Application of Simulation for the Improvement of Four Wheeler Service Sector

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Abstract : The contribution of the service sector to the economy of the developed and developing countries are significant. For instance, in India, the service sector contributing nearly more than 5 percentage of GDP. To retain its role for contributing much for the economy and to enhance customer satisfaction, there is a need to study the underlying factors in the service sector. In this paper automobile four-wheeler service sector in India has been presented. A discrete event simulation has been used to highlight the difficulties involved in a typical four-wheeler service centre.

Key words: Discrete event simulation, service sector, four-wheeler Maintenance

I. Introduction

The contribution of the service sector plays a significant role in employment generation and growth of economy as well in developed countries like India. Hence, many of the researchers are focusing to study the issues involved in and developing this sector. Studies reveals improvement of technology and implementation of scientific approaches etc. are the important issues needs to be exploited for improving the service rates of the centers to retain its role for contributing much for the economy and the customer satisfaction as well.

With advent of liberalization and globalization, automobile Industry sector in India has shown a significant growth over the past two decades. India has become the second largest producer of four wheeler vehicles after China. Literature shows when compared to the growth rates of four wheelers, there is no proportionate growth in the service centers, as a result, servicing rates are decreasing and average delay is increasing which causing the customer dissatisfaction. In this backdrop, the objectives of the thesis have been framed to study the service center and proposing the some improvements to it for enhancing the service rate, which in turn improves the growth of the whole sector.

Literature shows that there is a huge gap between sales volume of vehicles and number of service centers, and the service rendered by the service centers and the gap is steadily increasing. Naturally, the delivery of the vehicle decreases which directly impacts the satisfaction of the customers. Considering these issues, the objectives have been framed to study the service centers and proposing the some suggestions for improving the growth. A questionnaire survey in various service centers in major cities in Andhra Pradesh in India has been conducted.

Rest of the paper has been organized as follows. Section 2 gives a review on discrete event simulation (DES), section 3 gives details on questionnaire survey and data collection and section 4 on model development and results obtained using the simulation finally conclusions are presented in section 5.

II. Discrete Event Simulation

Simulation has become important and its use is widespread, in manufacturing and service industries as well (Herbst et al., 1997). Simulation is the imitation of the operation of a real-world process or system over time. It involves

- Generation of an artificial history of the system
- Observation of the artificial history
- Drawing inferences concerning the operating characteristics of the real system

It is an analysis tool for predicting the effect of changes to existing systems and also predicts the performance of new systems under varying sets of circumstances.

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Several researchers have used DES for various applications like

- to study and experiment with internal interactions of a complex system
- study the effects of informational, organizational and environmental changes on model's behaviour
- to suggest improvements in system

DES has originally proved its worth and power as a process improvement tool within the manufacturing sector of the economy (Miller et al., 2000). Simulation is being used widely to analyze telephone call center handling for both inbound and outbound traffic. Nanthavanij et al. (1996) described as an application in which simulation was used to improve services provided by car-park systems. (Boyd et al., 2007) conducted study in an analysis of the marketing and logistical considerations of an air taxi service using a discrete-event simulation. The simulation models the passengers, aircrafts, airports, and dispatchers. Iannoni et al. (2004) applied discrete event simulation techniques to study the reception area processes of a sugarcane plant, analyzed the performance of the system and investigated alternative configurations and policies for its operations. . Patel and Ashby (2002) used discrete event simulation to develop an effective and efficient process to ensure the system throughput. Operators and machines perform a series of crucial testing procedures before shipping a vehicle. The work discussed the methodology of modeling and studying the final process system. Gupta et al. (2004) used discrete event simulation for improving the process in an automobile industry. The study described the successful application of simulation to process management and improvement with in a business devoted to aftermarket repair of privately owned automobiles and trucks.

III. Questionnaire Survey and Data Collection

A structured questionnaire has been developed (Best and Kahn,1986) to obtain the data from the service centers. It contains two sections. Section one seek the respondents profile and the other section seeks information related to service activities and its duration. In this paper, for simulation four-wheeler passenger car vehicles service centers data has been taken and especially Maruti Suzuki Dealer workshops and authorized service stations because Maruthi Suzuki brand occupied 60% of the passenger car in the market. To assess centre validity a dry run was made and few questionnaires were administered with two leading practitioners, one professional and two academicians. Based on their feed back a final structured questionnaire form has been evolved and it was sent to the heads of the of 71 service centers of Maruthi service centre in Andhra Pardesh State in India.

After reminders, phone calls, e-mails and re-reminders, 22 filled responses have been received, which shows a 31% response rate. Out of 22 responses 9 were collected through postal mail and 13 through personal interview. For personal interview appointment was taken on phone and it was conducted in service centers located in and around Visakhapatnam, and Hyderabad cities in Andhra Pradesh state of India.

3.1 Profile of Respondents

Among 22 respondents, 7 were proprietor/general manager/assistant general manager category with 20 to 40 years experience and 15 were of works manager / assistant works manger category with 5-20 years experience. According to qualifications 6 respondents were of bachelors degree in technology and engineering (B.Tech /B.E,) 12 respondents were of diploma in automobile and mechanical engineering (DAE/DME) and 4 were of technicians having industrial training certificates.

Table 1: Statistics of the Respondent service centers

S.No	Parameter	Number	Percentage
Number of employees			
1	<50	9	41
2	50 – 100	10	45
3	>100	3	14
	Total	**22**	100
Sales Turn over (in Lakhs of Rs.)			
1	<10	0	0
2	10 to 200	11	50
3	200 to 500	8	36
4	>500	3	14
	Total	**22**	**100**
Respondents:			
1	Proprietor/General Manager/Asst.General Manager(with 20-40 years experience)	7	32
2	Works Manager/ Asst. Works Manager (with 5-20 years experience)	15	68
	Total	**22**	**100**

3.2 Service Operations in a Typical Service Center

To simulate the maintenance operations in a service centre, data related to the failures are collected. On the basis of the failures, the prominent activities to be carried out are assessed. The data regarding four wheelers has been collected from an authorized service center of a particular make and model. It is so done because of the reason that 90% of service history of the vehicle is present with the service center, for a number of vehicles along with the problems at various mileages, thus making us to

track the problems at various distances traveled by the vehicle. The details are shown in Figure 1.

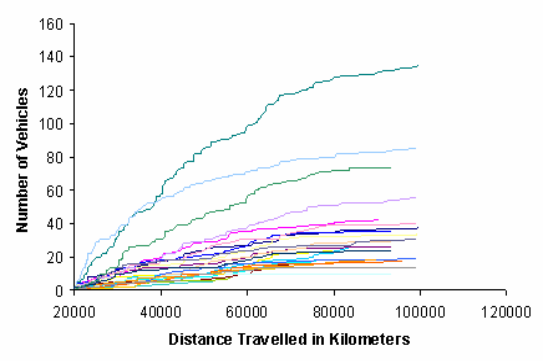


Figure 1: Failure Data of the Vehicles

Each curve indicates the type of failure and its frequency based on the vehicle usage (mileage). For instance, the Figure 2 indicates the frequency of the clutch problems with mileage of the vehicles.

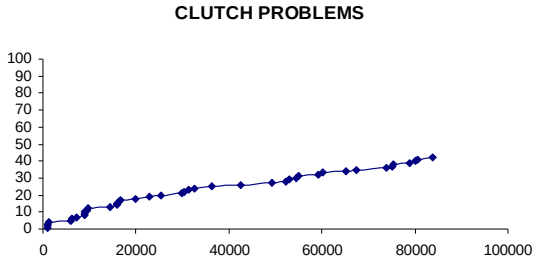


Figure 2: Frequencies of Clutch Problems

Here the failures are recorded for the vehicle run beyond 20,000 kilometers, since, it is the warranty or service holiday period for the vehicle offered by the manufacturer. For all the curves the associated failures are listed in Table 2 and shown below

Table 2: Prominent Failures in Four-Wheelers

S.No	Failures	S.No	Failures
1	Brake problems	14	Clutch problems
2	Wheel balancing and alignment	15	Coolant checking and top-up
3	Door problems	16	Air-Conditioner problems
4	Suspension related problems	17	Silencer related problems
5	Door sounds	18	Air filter cleaning and replacement
6	Wheel related problems	19	Lighting alignment
7	Air-Conditioner problems	20	Body sounds
8	Battery electrolyte check & problems	21	Fuel filter check and replacement
9	Lighting system, Horn operation check	22	Seats / Seat belts adjustment
10	Bumper check and repair	23	Starting problems-vibrations at starting
11	Steering related problems	24	CO-HC level check and adjustment
12	Engine tuning	25	Vibration checking
13	Engine oil check and replacement	*	*

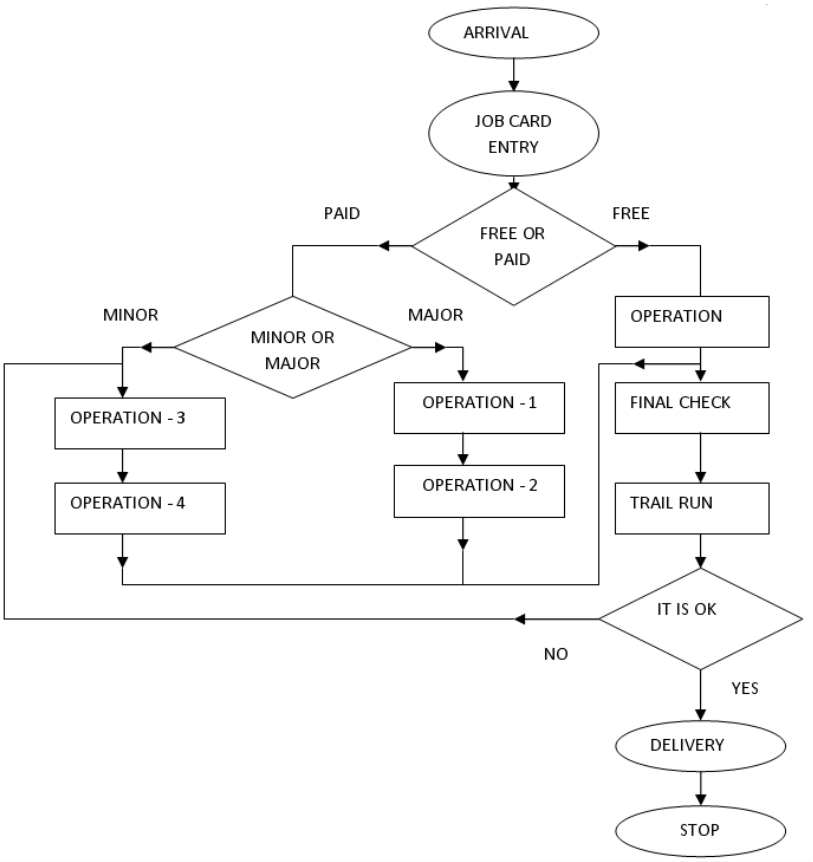
3.3 Activities Related Vehicle Failure

Based on failure and problems, and discussions had with the respondents, the overall maintenance activities to be carried out for the frequent failure as obtained and shown in the Table 2 are categorized into 3 groups namely basic operations, the rest of the operations are divided into group 1 and group 2 are presented in the Table 3 below along with the average duration.

Table 3: Sevcicing Opeartions and Its Duration

Activity	Average Time (in Hours)
Basic Operations	
Waiting in queue	0.4
job card entry	0.1
Water washing	0.75
Group I Operations	
Engine testing	0.5
Fueling system	0.2
Steering check and setups	0.3
Lighting and battery checking	0.5
Body repairs	1.0
Air conditioner testing	0.3
Ignition timings	0.4
Trail runs	0.4
Rectifications (1)	0.5
Rectifications (2)	0.5
Group II Operations	
Gear Box Overhaul	2.5
Wheel balancing and alignment	1.0
Clutch and transmission system	1.0
Brake system	1.0
Suspension system	1.5

The corresponding time required to complete each activity is also mentioned. The total activities carried out in the service centre from the entry of the vehicle till it is delivered are shown in the Flow chart Figure 3.



4 Simulation Model Development and Its Analysis

Based on the above flow chart, the simulation model (Figure 4) was developed using a well known and versatile simulation software package tool Arena-10. In this model, routinely used standard area modules such as create (customers vehicles enter the system), dispose (customer's vehicles leave the system), process or operation (vehicles undergo evaluation, repair, or inspection) and decide (free or paid service and minor or major operations) operations are used. The model was simulated using the collected data and analyzed the results.

Basically the rate of new arrival vehicles is increasing day by day. Similarly the paid vehicles number also increases. It shows that as the number of paid service vehicles increases, the corresponding delivery rates are decreasing and observed that operations carried out in the second stage are bottleneck to the delivery.

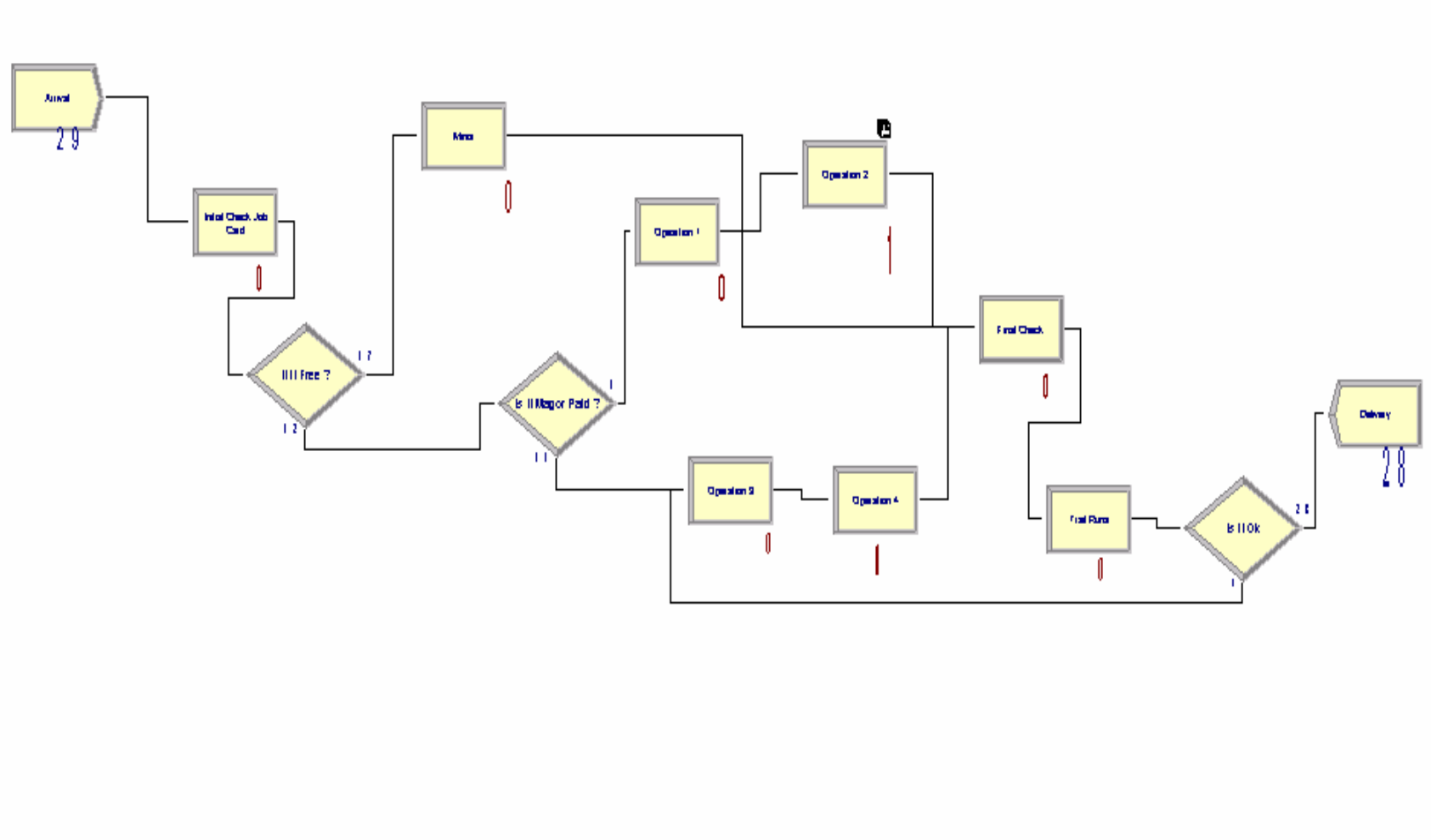


Figure 4: Simulation Model

The input data related to servicing times (shown in Table 3) of the activities are fed into the simulation model. The corresponding rates of free vehicles and the average major vehicle arrivals are changed for each set of data. The results obtained are shown in the below Figures 5 -12.

Each series indicates the following

Series 1: Average Total Service Time For The Delivered Vehicles

Series 2: Average Total Waiting Time of Delivered Vehicles

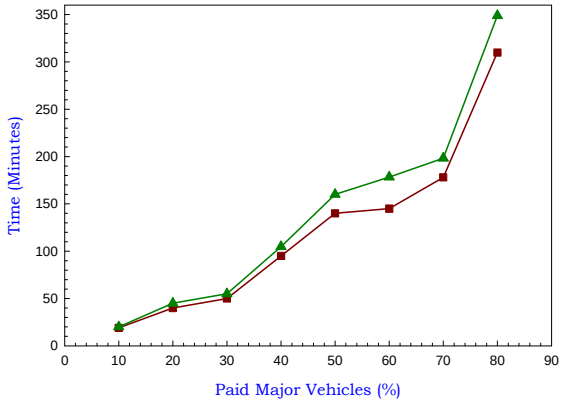


Figure 5. Service status (free 28%)

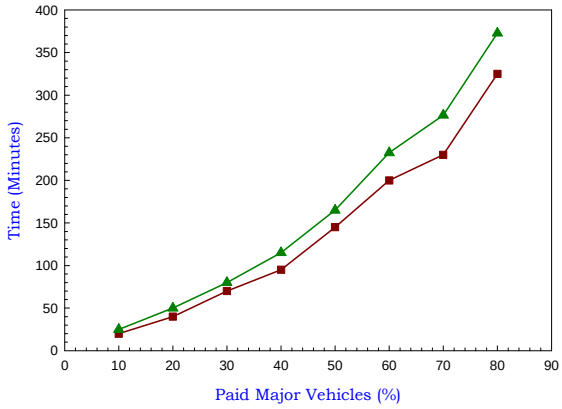


Figure 6. Service status (free 30%)

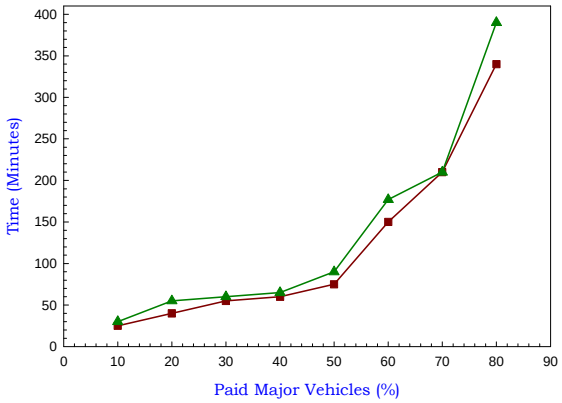


Figure 7. Service status (free 35%)

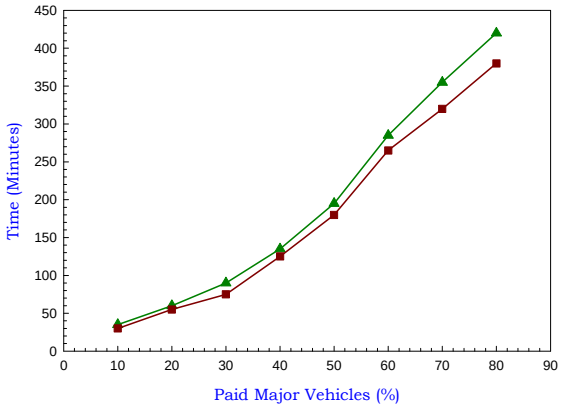


Figure 8. Service status (free 40%)

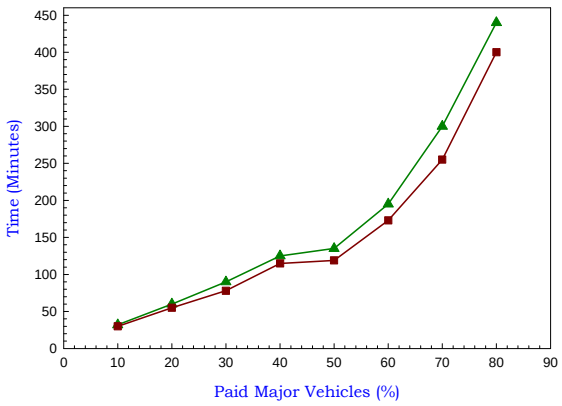


Figure 9. Service status (free 45%)

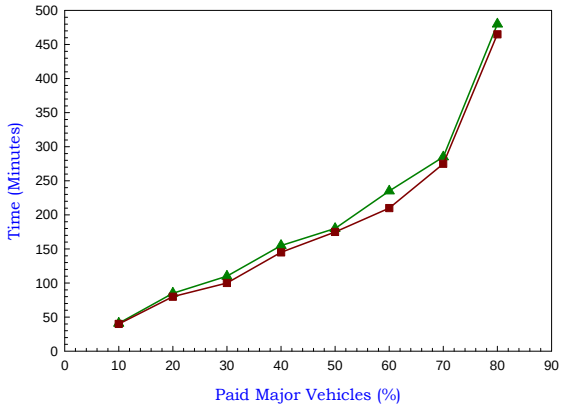


Figure 10. Service status (free 60%)

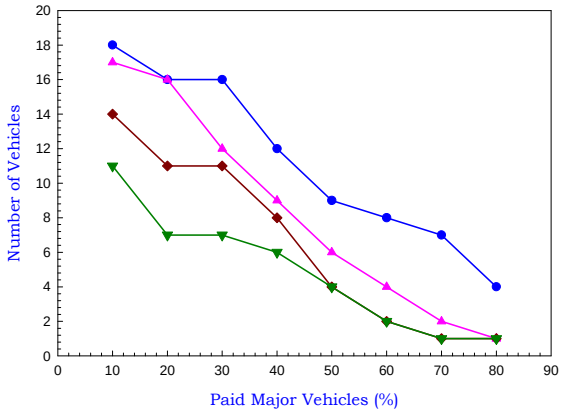


Figure 11. Delivery trend for Various % of free services

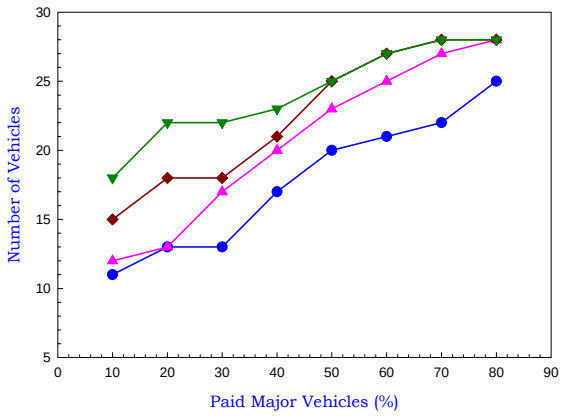


Figure 12. Waiting Trend for Various % of free services

For an average vehicle arrival rate 29 per day in a service centre, the number vehicles left in the servicing center at various stages and delivered are shown in the Table 4

Table 4: Number of Vehicles Waiting for Service (for 30% free service)

Vehicle Arrival Rate	Paid Major % in Arrival	Waiting for service		Vehicles delivered
		Operation 1	Operation 2	
29	10	0	3	26
29	20	0	5	24
29	30	0	7	22
29	40	0	8	21
29	50	0	11	18
29	60	0	12	17
29	70	0	15	14
29	80	0	18	11

5 Conclusions

In this paper, servicing activities carried out in a 4-wheeler service centers have been studied through a questionnaire survey. To understand the bottleneck operations and to improve the service rate, a discrete event simulation model has been developed. The conclusions drawn from the results are

1) In service centers as and when the sales increase, the number of vehicles arriving for the service generally increases. As this number increases the rate of delivery of vehicles are decreasing. Hence the capacity of the vehicle to be delivered is shown in a declining trend.
2) The results depicts that operation 2 is the bottleneck for the delivery of the vehicle. Most of the vehicles are getting delayed at operations 2.
3) In the group of operations 2 five activities are being carried out and hence, further study of these activities and related issues needs to be studied. An optimal sequencing of the activities may improve the delivery rate.

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