Decision making for Profit optimization at Bharat Bazar

A project report submitted in fulfilment of the requirement for the

BAN 630 – Optimization Methods for Analytics

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Abstract

This research addresses the problem of Bharat Bazar of insufficient deliveries under Pandemic. We are motivated by a problem that arises due to COVID-19 where the deliveries are preferable over in-store shopping which should be considered. Bharat Bazar was one of the grocery stores which was facing problems in providing timely deliveries to the customers and this resulted in loss of customers and profit. The main objective of this study was to provide an optimal solution through prescriptive analysis by using a decision tree. So, a model was formulated based on the collected data i.e., total fixed cost of vehicles, probabilities of high, moderate and low demand, average number of orders delivered per year in each demand and annual revenue. A decision tree was made based on the four decisions , those were to buy a new vehicle, buy an old vehicle, third-party vehicle and curbside pick-up based on the estimated values. Based on this decision tree, an optimal decision tree and risk profile was made. Sensitivity analysis of different parameters was done to check the variations in the result and decision. We performed a one- way analysis for the probability of moderate demand, fixed cost of vehicle and average number of orders in high demand by new vehicle. Two-way sensitivity analysis is performed for the variation in average number of orders delivered by used vehicle, average number of orders delivered by third party vehicle, average number of orders delivered by new vehicle during high demand and the probability of high demand. This research concludes that the optimal solution is to buy a new vehicle which gives better payoffs compared to other decisions in any of the possible demands.

1. Introduction

1.1. Company

Bharat Bazar is one of the famous South Asian grocery stores in the Bay Area. It was established in 1974 by Hira and Veena Birla with the mission of making South Asian ingredients more readily available. It was first opened in Santa Clara in a modest 2,000 square foot location. At present, there are six different stores located in Sunnyvale, Fremont, Milpitas, San Jose, Union City and Palo Alto, a place where all the South Asian population in the Bay area could easily find the authentic ingredients they need. The annual returns of the store vary from $75,000 to $2.0 million at different locations. The main business activity for these stores is the selling of grocery and daily need items. The daily profit depends on the number of sales of different items each day. Hence, the aim of this research is to maximize the profit gained by the store by selling the items.

1.2. Problem

The current worldwide outbreak has left many shopping stores at loss due to the spread of the disease. Bharat Bazar is one amongst them. People are more concerned about their health and taking precautions against COVID-19, preferring grocery delivery and other essentials over in-store shopping. The sudden change of shopping pattern put Bharat Bazar in an unpleasant state, causing poor quality delivery due to the unavailability of vehicles at the time of delivery. Eventually, dropping daily sales profit by losing customers. As Bharat Bazar is privately owned, it has many resource constraints associated with the labors and vehicle availability. So, our data analyst team decided to aid Bharat Bazar through this problematic state by proposing an appropriate solution as described below. After thorough research and suggestion, necessary best actions are required to be taken by the owners of Bharat Bazar for betterment and productive results.

1.3. Proposed Solution

After a keen study and observation of circumstances faced by Bharat Bazar, our data analyst team decided to provide an optimal solution through decision tree analysis. We recommended either buying a vehicle or seeking another alternative that improved profit gained by the deliveries which persuaded us to build an optimization model of decision tree with four decisions: buying a new vehicle, buying an old vehicle, third-party vehicle and curbside pick-up. This eventually led our team to proceed with data collection and model formulation and enabled us to present an optimal solution to the owner of Bharat Bazar.

2. Literature Review

A decision tree enables a decision maker to view all important aspects of the problem at once: the decision alternatives, the uncertain outcomes and their probabilities, the economic consequences, and the chronological order of events. Many examples of decision making under uncertainty exist in the business world, like bidding for contracts, introduction of new projects, Investment in any fund, etc. Likewise, Bayney and his colleagues while employed at a major Biopharmaceutical company facing a choice between competing product investment strategies, used Palisade's Precision Tree software to construct a multi-phase decision tree to bring clarity to the analysis and help facilitate a complex decision (Bayney R., 2010). Therefore, decision tree helps in making decisions under uncertainty. In previous research, Unilever which is one of the world's largest suppliers of fast-moving consumer goods in the refreshment, foods, home, and personal care sectors used decision tree tools for making decisions on innovation. This prevents opportunities and threats being overlooked and increases Unilever's agility in the marketplace by having the knowledge to make informed and high-quality choices (Evans A.).

3. Main Chapter

3.1. Data Collection

Based on the facts and statistics provided by the top management team of Bharat Bazaar, we accumulated the estimated data for fixed cost incurred by the grocery delivery transportation vehicles. So, the estimated fixed costs incurred by the usage of new vehicle, used vehicle and third-party vehicle would be $49,000, $25,000 and $20,000 respectively. The estimated average price per order delivered by a new vehicle, a used vehicle, third party vehicle and curbside pickup would be $95.75, $95.75, $95.75 and $46.50 respectively. Bharat bazar has set a minimum limit of grocery purchase as $50 to offer the door delivery service for the customer. And there is no such minimum purchase limit if the customer chooses curb-side pickup.

If the delivery happened at high demand(chance of 0.5), the estimated average number of grocery delivery orders per year, under pandemic for a new vehicle would be 20,000, an used vehicle would be 15,000, a third party vehicle would be 17,500 and curbside pickup is 11,000. If the delivery happened in case of moderate demand (chance of 0.4) the average number of grocery delivery orders per year estimated for new vehicle would be 15,000, a used vehicle would be 10,000, third party vehicle would be 12,500 and curbside pickup would be 6,000. And if the delivery happened, in the event of low demand (chance of 0.1) the average number of grocery delivery orders per year estimated for a new vehicle would be 10,000, an used vehicle would be 5000, a third party vehicle would be 7,500 and curbside pickup would be 1,000.

3.2. Data Analysis

This concluded and derived the earnings of Bharat Bazaar on various states and occurrences. The earnings were calculated by the product of average price per order and average number of orders per year in every possible situation. During high demand (chance of 0.5), the expected annual revenue by new vehicle, used vehicle, third party vehicle and curbside pickup would be $1,915,000, $1,436,250, $1,675,625 and $511,500 respectively. During moderate demand (chance of 0.4), the estimated revenue by new vehicle, used vehicle, third party vehicle and curbside pickup would be $1,436,250, $957,500, $1,196,875 and $279,000 respectively. During low demand (chance of 0.1), the estimated revenue by new vehicle, used vehicle, third party vehicle and curbside pickup would be $957,500, $478,750, $718,125 and $46,500 respectively.

3.3. Additional Data

However, after a series of conferences with the management council for reviewing additional expenses for maintenance and repair for new and used vehicles and wages for curbside pickup employees, we gathered the extra expected expenditure and anticipated the total fixed costs. The estimated maintenance and repair cost would be $380 for a new vehicle and $4500 for a used vehicle and the cost of additional labor required for curbside pickup would be $8,000. So, the estimated total fixed costs for new vehicle, used vehicle, third party vehicle and curbside pickup would be $49380, $29500, $20,000 and $8000 respectively.

3.4. Optimization Model

INPUT:

Grocery Delivery under pandemic condition					
Decisions and inputs	Fixed Cost (in $)	Maintenance and repair cost (in $)	Labour Cost (in $)	Total cost(in $)	Average Price/order, $
New vehicle	49000	380		49380	95.75
Used vehicle	25000	4500		29500	95.75
Third Party vehicle	20000			20000	95.75
Curbside Pickup	0	0	8000	8000	46.50

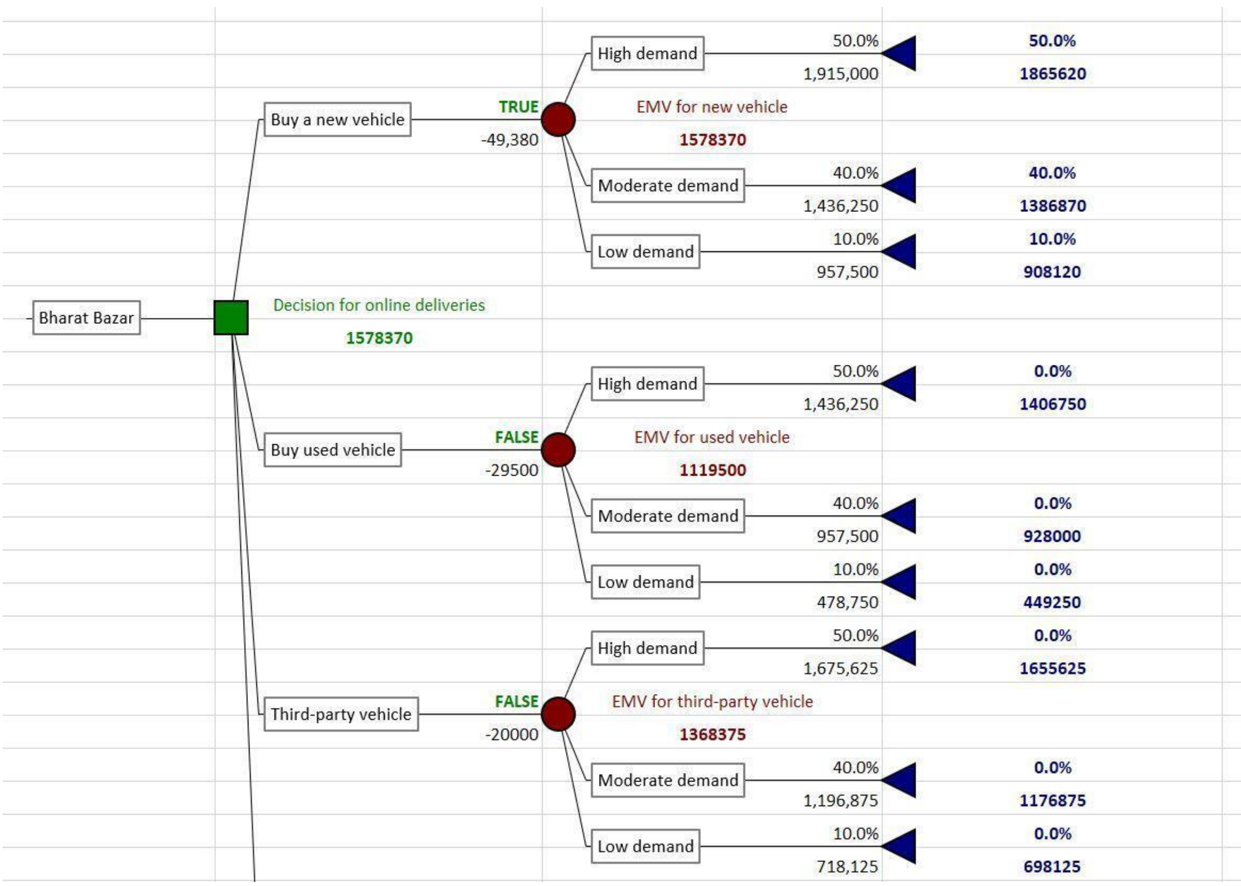
Outcomes	High Demand	Moderate Demand	Low Demand
Probabilities	0.5	0.4	0.1
Average Number of orders per year			
New Vehicle	20000	15000	10000
Used Vehicle	15000	10000	5000
Third Party Vehicle	17500	12500	7500
Curb side Pickup	11000	6000	1000

Decisions	Revenue		
	High Demand	Moderate Demand	Low Demand
New vehicle	1,915,000	1,436,250	957,500
Used vehicle	1,436,250	957,500	478,750
Third Party vehicle	1,675,625	1,196,875	718,125
Curbside pick-up	511,500	279,000	46,500

Figure 1: Inputs gathered from data collection and analysis

The table (**Figure1**) summarizes the inputs collected from the data collection and analysis phase. The inputs are used to build the decision tree model that include various decisions considered by Bharat Bazaar to handle the uncertainty in demand of online orders during pandemic at high, moderate, and low probability. The revenues for each of the demands (high,moderate,low) are calculated based on the forecasted average number of orders per year and the average price per order.

DECISION TREE:



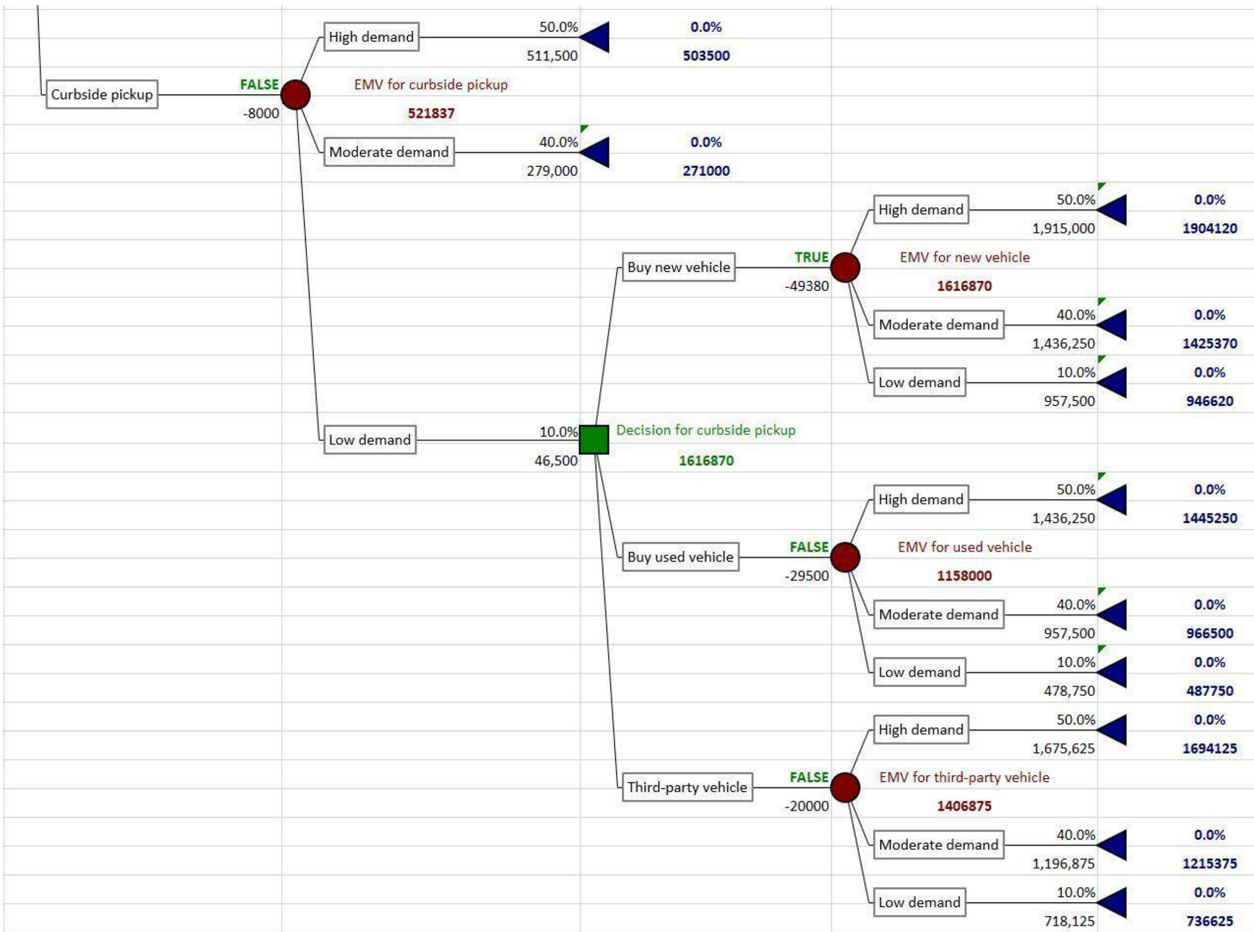


Figure 2: Decision tree for Bharat Bazaar using Precision Tree

Based on the values from the input table, the above decision tree(**Figure 2**) has been constructed utilizing the **Precision Tree** decision analysis tool. The decision tree evaluates the decisions and the demand uncertainties for Bharat Bazaar. It has four input decisions : Buy new vehicle, buy used vehicle, Third-party vehicle and Curbside pickup. The demand uncertainties are represented as chance nodes with the probability of 0.5 for high demand, 0.4 for moderate demand and (1- (0.5+0.4) = 0.1) for low demand.

The decision tree computes the expected values for each of the decisions as below:

Decision	Expected value(EMV)
Buy a new vehicle	1578370
Buy used vehicle	1119500
Third party vehicle	1368375
Curbside pickup	521837

Table 1

From (**Table 1**) it is noticed that buying a new vehicle has the highest payoff of $1578370 followed by third-party vehicle which has the next highest payoff of $1368375.

Since Bharat Bazaar intends to reconsider the other input decisions in case of low demand for curbside pickup, an additional secondary level of decision node has been added. This decision node considers re-exploring the options : buy a new vehicle, buy a used vehicle and use third-party vehicle. For each of these decisions the demand probabilities have been represented using chance nodes. Below are the computed expected values for this subtree :

Decision	Expected value(EMV)
Buy a new vehicle	1616870
Buy used vehicle	1158000
Third party vehicle	1406875

Table 2

Also, when there is a low demand for curbside pickup the best decision is to buy a new vehicle as it has the highest payoff of $1616870.

From the decision tree and the expected value tables (**Table 1 and Table 2**) it can be inferred that buying a store-owned vehicle is the best decision for Bharat Bazaar under all circumstances. The branches corresponding to buying a new vehicle are marked as TRUE in the decision tree.

3.5. Solution results and Analysis

3.5.1. Optimal decision tree

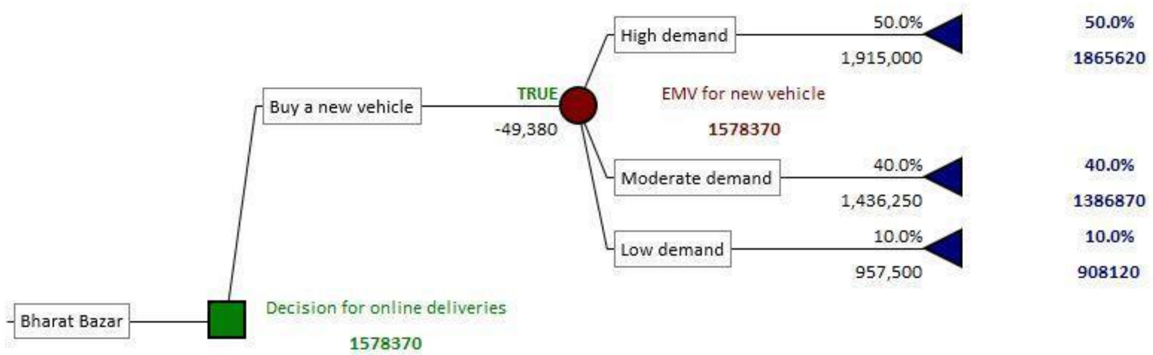


Figure 3: Optimal Decision tree

The optimal decision tree(**Figure 3**) depicts the best decision for handling online grocery orders during the pandemic for Bharat Bazaar. Buying a new vehicle (EMV = 1578370) is the optimal decision for the store. If there is a high volume (50% chance) of online orders, buying a new vehicle will fetch a payoff of $1865620. If the demand is moderate (40% chance) the payoff will be $1386870 and if the demand is low (10% chance) the payoff will be $908120. Utilizing the store-owned vehicle, Bharat Bazaar would be able to manage the online orders effectively.

3.5.2 Risk Profile

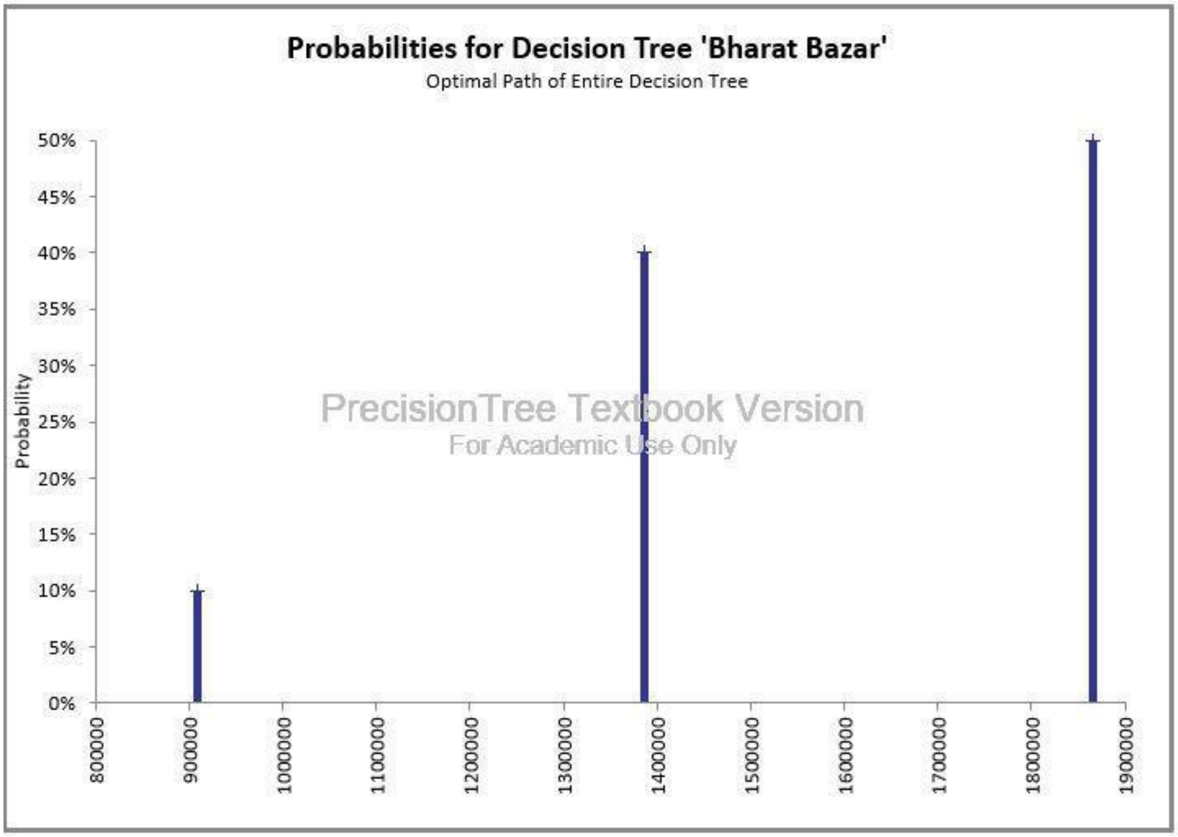


Chart Data		
	Optimal Path	
	Value	Probability
#1	908120	10.0000%
#2	1386870	40.0000%
#3	1865620	50.0000%

Figure 4: Probability chart using Risk Profile

From the risk profile chart(**Figure 4**) made for the optimal path of the decision tree, the following conclusions can be made:

(a) The probability chart for the optimal decision conveys all the payoffs are positive and will always produce revenue for the company.

(b) Probability of 10% will produce a payoff of $908120 when the demand is low and the store buys a new vehicle.

(c) With a probability of 40% the payoff will be $1386870 when the store buys a new vehicle and the demand is moderate .

(d) The payoff is highest with a value of $1865620 when the demand is high and the store purchases a new vehicle .There is a probability of 50% to get this payoff.

3.5.3 Precision Tree Sensitivity Analysis:

3.5.3.1 One-Way Analysis

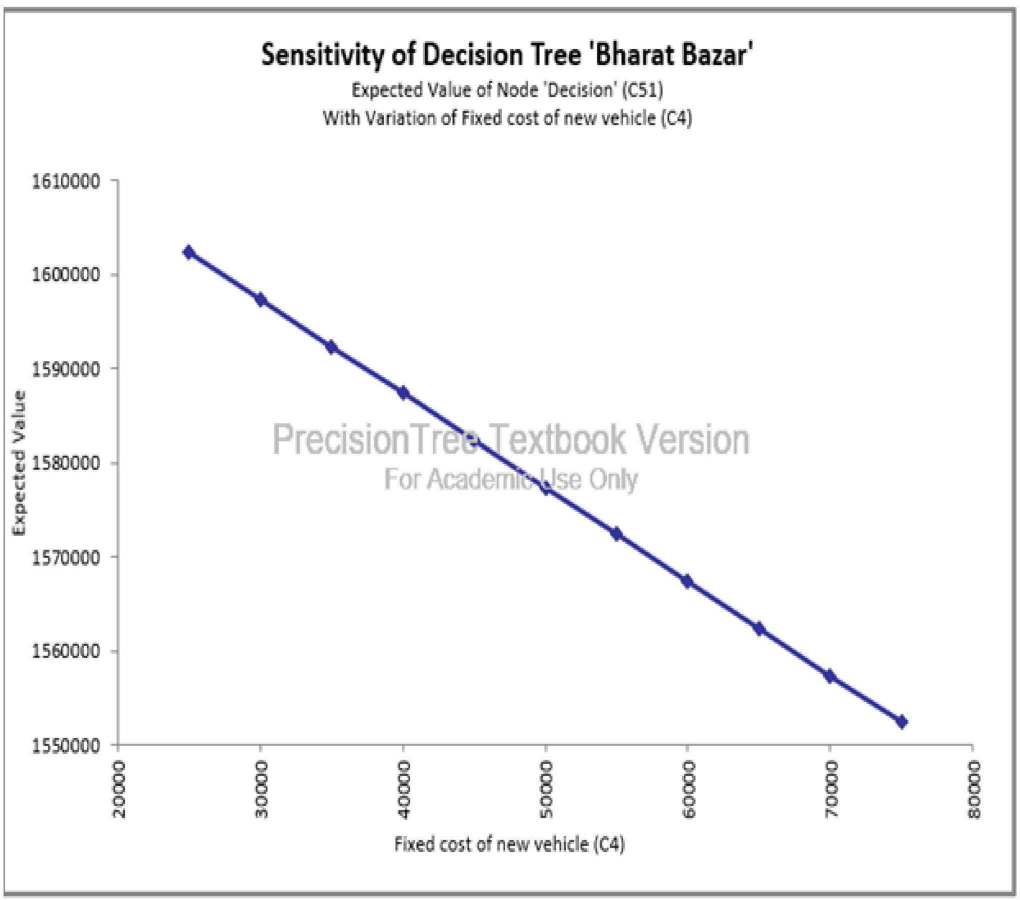


Figure 5: One-way sensitivity of Fixed cost of new vehicle

Using the Precision Tree One-way Sensitivity Analysis for our decision-making model, we observe the expected value (EMV) is sensitive to the fixed cost of a new vehicle. There is an inverse relation between the two, it decreases with increase in the cost (higher the cost of the vehicle, lower the EMV).

Specifically, as shown above in figure 5, one-way sensitivity for fixed cost of new vehicle(C4) from $20,000 to $80,000 with increment of $10,000, EMV is approx. $1,650,000 (highest) when the fixed cost is $25,000 and approx. $1,550,000(lowest) when fixed cost is $7,500.

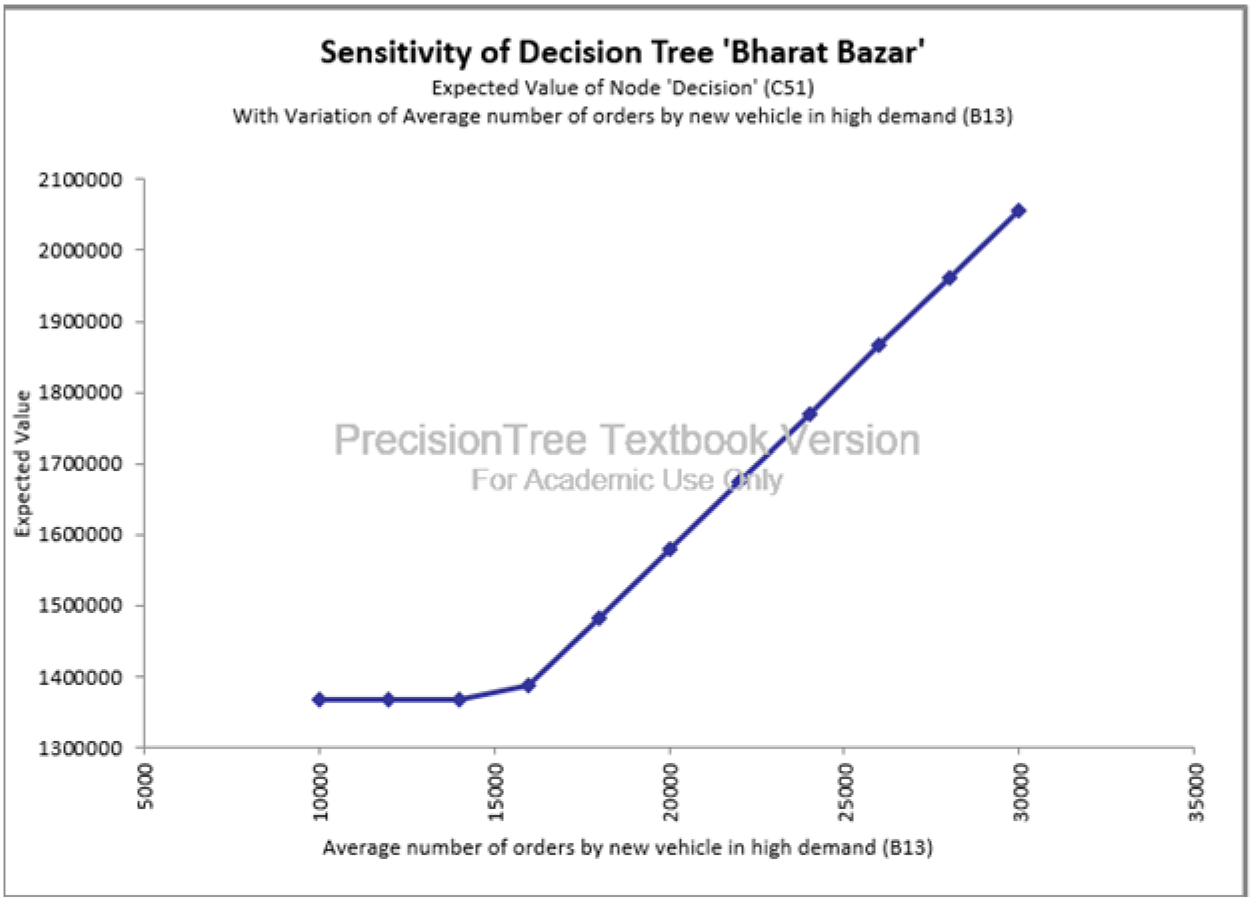


Figure 6: One-way sensitivity of Average number of orders for new vehicles in high demand

Using the Precision Tree One-way Sensitivity Analysis for our decision-making model, by varying the average number of orders for new vehicles in high demand, the expected value (EMV) is insensitive for lower values, however sensitive for higher range of values of average number of orders.

Specifically, as shown above in figure 6, one-way sensitivity for Average number of orders by new vehicle in high demand (B13) from 5000 units to 35,000 units with increment of 5,000 units. EMV is insensitive when the Average order is between 10,000 to 14,0000 approx. and later it increases as the number of orders increases. The EMV is highest at approx. $2,050,000 when the average number of orders by new vehicle in high demand is 30,000 units.

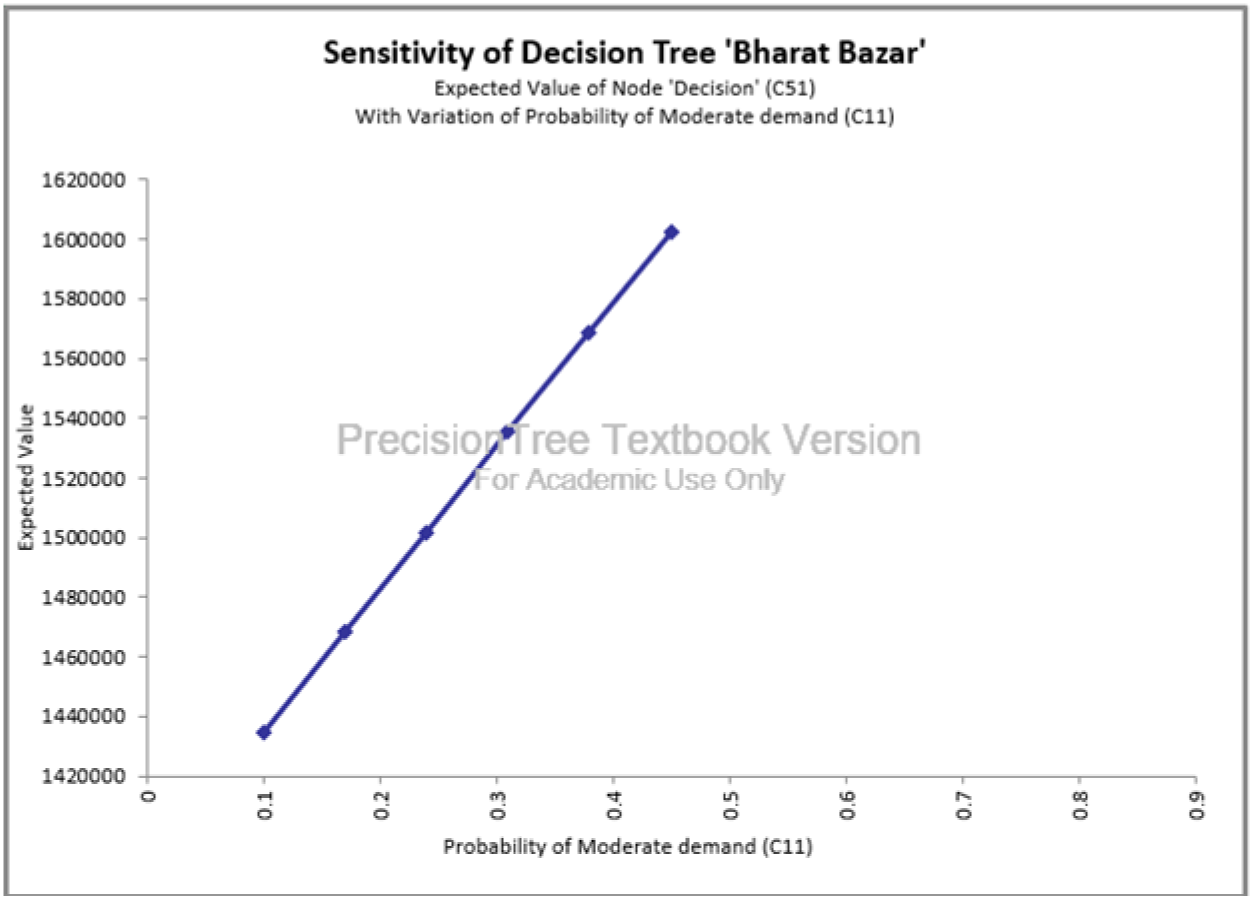


Figure 7: One-way sensitivity of Probability of moderate demand

Using the Precision Tree One-way Sensitivity Analysis for our decision-making model, by varying the probability of moderate demand, the expected value (EMV) is sensitive to the probability of moderate demand. There is a direct relation between the two.

Specifically, as shown above in figure 7, one-way sensitivity for probability of moderate demand (C11) from 0.1 to 0.9. The EMV is highest approx. $1,600,000 when the probability is 45% (0.45) and EMV lowest approx. $1,430000 when the probability is 10% (0.1).

Strategy Region Graphs:

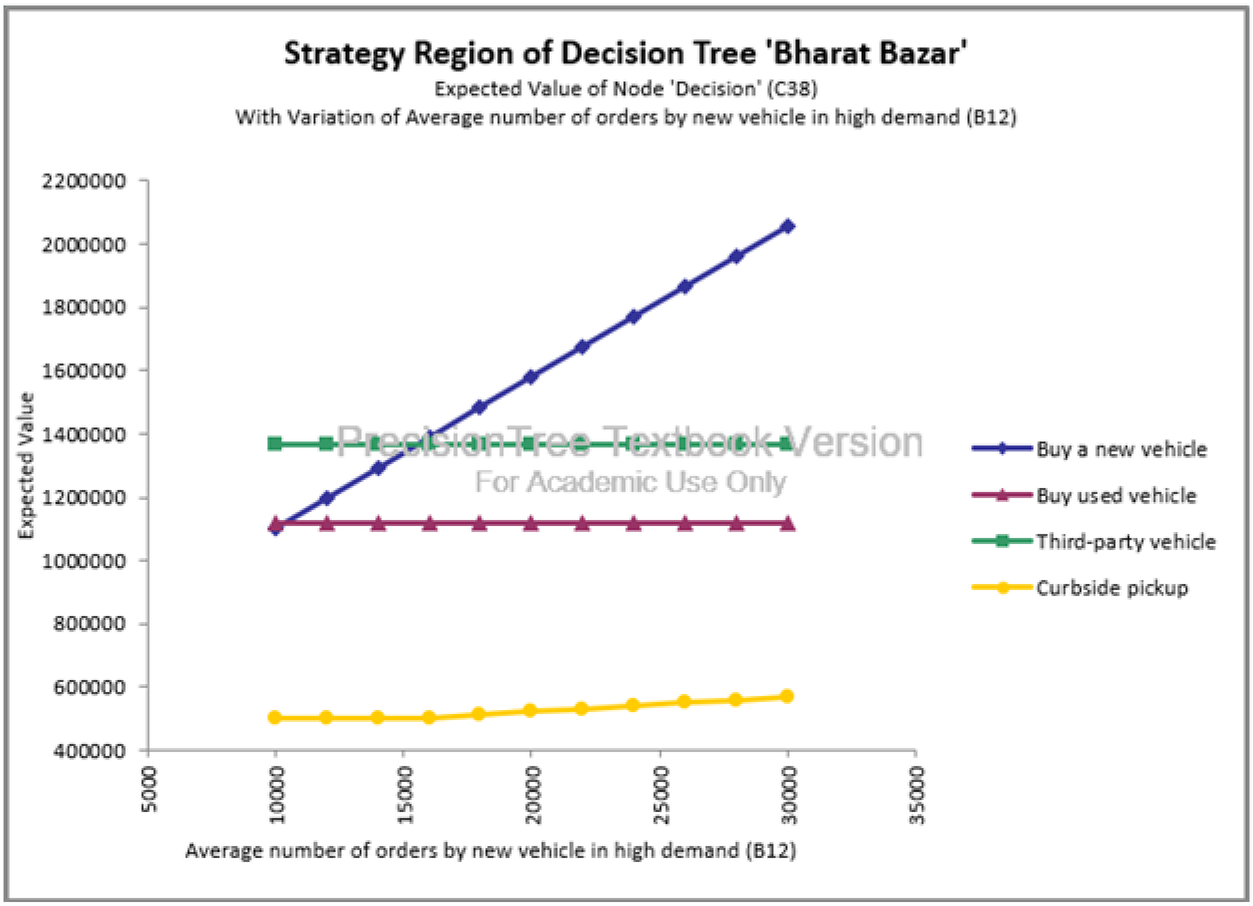


Figure 8: Strategy region graph of Average number of orders for new vehicles in high demand

In this strategy graph figure 8, for Average number of orders by new vehicle in high demand (vary between 5000-35,000 units), the optimal decision is to use third party vehicle when the average number of orders by new vehicle in high demand is between 10,000 to 15,500 units (approx.) and is to buy a new vehicle when for average number of orders by new vehicle in high demand is more than 15,500 units and less than 30,000 units. Therefore, the decision is sensitive to the change in Average number of orders by a new vehicle in high demand.

The EMV from buying the used vehicle and using a third-party vehicle is insensitive to the Average number of orders by a new vehicle in high demand.

The EMV from buying a new vehicle is sensitive to the Average number of orders by new vehicle in high demand and increases with increase in average number of orders.

The EMV from using curbside pick is insensitive when the Average number of orders by new vehicle in high demand is between 10,000 to16,000 approx. and is sensitive when demand is more than 16,000 and less than 30,000.

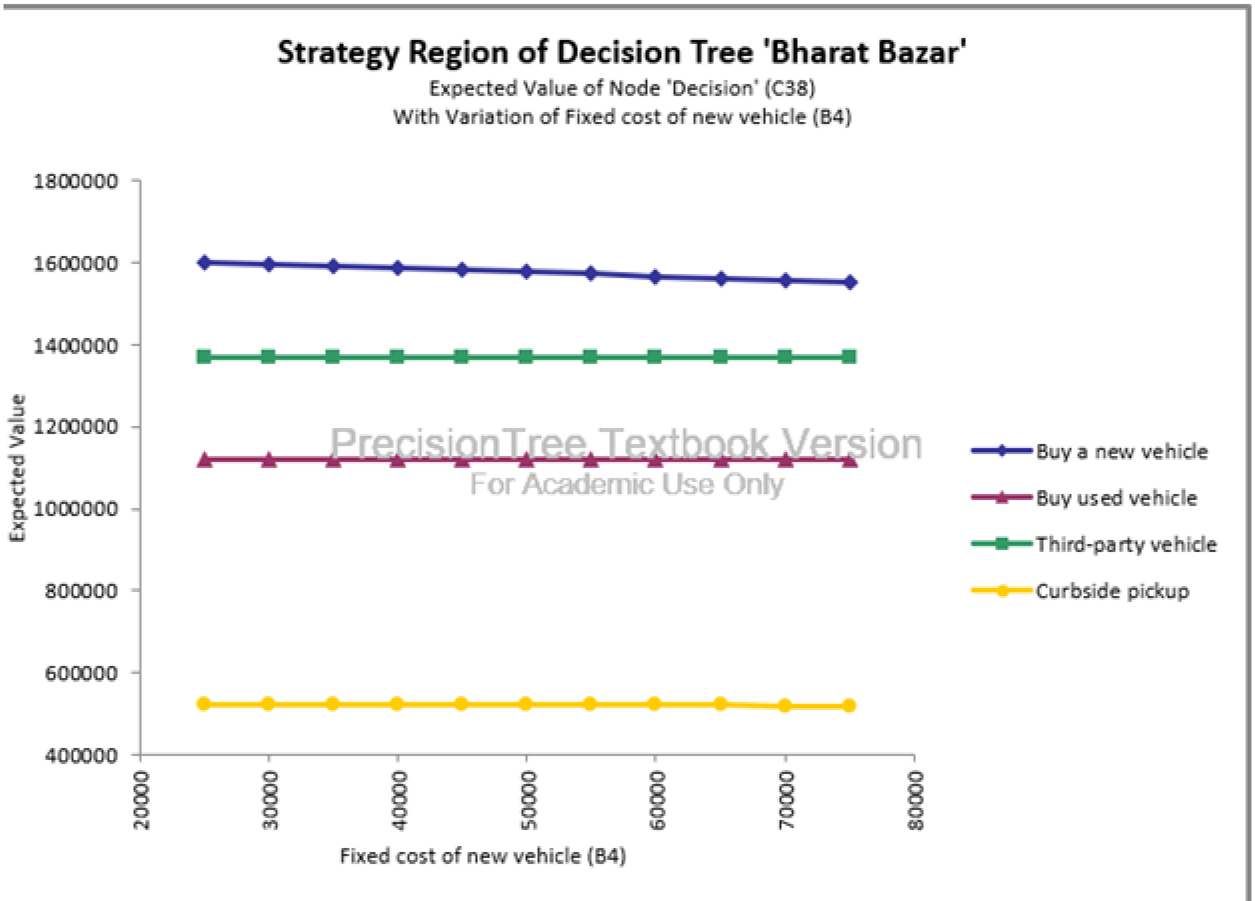


Figure 9: Strategy region graph of Fixed cost of new vehicle

In this strategy graph figure 9, for Fixed costs of a new vehicle (varying between $20,000-80,000),The optimal decision is to buy a new vehicle. This decision is insensitive to the fixed cost of a new vehicle and the EMV is slightly sensitive with a decline for every unit increase in fixed cost.

The EMV from buying the used vehicle, using third party vehicles, and using curbside pickup is insensitive to the fixed cost of a new vehicle.

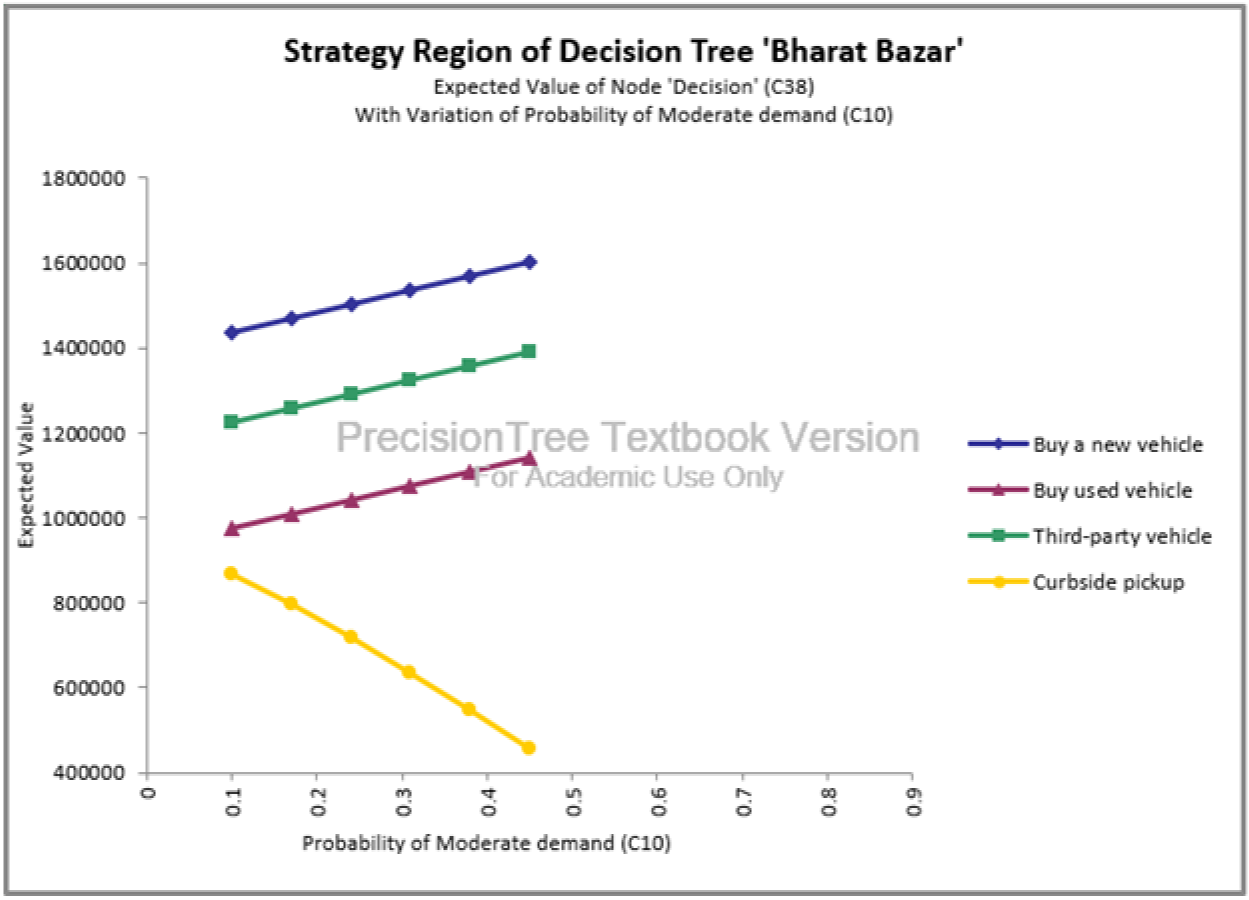


Figure 10: Strategy region graph of Probability of moderate demand

In this strategy graph figure 10, for probability of moderate demand (varying between 0.1-0.9), the optimal decision is to buy a new vehicle. The decision is insensitive to the probability of moderate demand. The EMV is sensitive and goes up with an increase in probability of moderate demand.

The EMV for buying used vehicles and third-party vehicles is also sensitive and goes up with an increase in probability of moderate demand. The decision is insensitive.

The EMV for using curbside pick is sensitive to probability of moderate demand and it decreases with increase in probability of moderate demand.

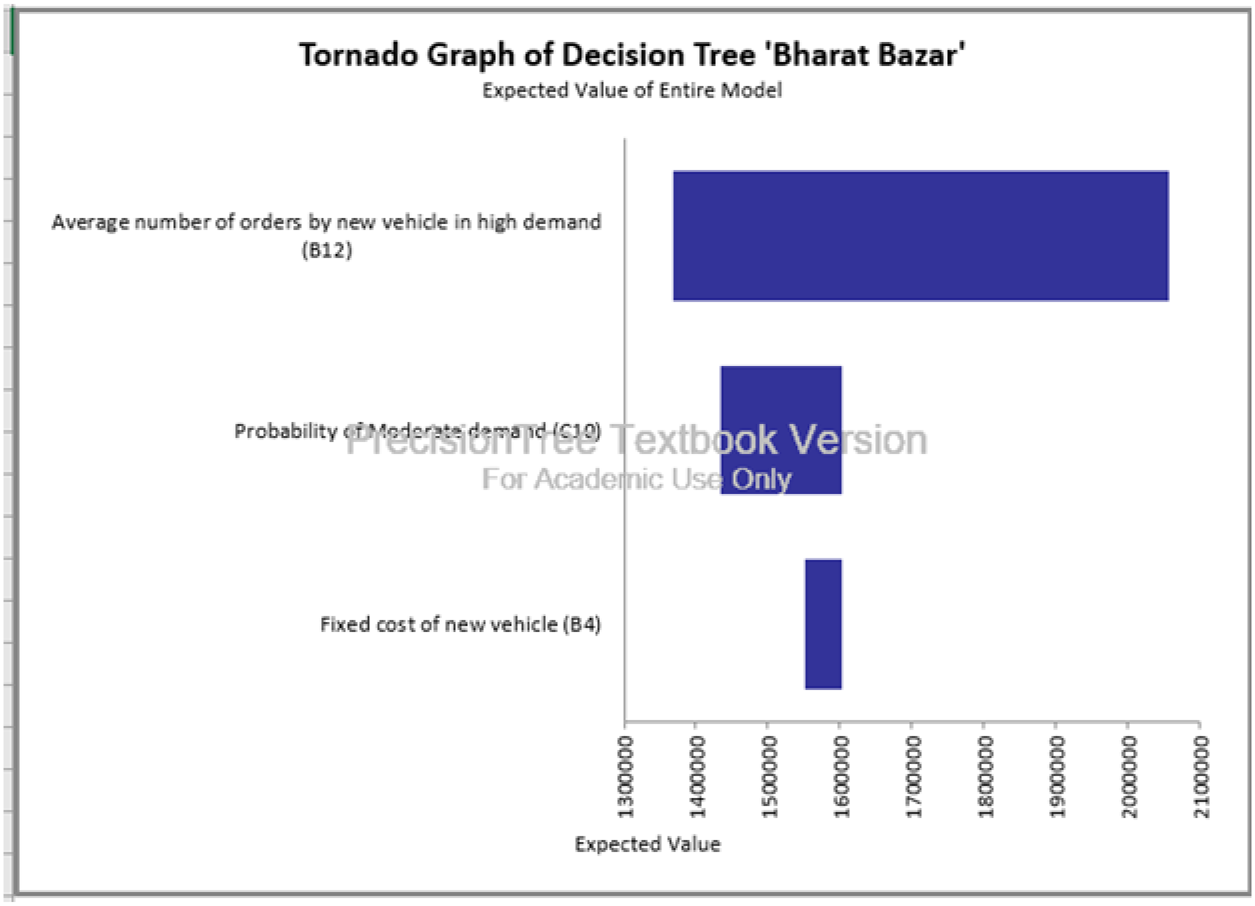


Figure 11:Tornado Graph

The Tornado graph shows that the most influential parameter considered for one-way sensitivity analysis is Average number of orders by new vehicle in high demand, which produces the highest variation in EMV. The second most influential parameter is the probability of the moderate demand. The least influential parameter is the fixed cost of a new vehicle.

3.5.3.2 Two-way Sensitivity Analysis

The store owner of Bharat Bazar wants to know, what if the used vehicle or a third party vehicle performs as efficiently as a new vehicle and delivers more orders on an average in a year during high demand periods (or) performs less efficiently and delivers less orders on an average in a year during high demand periods.

Two-way sensitivity analysis is performed to investigate the effect of expected value of each decision with respect to the variation in the average number of orders delivered by both the used vehicle and third-party vehicle from the range of 5000 to 25000.

3.5.1.1.1. Sensitivity graph

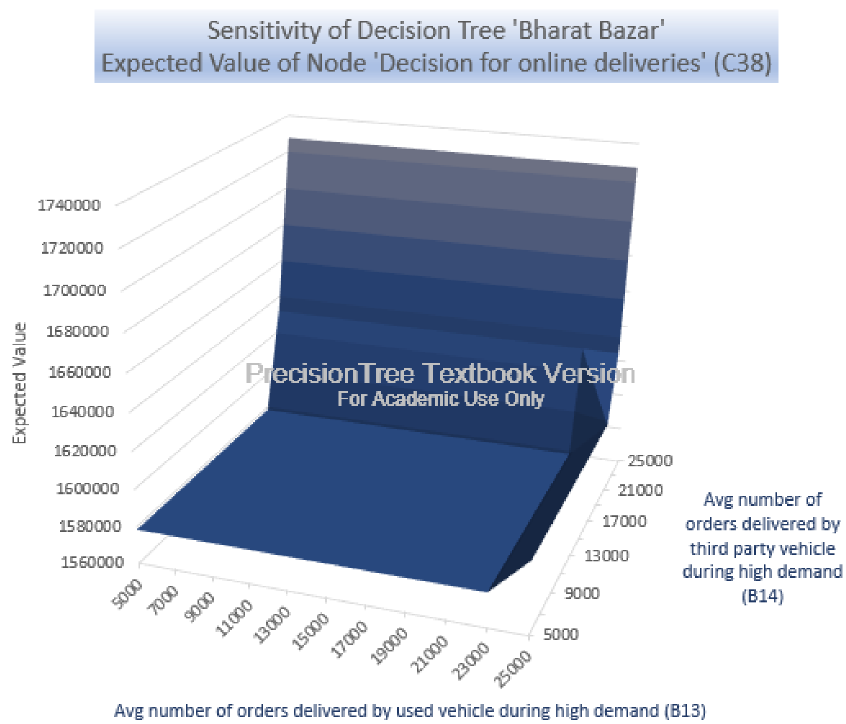


Figure 12: Sensitivity graph (2-way)

Two-Way Sensitivity Data of Decision Tree 'Bharat Bazar' (Expected Value of Entire Model)												
With Variation of Avg no of orders delivered by used vehicle during high demand (B13) and Avg no of orders delivered by third party vehicle during high demand(B14)												
		Avg number of orders delivered by used vehicle during high demand (B13)										
		5000	7000	9000	11000	13000	15000	17000	19000	21000	23000	25000
Avg number of orders delivered by third part vehicle during high demand (B14)	5000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	7000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	9000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	11000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	13000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	15000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	17000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	19000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	21000	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1578370	1598250
	23000	1631687.5	1631687.5	1631687.5	1631687.5	1631687.5	1631687.5	1631687.5	1631687.5	1631687.5	1631687.5	1631687.5
	25000	1727437.5	1727437.5	1727437.5	1727437.5	1727437.5	1727437.5	1727437.5	1727437.5	1727437.5	1727437.5	1727437.5

Figure 13: Sensitivity Table (2-way)

The above graph shows the expected value of the model with respect to the variation in average number of orders delivered by used vehicle and third-party vehicle per year. It is observed that for any average number of orders delivered by a used vehicle ranging from 5000 up to 23000 and for any average number of orders delivered by a third-party vehicle ranging from 5000 up to 21000, the expected value remains insensitive as **1578370**, but if the used vehicle can deliver more (i.e.) around 25000, the expected value can increase up to **1598250**.

For every 2000 units of increase in orders delivered by used vehicle ranging from 5000 to 25000 and by a third-party vehicle from 21000 to 25000, the expected value increases by 53317 and 95750 respectively up to **1727437.5**. It is to be noted that if the third party vehicle delivers orders around 23000 or above, the expected value depends only on the variation in the number of orders delivered by third party vehicle and remains insensitive to the variation in the number of orders delivered by used vehicle.

3.5.1.1.2. Strategy Region

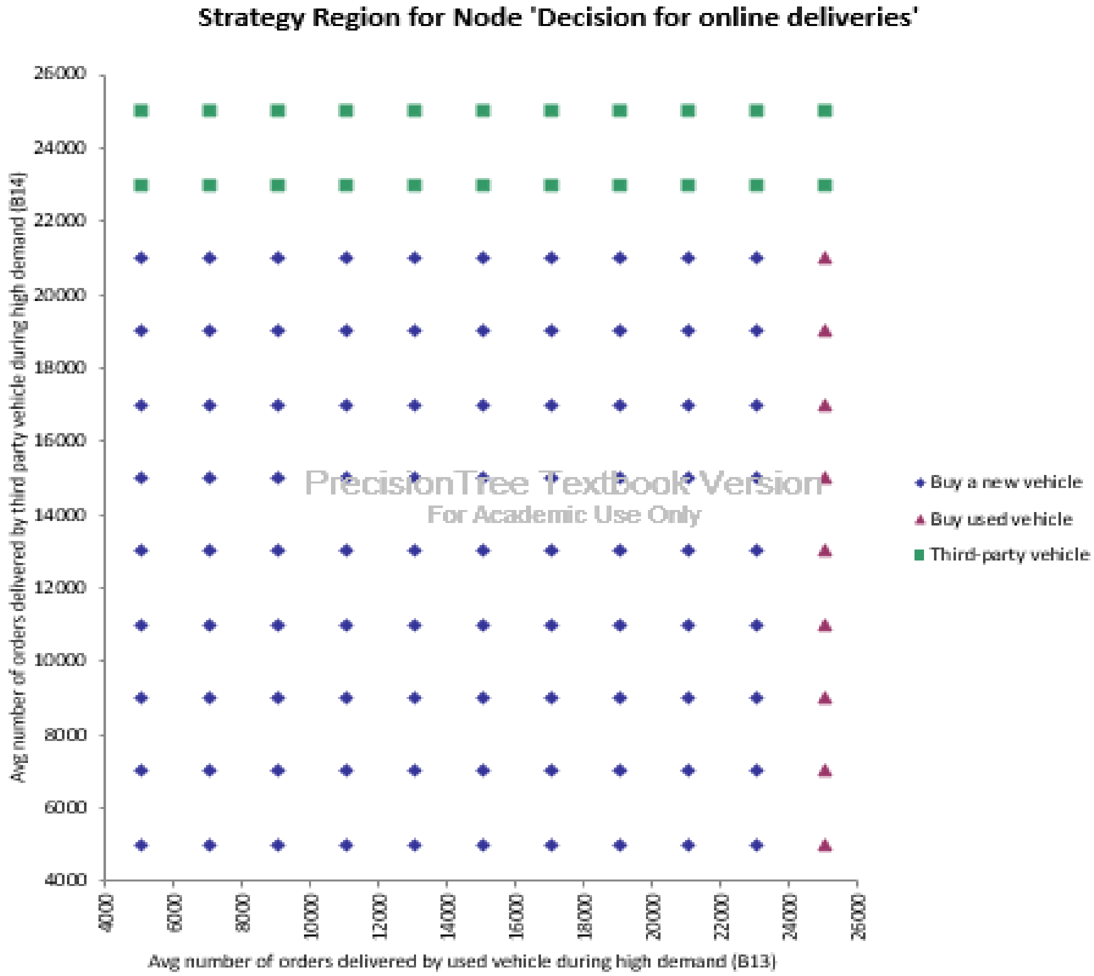


Figure 14: Strategy Region (2-way)

In the above strategy region chart, the blue diamond represents the decision of buying a new vehicle, the magenta triangle represents the decision of buying a used vehicle and the green square represents the decision of using a third-party vehicle. According to this two-way sensitivity analysis, during high demand periods, for any average number of orders delivered by used vehicle ranging from 5000 all the way up to 23000 and the orders delivered by a third-party vehicle ranging from 5000 and approximately up to 21000 per year, the optimal decision remains as ***buying a new vehicle***.

In case if the third party vehicle is performing even better and the average number of orders it delivers per year exceeds 23000, and on the other hand if the average number of orders delivered by the used vehicle is somewhere between 5000 and 25000, the optimal decision for the store management would be to use a ***third-party vehicle***. In this case, it is to be noted that even if the used vehicle delivers 1500 orders more than the third-party vehicle (25000-23000=2000), buying a used vehicle is not considered as an optimal decision. This is due to the fact that the cost incurred for buying a used vehicle is considerably higher than the cost incurred for using a third-party vehicle. Using a third-party vehicle would still remain as the optimal decision even if it delivers around 22100 orders and the orders delivered by a used vehicle is somewhere between 5000 to 23500.

If the scenario changes such that the third-party vehicle delivers a less number of orders somewhere between 5000 and 20700 on an average but the used vehicle is efficient than a third party vehicle and delivers more orders around 25000 on an average, then the optimal decision turns out to ***buy a used vehicle***. But it is very important that the store management should buy a used vehicle which is in an excellent condition such that it can deliver many orders as large as 25000 during high demand periods. In this case, buying a used vehicle will remain as the best decision even if the average number of orders delivered by a third-party vehicle is around 22100.

As some useful insights are given to the store management on what would be the optimal decision that needs to be taken depending on the variation in the efficiency of used and third party vehicles in delivering the products during high demand, now the store owner of Bharat Bazar is also curious to know, what if the probability of high demand decreases and at the same time what if the average number of orders delivered by the new vehicle becomes less or more varying from 1000 to 3000 (currently the new vehicle delivers 20000 orders on an average per year). So, again a two-way sensitivity analysis is performed to investigate the combinational impact of variation in the probability of high demand from 0.1 to 0.5 and the average number of orders delivered by a new vehicle during high demand periods ranging from 10000 to 25000 on the expected value of the decision tree model.

3.5.1.1.3. Sensitivity Graph

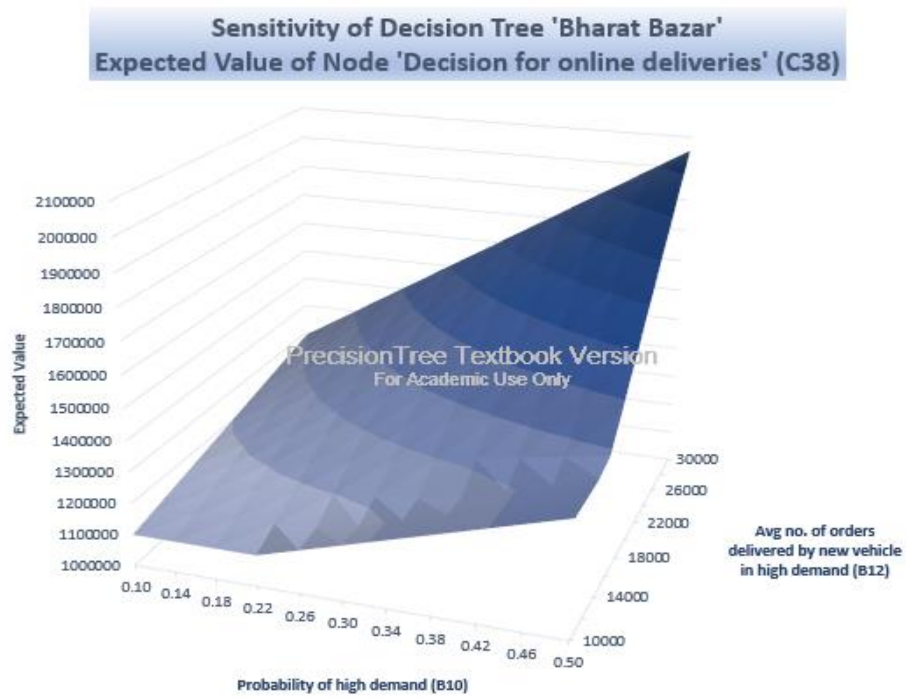


Figure 15: Sensitivity graph (2-way)

Two-Way Sensitivity Data of Decision Tree 'Bharat Bazar' (Expected Value of Entire Model)

With Variation of Probability of high demand (B10) and Average number of orders by new vehicle in high demand (B12)

Average number of orders by new vehicle in high demand (B12)	Probability of high demand (B10)										
	0.10	**0.14**	**0.18**	**0.22**	**0.26**	**0.30**	**0.34**	**0.38**	**0.42**	**0.46**	**0.50**
10000	1099620	1099620	1099620	1100275	1138575	1176875	1215175	1253475	1291775	1330075	1368375
12000	1118770	1126430	1134090	1141750	1149410	1176875	1215175	1253475	1291775	1330075	1368375
14000	1137920	1153240	1168560	1183880	1199200	1214520	1229840	1253475	1291775	1330075	1368375
16000	1157070	1180050	1203030	1226010	1248990	1271970	1294950	1317930	1340910	1363890	1386870
18000	1176220	1206860	1237500	1268140	1298780	1329420	1360060	1390700	1421340	1451980	1482620
20000	1195370	1233670	1271970	1310270	1348570	1386870	1425170	1463470	1501770	1540070	$\boxed{1578370}$
22000	1214520	1260480	1306440	1352400	1398360	1444320	1490280	1536240	1582200	1628160	1674120
24000	1233670	1287290	1340910	1394530	1448150	1501770	1555390	1609010	1662630	1716250	1769870
26000	1252820	1314100	1375380	1436660	1497940	1559220	1620500	1681780	1743060	1804340	1865620
28000	1271970	1340910	1409850	1478790	1547730	1616670	1685610	1754550	1823490	1892430	1961370
30000	1291120	1367720	1444320	1520920	1597520	1674120	1750720	1827320	1903920	1980520	2057120

Figure 16: Sensitivity Table (2-way)

The above graph and the chart shows the expected value of the model with respect to the variation in the probability of high demand from 0.1 to 0.5 and in the average number of orders delivered by a new vehicle per year from 10000 to 30000. The current expected value of our decision tree model is highlighted in the above Figure 15. From the above table, it is observed that if the probability of high demand decreases from 0.5 to 0.1, and if the average number of orders delivered by the new vehicle decreases from 20000 to 10000, then the expected value can decrease up to **1099620**.

On the other hand, if the pandemic persists and people prefer online grocery shopping and door delivery, (i.e.) the probability of high demand remains as 0.5, and also if the new vehicle delivers more orders, say 30000, the expected value can increase up to **2057120**.

3.5.1.1.4. Strategy region

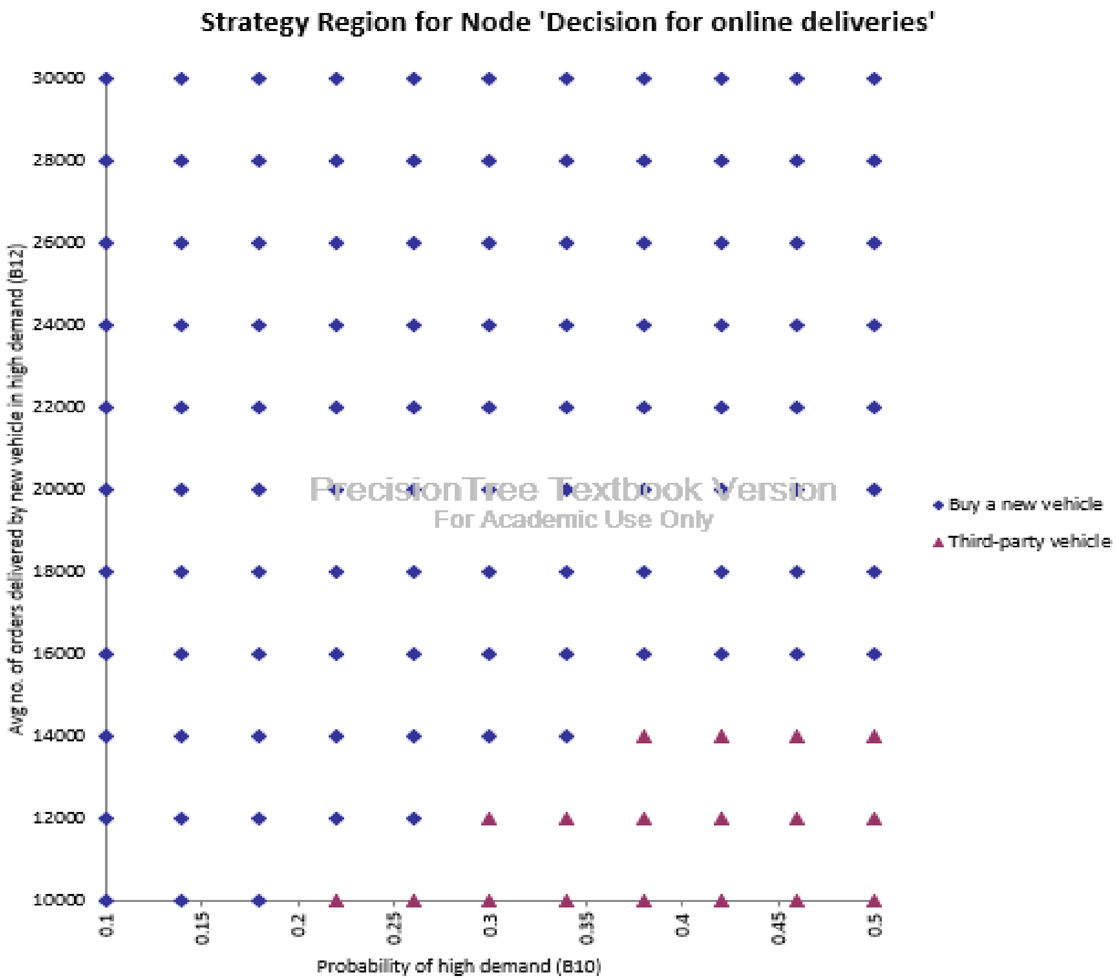


Figure 17: Strategy Region (2-way)

In the above strategy region chart, the blue diamond represents the decision of buying a new vehicle and the magenta triangle represents the decision of using a third-party vehicle. According to this two-way sensitivity analysis, for any combination of the probability of high demand from 0.1 to 0.5 and the average number of orders delivered by a new vehicle per year ranging from 1600 to 3000 the optimal decision still remains as ***buying a new vehicle***.

But if the number of orders by a new vehicle reduces below 1600, the store might have to rethink their decision to maximize their annual profit. From the above chart, it is observed that if the probability of high demand reduces and lies somewhere between 0.22 to 0.5, and if the average number of orders delivered by the new vehicle per year reduces to around 1000, then the optimal decision would be to ***use a third-party vehicle*** instead of buying a new vehicle. Using a third-party vehicle would be the best option, if the number of orders during a high demand period is around 1200 with the probability of high demand is between 0.3 and 0.5. Also, this decision remains when the average number of orders during high demand is around 1400 and the probability of high demand is between 0.38 and 0.5.

Baseline is, if the average number of orders delivered by a new vehicle is more than 14000 per year, regardless of the probability of high demand, buying a new vehicle would benefit the store. Assuming that the chances for low demand is very less considering this pandemic situation, and taking into account the average number of orders delivered by a new vehicle per year in moderate demand (i.e.) 15000 as given in the business data, which is more than 14000, buying a new vehicle would be an optimal decision the store owner can take under uncertainty.

4. Conclusion

This research concludes that the optimal decision for Bharat Bazar is to buy a new vehicle. We analyzed that buying a new vehicle can increase the annual revenue of the store and meet the demands of online orders. This will also help Bharat Bazaar maintain as well increase their customer base during the pandemic. Based on the optimal decision, the payoff of the store will be \$1865620 in high demand with the probability of 50%, \$1386870 in moderate demand with probability of 40% and \$908120 with probability of 10%. Based on the sensitivity analysis performed, it is observed that as long as the average number of orders delivered by a new vehicle is more than 14000 per year and the average the number orders delivered by used vehicle and third-party vehicle is less than 25000 and 23000 per year respectively, regardless of the demand whether it is high or moderate or low, buying a new vehicle would benefit the store under uncertainty. They could satisfy the customer demands effectively by offering a convenient door-step delivery.

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