

INVESTIGATING EFFECTIVE FACTORS ON IMPROVING MAINTENANCE & REPAIRS PERFORMANCE (STUDIED CASE: TABRIZ PETROCHEMICAL COMPANY)

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ABSTRACT

The subject of this survey is to investigate the affecting factors in the process of maintenance & repairs of Tabriz petrochemical industry. According to the purpose, this research is practical, using questionnaires for data collection, and a descriptive method in data analyzing. Target population included 50 members of staffs and experts in maintenance and repair part of Tabriz Petrochemical Complex. Throughout this research, the correlation effect between three dimensions (managerial, contractual and environmental) with maintenance & repairs, as well as t-test, between them, were analyzed using SPSS software. Results of this investigation indicated a significant, direct and positive relationship between employer, contractual and environmental dimensions; and maintenance and repair. All these three variables affect the maintenance & repairs. But this efficacy and correlation is more intense between managerial dimension and network performance improvement.

Keywords:

Maintenance & repairs, Tabriz petrochemical industry, managerial or employer dimension, contractual dimension, environmental dimension

INTRODUCTION

The petrochemical industry is part of the chemical industry, producing its products from crude oil or natural gas. The petrochemical industry is a mother and job-creative industry, which, feeding other sectors of the industry, plays a main role as a driving motor for the economy of developing countries. One of the important advantages of the petrochemical industry, considered as a competitive advantage, is supplying its raw materials inside the country. With the expansion of the petrochemical industry, while many domestic needs are satisfied, the value added to raw materials goes back to the country, boosting the economy as much as possible. Diversity of petrochemical products can complement the lost circles of countless industries, and undoubtedly the development of related industries in this industry will also play a significant role in supplying consuming goods and meeting the needs of our domestic industries. Correct and scientifically-planned maintenance & repairs, using new global methods, directly affects productivity, quality, direct production costs, reliability, and profitability. Therefore, efforts to provide and upgrade themaintenance & repairs, and its continuous improvement in any institution and organization, is similar to a movement, creating an important and decisive transformation in its environment, that anyone can declare it unnecessary, at least in the industrial sectors (Moeini Alireza, Golbabak Ravoshi, and Fatemeh Zeinali, p. 25, 2006). Each productive system and firm has specific goals; part of the activities is directly related to the objectives, while other part includes supporting activities. Production in the petrochemicals will not be realized without devices. And, the availability of devices without maintenance & repairs is not conceivable, even for a moment. Providing the cost of purchasing spare parts and consumables, etc., on the one hand; and the disability of the devices, on the other hand; have faced the organization with many problems. The disablement of a device may result in the shutdown of other devices, resulting in delays in production scheduling, and ultimately leading to non-economizing and increase in the fixed price. Therefore, the ever-increasing price of machineries and devices and the cost of manpower on the one hand; as well as maintenance & repairs costs of machineries, on the other hand; have more and more revealed the necessity for improved maintenance & repairs mechanisms. Therefore, any method or tool, increasing the productivity of maintenance & repairs, will certainly reduce costs and increase competitive ability

and profitability (Patten, Joseph Dey., p. 35, 2006). Currently, due to weaknesses and lack of a comprehensive and proper system for maintenance, also improper care and timely repair of machinery and equipment; large losses occur in most of our industries, including the petrochemical industry. Therefore, the existence of a comprehensive and planned system of maintenance & repairs is necessary, to provide continuous control and full information about the state of affairs and the manner in which a set of activities shall function (Seyed Hosseini, Seyyed Mohammad, p. 20, 2005). In an organization, maintenance & repairs plays a key role in all physical, financial and competitive aspects; the key role of which, serves in business and commerce. Emphasizing and focusing on maintenance & repairs methods is to preserve tasks defined for each asset (Jafari Mohammad, p. 32, 2005). The vital and strategic importance of maintenance & repairs is increasingly evident to various industries. This is where expert human resources, in the field of maintenance & repairs, are faced with great opportunities and challenges, and the need for behavioral changes, more and more vivid. Meanwhile, the need for making change and evolution in maintenance&repairs programs -in a way that can help the organization in the global competition- will play a decisive role. The process of maintenance&repairs is an organizational process and, in the large model having been seen for this system, the maintenance&repairs and inspection unit are concerned as a set being specialized in maintaining and repairing the devices, responsible for supporting parts such as engineering, finance, exploitation, procurement, purchase, warehouses and all other related organizations. In the past, the goal of repair activities was optimizing the availability of equipment with minimal cost, while new perspectives on maintenance&repairs activities, emphasizes the effects of those defects, on the business sector, efficiency, product quality, and safety-environmental hazards (Entezari Heravi, Abdul Rasul, p. 31, 2010).

Traditional maintenance&repairs was carried out periodically and according to a predetermined schedule; in many cases, there was no acceptable scientific reason to justify the best time interval between maintenance&repairs periods. However, in its new ways, maintenance&repairs of equipment is determined according to a separate schedule by employer. Companies, based on engineering perspectives and scientific reasons, seek to increase the intervals between maintenance & repairs of equipment, so that in addition to decreasing the maintenance & repairs costs, reduce also the probability of making damages to equipment, during periodic repairs as well. Companies will be able to compare and correct the measures and policies for optimizing the equipment in their company, with other companies (Nouri, Alireza and Ali Saei, pp. 12-14, 2008). The maintenance of factory capital, also heavy costs of capital equipment, especially the high exchange currency of equipment, on the one hand, and the increase in automation and the need for more efficient and economical use of equipment, on the other hand, demands maintenance&repairs to be considered more principally and precisely. Maintenance & repairs of the physical assets of an organization, will not be effective without benefiting data and information analysis techniques. Therefore, maintenance&repairs planning in the industrial unit, should be such as to minimize the opportunities lost as a result of stopping the machinery or equipment and failing to meet production needs. In addition, it calls for an integrated and coordinated maintenance&repairs system for the preparation and development of designs, methods and instructions, and the provision of all technical information for other parts of the organization or industrial unit, in relation to the technical and substantive protection of equipment and machinery (Nikoofar, Mohammad Hadi; Abdollah Zadeh, Vahid, p. 30, 2014)

The Necessity and Importance of maintenance&repairs:

The impossibility of doing preventive planning, inspections, and timely implementation of required repairs, has led to a great deal of time consumption for coordination between the units. Considering the importance and necessity of maintenance&repairs in increasing the life of the devices and equipment, and as a result, increasing the efficiency of the system, increasing the effectiveness of the repair plans, and Purposefulness of operational management, improving productivity, reducing the hours of unemployment and stopping the machines, preventing irreparable Material, spiritual and human damage, and improving the level of safety of work and product, reducing operating costs or production costs, reducing the cost of consuming spare parts, predicting the amount and time of consuming spare parts, the possibility of rebuilding, retrieving and reusing parts, improving the quality of work and the operational quality of the system, as well as the important role of the petrochemical industry in country development, prompted us to examine the factors affecting the performance of maintenance&repairs.

Reviewing the theoretical background of the research

Definitions and concepts of maintenance&repairs

Maintenance&repairs are a set of various activities, aimed at preserving parts, equipment and machinery, as well as safeguarding capital and assets used in the industry; so that make necessary prevention in the occurrence of disruptions in devices, and interruptions in the process of production, or the process of exploitation of the equipment and the related factories. It can be said that failure of any piece of network equipment, is a random variable that can predict its estimated occurrence and failure, so that getting readiness for its repair. This requires the adoption of necessary measures and proper planning, which is referred to as "Network maintenance&repairs planning" (Reayate sanati, Farshid, p.14, 2001). Most systems used today in some way in manufacturing, service and operational affairs, fail to function at times of their operation cycle, therefore, requiring maintenance&repairs. A series of activities increasing the useful life of machinery, so that reducing the consumption of spares parts, energy and costs, and increasing the efficiency of machinery, are called maintenance&repairs. Maintenance&repairs carried out in order to maintain industrial installations and equipment in a standard and acceptable level, includes planning, control and registering (the taken actions). This planning includes such things as preventive maintenance, adjusting repairs, basic repairs, planned replacement of parts, prediction and provision of spare parts, repair workshops' activities, predicting and considering accidental repairs, registration and maintenance of information related to the machine, improving working environment for easy maintenance and manufacturing of spare parts. Although most "maintenance&repairs" terms and definitions for some applications are used in the same row, they are in fact slightly different in meaning, and in maintenance & repairs planning, each of them is used in their own specific sense. Following is a brief reference to them. (Jamalian, Ahmad, 3-30, 2009)

Virtual Maintenance: Virtual reality is a simulated environment of reality that allows the repairer to feel that he is in a real environment and to see the reaction of phenomena to his decisions. (Winn W, pp.50-55, (1996))

Preventive Maintenance: A systematic, scheduled and planned method to carry out required maintenance tasks, based on the designed program, to prevent unusual erosion in machine parts, and reducing machine emergency stops (Winn W, pp. 50-55, (1996)).

Condition-based maintenance: A brief statement of condition-based maintenance&repairs can be defined as maintenance&repairs when needed. The strategy of condition-based maintenance&repairs is based on the anticipation of failures and halting its progress. (Winn W, pp. 50-55, (1996))

Total productive maintenance: Comprehensive productive maintenance refers to planned and scheduled maintenance&repairs with the participation of all members of the organization, from production line operators, to top management. (Winn W, pp. 50-55, (1996))

Reliability-centered Maintenance: A reliability-based maintenance&repairs is a process that first determines what should be done to maintain the life and increase the reliability of any physical capital, and second, to guaranty and make practical, the expectations of users on the equipment (Winn W, pp. 50-55, (1996))

From the factors influencing the performance of the maintenance&repairs can be pointed to the employer dimensions (leadership, planning, organization, control), contractual dimension (managerial, technical, and lateral factors), as well as environmental dimension (internal and external factors). The abovementioned factors can play a significant role in the performance of preventive maintenance&repairs programs. Maintenance&repairs are based on the fact that, after a while, the equipment must be visited and necessary adjustment repairs being done, to prevent parts from being burned out, and to plan for building or purchasing of parts. Below is the definition of each dimension.

Leadership component

Leadership is the relationship between a group of individuals in which one tries to lead others toward a certain goal. In general, it can be said that, leadership involves directing and influencing members of the organization, and requires influence on individuals (Seyyed Javadin and Jalilian, p. 683, 2014)

Planning component

Planning is to determine the purpose and design of the operation, in order to change an object or subject, based on the predicted pattern (Seyyed Javadin and Jalilian, p. 161, 2014)

Organizing component:

Organizing is a continuous and permanent activity, in which efforts are made to divide the work between individuals and groups of workers, then establish a coordination between them for that purpose (Seyyed Javadin and Jalilian, p. 209, 2014)

Control component:

Control is an activity in which the predicted operations are compared with the performed operations, and in the case of being a difference or deviation from the program, between what should be and what already exists, actions shall be taken, to fix and correct them. (Seyyed Javadin and Jalilian, p. 315, 2014)

Management component

Management is the process of efficient and effective use of material and human resources, based on an accepted value system, implemented through planning, organizing and mobilizing of resources and facilities, also directing and controlling of operations to achieve certain goals (Seyyed Javadin and Jalilian, p. 17, 2014).

Technical component

Failure analysis at the time of the device's failure can lead to significant costs. In order to reduce these costs, it is possible to create a virtual environment by analyzing the conditions in a controlled environment and, reduce the failure time when a failure occurs, by accessing the results of the analysis. Using the sensor facilities and diagnostic equipment, continuously monitoring of the state of machines, without requiring periodic human inspections, becomes possible. An important factor in reducing maintenance&repairs costs is by attention to specifications, technology and design of that device. Until there is no scheduled programs and well maintenance&repairs systems in place, and maintenance&repairs activities are not carried out in good time, with good spare parts, there should not be expected to reduce maintenance&repairs costs. Using quality original spare parts, is one of the important factors in reducing maintenance&repairs costs. In the environmental dimension, the environmental dimension's weakness factors (internal and external factors) are numerated, but considering the mentioned factors, big steps can be taken, in the improvement of maintenance&repairs performance (Al-Najjar Basim, Imad Alsyofm, pp. 85, (2003))

Internal-organizational factors

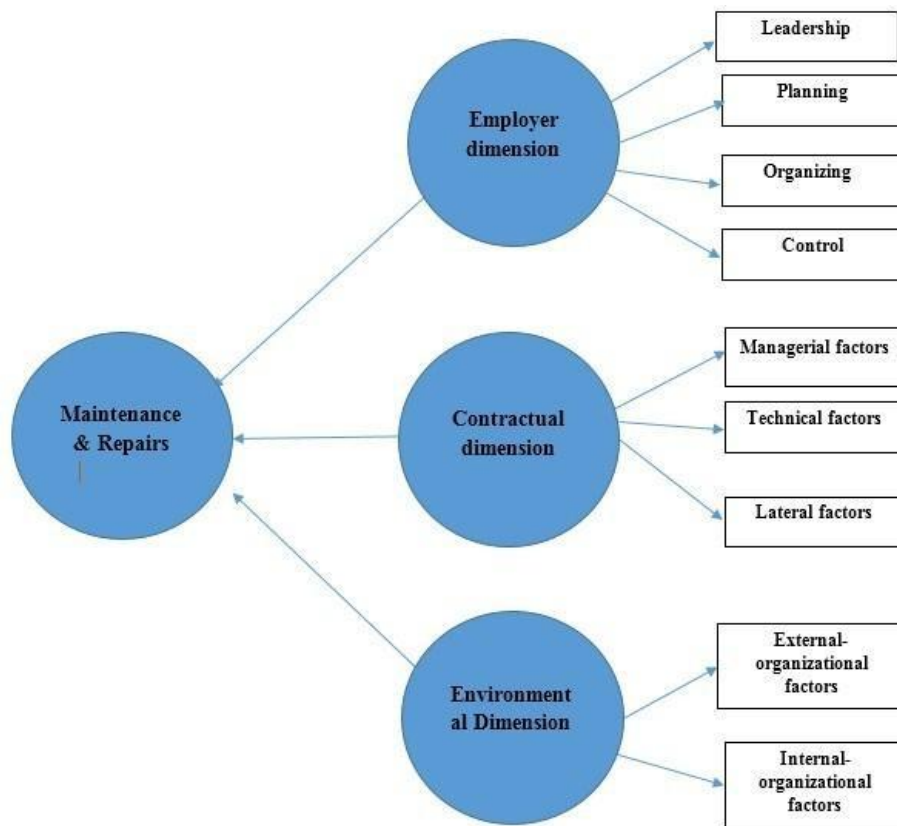
Among the internal factors, is creating the necessary cultural context for designing and deploying a comprehensive and efficient database; also aligning the knowledge and skills of employees with the new technologies; and deploying the organizational technologies tailored to the needs and objectives; and finally, delivering High quality services and products.

External-organizational factors

Out of the external factors, transparency of governmental laws and regulations can be considered, as well as periodic studying and reviewing on the relevant units, in the direction of economization (Robert J. Mockler, pp: 18-23, (2007)).

4. Conceptual model of research

In the present study, three factors affecting the improvement of maintenance&repairs performance were identified and examined as follows:



"Figure 1 illustrates the conceptual model of the research"

Hypotheses:

There is a significant relationship between the employer dimension and the maintenance&repairs performance improvement.

There is a significant relationship between the contractual dimension and the maintenance&repairs performance improvement.

There is a significant relationship between the environmental dimension and the maintenance&repairs performance improvement.

RESEARCH METHODOLOGY

The research methodology is a set of rules, tools and reliable ways to investigate the facts, discover the unknowns, and find solutions to problems. (13) It can be said that this is an applied research in terms of purpose, and due to using library and field methods such as questionnaires, it can be concluded that the present research is descriptive, in nature and method. Considering the time, it is cross-sectional, and considering the data type, it is quantitative. Independent variables of this research include employer dimension with its components (leadership, planning, organizing and control), contract dimension with its components (managerial, technical and lateral), environmental dimension with components (inside and outside organizational and organizational) and dependent variable (maintenance&repairs improvement). To collect the research literature, a library method (study of books and articles and internet sites) was used, also questionnaires to collect the data. Some personal profiles including gender and educational level were also collected. Cronbach's alpha coefficient was used to measure the reliability of the questionnaire, calculated 0.89, demonstrating the reliability of the research. The statistical population of this research encompasses the employees of Tabriz Petrochemical Company, 50 ones of which were selected as the sample population. The research questionnaire consists of 31 questions. All questions measured with Likert 5 scales. Data were analyzed using SPSS software, Pearson correlation test, Kolmogorov-Smirnov test and variance analysis.

Research findings

Prior to testing the research hypotheses in this section, the reliability of the questionnaire was evaluated using Cronbach's alpha coefficient. Table 2 shows the reliability of the research variables.

Table 1. Cronbach's alpha test for research variables (n = 50)

Variable	Cronbach's alpha	dimensions	Cronbach's alpha
Affecting factors on maintenance&repairs	0.744	Employer dimension	0.786
		contractual dimension	0.832
		Environmental dimension	0.791
Maintenance&repairs	0.750		

According to Table 1, the Cronbach's alpha value for all research variables is greater than 0.7, so that questionnaire is a desirable tool for data collection. It can be said that the research variables have acceptable reliability. Before testing the hypotheses, data must be evaluated whether they are normal or not. For this purpose, a Kolmogorov-Smirnov test was also used. In this test, if the significance level obtained from the test components was greater than the error value ($\alpha = 5\%$), it indicates that the data is normal. The results of this test are presented in Table 2

Table 2. Kolmogorov-Smirnov test for research variables

Variable	Test value	dimensions	Test value
Affecting factors on maintenance&repairs	0.150	Employer dimension	0.079
		Contractual dimension	0.093
		Environmental dimension	0.064
Maintenance&repairs	0.374		

Given that the significance level for the variables is greater than 0.05, we conclude that the data collected for the research variables, are normal.

Table 3 presents the mean and standard deviation of the research variables.

Table 3. Descriptive indices of research variables

Descriptive indexes Variables	number	Average	Standard deviation	Variation coefficient	Variance
employer Dimension	50	3.90	3.672	0.166	0.43
Contractual Dimension	50	3.76	3.775	0.174	0.45

environmental Dimension	50	3.94	3.099	0.175	0.44
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The table above shows the variation coefficient. Here, the employer has the lowest variation coefficient (166), and the environmental dimension, has the highest (17.15).

Prioritizing according to the variation coefficient:

1. employer dimension
2. contractor dimension
3. environmental Dimension

Correlation coefficient between independent variable and dependent variables:

Since the data are normal, Pearson correlation coefficient is used to test the hypotheses.

Table 4. Correlation coefficient between independent variable and dependent variables

Research variables	Maintenance&repairs
employer dimension	**0.804
contractual dimension	**0.721
environmental Dimension	**0.572
p<0.05* p<0.01**	

As Table 4 shows, the correlation coefficient between environmental dimension and maintenance&repairs is less than 0.6, so the relationship between the two variables is moderate. But considering that the correlation coefficient between the employer and the contractual dimensions and maintenance&repairs is more than 0.6, There is a strong relationship between these two components and maintenance&repairs.

Hypotheses:

1. Employer dimension is affective on maintenance&repairs, and the relationship between them is meaningful.
2. Contractual dimension is affective on maintenance&repairs, and the relationship between them is meaningful.
3. Environmental dimension is affective on maintenance&repairs, and the relationship between them is meaningful.

Table 5. Route coefficients, t statistic, and coefficient of determination, correlation coefficient, sig

Variables	Route coefficient (β)	t statistic	coefficient of determination R^2	correlation coefficient	Sig
employer Dimension	0.85	**6.10	0.707	0.804**	0.006
Contractual Dimension	0.68	**4.94	0.519	0.721**	0.001
environmental Dimension	0.66	**4.074	0.327	0.572**	0.001

Regarding the path coefficient of 0.85, also t-statistic with the value of 6.10, it can be said that the employer Dimension, at the confidence level of 99%, has a significant and positive effect on the maintenance&repairs; therefore, the first hypothesis of the research is significant and verifiable. The value of the multiple determination factor (R^2) has been 0.707. This coefficient examines the independent variable's ability to predict the dependent variable. Accordingly, the employer dimension variable has been able to predict 70.7 percent of the variation in maintenance&repairs variable.

Considering the path coefficient of 0.68, also t-statistic of 4.94, it can be said that the contractual dimension at a significance level of 99%, has a positive effect on maintenance&repairs; therefore, the third sub-hypothesis of the research is significant and confirmed. The value of the multiple determination coefficient (R^2) is equal to 0.327. This coefficient examines the independent variable's ability to predict the dependent variable. Based on

his, the variable (environmental dimension) was able to predict 32.7% of the variation in maintenance&repairs. The Pearson correlation coefficient between maintenance&repairs is equal to 0.804, and since the decision criterion amount (sig) for this variable is 0.006 (less than 0.01), so, this correlation coefficient is significant and it can be said that there is are relationship between maintenance&repairs and employer dimension. The correlation coefficient between maintenance&repairs, and the contractual dimension is 0.721, and the criterion of decision being 0.001, and since it is less than 0.01, it can be said that this correlation coefficient is significant and there is a significant relationship between maintenance&repairs and then the contractual dimension. The correlation coefficient between maintenance&repairs and environmental dimension is equal to 0.572, with a criterion of decision equal to 0.001 and, considering that it is less than 0.01, then it can be said that this coefficient is significant and there is a meaningful relationship between maintenance&repairs and environmental dimension.

From the above, it can be concluded that the correlation between the employer dimension and maintenance&repairs is stronger than the relationship of other 2 dimension, with maintenance&repairs.

Table 6. Analysis of variance for regression meaningfulness

Model	F	regression significance
1	16.739	0.001
2	17.657	0.006
3	40.429	0.001

Table 6 shows the analysis of regression significance. The F-value obtained for the employer dimension, the contractual dimension, and the environmental dimension, is significant.

Table 7. Coefficients (indices) of regression

Based variable	Predicting variable	Standard	Fixed value	R ²	T	Significance level
Maintenance&repairs	Employer	0.519	25.845	0.646	**6.10	0.006
Maintenance&repairs	Contractual	0.183	13.526	0.519	**4.94	0.001
Maintenance&repairs	Environmental	0,676	7.395	0.327	**4.74	0.001

Data analysis with regression method is shown in Table 7. Using the standard coefficients and constant coefficients, we can obtain the regression equation. Results show that employer, contractual and environmental variables can significantly predict maintenance&repairs.

CONCLUSION& RECOMENDATIONS

The petrochemical complexes are an asset-based organization, so the assets must be supported, maintained and repaired; while it is emphasized that by maintenance&repairs we do not mean the maintenance department, but technical inspection and repairs, as these two departments are responsible for maintenance&repairs. The objectives of the situation identified in this system, such as reducing incidents, reducing costs, increasing accessibility and reliability, and the subject of energy management for equipment, all depend on the Tabriz Petrochemical Company to operate the plans set out for it. The results of the research show that the employer's dimension, in comparison with other infrastructures (contractual dimension and environmental dimension), has the most impact and importance, from the perspective and viewpoint of respondents, standing as the first priority. After that, employer dimension, contractual dimension, and then environmental dimension, have the highest coefficient of influence and importance.

According to the above, it can be concluded that in organizing component, it is necessary to consider the description of the duties of the relevant units, responsibilities and authorities, the complete compilation of the

relevant instructions and providing an appropriate archive for the maintenance of the documents and instructions; in control component, to consider a quantitative and qualitative assessment of Human force being in a constant and systematic manner, and the use of expert human resources to assess the performance of units; and finally, in relation to the management component, which is an important factor in reducing or increasing costs, all important factors must be taken into account. For example, if the costing process is not well analyzed and not take the necessary management measures to correct any cost deviations, there would be no cost reductions.

In addition to the above, there are a number of maintenance&repairs challenges in the country's industries, including in the petrochemical industry, as follows:

1. What is most noticeable in our industry is the lack of sufficient trained repair worker. However, by training specialized personnel in the field of maintenance, it is possible to systematically prevent systems from failures, the most important consequence of which is preventing to stop the production line, resulting in economic losses, on the one hand; and reducing repairs cost, so that extending the devices' useful life, on the other hand. In this regard, it is demanded from the universities, to train the expert specialists in this field, in the long run, to reduce the current problems in this industry.
2. Supply chain problems can be referred to as other maintenance&repairs problems. In other words, since the supply of defective parts in the field of repairs is one of the main and decisive factors, there is some evidences that supplying these parts is sometimes difficult, due to reasons such as administrative bureaucracy, lack of localization, or effecting sanctions, which, through reforming the administrative structure, on the one hand, and the elimination of sanctions on the other hand, it is expected to witness the timely supply of components to prevent interruptions in future production.
3. The way of choosing maintenance&repairs contractors through biddings, is the other issue in this area; choices made without any qualitative assessment of the contractors' performance, only based on the lowest price. In some cases, a number of these companies, which are sometimes successful in the bidding process, not only have no experience and precedence in the field of maintenance&repairs, but also being intermediary firms. In some cases, the winner of a bid, after taking over its post, absorb the necessary human resources. While the lack of expertise and precedence in these contractual companies causes irreparable damage to the country's industries, leading to massive losses in national capital. In order to avoid this situation, a pre-assessment of the quality of contractual s in this area is demanded as necessary.
4. Proven today, if maintenance&repairs systems be implemented in principle, the product fixed price would reduce. But one of the problems in maintenance&repairs, is lack of belief in maintenance&repairs systems by managers. In fact, managers, especially in the medium and small industries, try to omit their maintenance&repairs budget, to reduce their units' total cost, ultimately resulting in huge financial losses for the industry.
5. Another problem in the area of maintenance&repairs, is using traditional methods in this area. In other words, while the world is moving toward mechanized maintenance&repairs and network utilization in this area, unfortunately, most of the industries in Iran are still managed in the old fashion. Here, through training new systems for managers, and showing the benefits of these methods, compared to traditional methods, they can be urged to take advantage of the technology in the field of maintenance&repairs.
6. Upgrading the petrochemical maintenance&repairs system to higher levels, such as reliability-centered maintenance&repairs (RCM), and ultimately reaching the top of the pyramid, which is the same as TPM.

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