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Simulation of Queuing System for Car Service Center using Arena Simulation Software

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ABSTRACT

In this project work, the objective is to investigate the average waiting times related to various processes of a car service center. This research uses Arena Simulation as a tool to find the average waiting times that a car spends in the car service. This study attempts to investigate and suggest the best possible configuration for a car service center through constructing computer-based simulation models. As the result of this study, the final suggested configuration shows improvement in terms of average utilization rate of every process and average waiting time that a car spends in the car service.

Keywords : arena simulation, automotive car service, process analyzer, queue time

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INTRODUCTION

The car service center, i.e., Pragati Motors, is one of the major car service centers which is situated at the west of Jorhat, Assam. It deals with both the Car selling and Repairing which was established in 2006. It has various ranges of automotive products such as wheels, tyres, batteries, alloy wheels, oil, accessories and genuine parts for cars etc. Waiting in lines is a common problem faced by every service industry.

Problem Definition

The significant problem of the work shop (Pragati Motors) is that they are unable to deliver most of vehicles according to the promised time. The main cause of this problem is because queues in various processes. Thus, it is most important to analyze the queues in every process in order to maintain their business and increase the profit. Usually, most of the cars will spend more than one day for receiving service. Therefore, in this study the data collected are based on number of cars arrival, different processes, resources etc. By using discrete event simulation (DES), average time for cars to wait for each process will be calculated at the end of this study. Some scenarios will be tested to find the best alternative to reduce cars waiting time.

Project Objectives

The main objective of this project work is:

- Build a simulation model of the car service by collecting adequate data.
- To find average waiting time of each vehicle.
- To find average waiting time of each process used by the car service.
- To compare different alternative scenarios with the original model.
- To improve the overall efficiency of the whole car service center

Literature Review

Mageed AG conducted a study on 'Modeling and Simulation of Queuing Systems', using Arena Software. Ch. Venkatadri et al. conducted a study on 'Application of Simulation for the

Improvement of Four-Wheeler Sector' using Arena simulation software [5]. Janar et al. conducted a study on 'Analysis of Vehicle Service Queuing System' using Arena Simulation in authorized Workshop. Maheshwaran et al. presented a model on 'Simulation-Based Planning of Maintenance' Juliana et al. conducted a model on Simulation by Queuing System at an Immigration Department name Johor Bahru, Malaysia, using arena Simulation [6]. Manjurul A conducted on Study of Queuing System of a Busy Restaurant and a Proposed Facilitate Queuing System by using Arena simulation software [8].

METHODOLOGY

This project work referred to the simulation modelling process as in Figure 1. After understanding the current behaviour of the problem to be modelled, the next stage is to formulate the aim and set the objectives of this project work. Figure 1 shows flowchart showing simulation modelling process used in this project work.

The data required for develop this project work have been collected from a car service center name Pragati Motors (TATA authorized dealer) which is situated in Puilibor, Jorhat. The whole process of the workshop starts from opening of a Job card to the disposal of cars. The various processes used by this car service are Job Card process, Speedo service, mechanical service, electrical service, dent and paint service and washing service. Also, the resources are service advisor, general technician, special technician, electricians, denter and painter and washing bay. Figure 2 shows the flowchart of the basic processes of car service.

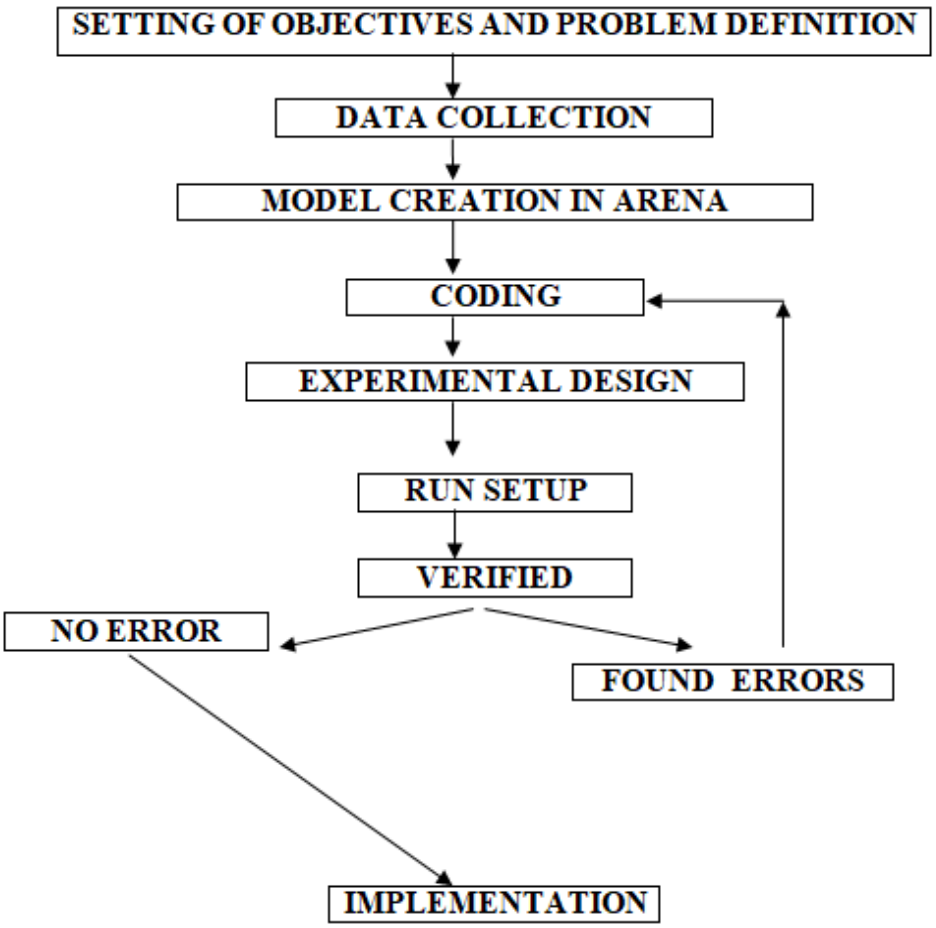


Fig. 1. *Simulation modeling process.*

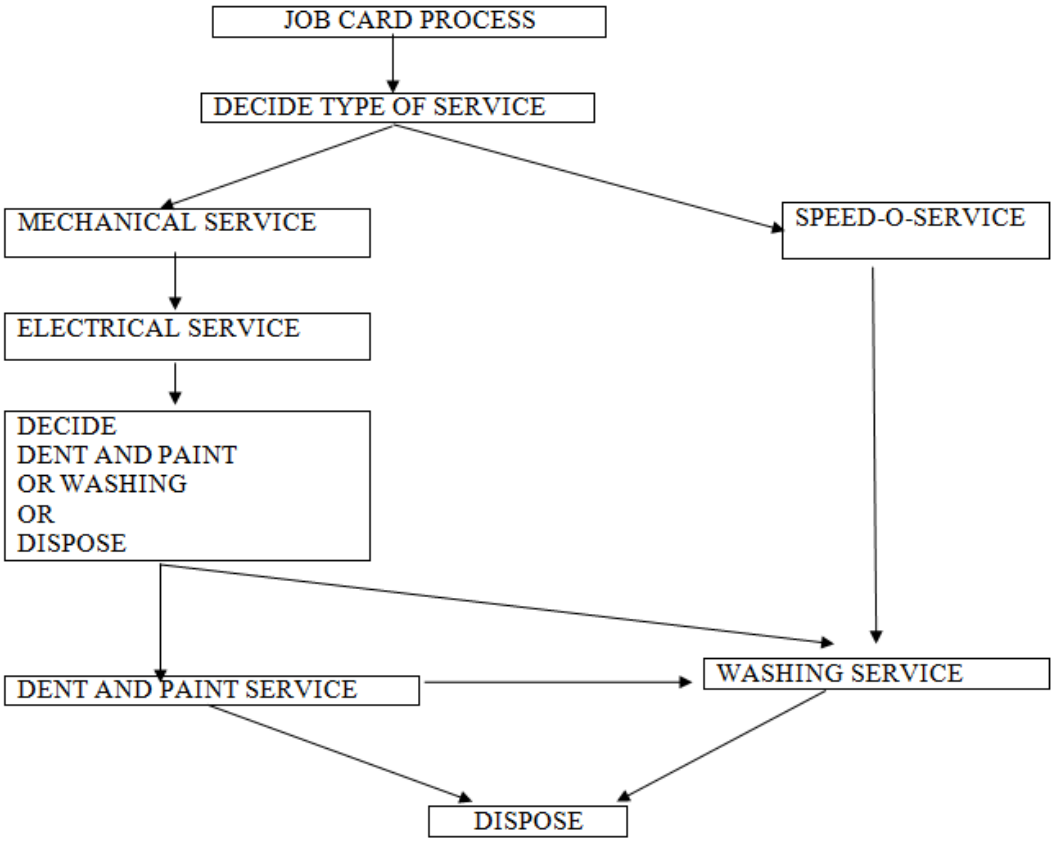


Fig. 2. *Flowchart view of the Basic processes of car service (Pragati Motors).*

Data Collection

The data was collected for *three months* i.e. *January, February and March* (2018).

Following table 1 shows the service type of sequences and number of cars of coming for speed-o-service.

Following table 2 shows the service type of sequences and number of cars of coming for Mechanical repairing service. The resources used by this car service are shown in below table 3. The processing time and probability distributions of each processes are given below the following table 4.

Table 1. *No. of cars of speed-o- service.*

Speed -o- service (total 616 no of cars)	
Type of service sequence	No of cars
Speedo-o-service and washing service	616

Table 2. *No. of cars of mechanical repairing service.*

Mechanical Repairing Service (Total 1247 Cars)		
Service type of sequence	No of cars	Percentage
Mechanical- electrical –dent and paint service	90	90/1247=7.2%
Mechanical-electrical- dent and paint service-washing service	140	140/1247=11.2%
Mechanical –electrical service-washing service	800	800/1247=64.2%
Mechanical-electrical service	217	215/1247=17.04%
	Total=1247	Total=100%

Table 3. *The resources used in each department.*

Resource	limit	department
Service Advisors:	3	Job Card Process)
Generel Technicians:	4	Speed-o- service)
Special Technicians:	12	Mechanical service
Electrical Technicians:	2	(Electrical service)
Denter and Painters	5	(Dent and Paint service)
Washing Bays: 2 Bays	2 Bays	Washing service

Table 4. *Processing times of various process.*

Process	**Minimum Processing time**	**Maximum Processing time**	**Mean Processing time**	**Time Unit**	**Probability Distribution-** ***[Triangular (minimum, mean, maximum)]***
Job card process	4	10	7	Minutes	Triangular (4,7,10)
Speed-o-service	80	90	85	Minutes	Triangular (80,85,90)
Mechanical service	2	3	4	Hour	Triangular (2,3,4)
Electrical service	0	60	30	Minutes	Triangular (0,30,60)
Dent and paint service	3	4	5	Hour	Triangular (3,4,5)
Washing Process	20	30	25	Minutes	Triangular (20,25,30)

Model Creation in Arena Simulation

To start the construction of a new model in Arena, the first clicks the File menu and select New. A new model is given the name *Model1* by default [1,9,10]. Various Modules are required using for creating of this model. The name is given the following model is *Simulation of Queuing System Using Arena In Car Service.* Following Figure 3 shows the final model created in Arena simulation Software.

Model Outputs

After Running the model, Arena will ask if the User is wants to see the results. By Selecting *Yes* option, Arena opens the default report (Category overview Report) [2]. For this model the software shows sections on Processes, Queues, Resources etc.

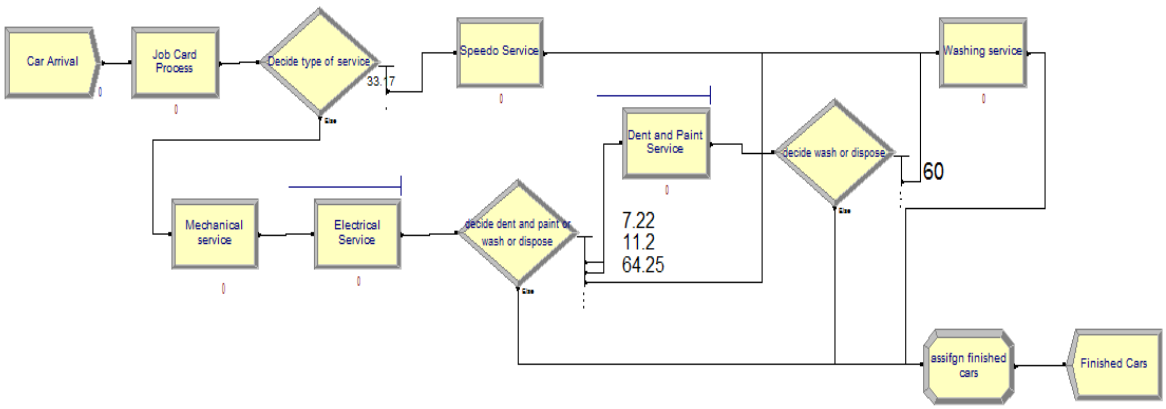


Fig. 3. *Final model created in Arena simulation.*

Result Window 1 (total no. of car disposal)

Following figure 4 and 5 represents total number disposal of cars and and queues in each process.

Result window 2 (Average waiting time of per cars)

Following figure 6 shows average waiting times of each vehicles

Result Window 3 (No of cars entered in each process.)

Following figure 7 shows no of cars entered in each processes Average waiting times of each process.

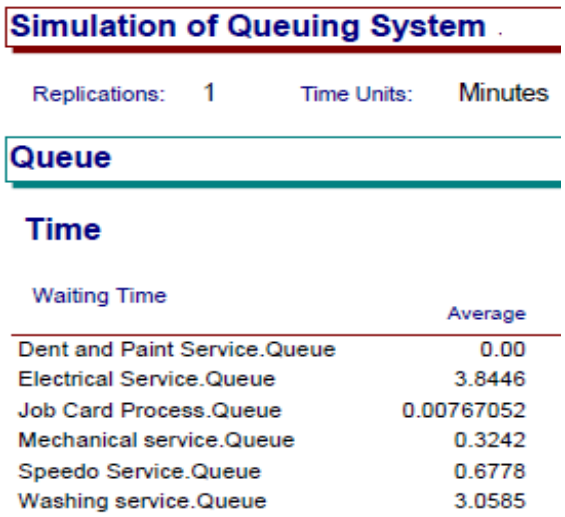
Simulation of Queuing System Using Arena in Car service

Replications: 1 Time Units: Minutes

Key Performance Indicators

System	Average
Number Out	1,749

Fig. 4. *Total no of disposal of cars.*



Simulation of Queuing System

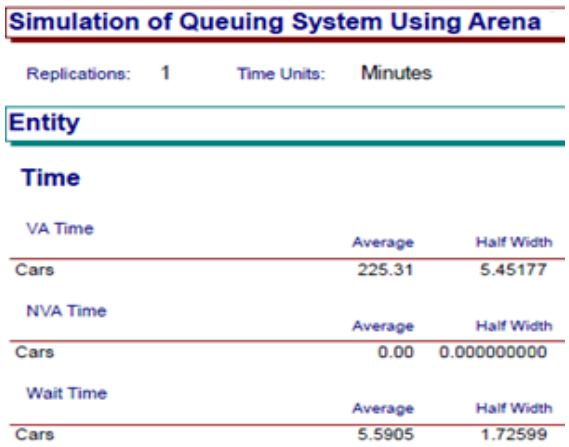
Replications: 1 Time Units: Minutes

Queue

Time

Waiting Time	Average
Dent and Paint Service.Queue	0.00
Electrical Service.Queue	3.8446
Job Card Process.Queue	0.00767052
Mechanical service.Queue	0.3242
Speedo Service.Queue	0.6778
Washing service.Queue	3.0585

Fig. 5. *Queue in each process.*



Simulation of Queuing System Using Arena

Replications: 1 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width
Cars	225.31	5.45177

NVA Time	Average	Half Width
Cars	0.00	0.000000000

Wait Time	Average	Half Width
Cars	5.5905	1.72599

Fig. 6. *Average waiting time of each car.*

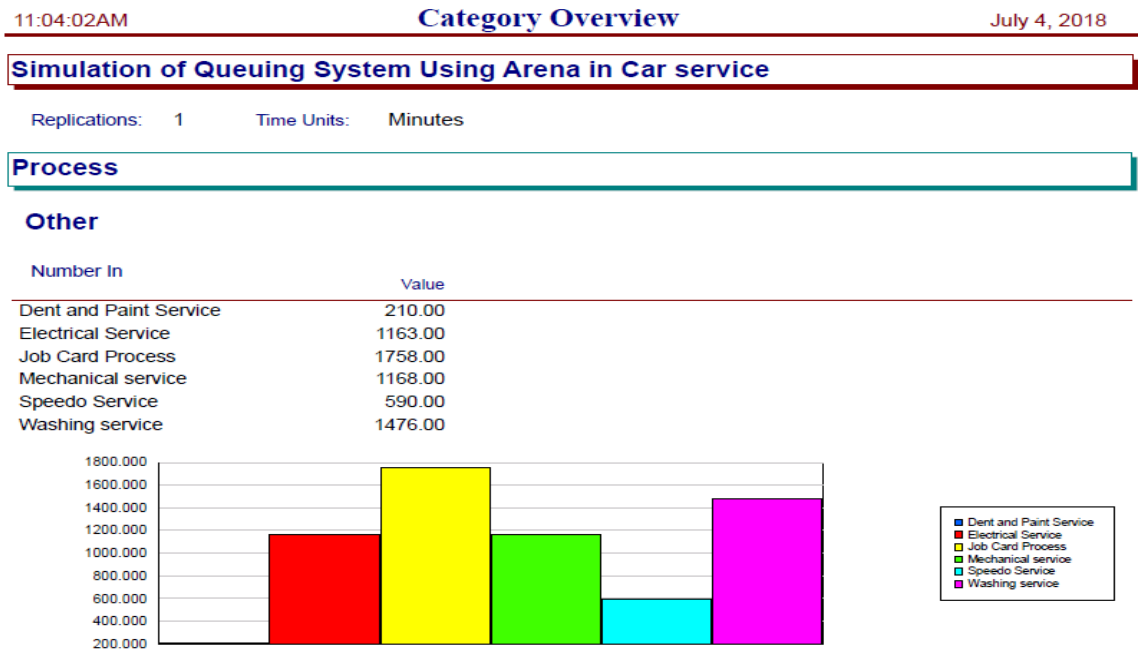


Fig. 7. *Total number of cars entered in each process.*

RESULTS AND ANALYSIS

The model was set to run for 90 replications. Each replication represents one day and hours per day were set as 8 hours. Key metrics getting from the model are shown in Tables 5–12.

- Total number of disposal of cars = 1749
- Average waiting time of cars = 5.5905±1.72599 minutes

Accumulated Number of Cars entered in Each Process

Table 5 shows the accumulated number of cars entered in various processes.

Table 5. *Accumulated number of cars entered in various processes.*

Process	Total number of Cars entered
Dent and Paint Service	210
Electrical Service	1163
Job Card Process	1758
Mechanical service	1168
Speedo Service	590
Washing service	1476

Table 6. *Average waiting times of each process.*

Process	Average waiting time in minutes
Queue in Dent and Paint Service	0
Queue in Electrical Service	3.84
Queue in Job Card Process	0.007
Queue in Mechanical service	0.3242
Queue in Speedo Service	0.6778
Queue in Washing service	3.05

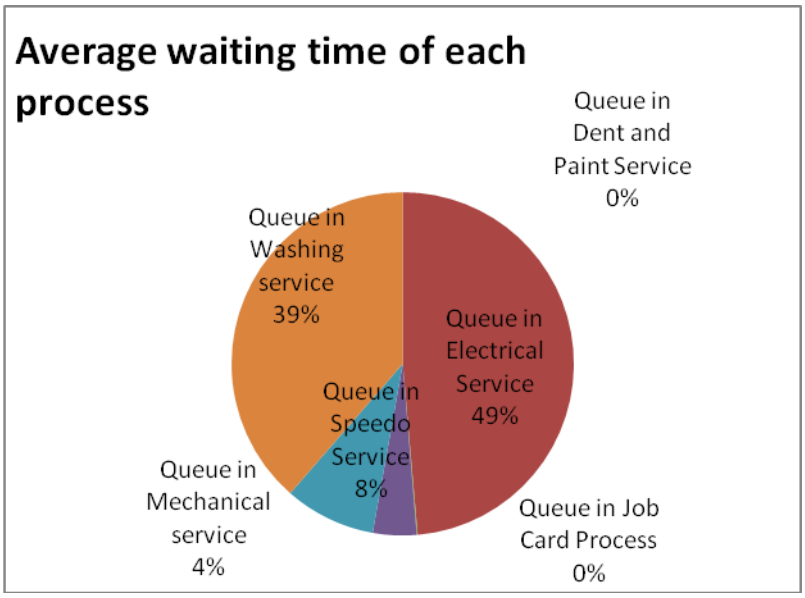


Fig. 8. *Pie chart queues in each process.*

From the Table 6, it is seen that average waiting time in washing and electrical service are 3.84 and 3.05 minutes, which are very large as compared to the other processes.

Scenario Analysis

Therefore, arena process analyzer is used in this research to compare three scenarios according to the number of resources [3,4,7]. Each scenario is signifying as:

- Scenario 1=addition of one more washing bay
- Scenario 2=addition of one more electrical technician and one washing bay
- Scenario 3=transferring one special technician to the electrical department and increasing washing bay from two to three

Table 7 shows comparison of two scenarios.

Queues in Various Scenarios

Table 8 shows queues in various processes after process analysis.

Figure 8 indicates the main effect plots of queues in various processes in across with different scenarios.

From the Figure 9, it seen that scenario 3 is the most beneficial because queues in each process are under one minute.

Average Number of Queue in Each Process

Table 9 indicates average number of queues in each process of the car service and Figure 10 indicates plot of average number of queues in each process.

From the Table 9, it is signifying that Average waiting time of each process in scenario 2 is reduced from 1.31 to 0.35 minutes. Therefore, it signifies that if the cars service transfers one special technician to the electrical department with the addition of one more washing bay, then the average waiting time of each process is reduced to 73%

Number of Cars Entered in Every Process

Table 10 shows number of cars entered in every process after pan analysis.

It is observed that, in scenario number 3, the number of cars entered in each process in gradually increases in each process. Therefore, scenario 3 is most beneficial for every process.

Table 7. *Various limits of resources in each scenario.*

Scenarios	Limits of service advisor	Limits of general technician	Limits of special technician	Limits of electrical technician	Limits of denter	Limits of painter	Limits of washing Bay
Original	3	4	12	2	3	2	2
Scenario 1	3	4	12	2	3	2	3
Scenario 2	3	4	12	3	3	2	3
Scenario 3	3	4	11	3	3	2	3

Table 8. *Queues results after pan analysis.*

Scenarios	Queue in Dent and Paint Service	Queue in Electrical Service	Queue in Job Card Process	Queue in Mechanical service	Queue in Speedo service	Queue in washing service	Queue average
Original	0.0	3.84	0.007	0.3242	0.6778	3.05	1.31
Scenario 1	0.14	5.09	0.014	0.3131	0.84	0.2167	1.102
Scenario 2	0.083	0.76	0.0061	0.0316	1.31	0.44	0.43845
Scenario 3	0.3442	0.466	.00937	0.1889	0.64	0.4834	0.35

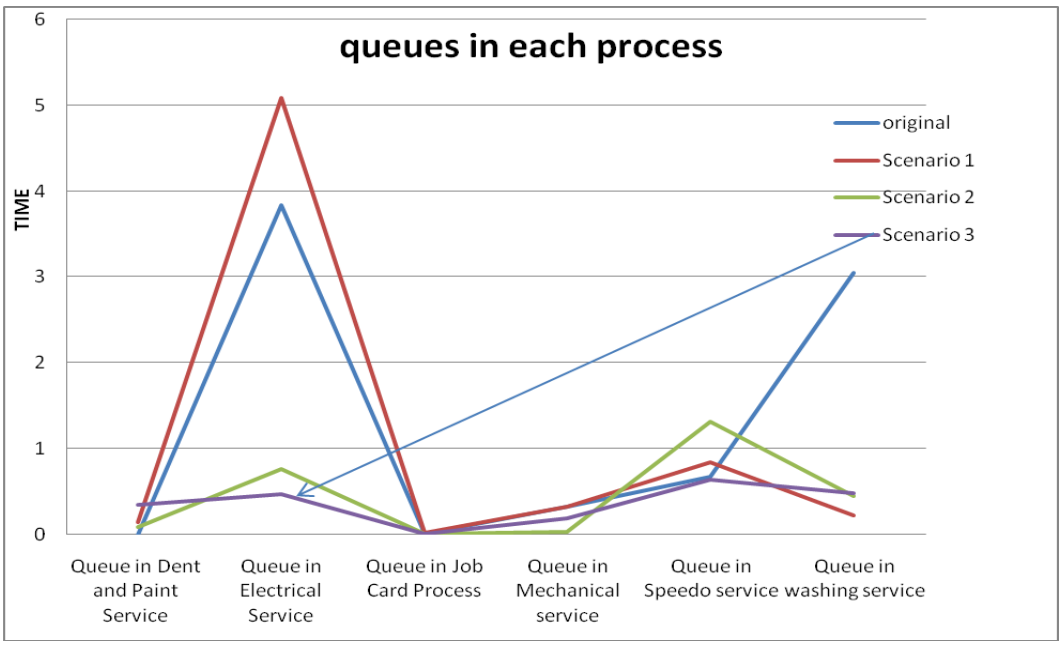


Fig. 9. *Main effect plots of different scenarios.*

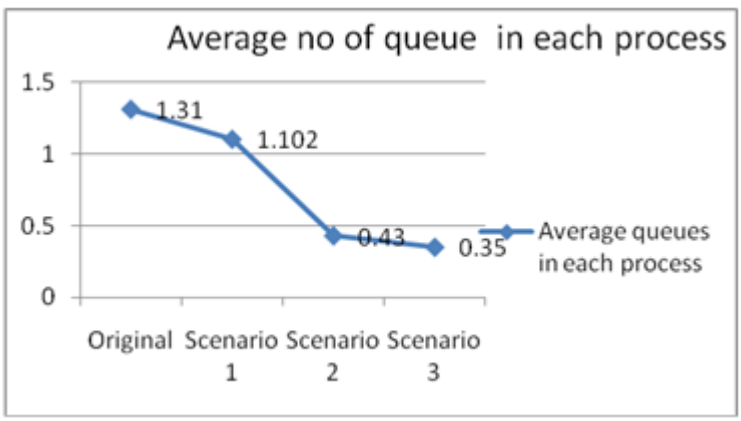


Fig. 10. *Average number of queues in each process.*

Table 9. *Average number of queues in each process.*

Scenarios	Average queues in each process
Original	1.31
Scenario 1	1.102
Scenario 2	0.43
Scenario 3	0.35

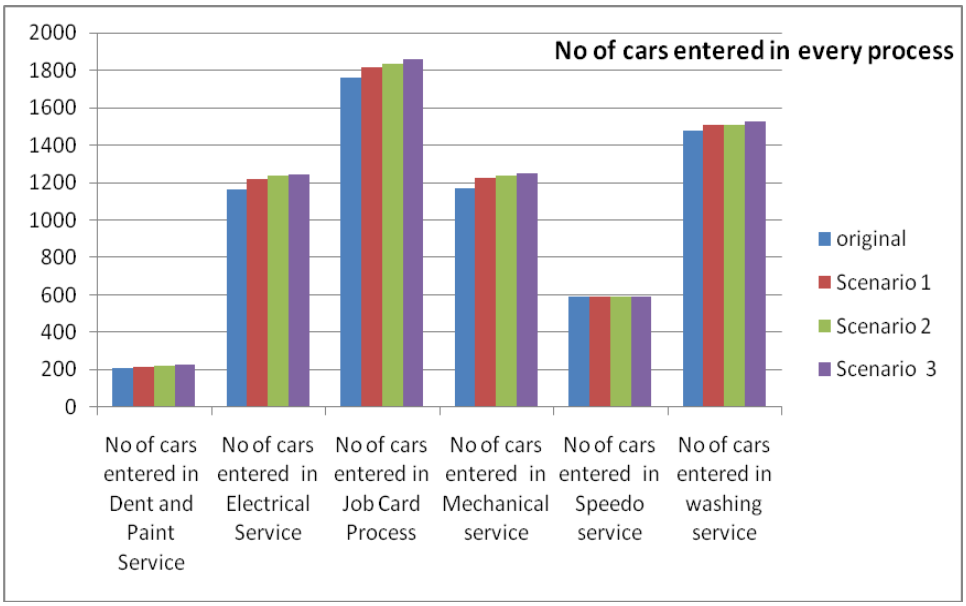


Fig. 11. *Bar graph of number of cars entered in each process.*

Total Number of Cars Entered

Table 10 and Figure 11 show total number of cars entered for process**.**

Table 10. *Total number of cars entered.*

Scenarios	Total Number of cars entered
Original	1758
Scenario 1	1814
Scenario 2	1835
Scenario 3	1838

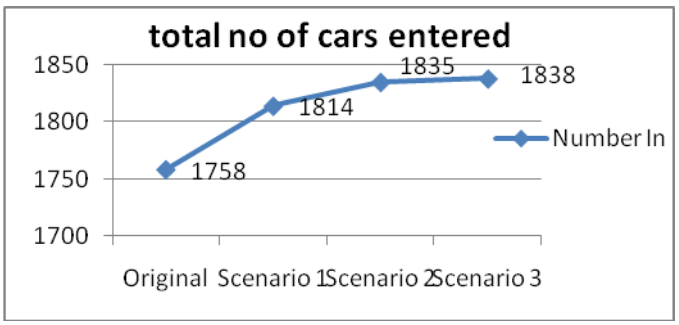


Fig. 12. *Plot of total number of car entered.*

From the Figure 12, it is signifying that number of cars entered in every process increased from 1758 to 1838. Therefore, it signifies that if the cars service transfer

one special technician to the electrical department with the addition of one more washing bay, then the total number of cars entered processing is increased to 4.5%

Average Waiting Time of Cars in Each Scenario

Table 11 and Figure 12 show Average waiting time of cars after Pan Analysis.

Table 11. *Average waiting time of cars.*

Scenarios	Average waiting Time in minutes
Original	5.59±1.725
Scenario 1	4.14 ±1.07503
Scenario 2	2.72 ±0.644643528
Scenario 3	1.10 ±0.377350901

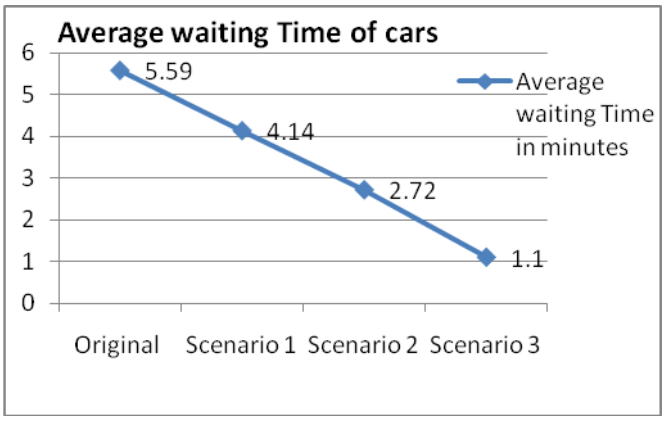


Fig. 14. *Plot of average waiting times of each car.*

Total Number of Cars Disposal

Table 12 and Figure 13 indicate disposal of cars in each scenario.

Table 12. *Total number of cars disposal.*

Scenario	Disposal Of Cars
Original	1749
Scenario 1	1804
Scenario 2	1828
Scenario 3	1833

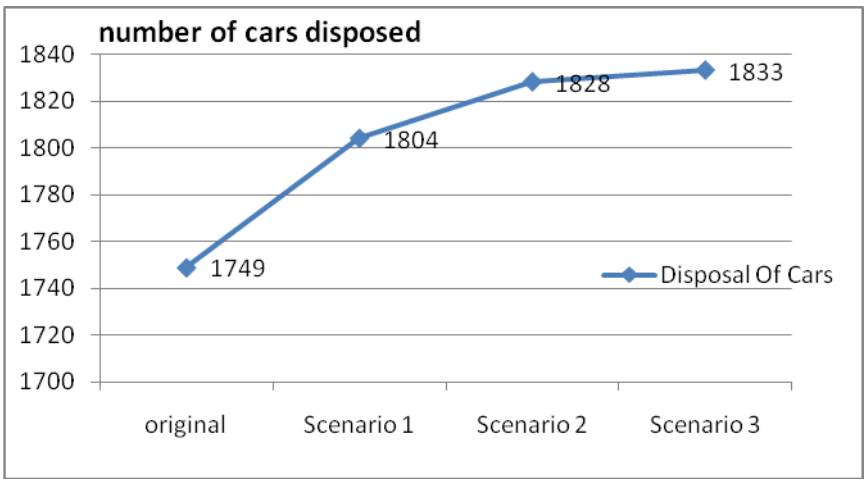


Fig. 13. *Plot of total number of cars dispose.*

CONCLUSIONS

Initially, it was found that in the existing system the average waiting times of washing service and electrical service was very high, i.e., 3.05 minutes and 3.84 minutes. It is because these two departments have very few numbers of resources in comparison with other departments. Therefore, various scenarios have been compared with the original model in order to reduce queues in these two processes. It was found that process analyzer is very effective tool for developing empirical relationship between the various parameters such as resource, number entity, time, queues, etc. Therefore, scenario number 3 implies that if the car service transfer one special technician from mechanical department to the electrical department and add one more washing bay then the amount of disposal of cars increased to 4.5%. Also, average waiting of times of each car and each process has been reduced to 80% and 73% which will be very beneficial for the car service. The key focus of this project is to deliver cars to customers earlier than the estimated time. The goal of this project is to analyze most of the work process carried out inside the workshop. So, as discussed in the result section, it can conclude that, cars can be delivered to the customer more quickly by the addition of one more washing bay. This would add value to the work the company carries out.

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