MSCI 719: Operations Analytics

Case study based Assignment 1: Drizly: Managing Supply and Demand through Disruption

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1. Comparison among Retailers

The CEO of Drizly would like to know whether the average delivery time and cancellation rate is different for different retailers.

1.1. Calculate the average delivery time for each retailer on each day. Is there a difference in the average delivery time between retailers? Test your hypothesis statistically.

For this assignment, we will use the following dataset, whose first few records are:

A	B	C	D	E	F	G	H	I	J	K	L	M
Retailer ID	Delivery Neighborhood ID	Order ID	Order Date	Order Time	Order Status	Delivery Time	GMV	Delivery Fee	Substitution	DayNumber	DoW	TimeInterval
1	1	11-00011	30-03-2020	12:05 PM	Delivered	34	$ 71	$ 4.99	FALSE	1.00	Monday	12
1	1	11-00012	30-03-2020	12:17 PM	Delivered	28	$ 156	$ 4.99	FALSE	1.00	Monday	12
1	1	11-00013	30-03-2020	12:34 PM	Delivered	30	$ 29	$ 4.99	FALSE	1.00	Monday	12
1	1	11-00015	30-03-2020	12:55 PM	Delivered	30	$ 32	$ 4.99	FALSE	1.00	Monday	12
1	1	11-00014	30-03-2020	12:55 PM	Delivered	26	$ 80	$ 4.99	FALSE	1.00	Monday	12
1	1	11-00016	30-03-2020	1:22 PM	Delivered	40	$ 80	$ 4.99	TRUE	1.00	Monday	12
1	1	11-00017	30-03-2020	1:56 PM	Delivered	28	$ 72	$ 4.99	FALSE	1.00	Monday	12

Below is a description of each field found in the data:

Field	Description
Retailer ID	Each retailer ID represents a unique physical store, open daily from noon-9pm.
Delivery Neighborhood ID	Assume that each retailer serves exactly one neighborhood, and that all retailers serving the neighborhood are included in the data.
Order ID	Unique Order #. Assume all orders are on-demand (as opposed to scheduled).
Order Date	Date order was placed.
Order Time	Time order was placed.
Order Status	Delivered = Order was delivered successfully Void = Order was voided (cancelled) by retailer The data does not include a very small percent of orders that were voided by the consumer.
Delivery Time	If the order was delivered, this represents the number of minutes between when the order was placed and when the order was delivered.
GMV	Gross Merchandise Value = the dollar value of merchandise that was ordered. When a substitution occurs, this number is updated to reflect the dollar value of merchandise delivered to the consumer.
Delivery Fee	Retailer delivery fee to consumers.
Substitution	TRUE = the retailer substituted at least one item on the consumer's order (due to availability) FALSE = the retailer did not substitute any items
DayNumber	Derived based on Order Date, where 1 suggests Monday, ... and 7 suggests Sunday
DoW	DoW shows day of Week, derived based on DayNumber
TimeInterval	It is calculated based on Order Time where 12 suggests 12-3 PM time interval of orders, and similarly 15 suggests 3-6 PM and 18 suggests 6-9 PM

***This data has been disguised and was developed solely for the basis of case study.**

Calculation for average delivery time for each retailer on each day: Using MS Excel Pivot tables, following summary can be created:

Average of Delivery Time	Retailer		
Day of Week	**1**	**2**	**3**
Monday	47.26	40.64	35.86
Tuesday	48.93	34.90	35.74
Wednesday	34.73	41.13	42.59
Thursday	51.55	35.02	41.24
Friday	97.28	91.65	89.76
Saturday	118.69	111.82	102.11
Sunday	79.00	81.93	71.32

Is there a difference in the average delivery time between retailers? Test your hypothesis statistically:

We may think, looking at this table, that the average delivery times differs to a certain extent, for any given day of week, between these three retailers. However, to prove this statistically we will consider following hypothesis:

Null hypothesis, H0: Homogeneous or same average delivery times for all 3 retailers

Alternate hypothesis, H1: Average delivery times differs between these three retailers.

We can answer this question by performing ANOVA test for above data. I will perform two- factor Anova, so that we can test the difference in Avg. delivery times across retailers as well as between days of a week. Moreover, I have used "Without Replication" function because it is robust to sample size variation between 3 retailers. So, following are the results:

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Monday	3	123.7587	41.2529	32.73664
Tuesday	3	119.5667	39.85556	61.90166
Wednesday	3	118.4538	39.48459	17.47481
Thursday	3	127.8102	42.60338	69.74398
Friday	3	278.6944	92.89813	15.29603
Saturday	3	332.6196	110.8732	69.45338
Sunday	3	232.2527	77.41755	29.99781
1	7	477.4432	68.20617	953.178
2	7	437.0875	62.44107	1018.58
3	7	418.6253	59.80362	768.8073

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	16108.7	6	2684.784	96.26155	1.92E-09	2.99612
Columns	258.5224	2	129.2612	4.634594	0.032254	3.885294
Error	334.6862	12	27.89051			
Total	16701.91	20				

Now, considering the average delivery times across the retailers, we see that it has a p-value of 0.0322, which is statistically significant at the 0.05 level of significance or 95% confidence level. Therefore, we can reject the null hypothesis of homogeneous or same average delivery times for all 3 retailers, in favour of alternative hypothesis which says that there is a difference between average delivery times between these three retailers.

1.2. Conduct a similar analysis to part 1 for the void rate:

I have created a pivot table which gives percentage of cancelled or void orders out of total orders for the given day of week and the particular retailer. So, below is the pivot table:

Count of Order Status	Retailer									
	1		1 Total	2		2 Total	3		3 Total	Grand Total
Day of Week	Delivered	Void		Delivered	Void		Delivered	Void		
Monday	93.33%	6.67%	40.98%	93.55%	6.45%	33.88%	95.65%	4.35%	25.14%	100.00%
Tuesday	95.83%	4.17%	42.35%	100.00%	0.00%	29.41%	95.83%	4.17%	28.24%	100.00%
Wednesday	100.00%	0.00%	31.28%	95.38%	4.62%	36.31%	93.10%	6.90%	32.40%	100.00%
Thursday	95.92%	4.08%	44.75%	96.36%	3.64%	25.11%	95.45%	4.55%	30.14%	100.00%
Friday	81.59%	18.41%	41.79%	84.08%	15.92%	32.64%	82.11%	17.89%	25.57%	100.00%
Saturday	79.27%	20.73%	40.68%	76.78%	23.22%	31.21%	79.47%	20.53%	28.11%	100.00%
Sunday	87.50%	12.50%	34.95%	86.99%	13.01%	35.44%	83.61%	16.39%	29.61%	100.00%
Grand Total	**86.54%**	**13.46%**	**39.70%**	**86.33%**	**13.67%**	**32.16%**	**85.91%**	**14.09%**	**28.15%**	**100.00%**

Is there a difference in the void rate between retailers? Test your hypothesis statistically:

So, we can extract required data, as shown below, for the void rate and will perform hypothesis testing on it.

Void Rate	Retailer		
Day of Week	1	2	3
Monday	6.67%	6.45%	4.35%
Tuesday	4.17%	0.00%	4.17%
Wednesday	0.00%	4.62%	6.90%
Thursday	4.08%	3.64%	4.55%
Friday	18.41%	15.92%	17.89%
Saturday	20.73%	23.22%	20.53%
Sunday	12.50%	13.01%	16.39%

So, our hypothesis will be:

Null hypothesis, H0: Homogeneous or same void rate for all 3 retailers

Alternate hypothesis, H1: Void rate differs between these three retailers.

We can answer this question by performing ANOVA test for the above data. I will perform two-factor Anova, so that I can test the Void rate across retailers as well as between days of a week. Moreover, I have used “Without Replication” function because it is robust to sample size variation between 3 retailers. So, following are the results:

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Monday	3	0.174661	0.0582	0.0002
Tuesday	3	0.083333	0.0278	0.0006
Wednesday	3	0.115119	0.0384	0.0012
Thursday	3	0.122635	0.0409	2E-05
Friday	3	0.522177	0.1741	0.0002
Saturday	3	0.644763	0.2149	0.0002
Sunday	3	0.419071	0.1397	0.0004
1	7	0.665502	0.0951	0.0062
2	7	0.668634	0.0955	0.0067
3	7	0.747624	0.1068	0.0053

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.1035	6	0.0173	40.875	2.6586E-07	2.99612
Columns	0.0006	2	0.0003	0.7327	0.50091373	3.885294
Error	0.0051	12	0.0004			
Total	0.1092	20				

As we can see, the p-value associated with columns source of variation is 0.5, which is not statistically significant, and therefore, we can not reject the null hypothesis. That means, void rate does not differ significantly between the given three retailers.

1.3. Based on the last two parts and the total GMV of each retailer, is there any significant difference between retailers?

To answer this, first we need to prepare pivot table for the total GMV, as shown below:

Sum of GMV	**Column Labels**			
Row Labels	**1**	**2**	**3**	**Grand Total**
Monday	6261	4021	2989	13271
Tuesday	5223	3225	3234	11682
Wednesday	3663	4435	4287	12385
Thursday	6574	3892	4338	14804
Friday	12832	10899	7887	31618
Saturday	18100	13515	12651	44266
Sunday	9344	9214	7368	25926
Grand Total	**61997**	**49201**	**42754**	**153952**

We will run a similar ANOVA test for this data as well, so that we can confirm regarding differences of total GMV between the three retailers. So, following are the results from ANOVA-test:

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Monday	3	13271	4423.666667	2798101.333
Tuesday	3	11682	3894	1324701
Wednesday	3	12385	4128.333333	167877.3333
Thursday	3	14804	4934.666667	2065289.333
Friday	3	31618	10539.33333	6210276.333
Saturday	3	44266	14755.33333	8576720.333
Sunday	3	25926	8642	1221532
1	7	61997	8856.714286	25600956.57
2	7	49201	7028.714286	16984567.57
3	7	42754	6107.714286	12000044.57

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	310193677.6	6	51698946.27	35.8196801	5.58161E-07	2.996120378
Columns	27409260.67	2	13704630.33	9.495270405	0.003370641	3.885293835
Error	17319734.67	12	1443311.222			
Total	354922673	20				

We can see from this test results that the p-value associated with columns source of variation is 0.00337, which is statistically significant, and therefore, we must reject the null hypothesis. That means, total GMV does differ significantly between the given three retailers.

Therefore, based on our results from the above parts, we can conclude following regarding the variation in different variables among 3 retailers:

- There is significant difference between retailers in terms of the average delivery time and total GMV; however, void rate is almost the same for all 3 retailers.

2. GMV and Order Rate Over Time

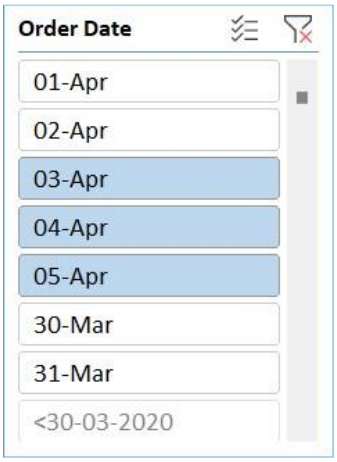
As I have shown in the dataset description part, I have created 3-hour time intervals (starting from 12:00 PM) and labelled that column as “TimeInterval”. We will be particularly analysing the data for the April 3rd, April 4th, and April 5th, i.e., Friday through Sunday- Weekend days.

2.1. Visually show how the total GMV and number of orders change during these time intervals.

Following pivot table can be prepared for this purpose:

Sum of GMV	Date			
Time Intervals	03-Apr (Friday)	04-Apr (Saturday)	05-Apr (Sunday)	Grand Total
12 (12-3 PM)	3699	4597	2679	10975
15 (3-6 PM)	13962	17097	10457	41516
18 (6-9 PM)	13957	22572	12790	49319
Grand Total	31618	44266	25926	101810

We have used following method for slicing data from our pivot table based on required days:



We can now prepare following chart to visualize the change in total GMV with respect to the time intervals and the dates:

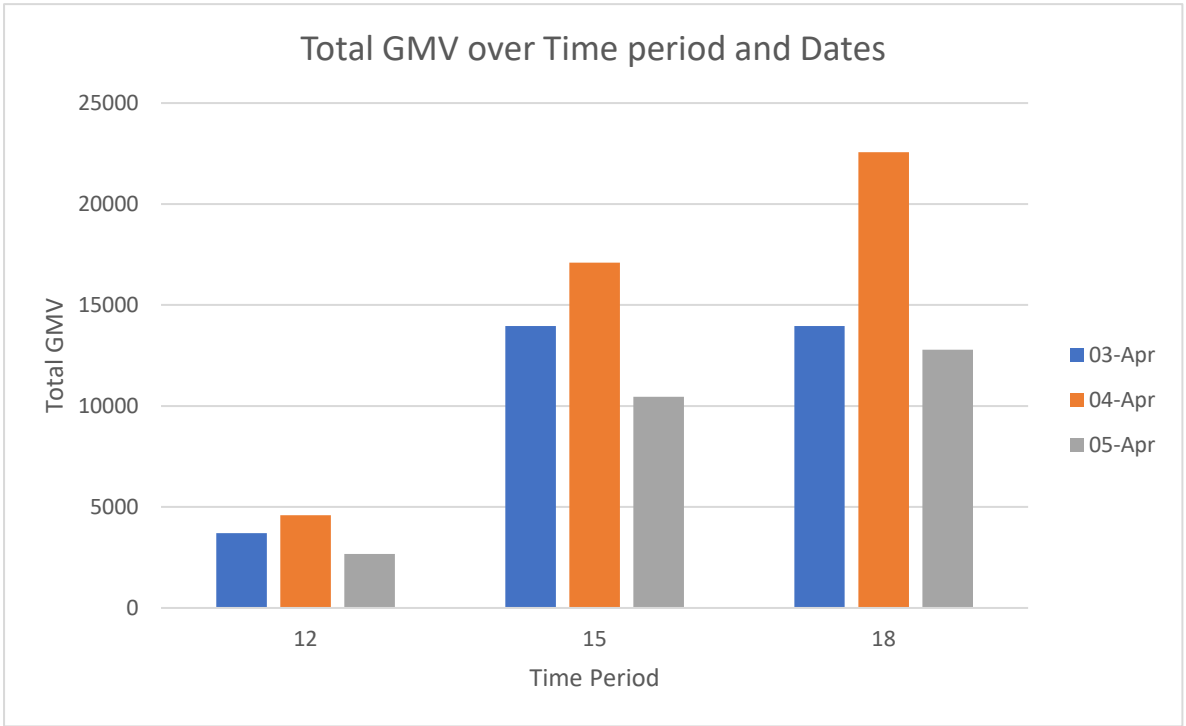


Fig. 2.1: Total GMV over Time period and Dates

Similarly, we can prepare the pivot table and the chart to analyse the number of orders in these time intervals and over the three weekend days:

Count of Orders	Date			
Time Intervals	03-Apr (Friday)	04-Apr (Saturday)	05-Apr (Sunday)	Grand Total
12 (12-3 PM)	60	69	46	175
15 (3-6 PM)	206	269	171	646
18 (6-9 PM)	215	338	195	748
Grand Total	481	676	412	1569

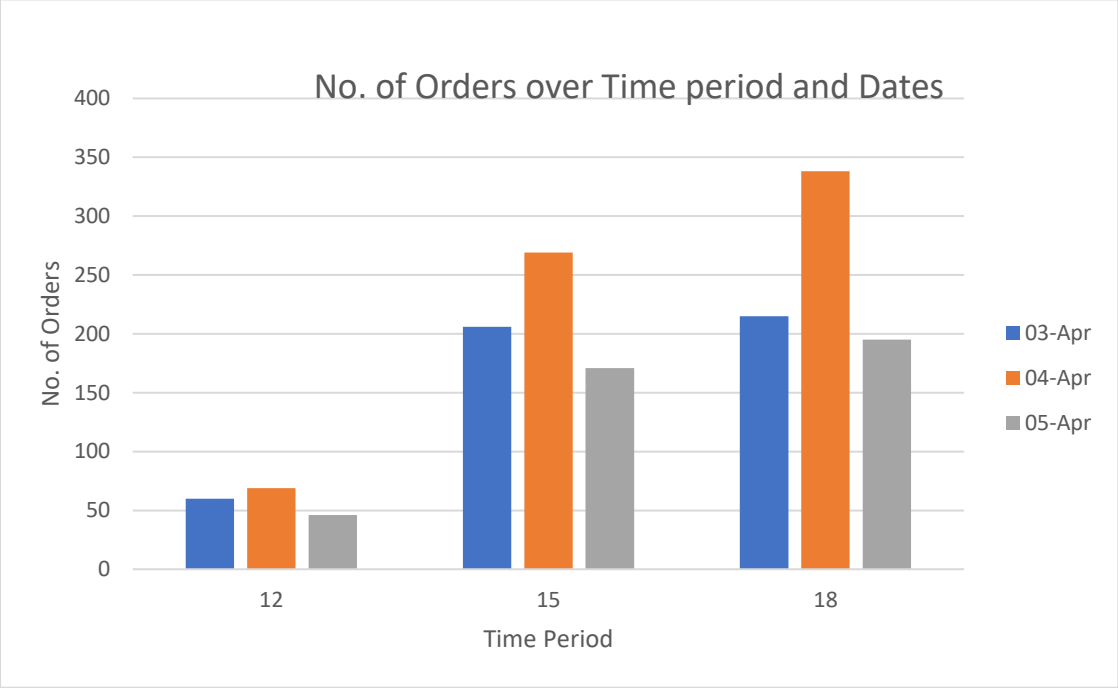


Fig. 2.2: No. of Orders over Time period and Dates

2.2. Do you think the total GMV and number of orders are different across different time intervals? In which time interval are they higher?

From the charts seen in Fig. 2.1 and 2.2, it is very clear that there is a sharp increase in the total GMV and no. of orders from the afternoon time to the late evening time. And, Drizly gets highest number of orders and GMV in the 6-9 PM evening time interval.

Moreover, it is interesting to observe here that, most customers prefer to order on the Saturday compared to Friday and Sunday. And Saturday 6-9 PM interval sees the highest number of orders and the total GMV for Drizly.

2.3. How could Drizly management use this analysis and make informed decisions?

Based on this analysis, Drizly Management can get detailed insights on exactly when can they expect highest number of orders and the GMV through their website. Also, this report provides insights into differences and behaviour of different retailers in terms of key performance and customer experience indicators viz. Average delivery time, void rate and GMV from each retailer.

Therefore, I would suggest Drizly Management the following implementations to consider, based on above analysis:

Suggestions to quickly tackle this disruption:

- Set capacity limits per hour
- remove on-demand delivery option for the weekends (enable scheduled delivery)

Features to consider for the future rollouts:

- Increase minimum GMV/ order
- Dynamic pricing
- Increase number of retailers in the portal
- Explore more 3rd party delivery options

Attachments:

"Drizly_Dataset_and_Calculations.xlsx"

References:

[1] H A Mehrizi, eBook: MSCI 719 Winter 2023 Cases Multiple (ID: 9723713) Accessed: Jan. 22, 2023. [Online].

Available: https://www.campusebookstore.com/integration/AccessCodes/default.aspx?permalinkId=ee044bf2-fe82-4db0-ad22-088e81954eef&frame=YES&t=permalink&sid=4u2faw45zyslbp45bbqlpc55