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A SIMULATION APPROACH FOR IMPROVING THE EFFICIENCY OF THE DEPARTMENT OF MOTOR VEHICLES

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ABSTRACT

Simulation as a primary tool was used to evaluate the effectiveness of the Santa Teresa Department of Motor Vehicles, California. The Department of Motor Vehicles was analyzed to determine improvement methods that would curtail the long customer lines or queues that are prevalent. A 2^3 factorial experimental design was performed to improve overall system effectiveness as measured by time in the system. With the above tools, a more efficient model of the Santa Teresa Department of Motor Vehicles was developed and proposed. This paper describes the developed model used and provides details on the analysis performed.

1 INTRODUCTION

Anyone who has been to any Department of Motor Vehicles branch would certainly know about the inconvenience of waiting in the queues for an incredibly long time regardless of the requested service. In fact, it is not uncommon for people to budget the entire morning or afternoon of their time to complete a successful trip at the Department of Motor Vehicles. It is due to this inefficiency that prompted this study (Senkandwa 1998).

In order to reduce the waiting time at the DMV, simulation was chosen as the method of analysis because it easily lends itself to incorporating the complexity of the relationships between system components (Banks et al. 1996). Furthermore, a 2^3 factorial experiment (Box et al. 1978) was performed to test the sensitivity of time spent at the DMV to the following factors: interarrival time, number of servers, and service time.

2 SYSTEM DESCRIPTION

Figure 1 illustrates the DMV system. After entering the DMV system, customers may seek help at the information desk. While they are in the Department of Motor Vehicles, they have different avenues or courses of action to choose

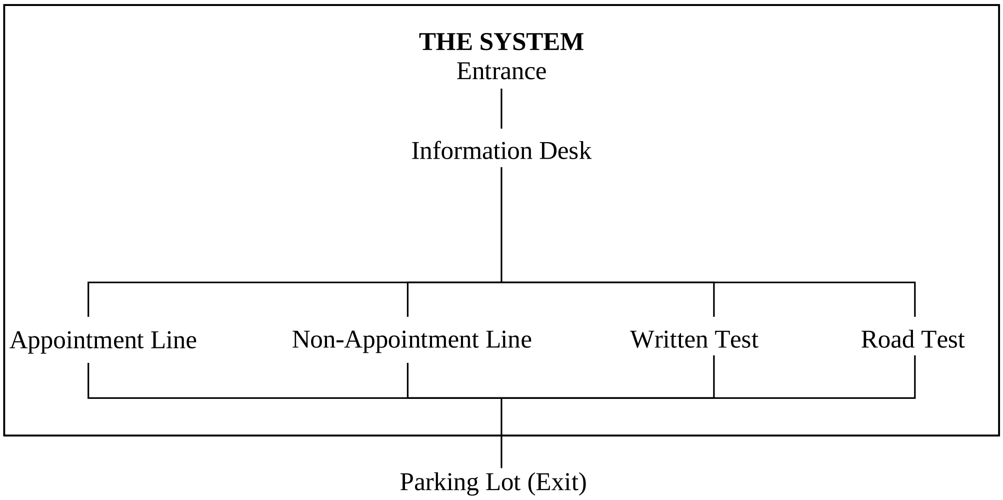

Figure 1: The DMV System

from. They could either go to the Appointment Line, Non-Appointment Line, Vehicle Registration Line, or the Driver License Line. They then exit the system via the Parking Lot.

Appointment Line – The appointment line covers vehicle registration needs and written driver license tests only for customers who have made appointments with the DMV prior to their arrival.

Non-appointment Line – Includes vehicle registration and transfer of car titles.

Written Test – Includes taking written driver license tests, obtaining California Identification Cards, and renewing driver licenses for non-appointments.

Road Test (By appointment only**)** – Driver license road tests include vehicles for commercial license, motorcycle licenses, special drive test for disability accommodations.

The following routing percentages were observed at each location:

Appointment Line	5%
Non-appointment line	50%
Written Test	30%
Road Test	15%

3 MODEL DESIGN

The model of the Department of Motor Vehicles was built using the simulation language PROMODEL (1996). PROMODEL provides a visual representation of the various physical components of the systems and links them through routing and processing statements. The following is a discussion of the concepts that were relevant for this system design:

Entity:

Customers

Locations:

Queue_1: The first incoming line of all DMV entrants.
Window_1: The initial desk where you get information on where you should go.
Pickup_Forms: Where customers get to fill out forms based on their needs.
Line1: Where customers wait for road tests.
Line2: Where customers wait for written tests.
Line3: Where customers wait if they made appointments.
Line 4: Where customers wait for non-appointments
Windows 3-5,7: Non-appointment lines.
Windows 6: Driver license road test.
Window 8-10: For written test, IDs, and renewals.
Window_2: Appointment line
Manager's Desk: Where clerks(customer server) go to talk to manager or take breaks.
Parking Lot: Where all customers exit the system.

Resources:

Customer_server 1: Person at "Start Here" initial window.
Customer_server 2 - Person at appointment line
Customer_server 3-5,7: People at counters for non-appointment line.
Customer_server 6: People at counters for the road test.
Customer_server 8-10: Person at counter for written test, IDs, and renewals.

Downtimes:

The following downtimes were accounted for: a one hour lunch break and two fifteen minute breaks.

Processing (Routing):

When customers enter the system, they all proceed to the "Start Here" window. After leaving the "Start Here" window, they go and pick-up the necessary or specific form/s they need to fill out. After picking up that form, there are only four possible locations to go to afterwards; 50 percent go to the non-appointment line, 5 percent go the appointment line, 15 percent go the road test, and 30 percent go the written test, Ids and renewals line. At the non-appointment line and the written test line, they wait for the next available counter. At the other locations, one service person is behind the counter. At all these service locations, after receiving their services, they exit the DMV and head for the parking lot.

Arrivals:

The Chi-Square Goodness of Fit Test verified the assumptions of exponential interarrival times. The interarrival time was 1.4 minutes.

Service Time:

To determine the service time at the window counters, data from the real system was observed. The Stat-Fit function in ProModel was then used to find the distribution for the service time. The data followed a lognormal distribution with an average of about 8 minutes and a standard deviation of about 3 minutes. In the processing, this was modeled at each service counter as "wait L(8,3)."

The assumptions of the study were as follows:

- With the real system, reneging occurs when customers enter the system and leave without receiving the services that brought them, due to long line, forgetting certain documents, etc. It was almost impossible to model this in our system since identifying a person who has left due to reneging or after receiving their services is hard to identify. This model assumes that there is no reneging.

- When two people entered the system who came from the same car , it was assumed that both (even three or four) were each entering the system to receive individual services from the DMV as opposed to merely escorting the one person. In this case, it was just impossible to identify whether both needed individual services or if one party was escorting the other. This would have required close monitoring of every couple and waiting to see what actually happened when they got to the service counter
- The DMV employees behind the counters were assumed to all work at the same pace. This assumes that they all have the same training despite the number of years on the job. Thus, the DMV employees in the model have the same service distribution.

4 EXPERIMENTATION

Table 1 shows the results of the simulation for the as-is case and the proposed case. With the current system the average time a customer spends at the DMV is 72.24 minutes with a standard deviation of 8.43. The proposed model reduces the time spent in the system to 14.61 minutes with a standard deviation of 1.35 minutes.

The second proposed model takes into account three modifications to the base case:

i) Increasing the number of customer servers from 7 to 10.
ii) Reducing the service time from L(8,3) to L(5,1)
iii) Increasing the interarrival time from E(1.4) to E(2)

Moving from 7 to 10 servers would be a change that could be accommodated by the space limitations of the building considering the extra computer equipment and space that would be needed. Going beyond 10 servers would likely demand expanding the building which would induce an incredible financial cost. With the service times, an improvement of 8 minutes to 5 minutes is something that would also be reasonable taking additional training into consideration. Otherwise, more improvement would suggest that workers work half as fast as they are capable of doing which is very unlikely. With the arrival rate, the as-is case has about 40 customers per hour coming in. The proposed case has about 30 customers per hour. Once again, this decrease in 10 per hour is what the DMV would likely be able to do by moving people into the appointment line without disrupting the people who have made appointments. What this does in essence is decrease the interarrival time in the non-appointment line.

After these recommendations were carried out in the proposed model, a notable improvement was noticed in the average waiting time in the non-appointment line. The average time in the system decreased from 72.24 minutes to 14.61 minutes. This constitutes an improvement of about 79.78% in just the average time in the DMV system. If we were to strictly look at the reduction in average time in the non-appointment line, the improvement percentage-wise would be greater than the above improvement in the overall system.

To analyze which factor contributed the most to the improvement in the system design, a 2^3 factorial experiment was performed. Table 2 shows the factors and their corresponding experimental values. The response variable of interest for this project is the average time spent in the DMV.

Table 3 illustrates the standard form of a design matrix for a 2^3 design and the values for the estimated effects. The columns corresponding to the various interactions are obtained by multiplying the signs for the factors contained in the interactions. Each of the effects is estimated by adding or subtracting the value of the response variable (average time in DMV system), depending on whether the sign of the appropriate column is a plus or minus.

Figure 2 shows a dot diagram of the effects. Effects clustered near zero on the diagram cannot be distinguished from variation due to nuisance variables. It is clear from Figure 2 and Table 3 that increasing the number of servers to ten has the biggest impact on reducing the time spent in the DMV, followed by a reduction in the service time.

Table 1: Results from Simulation

Model	Avg Time in DMV	Standard Deviation
As-is	72.24 Minutes	8.43 minutes
Proposed	14.61 Minutes	1.35 minutes

Table 2: Factors and Their Levels

Factors under Study	Levels	
# of Customer Servers	7 (-)	10 (+)
Service Time	L(8,3) (-)	L(5,1) (+)
Interarrival Time	E(1.4) (-)	E(2) (+)

Table 3: Design Matrix for Computation of Effects from DMV system

Test	Run Order	CS	SR	AR	CSSR	CSAR	SRAR	CSSRAR	Response
1	4	-	-	-	+	+	+	-	72.24
2	5	+	-	-	-	-	+	+	26.75
3	2	-	+	-	-	+	-	+	33.72
4	8	+	+	-	+	-	-	-	16.45
5	3	-	-	+	+	-	-	+	44.20
6	7	+	-	+	-	+	-	-	19.21
7	1	-	+	+	-	-	+	-	17.33
8	6	+	+	+	+	+	+	+	14.61
Effect		-22.62	-20.07	-13.45	12.62	8.76	4.34	-1.49	

CS – # of Customer Servers
SR – Service Time
AR – Interarrival Time

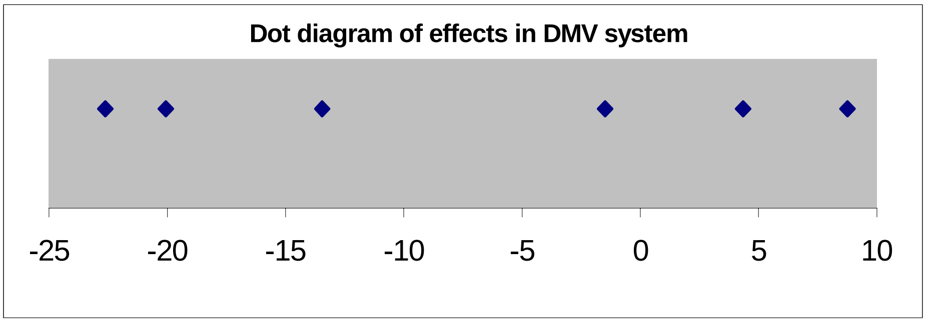

Figure 2: Dot Diagram of Effects of DMV System

5 CONCLUSION

Computer simulation was used successfully to assist in the development of a proposal to reduce the spent in the Department of Motor Vehicles. Statistical output from the designed model ascertained that an improvement over the current scenario exists. The recommended arrangement decreased the average time in the Department of Motor Vehicles from 72.24 minutes to 14.61 minutes. This is a 79.78% improvement at the Santa Teresa Department of Motor Vehicles. The sensitivity analysis or design of experiment techniques were also very helpful in our analysis of the DMV model. For the purposed changes, the analysis showed that increasing the number of servers behind the counters has the greatest effect on reducing the time spent in the DMV, followed by service rate of the people behind the counters, and finally by the interarrival rate of the customers.

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