

An Assessment of Maintenance Practices and problems in Jordanian Industries

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Abstract

In the move towards world-class manufacturing, many firms are realizing a need for the use of proper maintenance of production facilities and systems. Industrial plants, machines and equipment are becoming technologically more advanced and at the same time more complex and difficult to control. Therefore, the importance of the maintenance function has been greater than before, due to its role in maintaining and improving availability, performance efficiency, on-time deliveries, safety requirements and overall plant productivity.

In this context, Jordanian industries are more and more realizing the importance of the maintenance function. This paper aims at assessing the maintenance requirements in local industries. To achieve this goal, a questionnaire was designed in order to investigate maintenance needs and problems, namely, maintenance planning, spare parts, equipment calibration and maintenance staff training. The questionnaire was distributed on a selected sample of Jordanian industries and was filled, mostly, through personal interviews.

A hundred industries from all different existing sectors and from all sizes responded to the questionnaire. The collected data were analyzed using SPSS. It was found that most of the industrial firms in Jordan have maintenance departments, but still not all of them allocate budgets to these departments. About half of the firms apply preventive maintenance along side with corrective maintenance. Nearly 15% of the respondent firms were found not well aware of the different types of maintenance systems. Half of the firms calibrate their equipment locally. In this study, the main problems in machines' maintenance were highlighted. It was found that the major problem is the unavailability of spare parts in the local market. About 44% of the respondent firms consult foreign experts. The needs of industries related to specialties in the field of maintenance were also investigated. Finally, conclusions regarding the current situation of maintenance in Jordanian industries were derived.

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1. Introduction

According to [1], maintenance is the total of activities serving the purpose of retaining the production units or retaining them to the state considered necessary for fulfillment of their production function. Traditionally, maintenance was an activity that was put into action to solve production problems. Its objective was to keep the process running. Little time was spent on planning maintenance activities.

Nowadays, many firms are realizing a need for the use of proper maintenance of production facilities and systems. Industrial plants, machines and equipment are becoming technologically more advanced and at the same time more complex and difficult to control [2]. Therefore, the importance of the maintenance function has been greater than before, due to its role in maintaining and improving availability, performance efficiency, on-time deliveries, safety requirements and overall plant productivity [1, 3, 4]. As a matter of fact, the total losses due to maintenance omission or ineffectiveness has been highlighted by practitioners and researchers [5, 6, 7]. In order to assess the maintenance practices in their countries, several researchers have conducted surveys and studies. For example, a study was conducted in Hong Kong to assess maintenance practices there. In [9, 10], a study on

maintenance practice and challenges was conducted for Nigerian industries.

Jordanian industries are no exception. They are more and more realizing the importance of the maintenance function [11, 12]. This paper aims at assessing the maintenance requirements in local industries. To achieve this goal, a questionnaire was designed in order to investigate maintenance needs and problems, namely, maintenance planning, spare parts, equipment calibration and maintenance staff training. The questionnaire was distributed on a selected sample of Jordanian industries and was filled, mostly, through personal interviews.

2. Research Methodology

As mentioned earlier, the objective of this study is to assess the status of maintenance practices in Jordanian industries. In order to achieve this objective, a questionnaire was prepared and was filled during a direct meeting with the related people. The data collected in the questionnaire covered the following aspects: Maintenance department and expenditure, Problems regarding machines and calibration, Expenditure on spare parts, Maintenance staff qualifications, and Maintenance staff training.

2.1. Questionnaire design

The questionnaire was divided into four main parts as follows:

Part 1: General information

This part includes questions that are related to the classification that is followed in this study:

- **Classification by capital:** Capital is divided into five categories according to the classification followed by [13].
- **Classification by sector:** Companies have been classified into twelve major sectors of industry, following the classification of Amman Chamber of Industry (ACI) as shown in Figure-1.
- **Classification by size:** is achieved by combining the number of employees in an industrial firm and its capital according to the ACI classification (Table 1). The year of foundation of an industrial firm was also included in this part in order to see how it affects maintenance practices in general.

Table 1: Classification by size.

Class	No. employees (N)		Capital Investment (CI) (million JD)
Micro	N ≤ 50	Or	CI ≤ 0.25
Small	50 ≤ N < 100	Or	0.25 ≤ CI < 1.0
Medium	100 ≤ N < 500	Or	1.0 ≤ CI < 5.0
Large	500 ≤ N < 1000	Or	5.0 ≤ CI < 15.0
Giant	N ≥ 1000	Or	CI ≥ 15.0

Part 2: Maintenance department

This part includes 16 different questions that are related to the organization of the maintenance department. The first three questions measure the awareness of local industries of the importance of having a maintenance department, allocating a budget for the maintenance department, and the size of this budget with respect to the total operational cost.

Question 4 is concerned with the type of maintenance system applied. Questions 5 and 6 ask about scheduled maintenance and having records for machines breakdowns. Question 7 gives an idea about the effectiveness of maintenance planning. Questions 8 and 9 ask about machine downtimes (dead-times). Question 10 is concerned with the readiness of the maintenance department. Specifically, it asks about having enough tools to perform maintenance operations. Questions 11 and 12 are mainly to assess firms' ability of repairing their own machines, and to explore the major reasons for not repairing some machines. In question 13, companies are asked to summarize problems of maintenance in Jordanian industries in order to find out the major ones (vital few problems). Questions 14 to 16 aim at calibration problems in Jordan.

Part 3: Spare parts

Part 4: Maintenance staff

Questions 1 to 5 assess the technical qualifications of maintenance staff and their educational background. Questions 6 to 10 explore the shortages of any needed specialty in maintenance. Finally, questions 11 and 12 ask for industrial firms' opinions regarding the performance of both foreign and local experts.

2.2. Sample selection:

According to the ACI index, around 8730 industries are registered in the Amman Chamber of Industry. The ACI index classifies those facilities with four employees or less as workshops. About 80-85% of the 8730 facilities are considered to be small workshops. Hence, the remaining 20% (1746 firms) is the population that the survey is concerned with. This portion is selected because the objective of this survey is to study the needs of those industries that contribute considerably to the economy of the country. Accordingly, a sample of 10% of the population was selected and a total of 100 responses (in the form of a filled questionnaire) were achieved.

The requirements of a random, homogenous, and representative sample were taken into consideration. There are twelve different sectors of industry, as mentioned earlier. The number of firms that is chosen in each sector is proportional to the total number of registered industries in that sector (e.g. food companies represent about 7 % of all industries and the percentage of questionnaires that are filled by food companies is around this portion). Moreover, industries in each sector were chosen randomly. The survey covered different geographical areas, like Wadi elsir, Na'our, Zarqa, Fuhais, and most concentrated in the Amman Industrial City (AIC). As shown in Table 2 and Figure 1, the industries who responded to the questionnaire represent all sectors with, nearly, the desired ratio (the designed ratio is proportional to the actual total number of firms in each sector). The respondent firms covered the five ranges of capital investment as shown in Table 3.

2.3. Responses to the questionnaire:

A total of 150 industries were approached in the survey. Only 100 of these industries responded positively and provided answers to the questionnaire, which represented a 67% response rate.

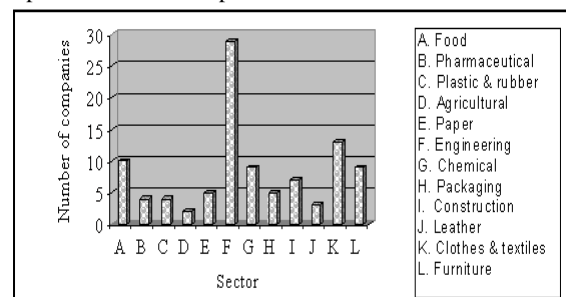


Figure 1: Distribution of the sample by sector.

Table 2: Distribution of respondent industries by sector.

Sector	Number of Firms	Sector %	Respondents %
Leather Products	433	5%	3%
Medical Supplies	81	1%	4%
Plastics and Rubber Products	208	2%	4%
Chemical Products	278	3%	9%
Engineering Industries	2789	32%	29%
Wood and Metal Furniture	1724	20%	9%

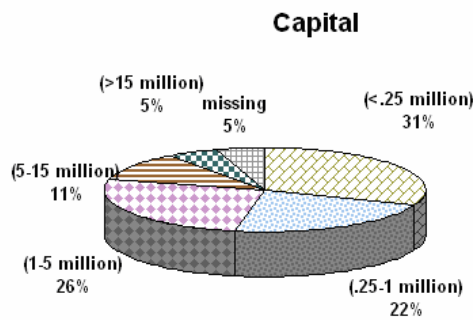


Figure 2: Distribution of the sample by capital.

Table 3: Classification of respondent industries by size.

Class	No. industries
Micro	31
Small	24
Medium	26
Large	12
Giant	5

3. Analysis of the Questionnaire

The questionnaire was analyzed in four different ways to come up with conclusions regarding maintenance practices in Jordanian industries. First, a simple description of the results is presented. Next, the effect of sector, size and year of foundation with respect to some questions in the questionnaire is investigated. Also, confidence intervals were constructed on the results for some questions. Finally, Pareto charts are developed in order to highlight the most important problems (vital few) that industries in Jordan face.

3.1. Description of the results:

3.1.1. Responses related to maintenance department:

Table 4 summarizes the responses of the surveyed industries to questions related to having a maintenance department.

Table 4: Responses related to maintenance department.

Question	%
Having maintenance department	86.0%
Allocating budget for maintenance	53.0%
Maintenance budget relative to total operating cost:	
• < 5%:	34.0%
• 5% - 10%:	27.6%
• > 10%:	24.3%
Adopted maintenance system:	
• Corrective:	26.0%
• Corrective & Preventive:	44.8%
• Corrective, Preventive & Predictive:	13.5%
Having periodic maintenance schedules	79.0%
Keeping records of machine breakdowns	77.0%
Ratio of sudden to planned maintenance:	
• < 20%:	68.8%
• 20% - 30%:	22.6%
• > 30%:	8.6%
Short time between a breakdown and repair	84.0%
Having adequate equipment for maintenance	89.0%
Having machines that failed and could not be repaired	20.0%
Calibration of machines (local or abroad):	
• Local:	52.0%
• Abroad:	3.0%
• Local & abroad:	12.0%
• Do not calibrate:	31.0%
Problems in calibration locally	31.0%

3.1.2. Responses related to spare parts:

Table 5 summarizes the responses of the surveyed industries to questions related to maintaining spare parts inventories.

Table 5: Responses related to spare parts.

Question	%
Keeping inventory of spare parts	83.0%
Annual expenditure on spare parts (JD):	
• < 20000	62.1%
• 20000 – 50000	17.9%
• 50000 – 100000	5.3%
• > 100000	14.7%

3.1.3. Responses related to maintenance staff:

Table 6 summarizes the responses of the surveyed industries to questions related to maintenance staff qualifications.

Table 6: Responses related to maintenance staff.

Question	%
Technicians facing problems understanding instructions in machine catalogues	45.0%
Technicians specializations satisfying maintenance needs	68.0%
Providing maintenance staff training	48.0%
Consulting foreign experts	44.0%
Dependability of local expert in solving technical problems:	
• Dependable to a large degree:	42.0%
• Dependable to a limited degree:	45.0%
• Not dependable	4.0%

3.2. Effect of sector, size and year of foundation:

The effect of industry sector, size and year of foundation of industries was investigated in this study in two ways. First, by constructing cross tables between these variables for some selected questions. Some percentages were calculated to derive conclusions. Secondly, analysis of variance (ANOVA) tables were constructed.

3.2.1. Effect of sector, size and year of foundation:

Tables 7(a), 7(b), 8(a), 8(b), 9(a), and 9(b) show how the answers to the question of having a maintenance department are distributed with respect to sector, size, and year of foundation.

With respect to sector, Table 7(a) shows that the sectors having least percentages of maintenance departments are plastics (50%), chemical (66.6%) and construction industries (71.4%). It is also noted that plastics and agricultural industries do not allocate budgets to their maintenance departments. Also, almost all pharmaceutical, food, leather and agricultural industries maintain periodic maintenance schedules. On the other hand, in the furniture sector, about 44% of firms do not have any periodic maintenance schedules. It is clear that food industries pay great attention to maintenance whether by specifying a budget for the department of maintenance or planning for its works. The same thing is true for the pharmaceutical industries. It is noticed that, in general, all sectors are interested in having machine breakdown tables, except for the plastic and furniture industries.

Table 7(a): Responses by sector related to maintenance department.

Sector	Having maintenance department	Budget for maintenance	Periodic maintenance schedules	Machine Breakdown records	Adequate maintenance equipment
Food	100.0%	90.0%	100.0%	100.0%	100.0%
Pharmac.	100.0%	75.0%	100.0%	100.0%	100.0%
Plastics	50.0%	0.0%	75.0%	50.0%	100.0%
Agricultural	100.0%	0.0%	100.0%	100.0%	100.0%
Paper	100.0%	20.0%	80.0%	100.0%	80.0%
Engineering	86.2%	60.0%	72.0%	79.0%	79.0%
Chemical	66.6%	83.3%	78.0%	67.0%	78.0%
Packaging	100.0%	60.0%	80.0%	100.0%	100.0%
Construction	71.4%	100.0%	86.0%	71.0%	86.0%
Leather	100.0%	100.0%	100.0%	100.0%	100.0%
Textiles	84.6%	81.8%	77.0%	69.0%	92.0%
Furniture	88.8%	14.3%	56.0%	33.0%	100.0%

Table 7(b): Responses by sector related to maintenance department.

Sector	Maintenance budget to total operating cost			Maintenance system		
	< 20 %	20% -30%	> 30%	corrective	Corrective & preventive	Corrective, preventive & predictive
Food	50.0%	50.0%	0.0%	10.0%	50.0%	30.0%
Pharmac.	75.0%	0.0%	25.0%	25.0%	75.0%	0.0%
Plastics	25.0%	75.0%	0.0%	25.0%	25.0%	0.0%
Agricultural	50.0%	50.0%	0.0%	50.0%	0.0%	0.0%
Paper	75.0%	0.0%	25.0%	0.0%	20.0%	20.0%
Engineering	72.0%	24.0%	4.0%	7.7%	57.7%	7.7%
Chemical	100.0%	0.0%	0.0%	25.0%	12.5%	25.0%
Packaging	80.0%	20.0%	0.0%	0.0%	80.0%	0.0%
Construction	57.1%	14.3%	28.6%	0.0%	42.9%	28.6%
Leather	100.0%	0.0%	0.0%	0.0%	33.3%	33.3%
Textiles	63.6%	18.2%	18.2%	15.4%	23.1%	15.4%
Furniture	75.0%	25.0%	0.0%	22.2%	66.7%	0.0%

From Table 8(a), it is noted that large and giant industries are interested in allocating a budget for maintenance department more than micro and small industries. 72% of medium sized industries having maintenance departments do allocate budget for maintenance; while 80.0% of the giant industries and 90.9% of the large industries allocate budgets for

maintenance. In general, companies (from medium to giant) are greatly interested in having machine-breakdown tables. Again, it is a result of their attention in following up machines' estate in order to avoid repeated breakdown. It is well known that for large-size companies, stopping of machines for several minutes costs them a lot.

Table 8(a): Responses by size related to maintenance department.

Size	Having maintenance department	Budget for maintenance	Periodic maintenance schedules	Machine Breakdown records	Adequate maintenance equipment
Micro	70.9%	40.9%	55.0%	45.0%	77.0%
Small	79.2%	57.8%	88.0%	83.0%	88.0%
Medium	96.2%	72.0%	92.0%	92.0%	88.0%
Large	91.7%	90.9%	83.0%	91.0%	92.0%
Giant	100.0%	80.0%	80.0%	100.0%	100.0%

Table 8(b): Responses by size related to maintenance department.

Size	Maintenance budget to total operating cost			Maintenance system		
	< 20 %	20% -30%	> 30%	corrective	Corrective & preventive	Corrective, preventive & predictive
Micro	60.0%	28.0%	12.0%	17.9%	32.1%	3.6%
Small	90.9%	9.1%	0.0%	14.3%	61.9%	4.8%
Medium	53.8%	34.6%	11.6%	7.7%	42.3%	23.1%
Large	81.8%	0.0%	18.2%	9.1%	63.6%	9.1%
Giant	80.0%	20.0%	0.0%	20.0%	20.0%	60.0%

Table 7(b) and Table 8(b) investigate the ratio of maintenance budget to the total operational cost versus sector and size. Table 7(b) shows how maintenance budget percentage is affected by sector. It is noticed that the highest percentages are in the food industries (55.6%), construction (80%) and textile industries (88%). Table 8(b) shows how the ratio of maintenance budget to the total operating cost is affected by size. Giant industries (as should be expected) have the largest percentage (75%).

It is noticed from Table 9(a) that industries that have been established recently are not so interested in having maintenance departments compared to older ones. The reason for this may be that they are new in the field and they have no genuine problems related to machines' maintenance. Industries which have been established in the 1950's to 1970's pay more attention to planning for maintenance works than recent industries.

Table 9(a): Responses by year of foundation related to maintenance department.

Years old	Having maintenance department	Periodic maintenance schedules	Machine Breakdown records	Adequate maintenance equipment
> 40	100.0%	83.0%	100.0%	83.3%
30 - 40	100.0%	88.0%	88.0%	100.0%
20 - 30	100.0%	100.0%	100.0%	100.0%
10 - 20	83.7%	78.0%	73.0%	83.8%
< 10	80.4%	73.0%	71.0%	90.2%

Table 9(b): Responses by year of foundation related to maintenance department.

Years old	Maintenance budget to total operating cost		
	< 20 %	20% -30%	> 30%
> 40	83.3%	16.7%	0.0%
30 - 40	87.5%	12.5%	0.0%
20 - 30	57.1%	28.6%	14.3%
10 - 20	68.8%	18.7%	12.5%
< 10	66.7%	25.6%	7.7%

According to tables 7(a) and 8(a), most of the responded companies from all sectors and sizes have enough tools and equipment for regular maintenance works.

Analysis of variance has been conducted to see whether the year of foundation has an effect on having a maintenance department in a company. That is, the year of foundation has no effect on having a maintenance department. Further, analysis of variance has been conducted to investigate the effect of sector. It was concluded that sector has no effect on the type of the applied maintenance system. Also, ANOVA table was constructed to study the effect of the size of an industry to having periodic maintenance schedules. The test showed that size has an effect on having periodic maintenance schedules.

Table 9(a) shows that older companies are more interested in breakdowns tables than recent ones. As it is said before, recent companies do not suffer from genuine problems in maintenance. The effect of the size of the company is studied regarding this question; the ANOVA test confirmed that the size of the company has an effect on having machine-breakdown tables.

3.2.2. Spare parts:

Table 10 presents the responses of industries by sector to keeping spare parts inventories. Most interested companies in keeping enough inventory of spare parts are from the food, pharmaceutical, packaging and leather industries. Table 11 presents the responses to keeping spare parts by industry size. It also presents industry responses to annual expenditure on spare parts. The table shows that most of the responded companies (especially for micro, small and medium sizes) spend yearly less than JD 50,000 on spare parts.

Table 10: Responses by sector related to spare parts.

Sector	keeping inventory of spare parts
Food	100.0%
Pharmaceutical	100.0%
Plastics	75.0%
Agricultural	50.0%
Paper	80.0%
Engineering	72.0%
Chemical	66.0%
Packaging	100.0%
Construction	85.7%
Leather	100.0%
Textiles	92.3%
Furniture	88.9%

Table 11: Responses by size related to spare parts.

Size	keeping inventory of spare parts	Annual expenditure on spare parts			
		< 20000 JDs	20000 - 50000 JDs	50000 - 100000 JDs	> 100000 JDs
Micro	74.0%	90.0%	10.0%	0.0%	0.0%
Small	67.0%	81.8%	13.6%	4.6%	0.0%
Medium	88.0%	44.0%	28.0%	8.0%	20.0%
Large	92.0%	10.0%	40.0%	0.0%	50.0%
Giant	100.0%	0.0%	0.0%	20.0%	80.0%

3.2.3. Maintenance staff:

Table 12(a) and Table 12(b) show the qualifications of maintenance staff according to the sector of industry.

Table 12(a): Qualification of maintenance staff percentage according to sector.

Sector	mechanical engineer	Electrical engineer	Chemical engineer	Industrial engineer
Food	11.0%	10.0%	1.0%	8.0%
Pharmaceutical	10.5%	10.5%	1.8%	31.6%
Plastics	25.0%	8.3%	0.0%	8.3%
Agricultural	5.6%	5.6%	16.7%	0.0%
Paper	30.0%	17.5%	0.0%	17.5%
Engineering	18.1%	10.6%	0.5%	13.9%
Chemical	4.8%	19.0%	4.8%	0.0%
Packaging	25.0%	8.3%	0.0%	8.3%
Construction	18.2%	9.0%	13.6%	11.4%
Leather	25.0%	25.0%	0.0%	0.0%
Textiles	26.1%	8.7%	0.0%	8.7%
Furniture	13.3%	13.3%	0.0%	20.0%

Table 12(b): Qualification of maintenance staff percentage according to sector.

Sector	Polytechnic	vocational	Community college
Food	12.0%	19.3%	9.2%
Pharmaceutical	35.1%	0.0%	12.3%
Plastics	0.0%	0.0%	0.0%
Agricultural	16.7%	0.0%	0.0%
Paper	17.5%	10.0%	7.5%
Engineering	23.6%	15.3%	7.4%
Chemical	47.6%	0.0%	4.8%
Packaging	0.0%	0.0%	0.0%
Construction	15.9%	2.3%	11.4%
Leather	0.0%	0.0%	0.0%
Textiles	15.9%	5.8%	5.8%
Furniture	13.3%	20.0%	6.7%

Table 13 shows the answers to the rest of the questions related to maintenance staff by sector of industry. It is obvious from Most industries, except leather industries, do not face real problems in dealing with machines catalogues. Leather industries have the highest percentage of companies that are not satisfied with their technicians' specialties. Plastic and agricultural industries are mostly not interested in providing their employees with training in maintenance field.

Table 14: Confidence intervals for some industry responses.

Question	Answer: Yes	Sample Size	P (%)	Confidence Interval
<i>Maintenance Department:</i>				
Have maintenance department	86	100	86.0%	80.3 – 91.7
Have maintenance budget	53	87	60.9%	52.3 – 69.5
Budget percent (<5 %)	21	52	40.4%	29.2 – 51.6
Have periodic maintenance schedule	79	100	79.0%	72.3 – 85.7
Have machine breakdown records	77	100	77.0%	70.1 – 83.9
Sudden to planned maintenance (< 20%)	64	92	69.6%	61.7 – 77.5
Long breakdown duration	16	96	16.7%	0.0 – 23.0
Have adequate maintenance equipment	88	99	88.9%	83.7 – 94.0
<i>Spare Parts:</i>				
Keeping enough spare parts inventory	81	98	82.7%	76.4 – 89.0
Annual spending on spare parts (< 20000 JD)	59	94	69.8%	62.0 – 77.6
<i>Maintenance staff:</i>				
Have problems with maintenance catalogues	44	94	46.8%	38.3 – 55.3
Satisfactory maintenance staff specializations	68	91	74.7%	67.2 – 82.2
Providing maintenance staff with training	46	91	50.5%	41.9 – 59.1

Table 13: Responses by sector related to maintenance staff.

Sector	Problems following catalogues	Satisfactory staff specializations	Providing staff training
Food	60.0%	80.0%	60.0%
Pharmaceutical	75.0%	100.0%	75.0%
Plastics	75.0%	50.0%	0.0%
Agricultural	50.0%	100.0%	0.0%
Paper	60.0%	100.0%	40.0%
Engineering	55.2%	58.6%	45.0%
Chemical	66.7%	55.6%	56.0%
Packaging	60.0%	80.0%	60.0%
Construction	47.1%	85.7%	43.0%
Leather	0.0%	0.0%	67.0%
Textiles	30.8%	69.2%	54.0%
Furniture	66.7%	66.7%	44.0%

3.3. Confidence intervals:

Confidence intervals have been computed for some selected questions. Point estimates are first calculated for these questions (proportion estimates), then α interval estimates are found. For example, companies who said that they have maintenance department are 86 companies from 100 companies, then

$$C.I. = p \pm Z_{\alpha/2} (p(1-p)/n)^{1/2}$$

Where;

$$p \text{ (the proportion estimator)} = 86/100 = 0.86$$

$Z_{\alpha/2}$: upper $\alpha/2$ percentage point of the standard normal distribution [13].

Taking a significance level of 90 %, then:

$$C.I. = 0.86 \pm 1.645 (0.86(1-0.86)/100)^{1/2}$$

$$C.I. = [80.3 - 91.7]$$

This means that with 90 % confidence the proportion of companies who have maintenance department in Jordan lies within a [80.3% - 91.7%] interval. Table 14 shows all of the computed intervals.

3.4. Maintenance problems in Jordan:

In the questionnaire, question 13 asked companies to summarize maintenance problems in Jordan based on their own experiences. Figure 3 shows the frequency of each problem. Shortage of spare parts and their raw materials in the local market occupies the highest frequency (58 answers). The next main problem is the unavailability of local agent for machines and parts. The third problem is the lack of some specialties in the field of machines' maintenance in the local market. Some sectors of industry face other main problems as a consequence of their type of activity or production they are engaged in.

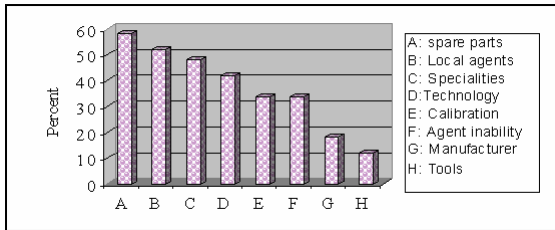


Figure 3: Problems of maintenance in Jordan.

For the food industries, in addition to the main three problems, about 40% of companies face problems in calibration, as shown in Figure 4.

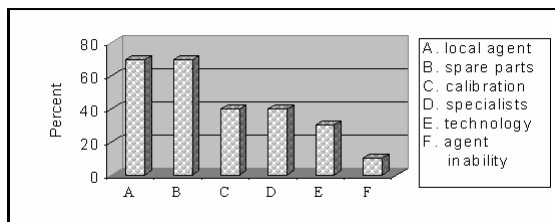


Figure 4: Maintenance problems in food industries.

For the paper industries, about 60% of companies have main problems regarding the lack of knowledge about the basics of technologies used in machines. About 40% of companies face problems in calibration. Figure 5 shows the problems faced in this sector.

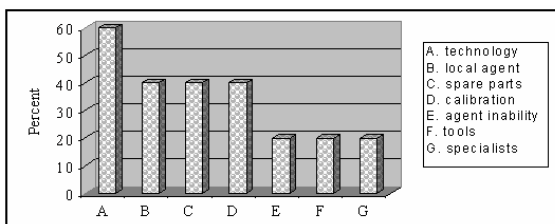


Figure 5: Maintenance problems in paper industries.

For the furniture industries, about 30% of the companies in this sector face problems related to calibration (see Figure 6).

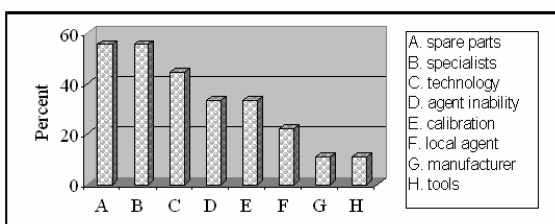


Figure 6: Maintenance problems in furniture industries.

For clothes and textiles industries, nearly 58% of companies suffer from the lack of knowledge about basic technology used in machines, as shown in Figure 7.

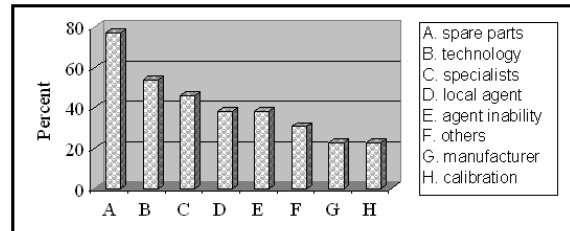


Figure 7: Maintenance problems in clothes and textiles industries.

For the engineering industries, there are 10 companies and so some percentages can be generalized over this sector. About 31% of companies have problems related to calibration. 66% of the companies have problems regarding the unavailability of local agent for machines and tools. The lack of spare parts in the local market is a main problem for 62% of companies in this sector of industry. Nearly 41% of companies say that the local agent, in case of availability, is not capable to solve technical problems. The companies that face problems resulted from the lack of some specialties in the field of machines' maintenance are 41% of the 29 companies. Figure 8 shows problems mentioned above and other problems.

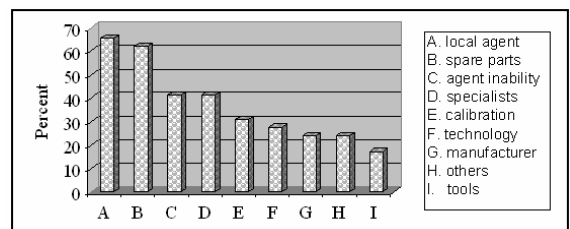


Figure 8: Maintenance problems in engineering industries.

For the packaging industries, about 60% of the companies in this sector face problems in calibration. This may be due to their type of work that needs high accuracy in the fabrication of packages. Figure 9 shows problems faced in this sector.

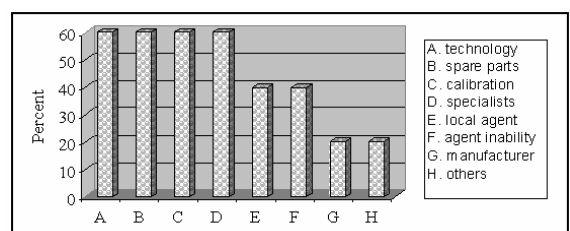


Figure 9: Maintenance problems in packaging industries.

For the plastic industries, it can be said that all companies in this sector of industry suffer from the lack of some technical specialties in the field of maintenance. About 75% of companies have problems related to the knowledge of the basics of technologies used in machines. Figure 10 displays the main problems of this sector.

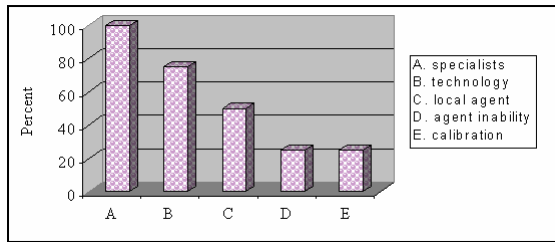


Figure 10: Maintenance problems in plastic industries.

3.5. Companies' ability of repairing their own machines:

The answers to question 11 (in maintenance department part) are almost satisfactory. Only 20 companies have machines that are out of order and have not been repaired yet. 19 companies of those twenty gave reasons for not repairing machines in question 12. Figure 11 shows the frequencies for each reason. About 47% of companies that have a problem say that this is due to the unavailability of spare parts for old machines. 42% of them find it more feasible to buy a new machine comparing with the cost of repairing the existing one. About 37% of companies refer the reason of not repairing a machine to the frequent breakdowns and the useless repair of it.

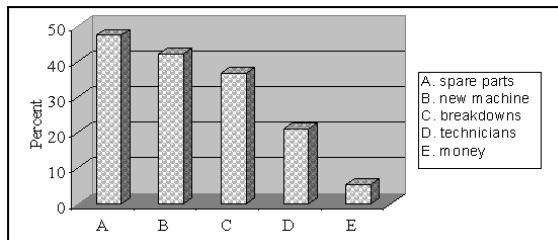


Figure 11: Reasons of not repairing a machine.

3.6. Calibration problems in Jordan:

Twenty three companies answered question 15 that they face problems in calibrating some sets of measurement and control. 22 companies answered question 16 regarding the type of problems they face. Figure 12 displays those problems and their frequencies. The main problems upon which 86 % of responded companies agree is the lack of local capabilities of calibration and the lack of experts in this field.

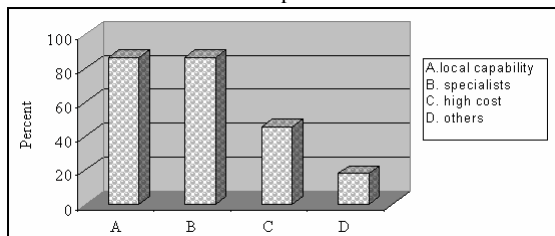


Figure 12: Calibration problems in Jordan.

3.7. Foreign experts specialties needed in maintenance works:

In question 10 (in maintenance crew part) companies that need experts from abroad are asked to specify the specialties they need. Figure 13 shows the frequencies of specialties needed. 44 companies answered this question. About 59% of the companies need experts for control

systems. 48 % of companies require experts specialized in printed circuits. The third required specialty, which is needed by 43% of the companies, is the calibration works. In general, companies facing problems locally in calibration are those who request foreign experts for it.

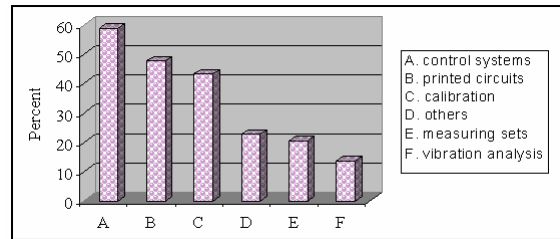


Figure 13: Foreign experts specialties needed.

4. Summary of Major Findings

Through the previous discussion of the questionnaire, it has been found that 86 % of the respondent companies have maintenance departments. Meanwhile, plastic, chemical and construction industries are the sectors that have the lowest percentages of companies that have maintenance departments. Companies that activate the maintenance department role by allocating a budget for it constituted 61.6% of those who said they have departments. The most interested sectors in allocating a budget are food, leather and construction industries. Large companies showed more concern than small ones regarding the size of maintenance budget relative to the total operating cost.

It seems that local industries are in, a rather, good situation since 44.8 % of the respondent companies apply both corrective and preventive maintenance systems. 26 % of the companies apply only corrective maintenance. These companies should start thinking of applying preventive maintenance in order to improve their machines' efficiency. 12.5 % of the companies apply only preventive maintenance, which is not logical, because it is necessary to do corrective maintenance for out-of-order machines. 1 % of the companies apply predictive maintenance only; this is again unreasonable since predictive maintenance requires applying preventive maintenance. 1 % of the respondent companies apply preventive and predictive maintenance and 1 % of them apply corrective and predictive maintenance systems. It is clear from companies answers to this question (the applied maintenance system) that some companies are not well aware of the types of maintenance systems (nearly 15.5%).

Seventy seven percent of the respondent companies have machine-breakdown tables. Companies, except micro ones, are interested in keeping both periodic maintenance tables and machine-breakdown records (above 80 % of the companies in each size).

Eighty four percent of the companies do not have relatively long dead-times. This may be referred to the fact that 89% of the respondent companies have the required tools for regular maintenance works. In addition, an out-of-order machine may lead to stopping of a complete production line, which in return affects the company's estate negatively.

More than half of the respondent companies do their machines' calibration locally (nearly 52% of companies). The main problems that companies face in local calibration are related to the inability of performing calibration works

and the lack of specialties in this field. Thirty one percent of the companies do not calibrate their machines. This may lead to change in the specifications of their products or affect their quality.

Regarding maintenance problems in Jordan, the main problems on which most of the companies agreed are:

- The unavailability of spare parts or their raw materials in the local market (58 %).
- The unavailability of local agents for parts and machines (52 %).
- The lack of some specialties in maintenance field (48 %).
- The lack of knowledge about basic technology used in machines (42 %).
- Problems related to calibration (34 %).

Related to spare parts, 83% of the companies said that they have enough spare parts. Companies (medium, large and giant) are more concerned than small ones with having sufficient inventory of spare parts. The annual expenditure volume on spare parts shows that 62% of the companies spend less than JD 20,000 annually. As can be concluded from the ANOVA test, the expenditure is affected by the size of the company.

About 70% of the respondent companies are satisfied with their technicians specialties. Some sectors such as the plastic and leather industries have large percentages of companies who do not have satisfactory specialties, which cover their needs. 44 % of the respondent companies compensate for this lack of specialties by consulting foreign experts. Foreign experts are mainly needed in the field of control systems, printed circuits and calibration.

Related to the training sessions, it was found that 48 % of the respondent companies said that they do provide their employees with sessions related to maintenance. Companies with micro (32%), small (54%) and medium (46%) sizes were found less concerned with technicians' training.

The plastic industry is one of the sectors that face real problems related to maintenance. Its main problems are technical ones; all of the respondent companies in this sector agreed that there is a lack of knowledge regarding the basics of technology used in machines. In spite of their need to specialists, plastic industries have the least percentage of companies that provide their technicians with training sessions concerning maintenance works and machines technology. Only 50% of plastic companies have maintenance departments, and non of them specifies a budget for its department.

To the contrary of plastic industries, the responses of food industries revealed that these companies are in good situation. All of the respondent food companies have maintenance departments and 90% of them specify separate budgets for their departments. All of these companies are interested in keeping periodic maintenance tables and machine-breakdown records, which reveals their efficiency in planning. They pay attention for training since 60 % of the companies provide their technicians with sessions.

Related to experts, 52% of the respondent companies see that foreign experts have an ordinary performance. 42% of companies stated that they can depend on the local experts to a great degree.

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