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Time Management of Construction Machinery Using the FMEA Method

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ABSTRACT:
FMEA techniques is one of the most common and the most effective method of failure modes and effects analysis. This technique has many benefits that they offer perhaps the most systematic and dynamic approach to identify and prioritize the failure modes based on a few factors. Despite all its advantages, this technique has disadvantages in practice. Therefore, it is essential that in this article, the analysis of these features to manage machines is discussed and presented suggestions to improve it. In this article, the proposed method based on the FMEA is provided and prioritize the problems of management of machines, resulting in increased time and cost of the project is to solve and prioritize repairs based on calculations jump a method strong more and more logical to lose. Since in this situation of absolute failure, and the relative, between modes of failure of the evaluation will be possible to estimate the costs and other factors required in the management discussion more easily be possible. Based on the chart to prioritize management machinery parts on the basis of FMEA can be seen that the following as the most important priority of trying to manage machines for hot and cold too, loosening and strengthening and increasing or decreasing the pressure recommended.

Keywords: Time management, Machinery, FMEA, Construction projects

INTRODUCTION:

Improving and improving the level of service quality provided by companies is the first and main factor of surpassing competitors and gaining a major share of the market. Therefore, today the concept of quality has been developed and considered as a comprehensive view and a general culture at all organizational levels. In this direction and in order to achieve the above goal, various tools have been introduced and developed. Analysis of error modes and their effects is an efficient tool in quality management, and their use is increasing day by day in practice. The error analysis method and its effects calculates the risk of potential risks during the design and production stages to prevent the customer from receiving an undesirable product and to prevent the company's credit and reputation from being jeopardized, and through that, recommends corrective measures. . Since one of the goals of FMEA is to choose appropriate corrective measures to reduce risk and delays, therefore, the options that have a higher risk of delay are especially important. Therefore, we will always deal with a number called the risk tolerance number. Finally, by prioritizing the potential causes based on the risk number, corrective measures will be defined and solutions to reduce the delay caused by the operation of the machines will be investigated. Since 1930, many advances have been made in the science of maintenance and repairs. In this section, to explain these changes and their concepts in the three fields of techniques, tactics and net systems and the position of maintenance and repair of construction machinery in each of the three fields. We will pay the mentioned item. The topic of maintenance and repairs in construction machinery has its own characteristics. To explain these features, it is necessary to examine the science of maintenance and repairs from a new perspective. In this view, Net science topics are divided into three groups of techniques, tactics and systems.

•**First group**: techniques
All types of maintenance and repair activities including cleaning, screwdriving, oiling, replacement of parts and spare parts, etc. are included in this group. Net techniques are used in production machinery and construction machinery and the only point of difference is in the way of doing the activities and the tools used to do them.

•**The second group**: tactics
Different types of planning methods for performing net techniques include periodic planning based on working hours and distance traveled (TBM), work planning based on component performance conditions (CBM), troubleshooting hidden defects and daily services is divided in This group.

•**The third group**: systems

A maintenance and repair system is a process that uses hardware resources (including workshops, specialized manpower, tools, equipment and parts) and software resources (including net standards, information circulation cycle, techniques, tactics and software Net (CMMS) takes steps to achieve goals such as reducing costs, emergency stops, and increasing the useful life of machines, etc.

uposite net techniques and tactics that have predetermined patterns and their use is based on these patterns, the use of existing patterns in the field of net systems has resulted in limited success and in some cases, the results will be reversed. Therefore, it is necessary to make changes in the system to adapt the system to the conditions of its use.

For companies that use construction machinery, it is possible to model the concepts of the MTPM system and design a system that fits the conditions governing this group of machinery, which will be discussed further.

Literature review:

Alinejad et al. (2012) evaluated a new combined method of analysis of potential failure states and coverage analysis of stable data. In this research, a new type of risk priority number has been obtained by assigning different weights for each of the risk factors. Due to the fact that the numbers of severity, occurrence and diagnosis are obtained by a team consisting of different groups of experts and is not a definite and fixed factor, in this research to solve this problem and justify the answers based on optimization models. has been used.[1]

Ghanbari et al. (2012) analyzed failure modes and their effects (FMEA) in oil and gas transmission pipelines. This research was conducted with the aim of determining the failure modes and their effects in the process of oil and gas transmission. In this study, various specialties and experienced people were used, the failure modes of pipelines were analyzed by the method of brainstorming and related documents, including repair offices. The results showed that RPN attributed the highest and lowest risks to corrosion due to deposition of fluid impurities and corrosion and cracking due to incorrect design.[2]

Kianfar et al. (2013) calculated the risk priority level in the FMEA model using fuzzy theory. Since one of the goals of FMEA is to choose appropriate corrective measures to reduce risk and failures, therefore, the options that have a higher risk of failure are of particular importance. Therefore, we will always deal with a number called the risk tolerance number, which is obtained from the product of three parameters: error severity, error probability, and error detection probability. D*O*RPN=S Finally, by prioritizing potential causes based on the risk number (RPN), corrective actions are defined and limited resources are allocated to high-risk errors.[3]

Zablei et al. (2013) studied the application of fuzzy logic theory in calculating and evaluating the risk priority number with the failure mode analysis method. This article has identified the errors and dangers hidden in one of the main and key subsystems of the engine, the crankshaft, by using the analysis of failure and failure states. Then, using two methods of fuzzy logic theory, he prioritized and compared risks. Analysis of failure modes and their effects. FMEA is an instruction or method in the field of reliability programs that identifies and codifies all possible failures within the framework of specified instructions .[4]

Trafialek et al. (2014) investigated failure modes and effects analysis (FMEA) to ensure quality and improve reliability. Determining input factors such as frequency of occurrence, severity and detection of a failure may be difficult. Due to the qualitative and subjective nature of the input information and in order to perform a consistent and logical analysis, a method using fuzzy logic has been proposed. The results of the case study show that in this method, the risk assessment of failures Their categorization and prioritization is in line with the knowledge, experience and opinion of experts and is more flexible and realistic compared to traditional FMEA techniques [5].

In the article by Liu et al. (2013), an attempt is made to get acquainted with the FMEA technique in a practical way. FMEA is an analytical technique based on the "prevention before the event" method, which is used to identify potential causes of failure. It means that, this is a proactive approach against what may happen in the future, and surely applying corrective measures in the early stages of product or process design will cost much less time and cost.[6]

Bahrami et al. (2012) have provided reliability and safety analysts with a suitable tool to assess the criticality or risk associated with system failure states. In their article, first the weaknesses of traditional FMEA are examined, then its corresponding verbal modeling is presented in the form of fuzzy inference system design, and finally, the said fuzzy model is implemented in a case study by MATLAB software .[7]

Hoseynabadi et al. (2010) have examined all the machines and equipment in the project using the FMEA technique. By calculating the risk number of each of the potential failures of the machines, the weak points of the system have been identified [8].

Algorithm stages of the proposed model:

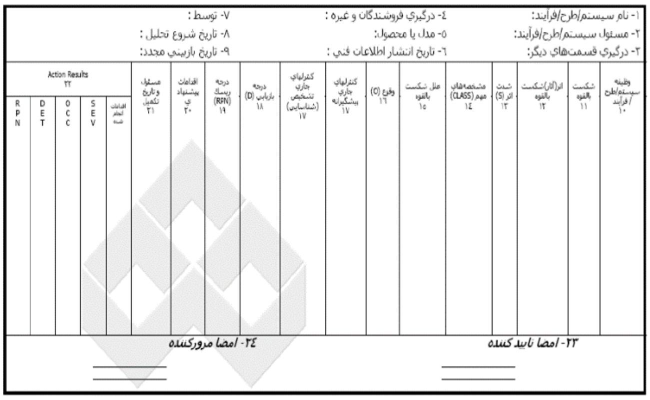
Step by step analysis of failure factors:

In order to analyze the failure factors in the system, design and process, two conditions are necessary.

- Determining the form used to perform this analysis.
- Determining the evaluation guidelines that are used in evaluating the intensity, event and identification (recovery).

The form shown for analysis of failure factors (figure no. 1) is used with almost a few changes in the world. In order to standardize the FMEA form in the United States, this form was printed and published by the American Automobile Industry Working Group

(AIAG) in July 1993. The failure factors analysis form consists of three parts, which are:
A- Initial information (FMEA file) which is items 1 to 9 in the form number 1.
B- The main information (the main skeleton of the analysis) which is items 10 to 22 in the form number 1.
C- Reviewing and confirming the FMEA, which is items 23 and 24 in the form number 1.


۱- نام سیستم/طرح/فرآیند:
۲- مسئول سیستم/طرح/فرآیند:
۳- درگیري قسمت‌هاي دیگر:
٤- درگیري فروشندگان و غیره :
٥- مدل یا محصول:
٦- تاریخ انتشار اطلاعات فني :
۷- توسط :
۸- تاریخ شروع تحلیل :
۹- تاریخ بازبیني مجدد:

وظیفه سیستم/طرح/فرآیند ۱۰	شکست بالقوه ۱۱	اثر(آثار)شکست بالقوه ۱۲	شدت اثر (S) ۱۳	مشخصه‌هاي مهم (CLASS) ۱٤	علل شکست بالقوه ۱٥	وقوع (O) ۱٦	کنترلهاي جاري پیشگیرانه ۱۷	کنترلهاي جاري تشخیص (شناسایی) ۱۷	درجه بازیابي (D) ۱۸	درجه ریسك (RPN) ۱۹	اقدامات پیشنهادي ۲۰	مسئول و تاریخ تکمیل ۲۱	Action Results ۲۲					
													اقدامات انجام شده	SEV	OCC	DET	RPN

۲۳- امضا تایید کننده
۲٤- امضا مرورکننده

Figure 1. The main form

Basic information (FMEA file):
There are cases where the preparation of these items is not mandatory and the company can change it in any way it wants. These cases are specified in Figure 1 under numbers 1 to 9, which are:
1- Identification of the system: its design and processes 2- Responsibility 3- Involvement of other parts 4- Involvement of vendors, etc. 5- Model or product 6- Date of release of technical information 7- Manufacturer 8- Start date of analysis (date of doing Analysis) 9- Date of revision (date of revision)

Main information (main skeleton of analysis):
There are some cases that make up the main skeleton of FMEA in Figure 1-3 and are specified from columns 10 to 22. The existence of these columns is mandatory in the analysis of failure factors, the order of these columns can be changed or columns can be added, but none of the columns should be deleted.

Function:
In this part, the designer states the intention and purpose or the operational goal of the system or plan or process in order to analyze and identify the failure factors one by one in this column, the task of the plan is usually through needs and demands or conditions. The customer states that these duties usually include safety conditions, government laws and other internal and external regulations of the organization, accepted technical standards and obligations that the manufacturer has made with the customer while producing the product.

Potential Failure Mode:
It is a state where the system is not able to meet the customer's demands. The more specific the failure, the easier it will be to identify its effect and cause, which will be analyzed in the next columns of FMEA. Examples of possible failures are shown in the table 1.

Table 1 examples of possible failures

1- leaks	9- The presence of a bow in the piece	17- Getting too hot and cold
2- Loosening and hardening	10- Crack in the piece	18- Weeding the screw
3- Vibrations	11- Changing the shape of the piece	19- Excessive dryness or wetting
4- Increase or decrease pressure	12- Infiltration of dust	20- More or less lubrication
5- Jamming of moving parts	13- Corrosion	21- Fracture
6- Formation of crust in paint or coatings	14- Oxidation	22- Reduction of strength
7- Change the color of the piece	15- Fatigue	23- Creating a connection in the components
8- indentation	16- Too much course	24- Adhesion

Potential Effects of Failure:
The potential effects caused by the occurrence of an error are the effects of the error states on the customer. Therefore, in the description of the effects, we describe the complications and issues that the customer experiences due to the occurrence of the error.

Severity:
Severity indicates the seriousness of the potential failure effect and there is a direct relationship between the effect and severity. For example, if the failure effect is important, such as life risks, violation of government regulations, etc., the severity will be higher, and on the contrary, if the effect is minor, the severity It will be low.

Class:
This section is usually related to the design failure factor analysis (DFMEA) because it determines the conditions for doing the work of the process, such as the order in which the work is done, the tools that are used, or anything that affects the product's function and is used to classify certain characteristics of components or sets that sometimes need special process controls, terms such as critical, key, main, and important can be used for classification.

Failure Of Causes Potential:
Potential failure causes indicate the existence of defects in the system, design or process. Sometimes, in the event of an error or failure, there are different causes, each of which has a different role and contribution in the possibility of the occurrence of that

error, in which case a Pareto diagram can be used to classify the causes of potential failure. To evaluate severity in DFMEA, the proposed criteria are shown in Table 2

Table 2 Suggested criteria for severity evaluation in DFMEA

Effect	Criterion of impact intensity	rank
Dangerous without warning	It may be dangerous for the operator of the machine or device. When, without prior warning, the malfunction affects the car's safety performance or violates government regulations.	10
Dangerous with warning	It may be dangerous for the operator of the machine or device. When, with a previous warning, the malfunction affects the car's safety performance or violates government regulations.	9
Very much	It creates a major disturbance in the line. 100% of the products may be scrapped. The car will not work and the customer is very unhappy.	8
very	It creates a partial disturbance in the line. The product may need to be separated and part of it may be scrapped. The car is working with unfavorable performance and the customer is very unhappy.	7
medium	It creates a partial disturbance in the line. A part of the product may be scrapped without separation. The car works but does not have the necessary comfort, the customer is unhappy.	6
little	It creates a partial disturbance in the line. 100% of the products may need to be reworked. The car works but does not have the desired comfort, the customer is somewhat dissatisfied.	5
Very low	It creates a partial disturbance in the line. Products may need to be separated and some may be scrapped. It makes a sound, it rattles, most of the customers notice the defect (around 75%).	4
minor	It creates a partial disturbance in the line. A part of the product may be reworked outside the station. It makes a noise, it wobbles, it is not polished. Average customers notice the defect (about 50%).	3
very detailed	It creates a partial disturbance in the line. A part of the product may be reworked at the station. It makes noise, it is not polished. Few customers notice the defect (less than 25%).	2
no effect	No detectable effect	1

According to Table 3, some of the causes of potential failures are:

Table 3 examples of potential failure causes

1- Lack of safety devices and environmental factors	8- Choosing inappropriate materials for parts
2- Wrong design of some product dimensions/tolerances	9- Improper repair and maintenance of machinery
3- Considering short and insufficient life for the product in the design stages	10- Wrong implementation instructions and incorrect use of tools and machines
4- Being under too much pressure	11- Failure to consider human errors in the process
5-Lower delivery point	12- Corrosion
6- Material instability	13- Exhaustion
7- Creep	14- Pressure increase with temperature in the process

It is necessary to clarify that the relationship between potential failure and potential causes of failure is not a direct and one-to-one relationship, and in many cases, there may be several causes for a particular failure, and of course we will have different occurrences for that failure**.**

Occurrence:

An event is a type of rating or value that is estimated for the probability of occurrence of any cause, by eliminating or controlling a number of causes or mechanisms, the probability of an error can be reduced. To determine the occurrence rate of each of the causes, it is possible to use mathematics, process competence scale, product reliability, or potential possibilities or the total number of component failures based on each one hundred components during the useful life of the product. (It means the durability or survival of the product that is taken into consideration in the design) used. The probability of the event can be ranked in terms of numbers from 1 to 10, which is based on the frequency of the event.

10-1-3- Detection methods or current methods for control

It is a control that prevents the occurrence of a malfunction as much as possible or identifies it in the event of a malfunction. In this case, all the activities by which the adequacy of the design against the error can be determined should be recorded in this column.

In this context, three types of design control can be mentioned, which are given in the order of preference.

1- Preventing the occurrence of the cause of the error and reducing the probability of its occurrence.

2- Discovering and revealing the cause of the error and taking corrective action.

1- Tracing and revealing the error.

Degree of recovery/identification:

It is an estimate of controllability (proposed) of the second and third type, which is mentioned in the recovery method for design controllability. It is necessary to mention this point that in order to reduce the amount of risk, the way of design controls, such as taking measures to prevent the occurrence of errors or the methods of investigation and verification of the design, should be improved and planned. Numbers 1 to 10 can be used to rank the degree of recovery, which is based on the control ability in error recovery.

Risk Priority

The risk priority score (RPN) is the product of severity (S), diagnosis (D) and event (O).

RPN = (S) × (O) × (D)

This number is the basis for the prioritization of malfunctions. Due to the fact that the severity of the failure and event and recovery numbers between 1 and 10 can be chosen, RPN can have a number between 1 and 1000. For high RPNs, the team should take appropriate corrective measures to reduce it. Also, in general, regardless of the result of RPN, special attention should be paid to failures whose intensity (S) is high.

There is another new method for classifying the sensitivity or risk of errors. This new method, which is called Area Chart, has a special importance for the intensity of the effect and the probability of the event.

This diagram distinguishes three areas:

1- High priority area

2- Area with medium priority (Medium Priority)

3- Low priority area

The values obtained from these two factors of effect intensity (S) and event probability (O) are converted into a Cartesian coordinate (S.O) and their position is determined in the diagram. The important point of view in this method is that before allocating the resources of an organization to focus on the development and improvement of error detection, it is necessary to reduce the occurrence of errors and minimize the intensity of their effect.

The division and determination of areas with high, medium and low priority in the surface diagram is done according to the policies adopted in each organization. At the same time, in both methods (surface diagram and RPN), it is emphasized that special attention should be paid to error situations with high effect intensity (S).

Suggested actions or suggested performance:

After prioritizing the errors, it will be necessary to propose or plan corrective and preventive measures. It is necessary, first of all, that this set of measures be directed to items with higher priority (priority is determined based on RPN or surface diagram).

The aforementioned corrective measures are taken in order to reduce the score of the severity factors of the probability of the event and error detection. Basically, the use of methods that lead to the elimination or reduction of the intensity and event have a preventive aspect, while they have a corrective aspect in order to increase the possibility of identification.

If it is possible to remove the error event, this action is recommended before any other action. At the same time, the least possible response to an error is to create a possibility for better identification of the error. Therefore, corrective measures are recommended as follows:

1- Carrying out preventive corrective measures to eliminate the possibility of the event

2- Carrying out preventive corrective measures to reduce the severity

3- Carrying out preventive corrective measures to reduce the probability of the event

4- Carrying out preventive corrective measures in order to increase (develop and improve) the possibilities of error detection and detection before delivering the product to the customer.

5- Carrying out preventive corrective measures in order to increase (develop and improve) the possibilities of identifying and revealing errors when using the product by the customer.

Also, in some cases where none of the mentioned corrective measures are possible, in this case, the word "None" is written in column 20 (Figure 1).

Some of the measures that are considered to reduce RPN are given in the table 4.

Table 4 Some measures to reduce RPN

identification	event (O)	intensity (S)	FMEA
Confirmation of the validation design	Eliminating or controlling the causes of the error event by reviewing the design	Design review	DFMEA
Renewal of prototype test calculations	Revision of the test program	Change in design revision of material specifications	DFMEA
Revision of the production process or revision of the product design, change in the	Reviewing the production process or reviewing the product design, studying the process with statistical methods	Revision of the production process or	PFMEA

control system, increase in inspection frequencies.	along with appropriate information feedback in order to continuously improve the process.	revision of product design	

The effect of FMEA on product failure rate:

The use of FMEA in different stages reduces the rate of product deterioration during consumption, and the advantages of each of its parts are briefly mentioned below:

A- Implementation of FMEA-Design/System: strengthens the design process by reducing the risk of damage. Also, by correcting product and (or) system design defects, it reduces the amount of damage during the useful life period, and also postpones possible failures during wear and tear.

B- Implementation of FMEA-Process: It identifies the potential factors of failure of the manufacturing or assembly process that lead to the production of an inappropriate product, and therefore strengthens the process of manufacturing and production of the product by reducing the risk of failure. By correcting defects in the manufacturing or assembly process, PFMEA reduces the rate of product defects in the initial life period of the product.

Due to the fact that there are different methods to identify and evaluate machinery defects, FMEA method has been used in this article, which due to the fact that in this method small values are used for probability and severity, the ratio It has been intended by other existing methods.

Also, in the method used, the adaptation of the triangular mathematical function (in a fuzzy form) is used on the graphs. In this article, due to the fact that the most extreme state was desired, the value of the statistical average and the mathematical function are equal. However, if the defect acceptance level is changed and, for example, from 0% (in this article) to another value, it is necessary to calculate the probability and intensity based on the mathematical function that is considered in this article. Finally, the values of probability and intensity have been calculated and determined based on the graphs from SPSS and the fuzzy triangular mathematical function. The defects identified and the required repair time are shown in Table 5.

Table 5 Defects identified and required repair time

Row	Repair time	Part defect
1	Minor repairs	leaks
2	General repairs	The presence of a bow in the piece
3	Minor repairs	Loosening and hardening
4	General repairs	Crack in the piece
5	General repairs	Change the shape of the piece
6	Minor repairs	Excessive dryness or wetting
7	Minor repairs	Weeding the screw
8	Minor repairs	Excessive heat and cold
9	Minor repairs	More or less lubrication
10	General repairs	failure
11	General repairs	Decrease in strength
12	General repairs	oxidation
13	General repairs	corrosion
14	Minor repairs	Dust penetration
15	Minor repairs	Jamming of moving parts
16	Minor repairs	Increase or decrease pressure
17	Minor repairs	Vibrations
18	Minor repairs	Formation of crust in paint or coatings
19	General repairs	tiredness
20	Minor repairs	Change the color of the piece
21	Minor repairs	Creating a connection in the components
22	Minor repairs	stickiness
23	General repairs	Too much course
24	Minor repairs	indentation

Statistical community:

The statistical population researched in this article was selected in a purposeful way and 8 people were selected from among the repair and maintenance experts in the group of contracting companies in Kerman province for specialized answers.

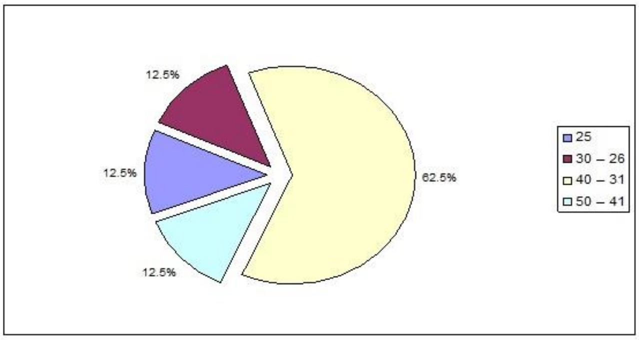


Figure 2. Age conditions of the statistical population

According to Figure 2, the age conditions of the statistical population have been observed that about 62% of the questioned people were between 31 and 40 years old.

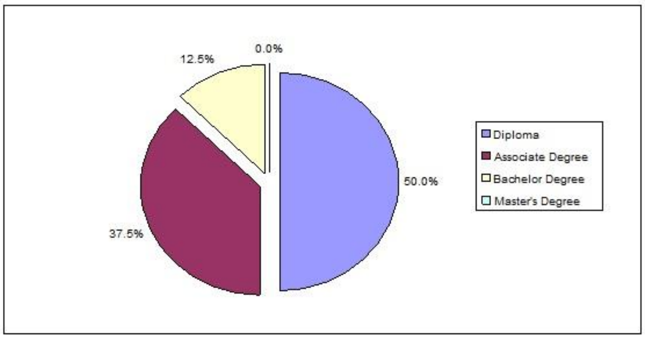


Figure 3. The level of education of the statistical population

Based on the graph 3 of the level of education of the questioned people, it has been observed that 50% of the statistical population has a diploma.

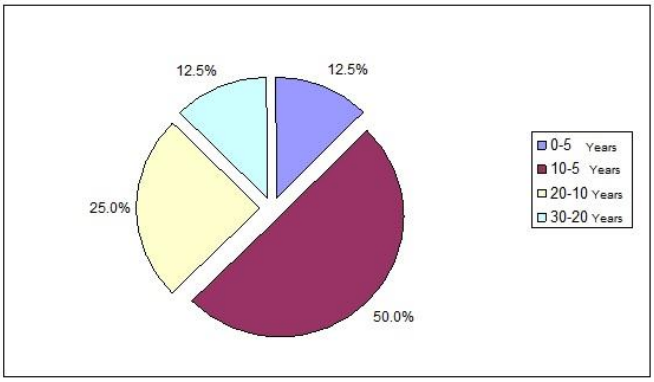


Figure 4. The amount of work experience

Based on chart 4, it has been observed that 50% of the people questioned have 5 to 10 years of relevant work experience.

Probability of occurrence, severity of failure and priority

Table 6 shows the values related to the probability of part failure, the severity of part failure and its priority for different defects:

Table 6 Numerical calculations of parts management prioritization based on FMEA

Part defect	The possibility of component failure	Severity of component failure	Prioritize based on FMEA
leaks	3	3	9
The presence of a bow in the piece	2.13	2.13	4.5369
Loosening & hardening	3.38	3.25	10.985
Crack in the piece	3	2.88	8.64
Change the shape of the piece	3.25	3.25	10.5625
Excessive dryness or wetting	2.5	2.5	6.25
Weeding the screw	3.25	3.13	10.1725
Excessive heat and cold	3.38	3.38	11.4244
More or less lubrication	3.25	3.13	10.1725
failure	2.5	2.5	6.25
Decrease in strength	2.75	2.75	7.5625
oxidation	2.88	2.88	8.2944
corrosion	2.13	2.13	4.5369
Dust penetration	2.38	2.38	5.6644
Jamming of moving parts	2.88	2.75	7.92
Increase or decrease pressure	3.38	3.13	10.5794
Vibrations	2.5	2.5	6.25
Formation of crust in paint or coatings	2.5	2.5	6.25
tiredness	3.13	3.13	9.7969
Change the color of the piece	3.25	2.63	8.5475
Creating a connection in the components	2.63	2.38	6.2594
stickiness	2.63	2.38	6.2594
Too much course	3.13	3.13	9.7969
indentation	2.75	2.75	7.5625

RESULTS:

In this section, research findings and results are presented according to the probability of failure, severity of failure and finally prioritization.

Based on the failure probability diagram of machine parts based on FMEA(Figure 5), it can be seen that the most important defects of the parts are as follows:

- Increase or decrease pressure
- Excessive heat and cold
- Loosening and hardening

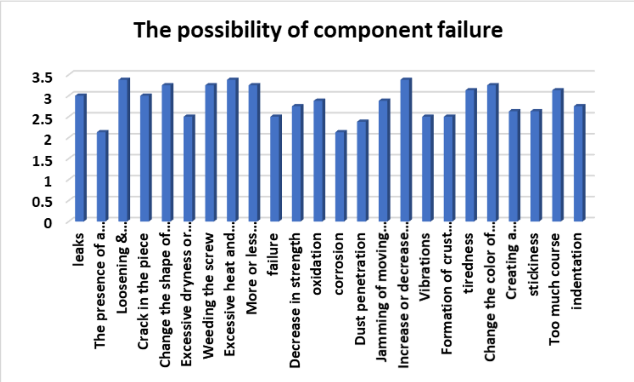


Figure 5. Probability of failure of machine parts based on FMEA

Based on the diagram in Figure 6, it can be seen that the severity of the failure of the machine parts based on FMEA is that the most important defects of the parts based on the severity of the failure are as follows:

•Excessive heat and cold

•Changing the shape of the piece

•Loosening and hardening

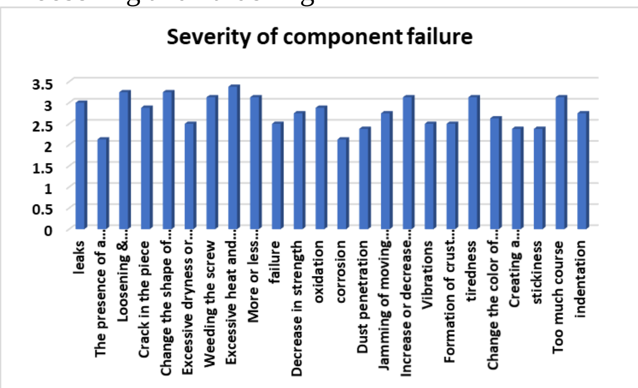


Figure 6. Damage severity of machine parts based on FMEA

According to the diagram in Figure 7, the prioritization of the management of machinery parts based on FMEA can be seen that the following items are suggested as the most important priorities for the management of machinery:

•Excessive heat and cold

•Loosening and hardening

•Increase or decrease pressure

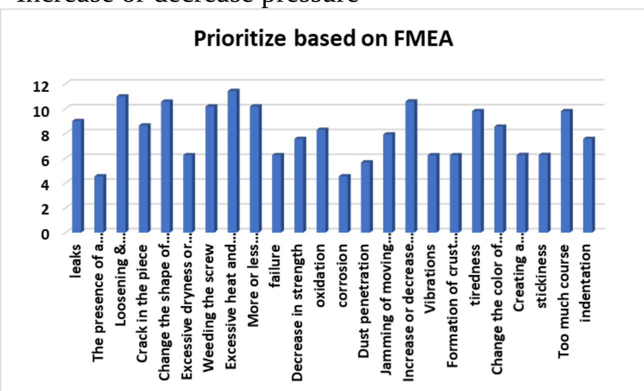


Figure 7. Prioritizing the management of machine parts based on FMEA

Based on the findings, the proposed answer for the three main factors is as follows:

•Excessive heat and cold

Long-term use of machines and the failure of the cooling systems of the machine to work properly lead to the creation of this factor. Therefore, determining the work shift of each device can help to solve this problem.

•Loosening and hardening

In order to prevent this factor and as a result of time management in the project, it is necessary to carry out periodic visits and preventive repairs.

•Increase or decrease pressure

Deformation of parts is generally caused by factors such as increasing or decreasing pressure, increasing permissible load, fatigue stress, etc. Therefore, it is necessary to perform a periodical inspection of the device in addition to correct use and according to the permitted conditions, and also according to the technical instructions of each device.

CONCLUSION:

In this article, a proposed method based on FMEA is presented and it solves the final prioritization of machinery management problems that lead to an increase in project time and cost, and in prioritizing defects based on questionnaire calculations, a method gives more decisive and logical results, since in this method the absolute condition of each damage and its relative condition in comparison with other damage modes are evaluated at the same time, the possibility of estimating the costs and Other factors needed in the management discussion will be possible with more ease.

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