000 for the installation costs. According to [9], between 25%-40% of CMMS implementations succeed, and between 6%-15% of users exploit the system at its full capacity. Reasons for these low figures include e.g. believing that CMMS automatically implements a new maintenance strategy, and the decision makers not understanding the benefits of the investment. For the case company, a more detailed analysis is still needed to evaluate the actual investment costs related to various CMMS packages, and to assess the failure modes and effects to evaluate the impact and breakdown prevention rate achievable through preventive maintenance.

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