Using Discrete Event Simulation to Analyze Pricing Strategies for Same-Location Car Rentals

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Objective

- The key objective of this research is to analyze and understand the effects of employing dynamic pricing strategies for same-location and different-location car rentals at a rental company.

- Specifically, the researchers aim to study pricing policies involving:
  1) Discounts offered to customers for rentals where the pick-up and drop-off location are the same place.
  2) Price increases applied to rentals where the pick-up and drop-off locations differ.

- The main goal is to identify optimized combinations of same-location discounts and different-location price increases in order to maximize total revenue for a car rental company.

Resources

The paper utilized several key resources to develop the discrete event simulation model.

1. **Discrete event simulation model**
   - Created using ExtendSim software.

2. **Interviews with industry experts**
   - Provided real-world input to establish model requirements.

3. **Car rental demand data**
   - Based on actual rental company information from Saudi Arabia
   - Captures real-world customer arrival patterns

4. **Pricing scenarios**
   - 195 experimental simulations testing different combinations of:
   - Discounts for same-location rentals
   - Price increases for different-location rentals.

Modelling

- A discrete event simulation model was developed using ExtendSim to represent the complex operations of a car rental network.

- **The model incorporates:**
  1. Multiple rental locations (at least 15 branches)
  2. 5 vehicle classes (categories)
  3. Customer types:
     a. Walk-in rentals
     b. Reservations

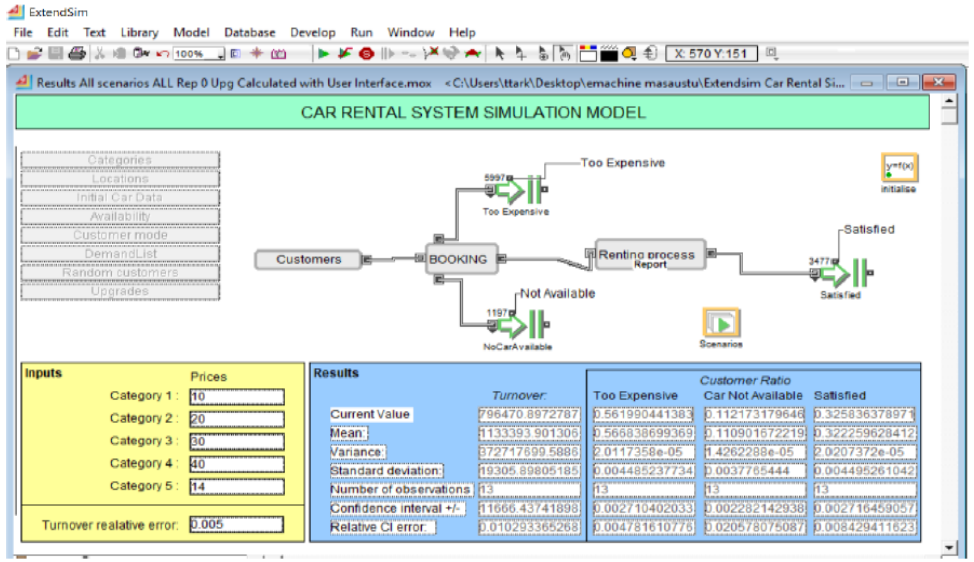
- **Key rental parameters modeled probabilistically:**
  1. Customer arrival times (exponential distribution)
  2. Rental duration (empirical distribution)
  3. Time between reservation and pickup
  4. Vehicle class preference
  5. Pick-up and drop-off location preferences (see table)

Location Code	Pick-up probability
1	0.0429
2	0.0613
3	0.0919
4	0.0153
5	0.0245
6	0.0306
7	0.0613
8	0.0140
9	0.0208
10	0.0340
11	0.0459
12	0.1532
13	0.1838
14	0.1225
15	0.0980

Customer arrival probabilities to each pick-up location of car rental company.

Simulation:

- **Pricing strategies implemented by:**
  - Adjusting rental fees in different simulation scenarios
  - Applying discounts for same-spot rentals
  - Increasing prices for different-location rentals
- **Outputs:**
  - Total rental revenue
  - Customer satisfaction
  - Percentage of Unavailable cars
  - Percentage Budget exceeded



Car rental system simulation model interface.

- The model captures the random and dynamic nature of demands and operations. By flexibly implementing different pricing policies, their impact could be reliably evaluated. This enabled finding revenue-maximizing discount and price increase levels.

Results

- The table-2 presents the results of various scenarios, ordered by revenue, where different discount percentages are offered for same-location rentals.
- The findings indicate that offering a 5% discount for same-location rentals results in the highest revenue, yielding $1,404,416, which is 1.6% higher than the scenario with no discount.
- However, it is important to note that additional discounts result in lower revenue for the company.

Table 2: Results (ordered by revenue) when discounts are introduced for same-location rentals.

Scenario	Same-Location Discount	Increase for Different Locations	Revenue	Too Expensive	Unavailable	Satisfied
Baseline 1	0	0	$1,381,945	0.636	0.238	0.126
16	**5**	**0**	**$1,404,416**	**0.629**	**0.241**	**0.130**
31	10	0	$1,395,115	0.620	0.247	0.132
46	15	0	$1,374,876	0.612	0.254	0.134
61	20	0	$1,365,784	0.601	0.262	0.136
76	25	0	$1,346,902	0.592	0.269	0.140
91	30	0	$1,328,862	0.582	0.276	0.142
106	35	0	$1,301,543	0.570	0.285	0.145
121	40	0	$1,288,734	0.560	0.292	0.149
136	45	0	$1,250,919	0.547	0.303	0.150
151	50	0	$1,228,162	0.535	0.310	0.154
166	55	0	$1,182,858	0.521	0.322	0.157
181	60	0	$1,157,840	0.506	0.331	0.162

- The baseline scenario (Scenario 1) represents the revenue without any price increase for different-location rentals.
- The results show that introducing a 150% to 200% price increase for different-location rentals leads to the highest revenues.
- For example, Scenario 10, with a 150% price increase, results in a revenue of $1,695,284, which is the highest among the scenarios. This represents a revenue increase of 22.7% compared to the baseline scenario.

Table 3: Results when price increases are introduced for different-location rentals.

Scenario	Same-Location Discount	Increase for Different Locations	Revenue	Too Expensive	Unavailable	Satisfied
Baseline 1	0	0	$1,381,945	0.636	0.238	0.126
2	0	5	$1,423,105	0.647	0.228	0.125
3	0	10	$1,461,308	0.657	0.217	0.125
4	0	20	$1,496,372	0.676	0.202	0.122
5	0	30	$1,545,204	0.691	0.187	0.121
6	0	40	$1,572,883	0.707	0.174	0.119
7	0	50	$1,559,218	0.723	0.160	0.116
8	0	75	$1,622,024	0.748	0.139	0.113
9	0	100	$1,670,148	0.770	0.118	0.113
10	**0**	**150**	**$1,695,284**	**0.801**	**0.087**	**0.113**
11	0	200	$1,693,955	0.819	0.067	0.114
12	0	250	$1,650,656	0.832	0.052	0.116
13	0	300	$1,592,085	0.838	0.044	0.118

Inferences

- The discrete event simulation method used is flexible for modeling complex rental systems and experiments showed it can provide useful insights for increasing revenues.
- Offering a small discount (5%) for same-location rentals (pickup and drop-off at the same place) can increase revenue compared to no discount. But larger discounts reduce revenue.
- Increasing prices significantly (150-200%) for different-location rentals (picking up at one location and dropping off elsewhere) can increase revenue substantially (over 20% in the study). This works due to high imbalance between pickup and drop-off locations.
- Simulation model allows testing pricing strategies with historiacal demand company data to find optimal dynamic pricing policies.

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