A close up of a piece of paper

Description automatically generated

**Advanced Simulation Modelling 234061-0723**

**Case study: Machines and Tools**

Student:

Oleksandr Romanchenko – 83459

19.05.2020

Warsaw 2020

1. **Summary**

The report is based on Case Study – Machine and Tools from Advanced Simulation Modelling class.

The main goal of report is to make simulations of 2 scenarios of repairing tools transportation time in order to figure out which one will be optimal to use for the company.

Results of simulation showed that it’s more preferable for a company to use S (Star System) scenario since it shows lower average cumulative idle time for a machine.

1. **Introduction**

The input data is following:

* 6 machines
* 5 repair tools
* trouble-free operation time for the machine ~ Exponential Dist with exp = 75min
* tools transportation time
  + 1st scenario: 𝑡𝑖=𝑖∗2ti=i∗2
  + 2nd scenario: 3 minutes
* repair time ~ Erlang Dist with k=3 and exp = 15 minutes

The task is to create a model for each scenario and find out which of them is more cost-efficient based on overall number of inactive minutes of machines in each model.

1. **Problem statement**

There are 6 machines and 5 repair tools in both scenarios. Each machine can operate 75 minutes on average and after that has to be repaired.

Average repair time for the machine is 15 minutes.

Also, there is a transportation time for each repair tool. It is the time needed for repair tool to reach to a broken machine from its base (shown as “Tool” on pictures).

Another thing to note is that for both scenarios there is always less number of repair tools than machines, so that some machines are always waiting queue for its turn to be repaired.

1st scenario – Line System:

A picture containing drawing

Description automatically generated

*fig.1 – Line System*

Once machine is repaired – the repair tool has to go back to the base. In case there are no repair tools available at the moment, broken machine goes to the queue and waits for a repair tool. Transportation time of a repairing tool is calculated by the formula:

𝑡𝑖=𝑖∗2ti=i∗2

Which means that it spends 2 mins to reach to the closest machine (1) and 2 additional minutes to those which are further, so that it spends 12 minutes to get to machine 6.

2nd scenario – Star System:

A picture containing clock

Description automatically generated

*fig.2 – Star System*

In this scenario repair tools are placed in center of 6 machines thus creating a star. Each time a machine gets broken is gets repaired immediately. If there is no available repair tool at the moment, a broken machine has to wait in queue. Transportation time of repairing tool is 3 minutes.

1. **Findings**

Models have been created with the following events:

Events - vectors that are designed to control the simulation state:

* moments of occurrence of subsequent events
* machines status:
  + W - operating
  + Q - waiting for the tools
  + R - is being repaired
* inactivity time

2 models with exponential distribution have been created. The average idle cumulative time for a machine with Line System (1st scenario) = 9790 minutes. Whereas for Star System (2nd scenario) it = 8337 minutes.

A screenshot of a cell phone

Description automatically generated

*fig.3 – average idle time of models “L” and “S” with exponential distribution of events*

1. **Sensitivity analysis**

Sensitivity analysis helps us to see how the change of some crucial parameters affects results of the models.

The model from initial example was based on exponential distribution. So, for the sake of experiment I’ve decided to try also a poisson distribution in order to see how it affects the model L and S. Here are the results for idle cumulative average time of both models with poisson distribution:

A screenshot of a cell phone

Description automatically generated

*fig.4 – average idle time of models “L” and “S” with poisson distribution of events*

1. **Conclusion and recommendations**

Change of distribution hasn’t significantly affected the difference in average cumulative idle time of model S and L however in both cases it’s clearly seen that Star System yields a better result in terms of efficient usage of machines.

To conclude, I can say that model S should be a preferred choice for the company.

1. **References**

The Case Study Machines and Tools – Advanced Simulation Modelling class.