

Qualitative study on maintenance management in Moroccan industries

Amal NAJI, Mohamed EL OUMAMI, Othmane BOUKSOUR and Zitouni BEIDOURI

Laboratoire de Mécanique, Productique et Génie Industriel,
Ecole Supérieure de Technologie, Hassan II University of Casablanca, Morocco

naji.amal@gmail.com; mohoumami@gmail.com; bouksour2@gmail.com;
zbeidouri@gmail.com;

Abstract. Maintenance management is, and has been studied in depth, especially for strategies to be implemented in industry, even though, authors note that there is a gap between literature and management adopted by industries. In this paper, we present a qualitative study in five Moroccan industries to investigate “how maintenance is managed” rather than “how it should be”. The questionnaire utilized for the study consists on semi-structured and open-ended questions. We consider factors and variables related to maintenance management and we explore the relationships between those factors. The original contribution of this paper is to provide a « real view » about maintenance management in Moroccan industries, which could help to improve understanding of barriers to implementing maintenance strategy.

1. Introduction

Maintenance is not a function that stand alone in a company; it is a mix of management, operations, technology and business strategies, [1]. Due to the « interdisciplinary cross functional nature » of maintenance, its management is a part of a broad area of the company organization [2]. For Ostadi [3], maintenance management system (MMS), is a set of technical, administrative and management activities during the life cycle of equipment that aim to improve condition and functioning to an expected level.

When companies decide to improve the investment in maintenance management, it is often a challenge, as it is not a straightforward decision [4]. Therefore, research in maintenance should consider all the factors related on and explore in-depth the relationships between those factors.

As an emerging country, Morocco orients its political economy to increase industrialization by developing industrial zones and encouraging foreign investments. Industry in Morocco, contributes in about one-third of the annual GDP (Gross Domestic Product) and the main industries in Morocco are Phosphates, rock mining and processing, automotive and aviation, food processing, leather goods, textiles and construction.

Maintenance is an important issue for all these industries. That's why we took an interest in maintenance management in our country.

The purpose of this qualitative study is to explore in-depth maintenance management in five Moroccan industries by responding to two questions: What characterize maintenance management in those industries? What are the impact factors and the challenges to maintenance function?



In the first section, we present the method used to conduct the qualitative study. In the second one, we discuss results of the study followed by conclusions and limitations of our study.

2. Methods

2.1. Research model

The present study is a qualitative research, where the aim objective is to explore the variables that influence maintenance management, and to investigate the relationships between those variables in Moroccan industries. As cited by Creswell [5], the qualitative research is used in order to explore a problem or a subject. For Gerede [2], the objective in qualitative research is to collect in-depth data from people and events related to the topic of the research.

Since, maintenance management depends on measurable and non-measurable variables, it is necessary to use search tools like direct observation of events and interview with people involved in this issue. According to Yin [6], case studies are the preferred method when the objective of study is to answer questions like “how” and “why”. In this study, we select five case studies in industry.

2.2. Participants

The study is limited to five industries in Morocco. The participants are managers who set or implement maintenance strategies in their companies. The demographic data of the participants is shown in Table 1.

The five industries are large companies located in Morocco as detailed in Table 2 and they present similarities:

- Companies are founded for more than 20 years, (company E is founded in Europe for more than 20 years and its subsidiary is located in Morocco 10 years ago)
- The lifetime of the companies' equipment varies between 20 to 40 years, and is highly costly
- Their businesses are in a competitive environment
- Their work environment is risky.

Table 1. The demographic data of the participants

Gender	Male				Female
		5			
Age	25 - 30	30-40	40-50	50-60	
	1	2	2		
Education	Under graduated	Master's / Engineer	PhD		
	5				
Position	Maintenance manager	Maintenance Director	Equipment Manager	Operation Manager	Site Director
	1	1	1	1	1
Experience in the position	Less than 5 years	5 - 10 years	10 - 15 years	15 - 20 years	More than 20 years
	1	2		2	

2.3. Data collecting tool

The literature associated to empirical studies on maintenance management and factors defined through visits to industries were used to prepare the questionnaire. The development framework of the questionnaire is presented in Fig. 1.

The final version of the questionnaire comprises two parts. The first part of the questionnaire includes 77 semi-structured questions that are classified by subcategories related to variables and success factors of maintenance management. The second part consists of three open-ended questions in order to enable the participants to express freely their opinions about the following points:

- Maintenance management status in the company as perceived by them
- The barriers and the challenges for implementation of an optimal maintenance management strategy
- Added useful information about maintenance that was not included in the questionnaire or during interviews.

In order to collect data, we conducted face-to-face interviews with participants, in addition to exchanges via mails and conference calls while analyzing results.

The interviews consist of three parts;

- 1) We present the objective and the benefits of the study, and we ask the responder to present the company, the activity, products or services provided to clients, processes, equipment and the organizational chart.
- 2) The participant answers to the first part of the questionnaire, which consists of numerical and semi-structured questions.
- 3) The participant answers to the second part of the questionnaire, which consists of three open-ended questions. During this section, we discuss profoundly the impact of organization culture and the constraints that managers face to implement maintenance strategy.

2.4. Data analysis and interpretation

Qualitative research requires collecting data from the context where events occur in order to describe this occurrence. The aim objectives of qualitative research are describing, decoding and understanding eclectic data, [7].

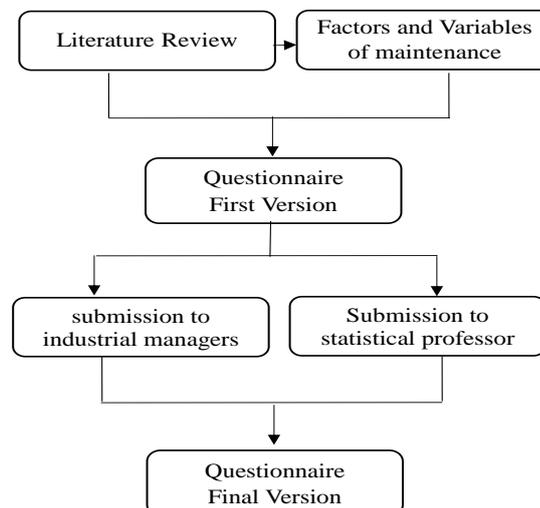


Figure 1. The development framework of the questionnaire

Table 2. Sectors and activities of the five companies studied

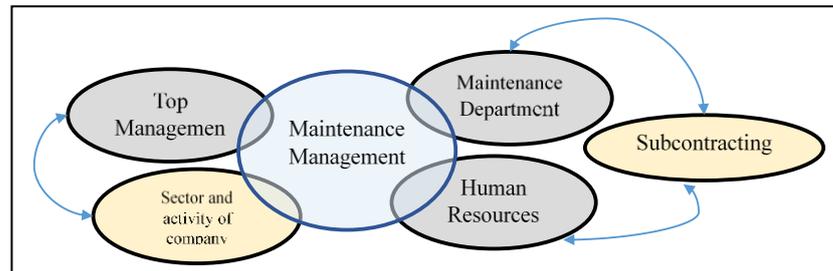
Company	Sector	Activities	Work hours
A	Logistic	Port operator	24h/24
B	Cement	Cement production	24h/24
C	Energy	Gas production	2 shift / day (16h)
D	Agri food	Oils production	24h/24
E	Logistic	Maritime transport	24h/24

The information collected was compiled. For each company, we evaluated separately each of subcategories. Then, we analyzed relationships between factors and variables to explain the causality of issues. Due to the complexity of the maintenance function, we contacted the responders in order to validate assumptions and interpretations. Finally, we compared the research findings to results in literature.

3. Results and discussion

3.1. Subcategories and degree of importance

Among the subcategories of the questionnaire, factors influencing maintenance management in the five industries studied were discovered through the qualitative analysis of results as shown in the figure 2. We notice that top management, maintenance department and human resources are the most impacting factors. In the following sections, we will discuss each of those defined factors and we will investigate the challenges and barriers to the maintenance management implementation.

**Figure 2.** Factors influencing maintenance management in the five industries studied

3.2. The impact of top management policy

Despite the procedures and objectives set by top management, it is the culture of the company that define the policy to be applied and adopted by people. Participants of companies A, C and D consider that availability and safety of equipment are more important than safety of staff, even though, companies organized periodically training session about safety personnel. Bupe Mwanza [8] considers that safety during maintenance works is also important and could save additional cost such as, worker's compensation, health insurance claims, regulatory fines, lawsuits and so many more.

The top management of the four companies A, B, C and E has an annual objectives but not a long term vision among one year, their priorities are essentially availability of equipment, respect of the budgets and maintenance preventive rates, therefore, no company have implemented a PMS (Performance Maintenance System). The process of maintenance performance measurement (MPM) is derived from the overall organizational strategy and should be oriented by the integration of critical success factors (CSF), ([9]–[11]). The participant of company A said that currently, the implementation of measures such MTBF, MTTR and LCC are ongoing in order to improve the maintenance management. In other hand, the participant of company C explained that the utilization of MTBF in the past, did not

improve the maintenance management, he believes that improvement of maintenance function must be more profound than calculating measures. Generally, the petroleum industry use the asset management approach that include the technical and the business aspects of an asset in a complex sociotechnical environment between organizations, personnel, technology and systems, [12].

We notice that consequences of failures have a crucial impact on the management maintenance policy. For company E, a failure could have catastrophic consequences, therefore top management set procedures and implement measures to improve continuously the maintenance function. According to Lazakis [13], the preventive maintenance is the best approach for shipboard equipment. For the company D, top management do not set annual objectives, as there are four lines production, while three lines are sufficient to satisfy the production rate required. However, the company had a production shutdown in a production line due to an accidental breakdown. Currently, the company are reviewing the organization and policies to remedy to the situation, which causes decrease of profitability ratio.

3.3. Challenges of maintenance department

Maintenance department set maintenance strategy and annual planning according to the top management objectives. Four companies have a preventive maintenance strategy as detailed in the Table 3. When setting the planning of maintenance operations, the managers consider experience feedback more than numerical measures. This is due to the lack of statistics, as most companies have an overall statistics about the failure rate and not detailed information about it. This issue is cited by Gopalakrishnan [14], with reference to his survey, he found a gap between criticality classification and maintenance planning industries, where bottleneck detection is widely used.

In our study, company B, uses RCA (Root Cause Analysis) to analyse fatal failure; we notice that the annual maintenance budget of this company is ten times greater than other companies' budget.

Historical events and accidents contribute to the evolution of maintenance in industries, according to participant of company B; there has been fatal accidents in the site 15 years ago and then since that time, safety during maintenance operations is a priority for top management.

Table 3. Maintenance strategy in the five industries

Companies	Preventive Maintenance	Conditional Maintenance	Corrective Maintenance
A	80%		20%
B	70%	10%	20%
C	75%	5%	20%
D	10%	5%	85%
E	77%	11%	12%

The subcontracted maintenance is a policy adopted by four companies. We present in Table 4 the rates estimated by participants concerning subcontracting complex maintenance operations. For the company D, the maintenance management are supervised by a centralized department and all operations are executed by the maintenance staff, expect a limited complex operations. According to participants of companies C and D, subcontracting is a policy to face union, rather than maintenance strategy. We mentioned that Marttonen [15] specifies requirements for maintenance contract-level, including technical, organizational and legal arrangements from operative maintenance of single assets to strategic management.

We note that the spare parts management is neglected by all the five companies. The spare parts stored are generally overestimated; more than 50% of spare parts stored have not been used yet for more than one year. For participants of companies A and C, the spare parts are overestimated in order to avoid a shutdown of production as importation of critical spare part take above one month. Cholasuke [16], mentioned that an effective spare part management could be a significant source of cost saving. We notice that all participant of companies A, B and C agree that spare parts management is a weakness that should be improved.

We conclude that in large companies studied, challenges on maintenance are relating essentially to maintenance managers, as today top management consider maintenance as an important function by including it in the annual objectives. Smith [17] cited this issue, as he considers that currently, maintenance and asset managers have a good opportunity to be a part of the business view and that they should make a choice to be a leadership that will take a step forward and will positively influence in the organization.

3.4. The impact of human resources management on maintenance function

Managers generally agree that maintenance staff is a pillar for implementing maintenance strategy. Smith [17] go further by suggesting that maintenance managers should have a new approach of leadership by considering hard (plant) and soft (people) assets.

In our study, we have devoted a large section to human resources management. Sheikhalishahi [18], presented an organization of publications related to human factors in maintenance into three main categories : human error / reliability calculation methods, workplace design / macro-ergonomics and human resource management. Ahmadzadeh [19], present a model to prioritize maintenance-related waste caused by human factors. During interviews, we deduce that such classification are not used in companies surveyed, as measurement of human factors are not yet applied.

Table 4. Subcontracting rate in the five industries

Companies	Percentage of subcontracted complex maintenance operations	Percentage of subcontracting cost Vs Maintenance cost
A	90%	70%
B	50%	30 to 40%
C	80%	60%
D	70%	70%
E	15%	11%

Table 5. Documentation of maintenance operation for operators

Companies	Scheduled maintenance tasks	Tool to be used	Measures before and after the operation	Safety measures	Duration of the operation
A	x				
B		x	x	x	
C			x	x	x
D					
E			x		x

The maintenance staff in the five companies has mainly the same demographic structure; they are composed of two categories in accordance to their age:

- Elderly staff, they have more than 10 years of experience in maintenance service, and are not graduated
- Young staff, they have generally five years of experience and are undergraduate, in maintenance or in production.

The most important human performance factors are ‘motivation’ and ‘competence’ [20]. We include those factors in the questionnaire. For motivation factor, the participants of all companies confirm that operators execute frequently risky tasks, but only company A and B provide to the personnel bonuses for risky tasks. For competence factor, participants of companies A, B, C and D affirm that lack of technical skills of maintenance staff constitute a barrier for improving maintenance management. According to the participants of companies A, B and C, it is due to the complexity of the equipment, which require a continuous training session and profound analysis to maintain it. However, we notice

that maintenance operations are not totally documented, to guarantee the accomplishment of maintenance task as shown in Table 5.

Also, training session are not sufficient regarding the complexity of tasks and of machine technologies either for maintenance managers who inform us that they ensure technologies watch by learning from subcontractors.

In parallel to the lack of technical knowledge and skills evoked by participants, we remarked that all companies subcontracted most of the maintenance operations. We conclude that subcontracting most of maintenance operations may contribute to transforming the role of maintenance department to a management supervisor.

3.5. Challenges and barriers to maintenance management implementation

We present challenges and barriers to implementing a maintenance strategy in Moroccan industries according to the five participant's response:

- Top management policy: four companies have written procedures and a clear organizational chart of maintenance department, except for the company D. However, the culture of organization is more important and may vary from written procedures and objectives.
- Lack of technical skills and knowledge: this obstacle concerns operators and managers. The participant of company A note that accidents may occur when a manager do not analyze the equipment operation. The participant of company C think that managers should have skills in order to control maintenance operations executed by subcontractors
- Complexity of machine and equipment: industries are facing challenges like optimization of maintenance function due to the evolution of technologies, [21]. The participant of company A think that it is difficult to ensure a technology watch on port equipment due to the continual evolving of technologies; also, participant of company B, evoke that the company failed to decentralize maintenance department, due to lack of technical skills.
- The production workhours: participant of company E evoke that time available is insufficient to accomplish preventive maintenance, because it is done during the stopover of ship. The participant of company C explained that the preventive maintenance operations are planned every Saturday, during the stoppage of the production, but if there is a need to increase the production rate, maintenance tasks are postponed to Sunday, or reduced to twice a month.

4. Conclusions and limitations of the study

We discovered through this qualitative study that in large companies, where preventive maintenance is up to 80%; production and top management policy are no more the important barriers for implementing maintenance strategy. Today, to improve maintenance function, challenges are related to technical skills and knowledge of maintenance staff. Therefore, maintenance managers should move from the day-to-day management of operations to long term vision by suggesting training session, diagnosing failures and analyzing equipment operations. As mentioned by Macchi and Fumagalli [22], a company should classify the criticalities in its maintenance processes and make a benchmark with the best companies to better drive the investment. This will help top management to view maintenance management in a strategic perspective and will contribute to set mid and long-term goals. This qualitative study focused on maintenance management on large companies, where maintenance is considered as an important function. Companies are located in Casablanca and Tangier, which are industrial cities in Morocco, then we could not extrapolate the finding of this research to small and medium companies in small cities. We consider complementing this qualitative study as mentioned by Yin [6], by "exploratory" and "descriptive" case studies in industries before generalizing the finding of this study.

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