2011 3rd International Conference on Information and Financial Engineering
IPEDR vol.12 (2011) © (2011) IACSIT Press, Singapore

Simulation of timing failure and downtime of production line applying dynamic systems

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Abstract. In this paper with the purpose of showing a sample of applying a system dynamic, we have made use of a dynamic system modeling to analyze and study the behavior improvement of timing failure and the downtime of the production line. Also the relationship between timing failure, downtime, repair time, machine performance, sale and the profit status in a dynamic system is analyzed. At first, the cause – effect diagram of the model is shown and then through analyzing the effect of different parts of model on other parts, the dynamic system has been studied. Then, by decreasing the factors of timing failure, the behavior of the model is analyzed from different aspects

Keywords: Timing Failure, Downtime, Simulation, Modelling, Dynamic Systems.

1. Introduction

Timing failure and downtime of production losses due to stopping production line; and none completed products impose a meaningful cost to organizations. Predicting of machines timing failure and downtime is very important in maintenance. So due to its high cost, that's really important to have a reliable system of predicting such lags in order to think about an appropriate system of maintenance. Because the continuous production line of the vegetable oil Factory of Narges Shiraz, as the production line stops, its balance changes and planning faces real problems.

Timing failure is duration of time which machine stops producing due to power disconnection, Shiraz dysfunction of electrical system and lack of raw materials and etc [1]. Downtime shows duration of timing failure to the time machines start normal performance [2]. Note that the repair time equal to total timing failure and downtime [3]. Simulation means showing phenomenon via numbers and shapes to study the phenomenon or their sides [3]. Due to interactions between different parts of a system, it's important to demonstrate behaviour of a system through systematic approach. This can be understood through the study of all components and communications interior the system [4].

2. Methodology

This study is practical and its methodology is case study. Data gathering is upon to documents and literatures. The vegetable oil Factory of Narges Shiraz is selected as a case study. We apply the cause - effect diagram to better understanding of dynamic systems modelling [5]. Relying on opinions of experts and production managers, relationships of cause - effect were extracted as the next figure.

The figures of timing failure and downtime in 2009 were gathered from literatures and documents. The frequency distribution diagram of disconnecting gas, broken parts, operator error and lack of raw materials was normal. Besides it was found that the frequency distribution diagram of downtime and disconnecting of power factors had a Uniform distribution.

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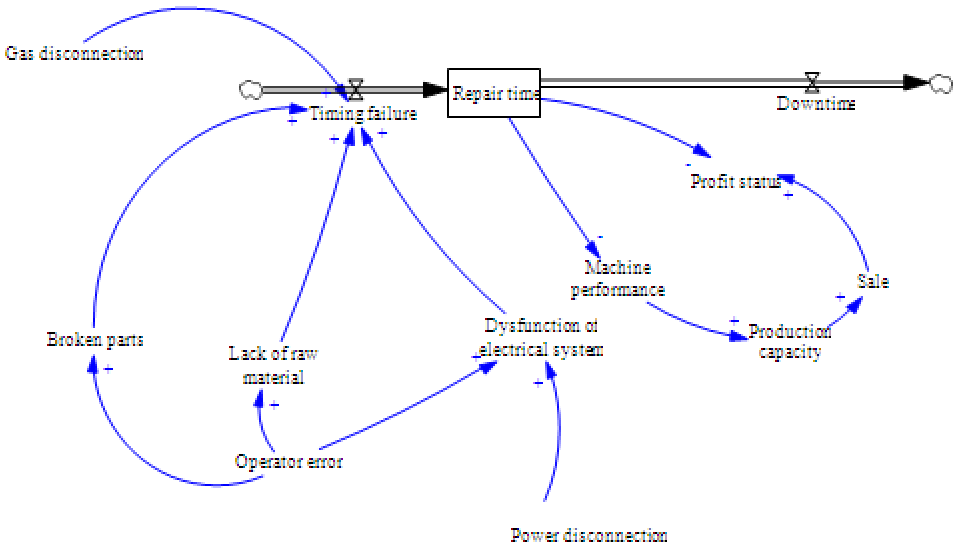

Fig. 1: "The cause - effect diagram"

The amount of timing failure and downtime in 2009 was gathered from existed formal documents as shown in Table 1. The frequency distribution diagram of gas disconnection, broken parts, operator error and lack of raw materials is normal and also it was found that the frequency distribution diagram of downtime and power disconnection factors follow the uniform distribution through Arena software.

Table. 1: "Duration of timing failure and downtime in 2009"

month	Operator error	Power Disconnection	Gas Disconnection	Lack of raw material	Brocken parts	Downtime
1	7	8	7	7	10	12
2	9	6	7	7	11	14
3	8	12	9	10	8	10
4	5	15	6	8	10	9
5	9	12	6	6	5	13.5
6	6	14	5	7	10	12
7	5	16	10	10	12	10
8	8	8	7	8	8	7.5
9	7	6	5	4	7.5	8
10	9	10	6	5	2	9
11	12	13	3	3	8	9
12	6	5	7	7	3	7

More other variables of this model come through the interview with experts as following:

65% of power disconnection variable and 40% of operator error led to dysfunction of electrical system.

As mentioned the repair time is equal to total timing failure and downtime.

According to documentation, the average factory-term performance is 530 hours per month, and to experts' comments the formula of machine performance variable would be as follow:

(530- repair time)/530.

The factory produces 2,500 tons of oil averagely, so the formula to determine the production capacity is: (2500 tons × machine performance).

Unit value per ton is equivalent to 673,500 Rials, so the obtained income from sales is:

(Production capacity × 673,500).

The cost of per hour repair time is 15,500,000 Rials, then total cost of repair time

would be:(15,500,000× total repair time

Total profit comes through :(total income from sales – total cost of repair time).

3. Simulation results

In this model, based on experts' ideas, the most important components of timing failure and downtime are as below:

The graphs predict simulation results in the year of 2010.

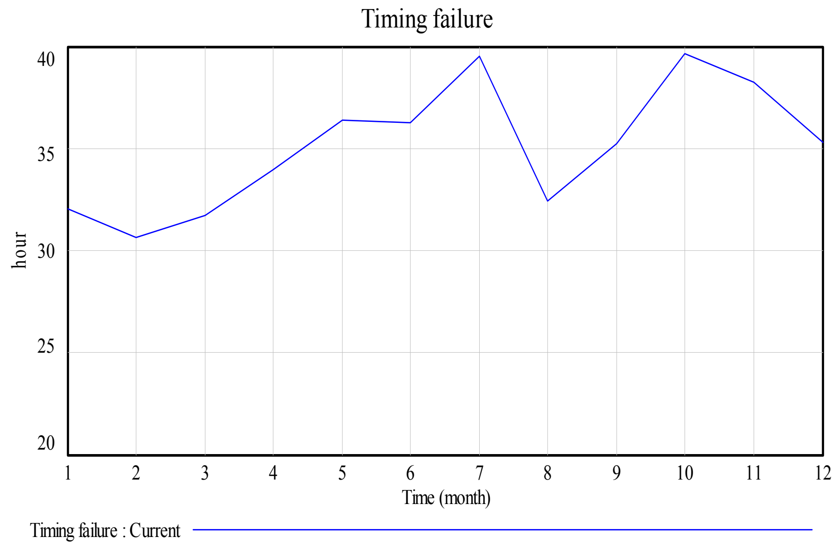

Fig. 2: "Timing failure"

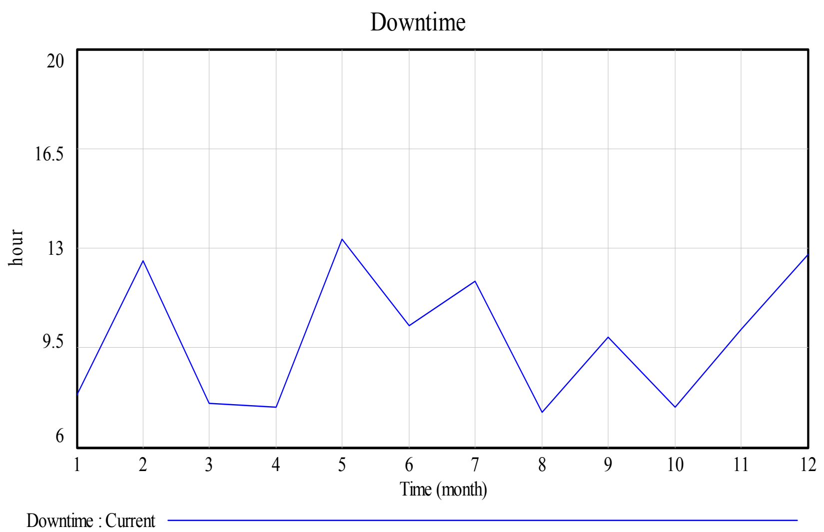

Fig. 3: "Downtime"

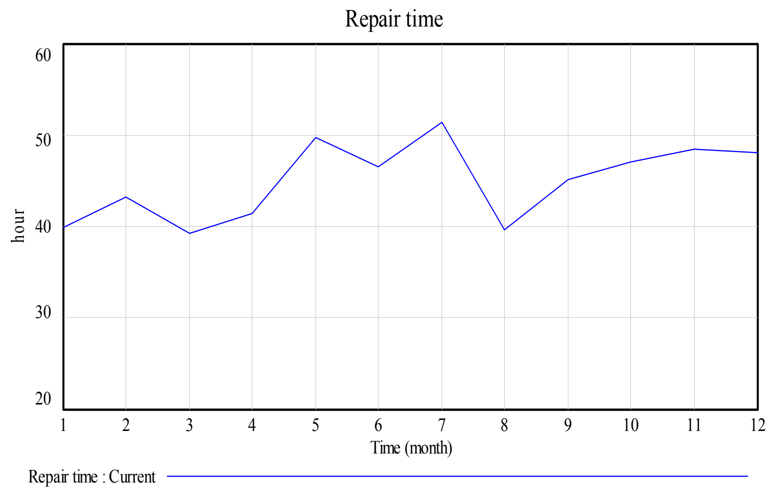

Fig. 4: "Repair time"

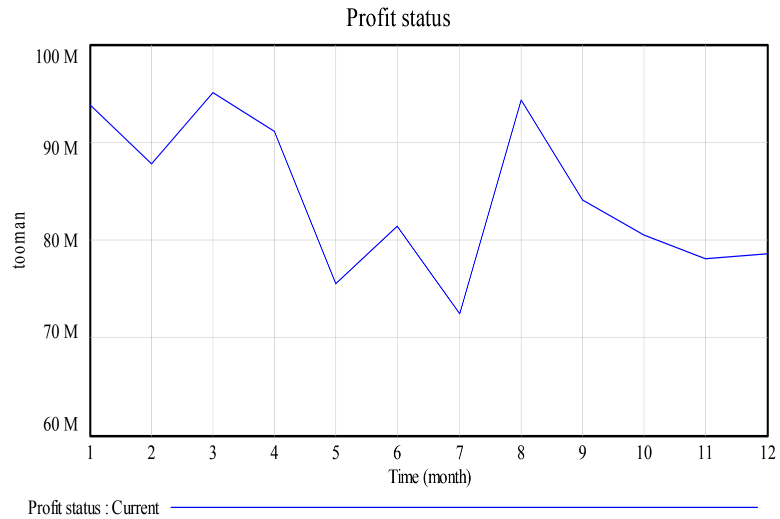

Fig. 5: "Profit status"

In the case of diminishing the effects of each factor on the timing failure, predicting of profit status in 2010 would be as following table:

Table. 2: "Simulation with assuming factors of timing failure reduction"

Month	Total profit due to reduction of power disconnection (Rials)	Total profit due to reduction of operator error (Rials)	Total profit due to reduction of lack of raw material (Rials)	Total profit due to reduction of gas disconnection (Rials)	Total profit due to reduction of broken parts (Rials)
1	1038910000	1056100000	1028740000	1068540000	1099280000
2	973258000	849284000	984595000	1038520000	974650000
3	910000000	950515000	1032740000	107980000	1097930000
4	1045170000	1051210000	1010130000	1036790000	1063910000
5	931526000	945123000	898375000	837435000	882963000
6	896476000	847875000	948384000	916562000	1028030000
7	911511000	899767000	881289000	802397000	876473000
8	1025110000	928430000	1067640000	1077600000	1074660000
9	956245000	896869000	961885000	918310000	1057590000
10	1010880000	1055910000	934296000	915512000	964782000
11	961411000	1005070000	897037000	871139000	968037000
12	1001020000	894050000	920409000	895215000	888418000

The sequent frequency distribution diagram of broken parts, operator error, power disconnection, gas disconnection and lack of raw materials follow ordinary Beta, Uniform, Weibull, Beta and Uniform.

Note that profit status of either above factors obeys a different function, so there is no way rather than applying the coefficient variables. Based on the coefficient variables, the importance amount of reducing the effects of each factors influencing on repair time (summation of timing failure and downtime) would be sequentially:

1 – power disconnection 2- gas disconnection 3- broken parts 4- operator error 5- lack of raw materials

4. Conclusion

In this paper, we tried to display a dynamic model of relationship between components of timing failure and downtime in production line. Through simulation techniques and dynamic systems by Vensim software, the timing failure factors of the production line, which reviews the results can be outlined as follow:

1 – Power disconnection is the most negative factor; It increases the cost and duration of repair time.

2 – As the priority, gas disconnection, broken parts factors, operator error and lack of raw materials are the most influential factors on repair time.

3 – Timing failure and downtime prediction require a reliable system of maintenance.

4 - This model is able to identify factors influencing the repair time.

5. References

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