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STUDY THE EFFECT OF PROGRAMMED PARTIAL MAINTEANENCE ON THE POWER FACTORY PRODUCTIVTY IN DIYALA COMPANY FOR ELECTRICAL INDUSTRIES

Lutfi Y. Zedan [1], Layth A. Hasnawi [2]

[1] Professor, [2] Assistant Lecturer, Department of Mechanical Engineering,
College of Engineering, University of Diyala
dr_lutfi512 @yahoo.com, leath_tech2004@yahoo.com

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ABSTRACT: - The present work has concerned with partial programmed maintenance that should be done on machines in order to increase production and improving quality in one of the biggest companies in Iraq. Data was collected by vesting one of the factories to five different machines for six months as to the number of stoppages in machine, the best period for testing, stoppage reasons, repair period and the number of stoppages. The possibility of monthly stoppage was calculated, and damage period, and the expected number for each machine stoppage. A computer program to calculate the best period for partial maintenance by using (Microsoft office Access 2007 program), In order to confirm the effective operation of the program was applied on ten default machines (A, b, C, D, E, F, G, H, I, J) for six months watching period as shown in table number (1).

Keywords: Programmed partial maintenance, Productivity, Power Factory, Diyala Company.

1- INTRODUCTION

The maintenance cost at the early age of any machine is much less than its revenues, then the cost begins to increase gradually with the progress in the machine age. The cost may go higher to exceed the hypothetical revenues of the machine, as the partial programmed maintenance is the process by which the machines are kept, changing oil, replacing damaged movable parts within regular periods as at the end of every production term (1) which is a part of preventive maintenance. The maintenance services have great importance in industrial enterprises at present time due to big and fast development in productive establishments and their numbers, and the wide use of the machines and equipment's distinguished by their speed, accuracy and high price; so it is required to have complete programs for their maintenance as the speed increase in machine leads to increase in production, meanwhile increases their consuming and worn-out. Might accuracy helps improve product quality, but it requires skill, ability and high cost to maintain. Many studies have been made about the subject of maintenance like the study by Zuhair Hasan Abdallah (2) who used mathematical and static methods to determine the economical periods for preventive maintenance as an attempt to decrease maintenance cost and the best use for available resources of metal, Doneld K. Hicks (3) studied the effect of maintenance devises stoppages which leads to making use of work time and devearsing maintenance cost and damages caused by stoppages of the machines, while Kathryn A. Zimmerman and David G. Peshkin (4) showed that there is balance between preventive maintenance and treatment maintenance regarding costs, it is possible to consider the maintenance costs are directly proportional to the time or to the machines age, as the treatment maintenance are less than preventive maintenance at early age of the machine and with the passage of time the cost of treatment maintenance gets more that preventive maintenance due to the importance of maintenance in increasing production and one of the biggest companies in Iraq, which has eight factories (Electric meters factory, Argon factory, Plug spark factory, Power transformer factory, optical cable factory, Ceiling fans factory, Distribution transformer factory). The research aims at using mathematical and statistical methods and computer programmers to determine the economical periods for preventive maintenance to machines and equipment's as an attempt to decrease maintenance cost and the best use of available materials to raise production levels.

2- THEORETICAL CALCULATION

The best time for maintenance was calculated then finding the possibility of monthly stoppages for each machine for six months as the following equation [5].

$$\text{Possibility of monthly stoppages for each machine} = \frac{\text{Number of stoppages every month for each machine}}{\text{Total stoppages for six months for this machine}} \quad \ldots\ldots\ldots..(1)$$

Table (2). Shows stoppages possibility for all machines used in inspection for six months with a total number of stoppages for each machine. A rate of (0.20) was determined as maximum of monthly stoppages possibility for each machine, and for calculating the best period for partial maintenance it is found that it does not depend on one factor but on many factors such as:

A) - Damage period: it is expressed by a percentage of total hours for machine operation [5] and a maximum of 4% was specified for damage period, equation (2) shows calculating the damage period. As shown in table (3)

$$\text{Damage Period} = \frac{\text{Hours of machines damage}}{\text{Hours planned for Machines operation}} \times 100 \quad \ldots\ldots\ldots..(2)$$

B) - Expected number of machines which have stopped: it was calculated by equation [3]:

$$\text{Expected number of stoppages In each machine} = \frac{\text{Number of machines used in inspection}}{\text{Expected average age of each machine (in month)}} \quad \ldots\ldots\ldots..(3)$$

Table (4) shows the number of machines expected to stop within 6 months. The expected age average of the machine may be calculated using equation (4) [6], and table (5) shows the results of applying equation.

Expected average age of each machine = (Month number × stoppage possibilities in that month)…. (4)

3- PROGRAM DESIGN

In this study, a computer program (Microsoft Office Access 2007) was designed to calculate the best period to do partial maintenance, this program is distinguished from:-

- Easy to use.
- Ability to find out the number of machines expected to stop.
- Big capacity to save data base.
- Prevent personal mistakes.

By depending on the data in tables (6-11) a computer program was designed to show the number of machines expected to stop during the inspection period, the figures (1-6) the interfaces of a program, and figure (7) shows the flowchart of the program.

4- RESULT AND DISCUSSION

Through theoretical calculation done in this research represented by figures (8, 9, and 10), the following results were found:

1- Figure (8)
- ❖ In the first month of watching the five machines under research, machines (1, 3, 5) stopped with stoppage possibility (0.25) for machines (1&3) and stoppage possibility (0.16) for machine (5).
- ❖ In the second month of watching, machine (1) stopped with stoppage possibility (0.25)
- ❖ In the third month of watching, machine (1) with the stoppage possibility (0.125).
- ❖ In the fourth month of watching, machines (1, 3, 5) with stoppage possibility (0.125) for machine (1) and (0.25) for machine (3) and (0.16) for machine (5).
- ❖ In the fifth month of watching, machine (1) stopped with stoppage possibility (0.125) and machines (3&5) with stoppage possibility (0. 5).
- ❖ In the sixth month of watching, machine (1) stopped with stoppage possibility (0.125) and machine (5) stopped with stoppage possibility (0.16).

2- Figure (9)
- ❖ It shows the stoppages of machine (2) through months (1-6) with stoppage possibility (0.2).

3- Figure (10)
- ❖ It shows the stoppages of machine (4) in the first month with stoppages possibility (0.4285).
- ❖ In second, third, fourth and sixth months, there is a stoppage possibility (0.1428).
- ❖ There was no stoppage in the fifth month.

The results, show that machine (1, 2, 3) has the highest possibility of stoppage which is (1) and machine (4) had stoppage possibility (0.998), and machine (5) had stoppage possibility (0.98) during six months, so the factory management should take necessary measures to prevent stoppages by replacing machines or doing overall repair for these machines so as not to affect the production. The sudden stoppage in machines which is shown in figures (8, 9, and 10) has a negative effect on production line which leads to a negative effect on production, especially if the production line is arranged in linear form when a machine stops leads to stoppage in all production lines which will cause big losses in a factory.

5- RESULTS OF THE COMPUTER PROGRAM.

There are (10) different machines (A, B, C, D, E, F, G, H, I, J) used in industrial enterprise put under watch for six months. The tables (12 to 22) show data regarding default testing machines with stoppage sample to each of the ten machines, tables (23) and (1) show results obtained by the supposed computer program.

6- CONCLUSIONS

From the present work may be concluded the following:-

1- Determining the best maintenance periods help to keep machine's accuracy and decrease number of damage machines leading to decreasing production defect.
2- Programmed maintenance decreases stoppages in production treading to benefit of work time and reducing production costs.
3- The purpose of applying the default program presented by the research is to show the possibility of applying it on any number of machines and it is possible to get the result showing machines expected to stop, so it is possible to take necessary measures to prevent damage which may be caused by this stoppage to the production line especially and production generally.

7- ACKNOWLEDGMENT

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Table (1): Results obtained following the software application.

Machine Name	Number of stops	The possibility of stopping
A	5	0.2
B	3	1
C	3	1
D	2	3.5
E	2	3.5
F	2	3.5
G	2	4
H	4	0.5
I	2	3.5
J	4	0.5

Table (2): The probability of interruptions to five machines for a period of six months

Number of Machine	The first month	The second month	The third month	The fourth month	The fifth month	The sixth month	Total
1	0.25	0.25	0.125	0.125	0.125	0.125	1
2	0.2	0.2	0.2	0.2	0.2	0	1
3	0.25	0	0	0.25	0.5	0	1
4	0.4285	0.1428	0.1428	0.1428	0	0.1428	0.998
5	0.16	0	0	0.16	0.5	0.16	0.98

Table (3): A period of five stops machines and monitoring period of six months

No machine	Hours malfunction machines for the six months observation		Hours planned to work the machines	% a period of work stoppage
	Per day	For six months		
1	6	180	15	8.333
2	6	180	8	4.44
3	6	180	5:30	2.944
4	6	180	88	48.88
5	6	180	16	8.888

Table (4): The number of machines is expected stoppage within six months

No machine	Machine number (1)	Machine number (2)	Machine number (3)	Machine number (4)	Machine number (5)
The expected number of machines stopped for six months	1 (Machine / month)	1 (Machine / month)	1.3 = 1 (Machine / month)	0.97 = 1 (Machine / month)	1.162 = 1 (Machine / month)

Table (5): The expected average five machines for six months

No machine	Average expected life of the machine (a month)
1	(1*0.25)+(2*0.25)+(3*0.125)+(4*0.125)+(5*0.125)+(6*0.125) =3 month
2	(1*0.25)+(2*0)+(4*0.25)+(5*0.5)+(6*0) =3.8 month
3	(1*0.25)+(2*0)+(3*0)+(4*0.25)+(5*0.5)+(6*0) =3.8 month
4	(1*0.4285)+(2*0.1428)+(3*0.1428)+(4*0.1428)+(5*0)+(6*0.1428) =5.1 month
5	(1*0.16)+(2*0)+(3*0)+(4*0.16)+(5*0.5)+(6*0.16)= 4.3 month

Table (6): The number of stops during six months, for five machines

No	The sequence of the machine in the test	Number of stoppages	The period of time dedicated to check
1	Machine No. (1)	8	From 1/11/2012 until 4/30/2013
2	Machine No. (2)	5	From 1/8/2012 until 31/01/2013
3	Machine No. (3)	4	From 1/11/2012 until 4/30/2013
4	Machine No. (4)	7	From 1/6/2012 until 30/11/2012
5	Machine No. (5)	6	From 1/11/2012 until 4/30/2013
Total		**30**	

Table (7): Number of stops, causes and period of repairs for STMRW17- machine lapping higher (Machine 1), during the six months.

Date of observation		Number of stoppages	Reason for stoppage	Period of repairs (hr.)
From	To			
2012/11/1	2012/11/30	1	Stop the movement of the vehicle	2:50
		1	High voice in the machine	2:00
2012/12/1	2012/12/31	1	Phys shortage	2:00
2013/1/1	2013/1/31	1	Phys shortage	2:00
		1	Shot in Kabul	0:30
2013/2/1	2013/2/28	1	Lack of movement in front of the machine	1:25
2013/3/1	2013/3/31	1	Damage	0:45
2013/4/1	2013/4/30	1	Lack of movement in front of the machine	3:30
Total		**8**		

Table (8): Number of stops, causes and period of repairs for Hydraulic Press (Machine 2)

Date of observation		Number of stoppages	Reason for stoppage	Period of repairs (hr.)
From	To			
2012/8/1	2012/8/31	1	Erratic work machine	3:00
2012/9/1	2012/9/30	1	Fracture at the base of the bolts	1:30
2012/10/1	2012/10/31	1	Non-functioning of the machine	2:00
2012/11/1	2012/11/30	1	Holiday Table	30:00
2012/12/1	2012/12/31	1	Lack of movement of the table	1:00
2013/1/1	2013/1/31	0	There is no	-------
Total		**5**		

Table (9): Number of stops, causes and period of repairs for Shernik (Machine 3), during the six months.

Date of observation		Number of stoppages	Reason for stoppage	Period of repairs (hr.)
From	To			
2012/11/1	2012/11/30	1	Non-functioning of the machine	2:00
2012/12/1	2012/12/31	0	There is no	-------
2013/1/1	2013/1/30	0	There is no	-------
2013/2/1	2013/2/28	1	Not rise and descent of a knife cutting	0:50
2013/3/1	2013/3/31	1	Screw break	1:50
		1	Shot in Kabul	0:50
2013/4/1	2013/4/30	0	There is no	------
Total		**4**		

Table (10): Number of stops, causes and period of repairs for Line radiator (Machine 4).

Date of observation		Number of stoppages	Reason for stoppage	Period of repairs (hr.)
From	To			
2012/6/1	2012/6/30	1	Non-functioning Altyrustr	24
		1	A malfunction in the electrical B1	21
		1	Cut in the electrode	14
2012/7/1	2012/7/31	1	Cutting, welding C2	2:00
2012/8/1	2012/8/31	1	Stop spare disk	4:00
2012/9/1	2012/9/30	1	Ball Bearing	2:00
2012/10/1	2012/10/31	0	There is no	--------
2012/11/1	2012/11/30	1	Stead cutting electrode	21:00
Total		**7**		

Table (11): Number of stops, causes and period of repairs for Smail Shearing MK (Machine 5).

Date of observation		Number of stoppages	Reason for stoppage	Period of repairs (hr.)
From	To			
2012/11/1	2012/11/30	1	Erratic cutting measure	8:50
2012/12/1	2012/12/31	0	There is no	-------
2013/1/1	2013/1/30	0	There is no	-------
2013/2/1	2013/2/28	1	Not rise and descent of a knife cutting	1:50
2013/3/1 2013/3/1	2013/3/31 2013/3/31	1	Ingress of water and mixing with air.	2:00
		1	Damage Alqaich	1:20
		1	High voice in the machine	2:00
2013/4/1	2013/4/30	1	Looseness incapable A	0:50
Total		**6**		

Table (12): Data for testing machines (test program).

No.	The name of the machine	The sequence of the machine in the examination	The number of daily hours of work	The number of weekly hours of work	Duration of examination	Examination period	
						From	to
1-	A	1	5	6	For six months	2013/1/1	2013/6/1
2-	B	2	6	6	For six months	2013/1/1	2013/6/1
3-	C	3	5	6	For six months	2013/1/1	2013/6/1
4-	D	4	7	6	For six months	2013/1/1	2013/6/1
5-	E	5	5	6	For six months	2013/1/1	2013/6/1
6-	F	6	8	6	For six months	2013/1/1	2013/6/1
7-	G	7	6	6	For six months	2013/1/1	2013/6/1
8-	H	8	4	6	For six months	2013/1/1	2013/6/1
9-	I	9	5	6	For six months	2013/1/1	2013/6/1
10-	J	10	6	6	For six months	2013/1/1	2013/6/1

Table (13): Number of stops for the machine (A).

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stop
A	5	2013/1/25	2013/1/26	6.3	Non-functioning of the machine
		2013/3/5	2013/3/7	12	Non-functioning of the machine
		2013/4/1	2013/4/1	2.50	Non-functioning of the machine
		2013/4/26	2013/4/27	3.20	Non-functioning of the machine
		2013/5/28	2013/5/30	1.15	Non-functioning of the machine

Table (14): Number of stops for the machine (B).

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stop
B	3	2013/1/10	2013/1/12	7.30	Non-functioning of the machine
		2013/3/15	2013/3/20	13.2	Non-functioning of the machine
		2013/5/10	2013/5/10	2.5	Non-functioning of the machine

Table (15): Number of stops for the machine (C).

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stoppage
C	3	2013/1/21	2013/1/22	3.20	Non-functioning of the machine
		2013/3/25	2013/3/26	6.30	Non-functioning of the machine
		2013/5/3	2013/5/4	5.30	Non-functioning of the machine

Table (16): Number of stops for the machine (D).

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stoppage
D	2	2013/3/7	2013/3/9	12	Non-functioning of the machine
		2013/5/12	2013/5/12	1.30	Non-functioning of the machine

Table (17): Number of stops for the machine (E).

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stoppage
E	2	2013/3/9	2013/3/7	15	Non-functioning of the machine
		2013/5/12	2013/5/12	1.30	Non-functioning of the machine

Table (18): Number of stops for the machine (F).

Machine	Number of stops	From	To	The period of work stoppage	Reason for stoppage
F	2	2013/3/9	2013/3/7	20	Non-functioning of the machine
		2013/5/12	2013/5/12	7.2	Non-functioning of the machine

Table (19): Number of stops for the machine (G)

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stoppage
G	2	2013/2/8	2013/2/11	18	Non-functioning of the machine
		2013/5/20	2013/5/21	2	Non-functioning of the machine

Table (20): Number of stops for the machine (H)

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stoppage
H	4	2013/3/7	2013/3/9	10	Non-functioning of the machine
		2013/4/2	2013/4/3	6.30	Non-functioning of the machine
		2013/5/12	2013/5/12	5	Non-functioning of the machine
		2013/5/26	2013/5/26	3	Non-functioning of the machine

Table (21): Number of stops for the machine (me)

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stoppage
I	2	2013/3/7	2013/3/9	13	Non-functioning of the machine
		2013/5/12	2013/5/12	1	Non-functioning of the machine

Table (22): Number of stops for the machine (J)

Machine	Number of stoppage	From	To	The period of work stoppage	Reason for stoppage
J	4	2013/2/23	2013/2/24	2	Non-functioning of the machine
		2013/3/15	2013/3/16	7.50	Non-functioning of the machine
		2013/5/2	2013/5/3	8	Non-functioning of the machine
		2013/5/6	2013/5/7	11	Non-functioning of the machine

Table (23): Report of the program shows the duration of the machines stops and ten observation periods.

مدة العطل المتوقع2

Monday, May 19, 2014
9:16:27 PM

ت	اسم الماكينة	ساعات التشغيل	الشهري	SumOfمدة التصليح	مدة العطل %
1	A	5	150	25.15	16.767
3	B	6	180	23	12.778
4	C	5	150	14.8	9.867
10	D	7	210	13.3	6.333
11	E	5	150	16.3	10.867
12	F	8	240	27.2	11.333
13	G	6	180	20	11.111
14	H	4	120	24.3	20.25
15	I	5	150	14	9.333
16	J	6	180	28.5	15.833

10

Page 1 of 1

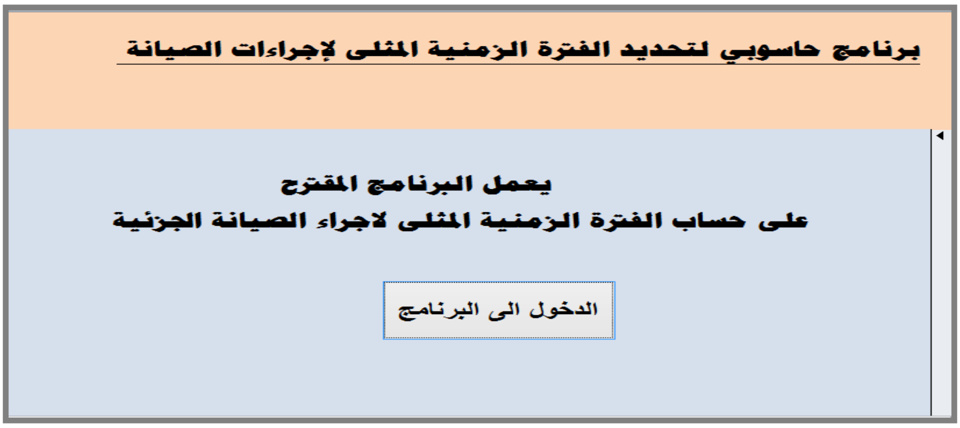


Figure (1): The main interface of the computer program snapshot.

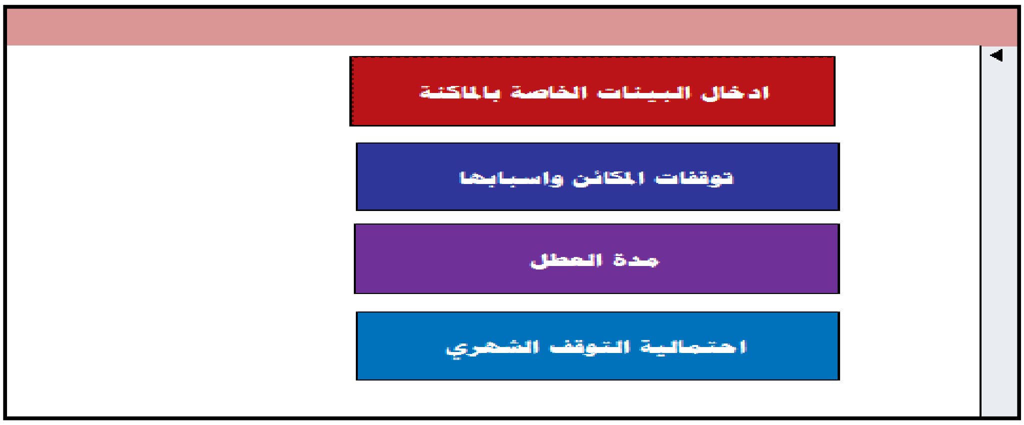


Figure (2): The interface choices snapshot.

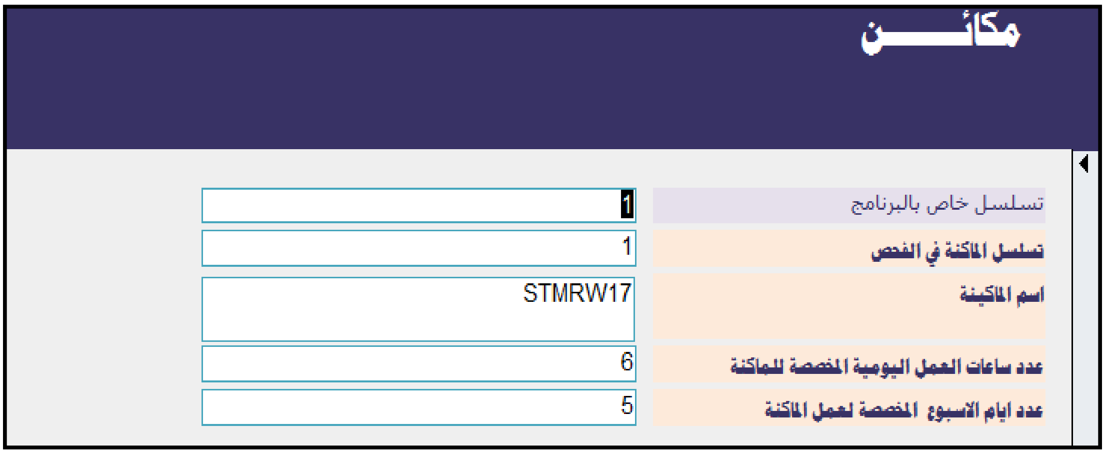


Figure (3): The interface and data entry machines preliminary snapshot

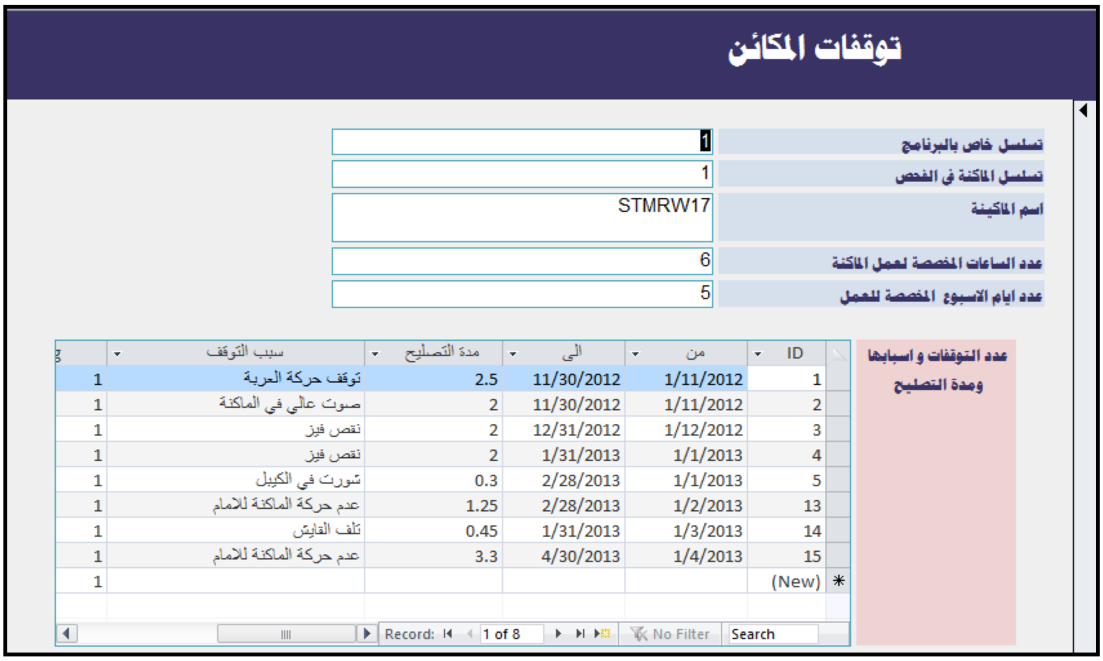


Figure (4): The interface and the introduction of those stops machine snapshot

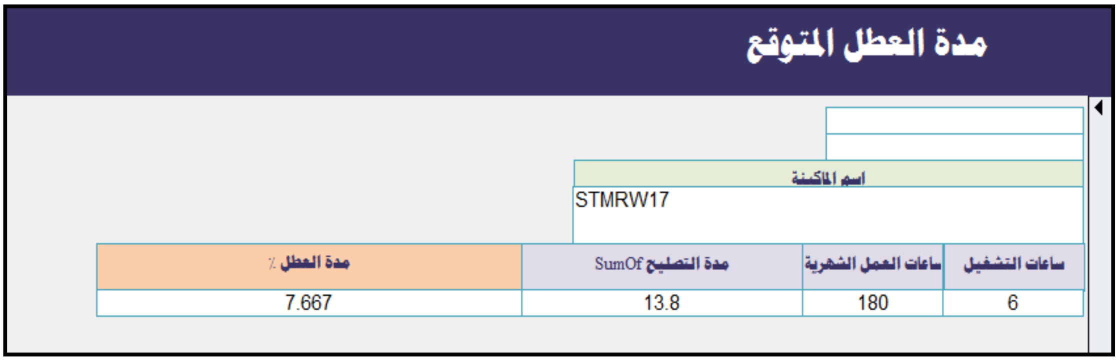


Figure (5): The calculated ratio for stops % snapshot.

Figure (6): The probability of the next step (probabilistic predictive) snapshot.

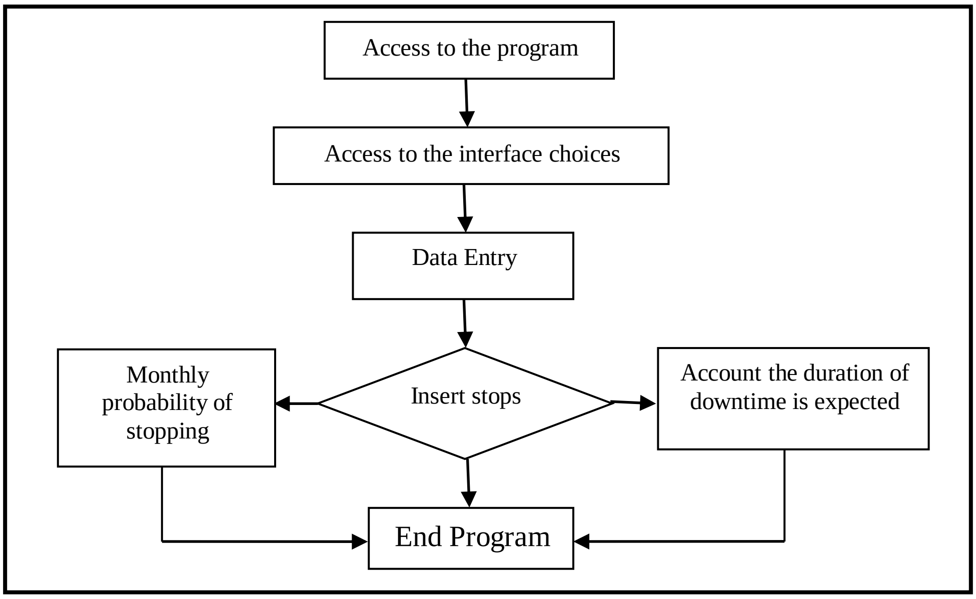


Figure (7): The flowchart of the program.

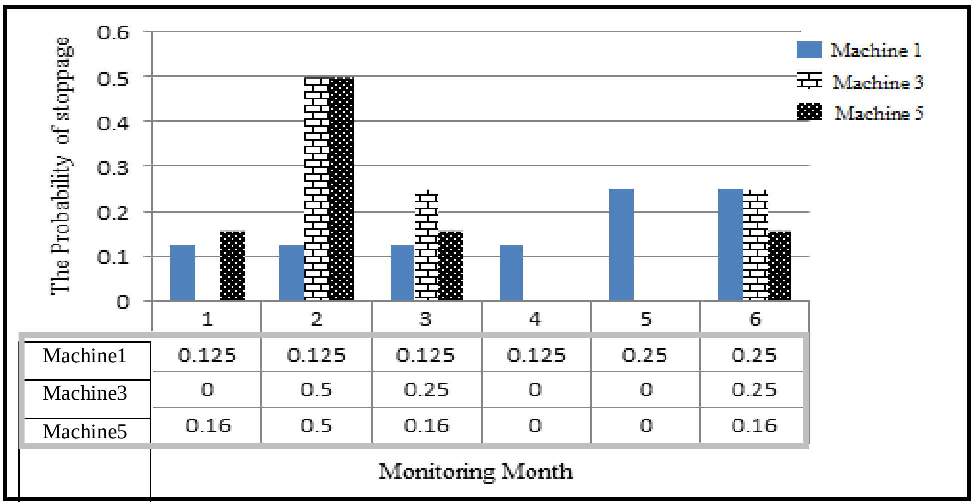


Figure (8): The likelihood of the machines stops number (1, 3, and 5) for the six months observation.

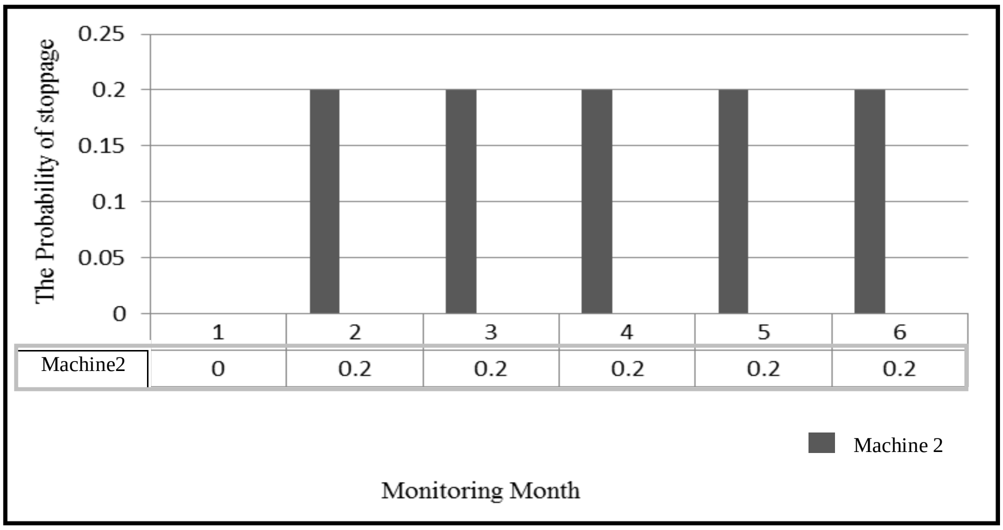
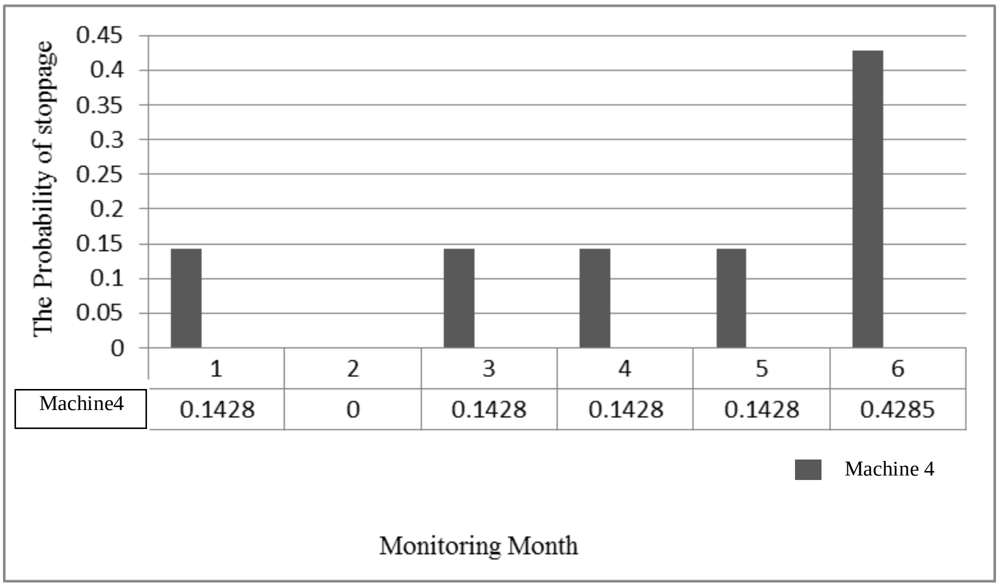


Figure (9): The possibility of stops machine no. (2) For the six-month monitoring.



	1	2	3	4	5	6
Machine4	0.1428	0	0.1428	0.1428	0.1428	0.4285

Figure (10): The probability of stops machine (4) monitoring the six months.

دراسة تاثير الصيانة الجزئية المبرمجة على انتاجية معمل القدرة في شركة ديالى للصناعات الكهربائية

أ.د لطفي يوسف زيدان

م.م ليث عبد حسناوي

جامعة ديالى – كلية الهندسة – قسم الهندسة الميكانيكية

الخلاصة

تناولت الدراسة الصيانة الجزئية المبرمجة التي أجريت على المكائن لما لها من أهمية كبرى على زيادة الإنتاج و تحسين نوعيته في واحده من اكبر الشركات العاملة في العراق .حيث تم جمع البيانات من خلال زيارة واحد من معامل الشركة ولخمسة مكائن مختلفة ولمدة ستة اشهر من حيث عدد توقفات الماكنة والفترة الزمنية المثلى المخصصة للفحص و أسباب التوقفات ومدة التصليح وعدد التوقفات. تم حساب احتمالية التوقف الشهري لكل ماكنة ومدة العطل و العدد المتوقع لتوقف كل ماكنة. تم تصميم برنامج حاسوبي لحساب الفترة الزمنية المثلى لاجراء الصيانة الجزئية بالاعتماد وعلى برنامج (Microsoft Office Access 2007). تم تطبيق البرنامج على عشرة مكائن افتراضية (A,B,C,D,E,F,G,H,I,J) وذلك من اجل معرفة مدى قابلية البرنامج على استيعاب اكبر عدد ممكن من المكائن ولفترة مراقبة مقدارها ستة اشهر و كما مبين في الجدول رقم (1).

الكلمات المفتاحية: الصيانة الجزئية المبرمجة، الإنتاجية، معمل القدرة، شركة ديالى للصناعات الكهربائية.