Group Coursework Submission Form

Specialist Masters Programme

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MSc in: Business Analytics	
Module Code: SMM641	
Module Title: Revenue Management and Pricing	
Lecturer: Oben Ceryan	**Submission Date:** 25/02/19

Declaration:

By submitting this work, we declare that this work is entirely our own except those parts duly identified and referenced in my submission. It complies with any specified word limits and the requirements and regulations detailed in the coursework instructions and any other relevant programme and module documentation. In submitting this work we acknowledge that we have read and understood the regulations and code regarding academic misconduct, including that relating to plagiarism, as specified in the Programme Handbook. We also acknowledge that this work will be subject to a variety of checks for academic misconduct.

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SMM641 REVENUE MANAGEMENT AND PRICING

Problem Set 1 (due 25 February 2019)

Question 1 a.

1. Found maximum and minimum willingness to pay.
2. Measured the demand for every single price point within the WTP – range from step one using the **countif()** function. This returns the given amount of people willing to pay said price.
3. Based on the demand we calculated the revenue for every price point by multiplying the demand with the different prices.

Summary table

Price	Demand	Revenue	Cars (w)	# Cars	Avg speed	Emmission pr car	Total emmision
6,00	345,00	1.152.000,00	1,00	192.000,00	18,00	316,90	60.844.800,00
7,00	339,00	1.320.626,09	0,98	188.660,87	18,21	313,41	59.129.105,42
8,00	303,00	1.349.008,70	0,88	168.626,09	19,46	292,50	49.323.716,96
9,00	263,00	1.317.286,96	0,76	146.365,22	20,85	269,27	39.411.571,18

For full table see sheet Q1A,B

- £8 would maximize the total revenue.
- The total level of emissions for this price will be 49.323.716g

Question 1 b.

1. We calculated the net utility for non-peak from a set price of £7
2. We created a utility price matrix for peak prices using the price range from £1-20
3. Based on the matrix above we managed to measure whether the different vehicle owners drove at Peak hours(P), Non-peak hours(N) or neither of them(O) using the same price range.

4. Finally we summarized the peak and non-peak demand by counting the number of purchases using he **countif()** function on the choice matrix.

   Assumption:

   a. Individuals act according to perfect rational, that is; they maximize their net utility.

   b. Model is only sensitive on an integer level (6,65 ≈ 7.0).

5. This gave us the total emission and revenue for each price within the price range.

Summary table.

Peak Price	7	8	9	10	11
Peak Demand	315	261	214	170	141
NonPeak Demand	24	53	77	90	105
Peak Revenue	2205	2088	1926	1700	1551
Nonpeak Revenue	168	371	539	630	735
w_cars peak	0,91	0,76	0,62	0,49	0,41
w_cars off peak	0,07	0,15	0,22	0,26	0,30
# cars peak	175.304,35	145.252,17	119.095,65	94.608,70	78.469,57
# cars off peak	13.356,52	29.495,65	42.852,17	50.086,96	58.434,78
Speed peak	19,04	20,92	22,56	24,09	25,10
Speed off peak (km/h	29,17	28,16	27,32	26,87	26,35
EPC (g/km)	299,47	268,11	240,81	215,25	199,87
EPC off peak (g/km)	194,17	195,58	196,75	197,38	198,11
Total emmision	55.092.497,42	44.711.903,58	37.110.104,56	30.250.610,21	27.260.097,57
Total Revenue	1.320.626,09	1.368.486,96	1.371.826,09	1.296.695,65	1.272.208,70

For full table see sheet Q1A,B

- Given the constraints of the non-peak price equals to £7, the maximum revenue equals to £1.371.826,09 at a peak price of £9. The total emission level at this price level equals 37.110.104,60g

Question 1 c.

1. In this part we use a compressed model of the answer in *b)*, as we need to consider a change of price would alter the demand of non-peak pricing
2. Then we repeat the process of optimization from task b)
3. Use solver to minimize total emission, under following restraints:
   - total revenue >= 1.100.000

- Non-peak price = 7
- Peak demand > 0

By changing the peak price variable.

4. This yields an optimal value of 12,65£ for peak pricing, however, the model is not decimal sensitive, meaning that a increasing the peak price to 13 would only positively affect total revenue, without increasing emissions.

Summary table

Peak Cars	48.417,39	Peak avg speed (km/h)	26,97
Non Peak Cars	78.469,57	Non peak avg speed (km/h)	25,10
Total Cars	126.886,96	Peak emission per car (g/km)	197,24
		Non Peak emission per car (g/km)	199,87
Real Peak Rev	629.426,09	Total peak emissions	9.549.677,85
Real Non Peak Rev	549.286,96	Total non peak emissions	15.683.404,95
Total Revenue(£)	1.178.713,04	Total emissions	25.233.082,80

For full table see sheet Q1C

- Total minimized emission is 25.233.083 and total revenue 1.178.713 at the corresponding prices:
  - Peak Price = 13
  - Non-Peak price = 7

Question 2

1. First create a Maximum Likelihood Estimation model to estimate the gross utility and maximize the sum Log likelihood.
2. This is done via creating the following linked components for each of the categories (Small, Regular, No Purchase):
   - V_j = attraction level
   - Prob_j = Probability that the individual selects option (j) given the price options offered to that individual at that time. This means that SUM(Prob_j) by row will be 1

- LN(Prob_j) = The log nominal function on Prob_j
- Log Likelihood = This is the sum product of the LN(Prob_j) and the respective actual binary observations of consumer sandwich choices.

3. We then use solver to maximize the Sum Log Likelihood by changing the values of the Gross Utility and mu (μ). A screen capture of the solver settings is displayed on the sheet.
4. We get the Observed probability form the 80 customers to get the percentage of individuals buying small or regular sandwiches or not purchasing at all in a day (assuming 100 customers per day).
5. **Very Key Assumptions.** We assume that the projection of demand will be made according to the respective observed probability shown. This means that:
   i. We get 100 customers each day. Each customer can only purchase 1 sandwich or not purchase at all
   ii. 38.75% or 39 customers will not purchase a sandwich
   iii. Across the small prices, total demand for small can only be 32.5
   iv. Across the regular prices, total demand for regular can only be 28.75

Of course, these assumptions are strictly confined to the mannerisms displayed by the 80 observed customers. However, I we were given more data regarding customer choices across a range of prices, we could probably offer a less rigid model.

	Brie Avocado Small	Brie Avocado Regular	Super Veggie Small	Super Veggie Regular	No purchase
Observed Prob	16.25%	10.00%	16.25%	18.75%	38.75%
Total Customers	100				

6. With this data, we create the MNL model for each price within the Small and Regular class of sandwiches. From this we determine the demand and corresponding revenues.
7. Note: the method by which each demand is determined for each corresponding price. This is done via selecting the prob_j with the corresponding target price and averaging this within that j category. For example, if the small sandwich price was

1.75, all the corresponding prob_j (small) where customers were offered a small sandwich at the price of 1.75 would be collected.

8. The resulting maximum revenue per day is **26,94** with the following optimized prices
    - Small Price = £ 1.75
    - Regular Price = £ 3.50

Alternative Method for Question 2

Same as above with steps 1-4.

5. However, in this method we do not assume such rigid constraints. The pricing decision here is solely captured by the gross utility optimized through maximizing the Sum Log Likelihood.
6. Subsequently, we calculated the attractiveness of the product via the following equation:

$$attractiveness = e^{\frac{Gross\ Utility - Price}{mu(\mu)}}$$

7. We then calculated the purchase probability within this context and the corresponding demand
8. Finally, we account for the cost of producing each sandwich within the calculation of the revenue and sum the total revenue. Using solver, we optimize the price that gives us the maximum revenue. A screen shot is included to observe solver settings
9. The optimal price achieved is:
    - Small Price = £ 2.00
    - Regular Price = £ 3.50

    With total revenue of = **£ 120.64**

Ultimately the decision of which method to use will be dependent on the client and their belief and expectations in the nature of the business. However, considering that this is a sandwich shop, it may be realistic to manage client expectations regarding revenue.

Alternative Method Via Solver

	Brie Avocado Small	Brie Avocado Regular	Super Veggie Small	Super Veggie Regular	No purchase
Price	£ 2.00	£ 3.50	£ 2.00	£ 3.50	£ -
Gross Utility	1.73608	3.60881	1.73608	3.75668	0.00000
Attractiveness	0.32016	1.56127	0.32016	2.92736	1.00000
Purchase Probability	0.05224	0.25474	0.05224	0.47763	0.16316
Demand	5.22377	25.47364	5.22376	47.76283	16.31601
Revenue	£ 5.24	£ 38.31	£ 5.24	£ 71.84	£ -
Total Revenue	120.63757				