



The role of maintenance in improving company's competitiveness and profitability

A case study in a textile company

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Abstract

Purpose – The purpose of this paper is to examine the role of maintenance in improving company's competitiveness and profitability. In the first part the paper aims to discuss the potential improvement areas from the company perspective. Second part of this paper examines maintenance impact on company's business.

Design/methodology/approach – An empirical case study was utilized aiming to provide an understanding of the role of maintenance in improving company's business. The empirical data for this study were collected from a Slovenian textile company. A gap analysis was used in order to address the research problem and to identify potential improvement areas.

Findings – Based on the gap analysis, the results suggest that from respondents' points of view, maintenance practices related to condition-based maintenance approach represent the highest opportunity for improvement. The most notable empirical results of the case study showed that around 3 per cent of additional profit could be generated at weaving machine, especially if all unplanned stoppages and loss of quality due to decrease in the productivity would be prevented.

Practical implications – This paper demonstrates to managers the potential benefits of maintenance policy in terms of productivity, quality and profitability. In this regard, this paper builds on a premise that company can gain higher performance benefits using more effective maintenance policy.

Originality/value – The proposed conceptual model contributes to the existing literature by showing the interactions between maintenance and company's competitiveness and profitability. Empirical findings of this study therefore, acknowledge maintenance's potential of increasing the overall profit. In addition this study advances prior studies by utilizing a gap analysis which is rare in this type of research.

Keywords Quality, Productivity, Effectiveness, Profitability, Maintenance, Stoppages

Paper type Case study

1. Introduction

The economic downturn and the dynamic business environment drive companies to seek more efficient and effective maintenance (Van Horenbeek *et al.*, 2010). Thus, the increasing competition in the market creates a need to search new ways in which companies can differentiate themselves and gain more profit and better competitive

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position. Al-Najjar (2007) stated that company's internal effectiveness is strongly influenced by the maintenance role and impact on other working areas such as production, quality, production cost, working environment, amount of work in progress and tied up capital. Many researchers have also discussed the importance of the maintenance function in the context of its role in keeping and improving availability, performance efficiency and product quality (e.g. Al-Najjar, 1996; Riis *et al.*, 1997; Al-Najjar and Alsyouf, 2003). Furthermore, researchers have also discussed how to assess the financial impact of maintenance on company's business (see for instance Al-Najjar, 2007; Al-Najjar and Alsyouf, 2004; Alsyouf, 2007). In this regard, Al-Najjar (2007) presented a model that can be utilised for examining whether the investment done in maintenance is cost-effective or not, and for simulating maintenance financial impact on the relevant working areas. Moreover, Al-Najjar and Alsyouf (2004) developed a model for identifying, monitoring and improving the economic impact of vibration-based maintenance. Additionally, Alsyouf (2007) showed how an effective maintenance policy could influence the productivity and profitability of a manufacturing process. Likewise, Löfsten (1999) reported that proper management of maintenance offers many companies significant potential of improving efficiency, productivity and profitability. In addition, author also stressed that one of the main problems is that the production and maintenance departments cannot show what effects preventive maintenance has on profitability. Therefore, the maintenance function plays a critical role in a company's ability to compete on the basis of cost, quality and delivery performance (Swanson, 1997; Ahuja and Khamba, 2008). The above statements indicate that if maintenance is tapped effectively there is a scope for improving the profit and productivity of a company (Pinjala *et al.*, 2006). It appears that aim of the maintenance function is to contribute towards a company's profit, clearly bringing the need for maintenance operations to be in harmony with corporate business objectives (Kutucuoglu *et al.*, 2001).

Effective maintenance is also critical to many operations. It extends equipment life, improves equipment availability and retains equipment in proper condition (Swanson, 2001). In general, it is not usual that old and deteriorated machines/processes can manufacture quality products with high overall equipment effectiveness (OEE) and at low prices (Al-Najjar, 1996). Thus, high equipment availability and high performance can be achieved through efficient equipment management programmes (Raouf and Ben-Daya, 1995). On contrary disturbances in production processes due to maintenance and other causes reduce productivity; increase product cost and thereby reduces profitability (Alsyouf, 2007; Cholasuke *et al.*, 2004). Applying effective maintenance aims to enhance company's profitability and competitiveness through continuous cost-effective improvement of production process efficiency, effectiveness and productivity, which can be achieved via maintaining and improving the quality of all the elements contribute in the production process continuously and cost-effectively (Al-Najjar, 2007).

Literature search identified different research works that have dealt with maintenance in relation to company's competitiveness and profitability. Despite that the importance of maintenance impact on company's business is emphasized, literature search showed that no previous works have investigated maintenance impact on company's competitiveness and profitability in the textile industry. Therefore, this paper seeks to explore the role of maintenance in improving company's competitiveness and profitability in the Slovenian textile company. In addition this study advances prior studies by adding a gap analysis in terms of searching the potential improvement areas.

A part of this paper was presented at the second IFAC Workshop on Advanced Maintenance Engineering, Services and Technology (Maletič *et al.*, 2012). This paper

expands the results in Maletič *et al.* (2012) by including the gap analysis in order to address the research problem and to identify potential improvement areas in the field of maintenance. The paper is organized as follows. In Section 2, the theoretical background is provided. In Section 3, conceptual model based on literature review is derived. Section 4 is devoted to presentation of research methods and brief explanation of the research design. The case study analysis and results are presented in Section 5, followed by the conclusions in Section 6.

2. Theoretical background

2.1 Maintenance approaches

A maintenance strategy involves the identification, researching and execution of many repair, replace and inspect decisions (Kelly, 1997). A maintenance concept can be defined as the set of various maintenance interventions (corrective, preventive, condition based, etc.) and the general structure in which these interventions are foreseen (Pintelon and Waeyenbergh, 1999). Several maintenance approaches, i.e. strategies and concepts, have been developed and implemented through the evolution of maintenance. The maintenance has emerged from failure-based maintenance, and has moved towards preventive and is now realized in the essence of process-oriented "holistic" approach (Alsyouf, 2007). Likewise, Waeyenbergh and Pintelon (2002) argued that maintenance has shifted from failure-based towards condition-based maintenance (CBM).

Literature review can reveal the following concepts that underline maintenance discipline: reliability centred maintenance, total productive maintenance, business centred maintenance, total quality maintenance. Description of these maintenance concepts can be found in Kelly (1997), Waeyenbergh and Pintelon (2002), Swanson (2001) and Al-Najjar (1996). More recently, focus has moved towards creating an internal and external partnership.

2.2 The relationship between quality, productivity and maintenance

Much has been written in quality management literature considering quality. For instance, Flynn *et al.* (1994) define quality management as an integrated approach to achieving and sustaining high-quality output. Several studies have also investigated the link between quality performance and cost reduction. For example, Maani *et al.* (1994) showed that quality performance (in terms of scrap, rework and customer complaints) has impact on operational variables (i.e. production cost, on-time delivery, worker idle time, lead time, productivity), as well as impact on business performance. However, interactions between quality and production can be also interpreted from maintenance point of view. The primary output of production is the desired product and its secondary output is demand for maintenance, which is in turn an input for the maintenance function (Ben-Daya and Duffuaa, 1995). Hence, a strong maintenance program is needed to provide reliable equipment maintenance and reduce equipment process variation (McKone *et al.*, 2001). Therefore, maintenance major role should be maintaining the quality of the elements involved in production instead of just jumping from one repair to another similar to fire men, according to Al-Najjar (2007). Also, it affects production by increasing production capacity and controlling the quality and quantity of output. When outlining the link between quality and maintenance, is also necessary to indicate that product quality, production cost, machine condition and its life length are not just influenced by the type of production machinery and maintenance policy, but also by the quality of the input of elements (such as raw material, production tools, methods and procedures, operating and maintenance staff competence and operating conditions) in the production process (Al-Najjar, 2007).

As noted earlier quality defects and rework are losses in quality caused by malfunctioning production equipment. According to Nakajima (1988) losses related to availability, performance efficiency and quality rate are equipment failure/breakdown losses, set-up/adjustment time losses, idling and minor stop losses, reduced speed losses, reduced yield and poor productivity due to poor quality. In a case study Alsyouf (2007), found that loss of production because of unavailability due to all types of unplanned stoppages and losses related to maintenance problems resulted in reduced productivity. Hence, reducing production losses and enhancing product quality always yield more profit and improvement in the company's competitiveness, (Al-Najjar and Alsyouf, 2003), especially through detecting and eliminating causes of problems at early stages (Al-Najjar, 1996).

3. Maintenance impact on company's profitability: a conceptual model

Maintenance is often regarded as a cost driving necessity rather than a competitive resource, especially within the manufacturing industry. A survey performed by Alsyouf (2004), showed that 70 per cent of the respondents considered maintenance as a cost centre. However, in many studies (Al-Najjar, 2000; Mitchell *et al.*, 2002; Waeyenbergh and Pintelon, 2002) authors have emphasised the role of maintenance in improving performance and profitability of manufacturing processes. This suggests that maintenance is no longer a cost centre, but could be profit-generating. In general, improvements in the performance of a maintenance policy aim to reduce production cost and increase company's profit and competitiveness through enhancing process availability, performance efficiency and quality rate (Al-Najjar, 2007). In this regard, we present a model (Figure 1) that describes the interaction between maintenance, production and company's profitability.

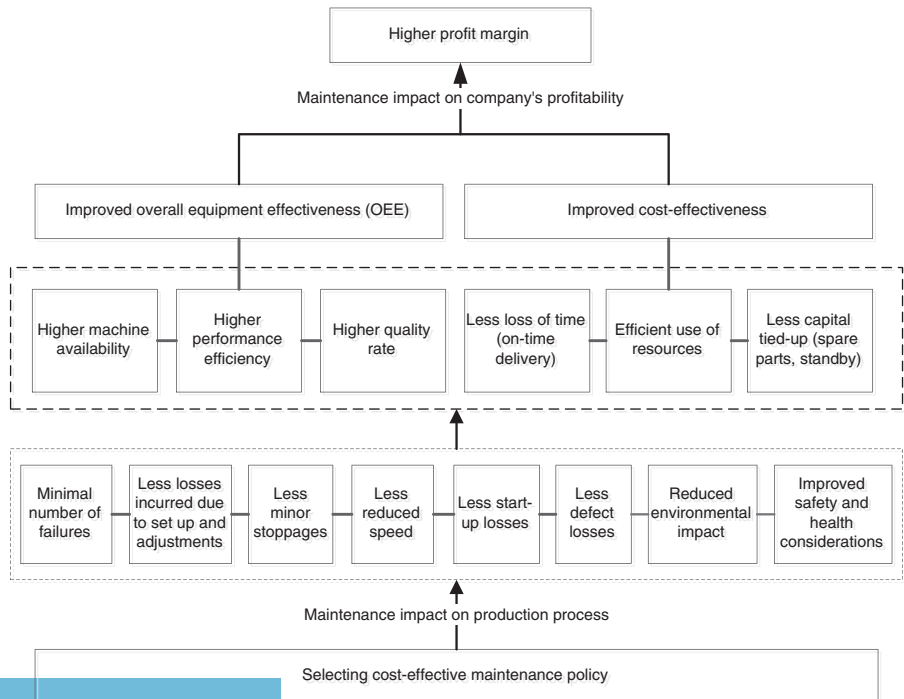


Figure 1. Conceptual model of maintenance impact on company's profitability

The model illustrates how an effective and efficient maintenance policy could affect the production process by improving OEE and cost-effectiveness. In this paper we define effective and efficient maintenance policy as that which reduces failures and utilises as long as possible of the component/equipment life before replacement (Al-Najjar, 1997). Thus, considering these elements company could benefit in higher productivity and nevertheless in higher profit margin.

Moreover, it is essential for companies to apply different indicators in order to assess and monitor the influence of selected maintenance policy on production performance and consequently on company's business. Different measures can be taken into account to assess the financial impact of maintenance on company's business (see Al-Najjar, 2007; Alsyouf, 2007). Nevertheless, it is also important to apply different indicators, such as maintainability indicators (Moreu De Leon *et al.*, 2012) as well as safety, security and environment (HSSE) indicators (Parida and Chattopadhyay, 2007), aiming to provide the required information to the management for effective decision making (Parida, 2007). Several different tools and technique such as failure mode effects and criticality analysis and reliability, availability, maintainability and safety analysis can also be viewed as a support to the decision-making process, which ultimately can affect the company business (González-Prida and Crespo Márquez, 2012).

4. Research approach

For purpose of this research a case study was used. In general, case studies are preferred strategy when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context (Yin, 2003). The research design of this study consists of two parts (Figure 2). In the first part a theoretical framework is developed, followed by a case study in the second part.

As shown in Figure 2, two phases are proposed for the empirical examination. The aim of the first phase is to explore in which areas in the field of maintenance, company has effectively deployed its resources and those areas that need more attention. The purpose here is to adapt and to apply the well-known gap analysis in order to address the research problem. The aim of the second phase is to assess the impact of maintenance improvement on company's business. Therefore, to address the research problem in the second phase, we propose the approach developed by Alsyouf (2007).

4.1 Research methods

Gap analysis. The paper draws on the gap analysis, i.e. to measure both importance and agreement of different maintenance practices. By identifying the gaps in a company, it is possible to discover areas where company needs to put more attention

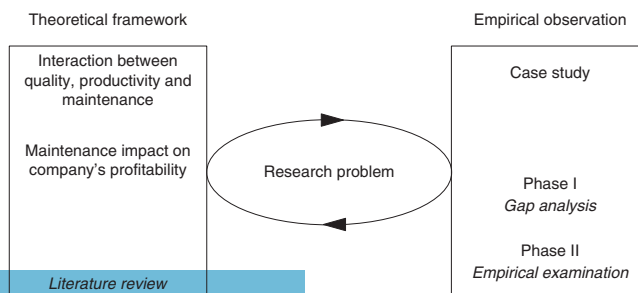


Figure 2.
Research design

in terms of improvement efforts. The idea behind this gap analysis is to ask the respondents both about agreement (P) and importance (I) of different maintenance practices. Generally the importance measurements can be understood as indications of the respondents' needs and the agreement measurements as indications of the company's performance. By doing so, it is possible to identify the potential areas for improvements in accordance with the respondents' importance perceptions (Dahlgaard-Park and Dahlgaard, 2010). While interviewing with the help of a questionnaire, respondents were asked to rank each question, formulated as statements, according to their perceived degree of agreement and importance using the Likert scale ranging from 1 to 5. On the "importance" scale, a "1" indicates that the statement according to him/her is of very minor importance, while statements that score "5" are perceived as having very high importance. The most important areas are related to the statements where the difference between importance and agreement is the highest. The instrument developed for this study consists of ten maintenance practices. The items used in this study were selected for the reason that they have been most commonly used in the empirical studies (Swanson, 2001; Alsyouf, 2009) conducted so far.

Profitability and quality analysis. The term profitability is the overriding goal for the success and growth of any business; it can be defined as the ratio between revenue and cost (Tangen, 2005). In order to address the purpose of this study we followed the approach of Alsyouf (2007), which can be discussed with American Productivity Centre (APC) model. APC model is based on the premise that a firm generates profits from two sources, productivity and/or price recovery improvements (Rao, 2000). Profit-linked total-factor productivity measurement models are well established in organizational performance measurement. Two of the established profit-linked total-factor productivity measurement models are the aforementioned APC model (Rao, 2000) and the PPP (profitability = productivity + price recovery) model (Miller, 1984). The advantage of total-factor measurement models lies in the fact that they link productivity to profitability (Miller, 1984; Miller and Rao, 1989; Sink *et al.*, 1984). In this study we focused on productivity, since it is hard to trace the changes in the price recovery index (Alsyouf, 2007). This approach also considers that for a given period of time, the variable cost (e.g. the cost of raw material per item), can be considered constant. On the other hand, the fixed cost per unit quality item will decrease based on how many items were produced in that period (Alsyouf, 2007). Therefore, company's profit in relation to productivity, can be calculated by using:

$$\text{Profit before improvement } F_1 = Q_1 (\text{Price} - TC_1) \quad (1)$$

$$\text{Profit after improvement } F_2 = Q_2 (\text{Price} - TC_2) \quad (2)$$

$$\text{Net Profit} = F_2 - F_1 \quad (3)$$

Using these formulas, author assumes that Q_1 is the quantity of quality product produced when using a certain maintenance policy, which resulted in total manufacturing cost (TC_1). However, if company improves the effectiveness of the implemented maintenance policy, or uses more effective maintenance policy that requires a new investment of (I) this could result in increasing the quantity (Q_2) and consequently in new TC_2 . If the net profit is greater than the cost of improvement, i.e. I, required for achieving the increase in output, then the investment is cost effective (Alsyouf, 2007).

Quality can be defined as the degree to which a company meets customers' perceptions on a variety of characteristics of the delivered products/services, and is

often expressed and managed using a variety of technical quality factors such as percentage of defect goods (Slack *et al.*, 1998). The quality rate can be used to indicate the proportion of defective production to the total productive volume (Dal *et al.*, 2000). Thus, quality rate can be calculated as the ratio of good quantity produced to the sum of total produced quantity, by using:

$$Q = \text{Quality rate} = [\text{Total production (units)} - \text{Defect amount (units)}] / \text{Total production (units)} \quad (4)$$

5. Case study

The case study was conducted in a Slovenian textile company. The study was conducted at weaving machine, one of the company's eight machines. Therefore, in response to the purpose of this study, data relating to this machine were used.

5.1 Data gathering

For the purpose of gap analysis a questionnaire was prepared, in order to evaluate importance and agreement of different maintenance practices in the observed company. To measure maintenance practices, respondents were asked to report the level of importance and agreement considering ten different maintenance activities (e.g. monitoring the production equipment status, use of computerized maintenance management systems (CMMS) and investing in improving the skills and competence of maintenance staff). The questionnaire is presented in the appendix. Respondents in this study were employees ($n = 5$) from production department, since maintenance is part of it. As regards the empirical examination a special form was prepared in order to obtain data, such as machine productivity, bad quality products, planned stoppage time, unplanned stoppage time, short stoppage time, planned stoppage time and economic data, such as fixed cost and selling price (Table I). The data were required as an input in Equations (1)-(4). As the economic data were confidential, the data used in the analysis were transformed using several suitable factors. There were also data collected for assessment of current state of maintenance function in the observed company. Due to the company's request for confidentiality, the name of the company is not disclosed.

5.2 Data analysis and results

In the first phase of the case study, analysis of perceived agreement and perceived importance scores was performed. The results of average performance scores, average importance scores and gaps are presented in Table II.

As can be seen from Table II the biggest gaps correspond to practices, such as monitoring the production equipment status, performing the maintenance tasks based on statistical modelling of failure data, investing in improving the skills and competence of maintenance staff and use of CMMS. These gaps represent the signals from the respondent's viewpoint about where to improve first. Based on these observations it can be assumed that company lacks an efficient CBM. Therefore, the gap between importance and agreement reflects the potential improvement priority.

Total production	5,500 items per month
Good quality products	5,280 items per month
Production lost because of unavailability due to unplanned stoppages	88 items per month
Selling price	10.60 € per item
Production cost	7.55 € per item

Table I.
Data for the case
study analysis

Table II.
Gap analysis

Maintenance practices	Importance (I)	Agreement (A)	Gap
1. Keeping the level low in spare parts inventory	3.6	3	0.6
2. Decreasing the repair time	3.6	3.2	0.4
3. Helping improve the production process	3.6	3	0.6
4. Performing periodic planned replacement	2.6	2.6	0
5. Recording process quality rate	3.8	3.6	0.2
6. Investing in improving the skills and competence of maintenance staff	3.8	2.4	1.4
7. Performing the maintenance tasks based on statistical modeling of failure data	2.6	1.2	1.4
8. Analysing equipment failure causes and effects	3.6	2.8	0.8
9. Use of computerized maintenance management systems (CMMS)	3.2	2	1.2
10. Monitoring the production equipment status	4.2	2.4	1.8

According to the conceptual model presented in this paper it is essential for companies to implement cost-effective maintenance policy in order to enhance their profitability. Nevertheless, it was found in many cases that an efficient CBM influences company's profit and competitiveness (see for instance Al-Najjar, 2007). In addition, Ilankumaran and Kumanan (2009) stressed the importance of selecting a proper maintenance policy in the textile industry.

The aim of the second phase of this case study was to exemplify the benefits that company could gain in terms of productivity and profitability of a manufacturing process, if more effective maintenance policy would be implemented. In this section we also discuss the maintenance impact on product quality. For this purpose the case study involved analysis of technical and economic data. First, the data analysis involved the identification and analysis of factors that cause the stoppage time. Based on the received data, the total stoppage time was distributed as short stoppages 60 per cent, unplanned stoppages 30 per cent and regular planned stoppages 10 per cent (Figure 3).

The short stoppage constitutes the largest portion of the stoppage time. Some stoppages were planned in order to perform maintenance tasks. It was estimated that 60 per cent of time spent for maintenance effort for this machine is for planning activities. However, according to the results 10 per cent of total stoppage time belongs to planned stoppages. Thus, this represents opportunity for improvement, by implementing more efficient and effective maintenance policy.

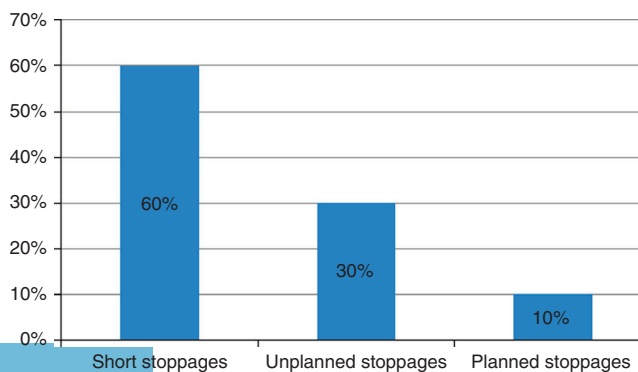


Figure 3.
Causes of total stoppage time at a weaving machine

The main causes for unplanned stoppages were due to electrical reasons, sewing threads, start-ups and adjustments of machine. Therefore, all these unplanned stoppages affect the productivity and quality, and by minimizing them, company could benefit in higher profit margin, as we presented in the conceptual model (Figure 1). Hence, in study (Al-Najjar and Alsyof, 2004) authors found that on average a value of around 3.5 per cent of the actual generated profit could have been gained if, ideally, all the failures, had been avoided using an efficient maintenance policy.

For calculating company's profit we used economic data and data relating to productivity. Machine's average monthly quantity produced was $Q_1 = 5,280$ items and the total production were 5,500 items per month. The average selling price was about 10.60 € per item. The average TC_1 , at Q_1 was 7.55 € per item. The average quantity of production lost due to all types of unplanned stoppages was estimated about 88 items per month. In ideal case, if an effective maintenance policy would eliminate all stoppages, the new quantity produced would be 5,368 items per month, and TC_2 would become 7.50 €. Thus, the impact on the company profit, considering improved productivity (without the considering any other costs, for instance cost of investment) was calculated by using Equations (1)-(3):

$$\text{Profit before improvement } F_1 = Q_1 (\text{Price} - TC_1) = 5,280 (10.60 \text{ €} - 7.55 \text{ €}) = 16,104 \text{ €}$$

$$\text{Profit before improvement } F_2 = Q_2 (\text{Price} - TC_2) = 5,368 (10.60 \text{ €} - 7.50 \text{ €}) = 16,640.8 \text{ €}$$

$$\text{Net Profit} = F_2 - F_1 = 16,640.8 \text{ €} - 16,104 \text{ €} = 536.8 \text{ €}$$

This means that in ideal case around 3 per cent of the profit per month could be additionally generated at weaving machine, according to improved productivity at one weaving machine. However, this result represents just the impact of productivity on company's profit. There could be several others factors, such as less consumed spare parts, less tied up capital in inventory, less delivery delay penalties and lower maintenance cost, that could influence the production process and therefore affect the manufacturing costs. This calculation does not include economic losses, such as, for example the cost of an idle machine in the time when the machine is not producing due to failures.

The empirical data showed that quality rate according to Equation (4) was 96 per cent. The results also showed that by using an efficient maintenance policy, company could increase quality rate in an ideal case for around 1.5 per cent. The value for quality improvement was estimated according to the company personnel's experience, regarding the production lost due to causes related to maintenance problems. Additionally, we assume that quality rate could be improved even more, if causes of failures due to operator's mistakes would be minimized. Higher knowledge and involvement of operators could improve equipment performance. In this regard, Crespo Márquez *et al.* (2009) suggest that higher levels of knowledge, experience and training is required, and at the same time, techniques covering the involvement of operators in performing simple maintenance tasks are extremely important to reach higher levels of maintenance quality and OEE. As such, it is also important for managers to support continuous improvement activities in order to improve maintenance performance (Maletič *et al.*, 2009, 2012).

The findings represent the economic result of an effective maintenance due to its impact on productivity and profitability of a manufacturing process. These findings are also consistent with the findings in the literature. According to Khan and Darrab (2010) a good maintenance policy and strategy leads towards improving equipment

reliability and maintainability, maximizing OEE and acts as contributor to quality and to higher productivity. An influence of an effective maintenance policy on productivity and profitability was also proved by empirical studies (Alsyouf, 2007; Al-Najjar, 2007). Hence, our results directly support the study of Alsyouf (2007) by providing the evidence of maintenance impact on productivity and consequently on company's business. On the other hand, the study of Al-Najjar (2007) distincts from our approach in terms of the model that can asses different savings (e.g. savings due to fewer number of stoppages and shorter average stoppage time) achieved by applying more efficient maintenance policy. However, our results also support the view of different studies (e.g. Swanson, 2001), which suggest that proper maintenance could ensure smooth running of machinery and uninterrupted flow of processes, which consequently leads to higher productivity, as well as better product quality. Hence, improving quality positively enhances operational performance and productivity, and certain indicators of business performance (Maani *et al.*, 1994).

While empirical findings provide interesting insight in maintenance in relation to company's quality and profitability, this can be also discussed in the view of the current state of the maintenance activities in the company. Maintenance function is organized as a part of production department. We found that time spent for planning does not result in preventing the failures in desired level, in order to reduce the level of unplanned stoppages. Further analysis reveals that company is not using advanced maintenance approaches and that there is still high portion of corrective maintenance. The main tasks conducted considering maintenance are, for instance: restoring equipment to operation, installing new equipment, etc. On the other hand some activities are focused in production process, such as, for example, helping improve the production process. Therefore, company is aware of the role of maintenance, but need to set maintenance strategy in order to be successful. However, this brief observation can be discussed in the view of our empirical results. If company would put more effort in implementation of modern maintenance approaches, such as CBM for properly describing current machine condition and predicting its future status it could prevent and minimize unplanned stoppages, and therefore benefit from higher quality and productivity.

5.3 Implications of the findings

Our study underscores the previous assertions that company can benefit from implementing more efficient maintenance policy (Löfsten, 1999; Al-Najjar and Alsyouf, 2004; Al-Najjar, 2007). Also consistent with prior studies (e.g. Al-Najjar, 2007) are the interactions we found (Figure 1) between maintenance, production and company's profitability. As presented in the proposed conceptual model a company could also benefit in terms of reducing environmental impact and improving safety and health aspects, especially if more efficient maintenance policy would be implemented. This implies that maintenance is endorsed by complex interactions with working areas such as production, quality, personnel competence, operating environment, etc. (Al-Najjar, 2007). This brings up new opportunities for a future research, mainly in terms of investigating the interactions between maintenance and these areas in more depth.

Management often looks at maintenance as a necessary evil, not as a mean to reduce costs (Paz and Leigh, 1994), or as a potential profit generating function (Al-Najjar, 2007). However, in today's highly competitive environment manufacturing systems are struggling to operate more effectively (Oke, 2005). This means that it is necessary

to implement a proper maintenance policy in order to remain competitive. Thus, by assessing potential benefits company could reveal how cost-effective the investments in maintenance were and whether or not they were relevant (Al-Najjar and Alsyouf, 2004). We recognize our contribution in the light of aforementioned discussion, indicating that maintenance should be viewed as a value-adding activity. From theoretical point of view this study therefore demonstrates that maintenance should be treated as a profit generating function.

The main implication for managers that has emerged from the study is that managers in manufacturing companies should place emphasis on assessing and monitoring the impact of maintenance on company's business. Therefore, managers could identify the potential benefits of maintenance policy in terms of productivity, quality and profitability. The latter is essential in order to achieve cost-effective decision making. Additionally, we also proposed a gap analysis which is very useful for identifying potential improvement areas. Regarding the managerial implications we can conclude that practitioners can use our proposed framework for identifying the potential improvement areas, as well as for assessing the impact of maintenance on company's business.

6. Conclusions

This study examined the role of maintenance from the perspective of improving company's competitiveness and profitability. Gap analysis was performed in order to identify areas for improvement in the field of maintenance in a Slovenian textile company. The research provides a clear result that company should put more effort in improving practices related to CBM approach. Therefore, the insights drawn from this study could help company balance their priorities and suggest the optimal areas on which emphasis should be placed. In this regard empirical examination was performed in order to investigate the effect of maintenance on company's profitability and product quality. To summarize the main findings, our results show that effective and efficient maintenance could affect the productivity and profitability of a manufacturing process. Hence, results provide as with prove that maintenance is not a cost centre, but could contribute to company's higher profit margin. These findings, therefore, demonstrate that company can benefit from implementing effective and efficient maintenance policy. Results also clearly reveal that proper maintenance policy can facilitate the manufacturing company's quest for achieving enhanced organizational performance.

Considering the directions for future research, our study highlights various research opportunities as discussed in the following. First, the proposed research approach can be applied in any type of industry; especially, it would be interesting to utilize the proposed model in process industry where processes are running 24/7. It is recognized that maintenance has a crucial role in the process industry, such as, for example in a paper industry (Al-Najjar, 2007). Second, it would be also interesting to examine the interactions between maintenance and other working areas as we highlighted in the implication section. Thus, future studies should broaden the perspective to include also other aspects of the overall organizational performance in order to provide more holistic view of the maintenance performance benefits.

Finally, one of the goals for future research could also be to improve the mathematical model, adding more variables that can provide more information about the impacts of maintenance on company's business.

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Appendix

To what extent does your company deploy the following maintenance practices?

*Please indicate your level of **agreement** with the following statements on a scale from 1 to 5, where 1 means totally disagree and 5 means totally agree*

Keeping the level low in spare parts inventory	1	2	3	4	5
Decreasing the repair time	1	2	3	4	5
Helping improve the production process	1	2	3	4	5
Performing periodic planned replacement	1	2	3	4	5
Recording process quality rate	1	2	3	4	5
Investing in improving the skills and competence of maintenance staff	1	2	3	4	5
Performing the maintenance tasks based on statistical modelling of failure data	1	2	3	4	5
Analysing equipment failure causes and effects	1	2	3	4	5
Use of computerized maintenance management systems (CMMS)	1	2	3	4	5
Monitoring the production equipment status	1	2	3	4	5

To what extent the following maintenance practices are important for your organization?

*Please indicate your level of **importance** with the following statements on a scale from 1 to 5, where 1 means totally disagree and 5 means totally agree*

Keeping the level low in spare parts inventory	1	2	3	4	5
Decreasing the repair time	1	2	3	4	5
Helping improve the production process	1	2	3	4	5
Performing periodic planned replacement	1	2	3	4	5
Recording process quality rate	1	2	3	4	5
Investing in improving the skills and competence of maintenance staff	1	2	3	4	5
Performing the maintenance tasks based on statistical modelling of failure data	1	2	3	4	5
Analysing equipment failure causes and effects	1	2	3	4	5
Use of computerized maintenance management systems (CMMS)	1	2	3	4	5
Monitoring the production equipment status	1	2	3	4	5

Table AI.
Questionnaire items

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Damjan Maletič is Teaching Assistant and Researcher at the Faculty of Organizational Sciences, University of Maribor. His research activities are mainly devoted to the fields of maintenance management and quality management. Currently one main area of his research has focused on studying the interaction between quality management, production and maintenance performance. He holds a bachelor's degree in Wood Science and Technology (University of Ljubljana) and Organization (University of Maribor). He is currently a PhD Student at the University of Maribor, Faculty of Organizational Sciences.

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Boštjan Gomišček is an Associate Professor at the Faculty of Organizational Sciences, University of Maribor. As Head of the Laboratory for Quality Management, he is engaged in the following research fields: quality management, environmental protection and maintenance management. After he finished electro-engineering study, he worked as a young scientist at the University of Ljubljana (Faculty of Chemical Engineering) and researcher at the University of Vienna at the Institute of Analytical Chemistry, where he obtained his PhD. He was involved at several national and international projects financed by EU and acted as a national coordinator for EURECA projects. Before he was in 2003 appointed as a Professor at the University of Maribor, he was four years researcher at the Austrian Academy of Sciences. Associate Professor Boštjan Gomišček is the corresponding author and can be contacted at: bostjan.gomiscek@fov.uni-mb.si

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