

Top 100 Independent Restaurants

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Introduction of Business Analysis

Project

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Data Collection and Exploration

Examining the 2020 business restaurants dataset can yield insightful information that restaurants can use to manage the COVID-19 pandemic's difficulties, adjust to shifting consumer preferences, and secure their long-term viability.

The benefits of studying this dataset are:

- **Adaptation to changing consumer behavior:** To better serve customers in the present environment, restaurants can use this information to modify their menus, pricing policies, and marketing campaigns.
- **Financial planning in uncertain times:** Amidst the economic instability resulting from the pandemic, the information holds significant value in aiding restaurants through difficult times through financial forecasting, budgeting, and cost control.
- **Risk management in a volatile environment:** It is possible to detect risks and create mitigation plans, such as managing changing customer demand and supply chain disruptions, by examining data on restaurant performance during the COVID-19 period.
- **Customer satisfaction in a new normal:** Restaurant owners can find opportunities to enhance the quality of their services and the overall customer experience while considering the new health and safety regulations by examining customer feedback and ratings from the COVID-19 period.

The dataset has 100 observations and 7 columns. Each observation talks about a different restaurant than the other. In addition, each has its own rank in the first column. The second column is talking about restaurant names that were determined to be at the top ranking; the third and fourth columns are about 36 cities for restaurants with their states; and the final column is about the meals they served that make the restaurants special and different from others in North America. After that, we will classify each column based on whether the data is categorical or quantitative. This classification will depend on whether we can perform arithmetic operations, which will be quantitative data, but if we cannot perform them, it will be referred to as categorical data.

- **Rank:** Categorical data.
- **Restaurants:** Categorical data.
- **Sales:** Quantitative data
- **Average check:** Quantitative data.
- **City:** Categorical data.
- **State:** Categorical data.
- **Meals Served:** Quantitative data.

Top 100 Independent Restaurants

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The original dataset:

Rank	Restaurant	Sales	Average Check	City	State	Meals Served
1	Carmine's (Times Square)	39080335	40	New York	N.Y.	469803
2	The Boathouse Orlando	35218364	43	Orlando	Fla.	820819
3	Old Dbbert Grill	29104017	33	Washington	D.C.	892830
4	LAVO Italian Restaurant & Nightclub	291616180	90	New York	N.Y.	198500
5	Bryant Park Grill & Cafe	26900000	62	New York	N.Y.	403000
6	Gibsons Bar & Steakhouse	25409952	80	Chicago	Ill.	348567
7	Top of the World at the STRAT	2523543	103	Las Vegas	Nev.	246054
8	Maple & Ash	24837595	99	Chicago	Ill.	210832
9	Balthazar	24547800	87	New York	N.Y.	519000
10	Smith & Wollensky	24501000	107	New York	N.Y.	257364
11	Angus Barn	24268160	75	Raleigh	N.C.	315000
12	Prime 112	23800000	135	Miami Beach	Fla.	206000
13	Joe's Seafood, Prime Steak & Stone Crab	23660000	86	Washington	D.C.	277850
14	Junior's (Times Square)	23640652	23	New York	N.Y.	914500
15	The Hamilton	23138062	33	Washington	D.C.	700861
16	Joe's Seafood, Prime Steak & Stone Crab	22981600	91	Chicago	Ill.	252500
17	Joe's Seafood, Prime Steak & Stone Crab	22859400	81	Las Vegas	Nev.	286000
18	Gibsons Italia	22749232	108	Chicago	Ill.	253962
19	Komodo	22500000	98	Miami	Fla.	265000
20	Buddakan	22395577	67	New York	N.Y.	221059
21	Bazaar Meat by Jose Andres	22181607	119	Las Vegas	Nev.	190000
22	SW Steakhouse	21523650	149	Las Vegas	Nev.	145700
23	St. Elmo Steak House	21422141	99	Indianapolis	Ind.	192774
24	RPM Steak	20853300	102	Chicago	Ill.	202900
25	Mon Ami Gabi	20120210	76	Las Vegas	Nev.	319200
26	Gibsons Bar & Steakhouse	19831818	81	Oak Brook	Ill.	276444
27	Paddlefish	19829500	48	Orlando	Fla.	417500
28	Taste of Texas	19530159	55	Houston	Texas	375241
29	Parc	19379153	35	Philadelphia	Pa.	486219
30	Bob Chinn's Crab House	18687601	48	Wheeling	Ill.	625907
31	Quality Meats	18679000	115	New York	N.Y.	163148
32	Del Posto	18652033	194	New York	N.Y.	95000
33	Shooters Waterfront	18601433	57	Fl. Lauderdale	Fla.	409752
34	Bottega Louie	18521000	36	Los Angeles	Calif.	322562
35	Le Diplomate	18490719	38	Washington	D.C.	363609
36	Gibsons Bar & Steakhouse	18483056	79	Rosemont	Ill.	252419
37	Lavo Italian Restaurant & Lounge	18386262	97	Las Vegas	Nev.	115500
38	Prime Steakhouse	18248030	173	Las Vegas	Nev.	113600
39	Makoto	18216906	54	Bal Harbour	Fla.	256830
40	Original Joe's Westlake	18159612	35	Daly City	Calif.	473492
41	Shaw's Crab House	17965500	72	Chicago	Ill.	270000
42	Founding Farmers (Washington, D.C.)	17910045	33	Washington	D.C.	648096
43	Junior's (49th Street)	17834390	22	New York	N.Y.	798000
44	Chops Lobster Bar	17816450	86	Atlanta	Ga.	168000
45	Chicago Cut Steakhouse	17743720	95	Chicago	Ill.	211000
46	Swift & Sons	17637400	119	Chicago	Ill.	195343
47	Harris Ranch Inn & Restaurant	17599468	29	Coalinga	Calif.	611928
48	Sparks Steak House	17519030	100	New York	N.Y.	198200
49	Quality Italian	17519000	95	New York	N.Y.	177337
50	Frankenmuth Bavarian Inn	17388751	19	Frankenmuth	Mich.	899284
51	Tavern on the Green	17212800	76	New York	N.Y.	250000
52	Abe & Louie's	17063477	106	Boston	Mass.	160762
53	Rusty Pelican	16981741	98	Miami	Fla.	182000
54	Beauty & Essex (New York City)	16364050	90	New York	N.Y.	187970
55	Grand Central Oyster Bar	16304883	62	New York	N.Y.	296000
56	Delmonico Steakhouse	16154000	103	Las Vegas	Nev.	133000
57	Portland City Grill	16111510	83	Portland	Ore.	268062
58	Sehder's of Frankenmuth	16063684	17	Frankenmuth	Mich.	950026
59	The Rustic Inn	15700000	43	Fl. Lauderdale	Fla.	371000
60	Harry Caray's Italian Steakhouse	15680000	59	Chicago	Ill.	287900
61	Keens Steakhouse	15629700	97	New York	N.Y.	168301
62	The Lobster House	15450000	43	Cape May	N.J.	320000
63	China Live	15106280	54	San Francisco	Calif.	3,00E+05
64	Prime & Provisions	15100000	130	Chicago	Ill.	116154
65	Carmine's (Las Vegas)	15067804	45	Las Vegas	Nev.	176221
66	Swan	1.50E+07	78	Miami	Fla.	225000
67	15th Street Fisheries	14978103	69	Fort Lauderdale	Fla.	356000
68	Atlanta Fish Market	14972300	57	Atlanta	Ga.	274000
69	Acme Feed & Seed	14897125	22	Nashville	Tenn.	527130
70	Hugo's Frog Bar & Fish House	14790123	80	Chicago	Ill.	190616
71	Cliff House	14465847	40	San Francisco	Calif.	199901
72	Castaway Burbank	14407413	60	Burbank	Calif.	180320
73	Matt's El Rancho	14381904	29	Austin	Texas	495927
74	Timberline Steaks and Grille	14362103	37	Denver	Colo.	553378
75	Beauty & Essex (Las Vegas)	14130500	99	Las Vegas	Nev.	150000
76	Carmine's (Atlantic City)	13987843	39	Atlantic City	N.J.	129630
77	Junior's (Brooklyn)	13908292	23	New York	N.Y.	359000
78	Quartino Ristorante & Wine Bar	13854856	32	Chicago	Ill.	394582
79	Paradise Cove Beach Cafe	13654113	39	Malibu	Calif.	312050
80	BOA Steakhouse	13552485	110	West Hollywood	Calif.	123204
81	Original Joe's	13177468	45	San Francisco	Calif.	267533
82	Founding Farmers (McLean, Va.)	13102742	38	McLean	Va.	390104
83	Siena Tavern	13100000	55	Chicago	Ill.	238182
84	Giri & the Goat	12894700	82	Chicago	Ill.	183000
85	Tavern on Rush	12884000	72	Chicago	Ill.	178944
86	Harry & Izzy's Circle Centre	12809921	66	Indianapolis	Ind.	174166
87	Scoma's	12713394	65	San Francisco	Calif.	292000
88	Farmers Fishers Bakers	12572109	37	Washington	D.C.	371025
89	Southern Steak & Oyster	12566618	39	Nashville	Tenn.	337920
90	Big Texan Steak Ranch	12505200	24	Amarillo	Texas	478000
91	Park Avenue Summer (Autumn, Winter, Spr	12498000	84	New York	N.Y.	164531
92	Farmers & Distillers	12278839	36	Washington	D.C.	375309
93	Virgil's Real Barbecue	12245998	31	New York	N.Y.	251800
94	Carmine's (Washington, D.C.)	12228168	39	Washington	D.C.	148135
95	Franciscan Crab Restaurant	12218147	59	San Francisco	Calif.	240000
96	George's at the Cove	12194000	80	La Jolla	Calif.	250000
97	Le Coucou	12187523	95	New York	N.Y.	87070
98	Mi Vida	12032014	38	Washington	D.C.	226226
99	Upland	11965564	52	New York	N.Y.	171825
100	Virgil's Real Barbecue	11391678	27	Las Vegas	Nev.	208276

Data Cleaning and Preparation

The chosen dataset for manipulation appears to be free from issues such as outliers, missing values, or incompatible data types. This means the dataset is in a good shape and ready for immediate analysis. The absence of missing values in the dataset indicates that the observations are complete. As a result, there is no need for filling empty cells with estimated values. Moreover, the absence of outliers implies that the variables are consistent and do not depart from the overall pattern. Furthermore, the dataset does not have any gaps between the variables that could affect subsequent calculations; therefore, it will be easy to interpret results and streamline the explanation process. Additionally, incompatible data types can lead to inaccurate calculations and errors in the analytical and statistical processes. Overall, a clean dataset provides an excellent foundation to initiate the analytical process.

Data Visualization

Data visualization is the practice of transforming information into a visual context, such as a map or chart, to make it easier for the human brain to understand and derive insights from the data. The main goal of data visualization is to facilitate the detection of patterns, trends, and outliers in large data sets. The term is often used interchangeably with other terms, including information graphics, information visualization, and statistical graphics.

Data visualization provides a fast and effective way to use visual information to convey information in a universal way. The practice also helps companies understand what factors influence customer behavior. Identify areas that need improvement or require more attention. Make it easier for stakeholders to remember data; know when and where to place certain products; and predict sales.

In this context, we used Excel to create meaningful visualizations and extracted information from the data presented and helped us analyze it. Charts such as histograms, bar charts, and pareto charts were used in the visualization section.

A histogram is a visual representation frequently employed in the field of data analytics, illustrating the frequency of variables on the y-axis within specified user-defined ranges on the x-axis. Bar charts, similar to histograms, depict categorical data but lack the concept of bins. Furthermore, a Pareto chart is a statistical graphic primarily utilized to identify issues or defects in descending order of importance, showcasing the cumulative impact on a system.

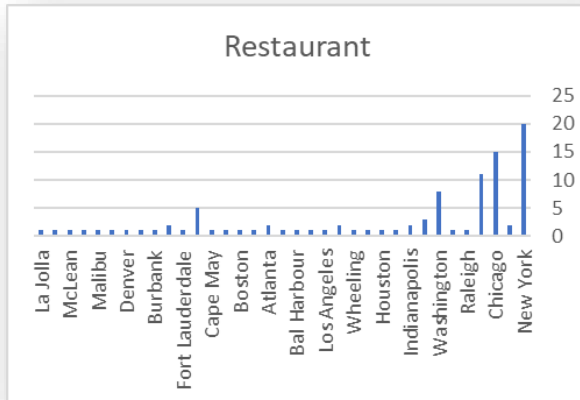
Bar Chart

Figure 0-1, Restaurant Counts

In the initial graph, American regions were arranged based on their respective highest sales, and the COUNTIF() function was employed to enumerate the restaurants within each region. A bar chart was then formulated, illustrating the regions on the x-axis and the corresponding restaurant counts on the y-axis. The visual representation delineates that, in 2020, New York boasted more than 20 top-ranking restaurants, securing its position as the region with the highest restaurant count, followed by Chicago.

This figure enables us to ascertain that New York exhibits the highest concentration of restaurants. To show whether the large number of restaurants has an impact on sales or meals served, a subsequent visualization will be generated.

Histogram

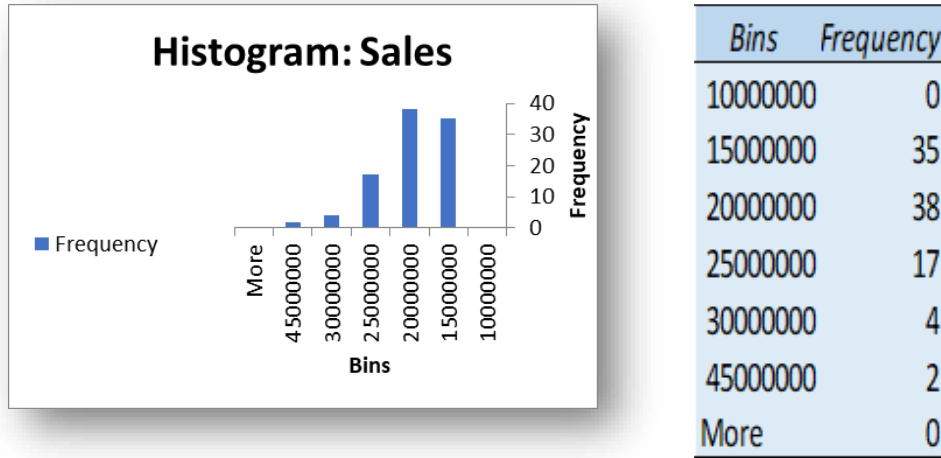


Figure 0-2, Sales

The second graph illustrates the sales distribution across all American restaurants, utilizing six bins for classification. On the x-axis, the bins of sales are represented, while the y-axis displays the corresponding frequency. According to the figure, the majority of restaurant sales during the COVID-19 period hovered around 20 million, with 38 establishments falling into this category, while 35 restaurants recorded smaller sales, estimated at 15 million. Additionally, there were 17 restaurants with estimated sales of 25,000,000, 4 restaurants with estimated sales of 30,000,000, and two restaurants with sales exceeding 30,000,000.

Through this graph, we conclude that the predominant range for restaurant sales during the Covid-19 period lies between 15 million and 20 million. Notably, all New York restaurants fall within the sales bracket of \$15m to \$40m, leading us to infer that New York's restaurants had higher sales compared to other restaurants in other regions.

Pareto Chart

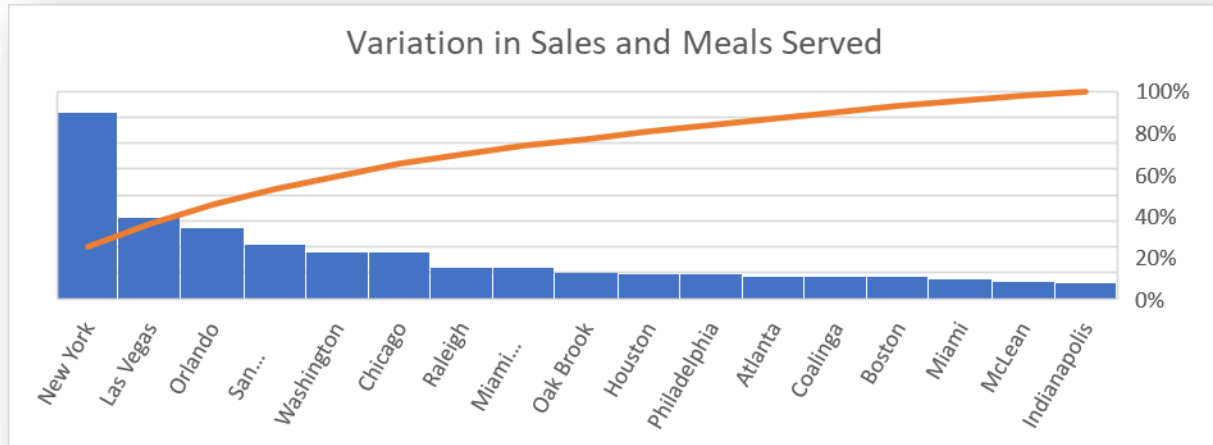


Figure 0-3, Variation

In the third diagram, a sample of 30 elements, comprising regions, sales per region, and meals served, was randomly selected using the RAND() function. A pareto chart was created, with the x-axis representing restaurants and the y-axis depicting sales for each region. Concurrently, the orange line on the chart illustrates the meals served. A noticeable trend from the chart is the inverse relationship between sales and meals served, indicating that an increase in sales correlates with a decrease in meals served.

Through this illustration, we conclude that New York, with its 20 restaurants, experienced high sales during the Covid-19 period, yet its meal service is notably low. This stands in contrast to Boston, which possesses only one restaurant characterized by low sales but a markedly high meals served counts.

Inference:

Upon comprehensive analysis of all graphs, we conclude that restaurants experiencing lower sales can be credited to the affordability of their products compared to those with higher sales, where the products are priced significantly higher. Consequently, restaurants with high sales tend to serve fewer meals. In other words, as sales volume increases, there is a corresponding decrease in the curve depicting the number of meals served.

Statistical Analysis

We will perform the k-Nearest Neighbor technique to get a continuous number. The k-nearest neighbor is easy to understand and perform due to its simplicity. This technique is pretty useful when capturing nonlinear and complex relationships between sales and, for example, promotions. Furthermore, it is important to mention that k-NN is a lazy learner meaning that it does not require a training set or phase. The model of k-NN is constructed at the time of prediction so it is flexible and adaptive to the changes in the extracted dataset. Moreover, k-NN technique is sensitive to outliers meaning that outliers impact the prediction process and leading to inaccurate forecasting. In the case of our dataset, fortunately, it does not have outliers.

In this statistical analysis, we made assumptions about the number of meals served to predict the sales of three distinct restaurants in the forthcoming year. Specifically, Slapfish recorded 959,026 meals served in 2020, while Melt Shop and Original ChopShop registered 87,100 and 317,166.66 meals, respectively, during the same period. Our objective revolves around forecasting the sales of these restaurants in 2021 based on their respective meals served. To begin calculating the forecasted sales, we computed the distances between the assumed meals of the three restaurants and actual meals served for each restaurant across a dataset of one hundred restaurants. This involved holding the assumed meal counts constant using the dollar sign symbol and applying the ABS() function to address potential issues arising from distance calculations yielding negative values.

After calculating absolute distances, we arranged them in ascending order, identifying the k-nearest neighbors for each restaurant. The selection was then expanded to include the rank and actual sales of the original top 100 restaurants alongside the absolute distances after sorting them. In this context, the closest neighbor for Slapfish held the 58th rank, with a distance of 0, while Melt Shop's nearest neighbor occupied the 97th rank, with a distance of 30. Finally, Original ChopShop's closest neighbor was ranked 25th, with a distance of 2,033.34. Since the variable k ranges from 1 to 100, each restaurant has a total of 100 k-neighbors.

After sorting the distances and determining the nearest neighbor, we calculated the average based on the chosen k value, meaning that if k equals to 5, we take the average of the last 5 sales. The average of sales is set to be the predicted sales. Although selecting the third nearest neighbor is a general recommendation, the optimal k value depends on the dataset's size and the analyst's discretion. For larger datasets, a relatively larger k is advisable, whereas smaller datasets are better suited to smaller k values. As we increase the number of k, the model starts to generalize, but increasing the value too much would result in a decline in performance. In our case, with a dataset comprising 100 observations, we opted for a k value of 15, striking a balance between generality and specificity.

Based on k-NN analysis conducted, the predicted sales for Slapfish at k=15 amount to 20,276,874.6, Melt Shop's predicted sales stand at 16,011,961.4, and Original ChopShop's projected sales reach 18,074,928.73. Upon determining the optimal k value as 15, we discerned

that, in the top 100 restaurants in the U.S. for 2021, Slapfish, Melt Shop, and Original ChopShop would be ranked 25th, 61st, and 42nd, respectively.

- 1- Assumed meals served of each restaurant. as for Slapfish, its assumed is the maximum of the original dataset, whereas Melt Shop's meals served number is the minimum. The meals served number of Original ChopShop is the average of the original dataset.

99	98 Mi Vida	12032014	38 Washington	D.C.	226226
100	99 Upland	11965564	52 New York	N.Y.	171825
101	100 Virgil's Real Barbecue	11391678	27 Las Vegas	Nev.	208276
102	101 Slapfish	?	194 Huntington Beach	Calif.	959026
103	102 Melt Shop	?	17 New York	N.Y.	87100
104	103 Original ChopShop	?	69.05 Plano	Texas	317166.66

- 2- Computing the distances between the assumed meals of the three restaurants and actual meals served for each restaurant across a dataset of one hundred restaurants.

	G	H	I	J	K	L
1	Meals Served			distance from Slapfish	distance from Melt Shop	distance from Original ChopShop
2	469803			=ABS(G2-\$G\$102)	=ABS(G2-\$G\$103)	=ABS(G2-\$G\$104)
3	820819			138207	733719	503652.34
4	892830			66196	805730	575663.34
5	198500			760526	111400	118666.66
6	403000			556026	315900	85833.34
7	348567			610459	261467	31400.34
8	246054			712972	158954	71112.66
9	210832			748194	123732	106334.66
10	519000			440026	431900	201833.34

- 3- Arranging them in ascending order, identifying the k-nearest neighbors for each restaurant and calculating the average, as known as the predicted sales.

Z	AA	AB	AC	AD	AE
Rank	Sorted Distance from ChopShop	Sales	k	Predicted Sales	
25	2033.34	20120210	k=1	20120210	
11	2166.66	24268160	k=2	22194185	
62	2833.34	15450000	k=3	19946123.33	
79	5116.66	13654113	k=4	18373120.75	
34	5395.34	18521000	k=5	18402696.6	
63	17166.66	15106280	k=6	=AVERAGE(\$AB\$2:AB7)	
89	20753.34	12566618	k=7	17098054.43	
55	21166.66	16304883	k=8	16998908	
87	25166.66	12713394	k=9	16522739.78	
60	29266.66	15680000	k=10	16438465.8	

T	U	V	W	X	
Rank	Sorted Distance from Melt Shop	Sales	k	Predicted Sales	
97	30	12187523	k=1	12187523	
32	7900	18625033	k=2	15406278	
38	26500	18248030	k=3	16353528.67	
37	28400	18386262	k=4	16861712	
64	29054	15100000	k=5	=AVERAGE(\$V\$2:V6)	
80	36104	13552485	k=6	16016555.5	
76	42530	13987843	k=7	15726739.43	
56	45900	16154000	k=8	15780147	

=AVERAGE(\$P\$2:P5)					
N	O	P	Q	R	S
Rank	Sorted Distance from Slapfish	sales	k	Predicted Sales	
58	0	16063684	k=1	16063684	
14	44526	23640652	k=2	19852168	
50	59742	17388751	k=3	19031029	
3	66196	29104017	k=4	=AVERAGE(\$P\$2:P5)	
2	138207	35218364	k=5	24283093.6	
43	161026	17834390	k=6	23208309.67	
15	258165	23138062	k=7	23198274.29	

a- The sorted list of Slapfish calculated absolute distances with its k-nearest neighbors.

Rank	Sorted Distance from Slapfish	sales	k	Predicted Sales
58	0	16063684	k=1	16063684
14	44526	23640652	k=2	19852168
50	59742	17388751	k=3	19031029
3	66196	29104017	k=4	21549276
2	138207	35218364	k=5	24283093.6
43	161026	17834390	k=6	23208309.67
15	258165	23138062	k=7	23198274.29
42	310930	17910045	k=8	22537245.63
30	333119	18687601	k=9	22109507.33
47	347098	17599468	k=10	21658503.4
74	405648	14362103	k=11	20995194.27
69	431896	14897125	k=12	20487021.83
9	440026	24547800	k=13	20799389.38
73	463099	14381904	k=14	20340997.57
29	472807	19379153	k=15	20276874.6
90	481026	12505200	k=16	19791144.94
40	485534	18159612	k=17	19695172.41
1	489223	39080335	k=18	20772125.89
27	541526	19829500	k=19	20722514
33	549274	18601433	k=20	20616459.95
5	556026	26900000	k=21	20915676.14
78	564444	13854856	k=22	20594729.77
82	568922	13102742	k=23	20268991.17
92	583717	12278839	k=24	19936068.17
28	583785	19530159	k=25	19919831.8
88	588001	12572109	k=26	19637227.08
59	588026	15700000	k=27	19491403.85
35	595417	18490719	k=28	19455665.11
77	600026	13908292	k=29	19264376.38
67	603026	14978103	k=30	19121500.6
6	610459	25409952	k=31	19324353.87
89	621106	12566618	k=32	19113174.63
34	636464	18521000	k=33	19095229.94
62	639026	15450000	k=34	18988017.29

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25	639826	20120210	k=35	19020365.66
11	644026	24268160	k=36	19166137.72
79	646976	13654113	k=37	19017164.08
63	659026	15106280	k=38	18914246.08
55	663026	16304883	k=39	18847339.33
87	667026	12713394	k=40	18693990.7
60	671126	15680000	k=41	18620478.73
17	673026	22859400	k=42	18721405.43
13	681176	23660000	k=43	18836256.47
26	682582	19831818	k=44	18858882.86
68	685026	14972300	k=45	18772514.36
41	689026	17965500	k=46	18754970.57
57	690964	16111510	k=47	18698726.72
81	691493	13177468	k=48	18583700.5
19	694026	22500000	k=49	18663624.98
10	701662	24501000	k=50	18780372.48
39	702196	18216906	k=51	18769324.12
18	706064	22749232	k=52	18845860.81
16	706526	22981600	k=53	18923893.62
36	706607	18483056	k=54	18915729.96
93	707226	12245998	k=55	18794462.11
51	709026	17212800	k=56	18766218.14
96	709026	12194000	k=57	18650916.07
7	712972	25233543	k=58	18764409.64
95	719026	12218147	k=59	18653456.03
83	720844	13100000	k=60	18560898.43
98	732800	12032014	k=61	18453867.54
66	734026	15000000	k=62	18398160
20	737967	22395577	k=63	18461611.06
45	748026	17743720	k=64	18450394.02
8	748194	24837595	k=65	18548658.65
100	750750	11391678	k=66	18440219.55
12	753026	23800000	k=67	18520216.27
24	756126	20853300	k=68	18554526.32
71	759125	14465847	k=69	18495270.1
4	760526	26916180	k=70	18615568.81
48	760826	17519030	k=71	18600124.61
46	763683	17637400	k=72	18586753.43
23	766252	21422141	k=73	18625594.36
70	768410	14790123	k=74	18573763.66
21	769026	22181607	k=75	18621868.24
54	771056	16364050	k=76	18592160.11
84	776026	12894700	k=77	18518167.12
53	777026	16981741	k=78	18498469.35
72	778706	14407413	k=79	18446683.82
85	780082	12884000	k=80	18377150.28
49	781689	17519000	k=81	18366555.83

65	782805	15067804	k=82	18326327.15
86	784860	12809921	k=83	18259864.42
99	787201	11965564	k=84	18184932.27
61	790725	15629700	k=85	18154870.72
44	791026	17816450	k=86	18150935.59
31	793878	18678000	k=87	18156993.8
91	794495	12498000	k=88	18092687.06
52	798264	17063477	k=89	18081122.9
75	809026	14130500	k=90	18037227.09
94	810891	12228168	k=91	17973391.27
22	813326	21523650	k=92	18011981.04
56	826026	16154000	k=93	17992002.75
76	829396	13987843	k=94	17949405.31
80	835822	13552485	k=95	17903121.94
64	842872	15100000	k=96	17873922.75
37	843526	18386262	k=97	17879204.6
38	845426	18248030	k=98	17882968.12
32	864026	18625033	k=99	17890463.73
97	871956	12187523	k=100	17833434.32

b- The sorted list of Melt Shop calculated absolute distances with its k-nearest neighbors.

Rank	Sorted Distance from Melt Shop	Sales	k	Predicted Sales
97	30	12187523	k=1	12187523
32	7900	18625033	k=2	15406278
38	26500	18248030	k=3	16353528.67
37	28400	18386262	k=4	16861712
64	29054	15100000	k=5	16509369.6
80	36104	13552485	k=6	16016555.5
76	42530	13987843	k=7	15726739.43
56	45900	16154000	k=8	15780147
22	58600	21523650	k=9	16418314
94	61035	12228168	k=10	15999299.4
75	62900	14130500	k=11	15829408.55
52	73662	17063477	k=12	15932247.58
91	77431	12498000	k=13	15668074.69
31	78048	18678000	k=14	15883069.36
44	80900	17816450	k=15	16011961.4
61	81201	15629700	k=16	15988070.06
99	84725	11965564	k=17	15751452.06
86	87066	12809921	k=18	15588033.67
65	89121	15067804	k=19	15560653.16
49	90237	17519000	k=20	15658570.5
85	91844	12884000	k=21	15526448.1
72	93220	14407413	k=22	15475582.86
53	94900	16981741	k=23	15541068

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84	95900	12894700	k=24	15430802.67
54	100870	16364050	k=25	15468132.56
21	102900	22181607	k=26	15726343.12
70	103516	14790123	k=27	15691668.3
23	105674	21422141	k=28	15896328.04
46	108243	17637400	k=29	15956365
48	111100	17519030	k=30	16008453.83
4	111400	26916180	k=31	16360315.97
71	112801	14465847	k=32	16301113.81
24	115800	20853300	k=33	16439058.85
12	118900	23800000	k=34	16655557.12
100	121176	11391678	k=35	16505160.57
8	123732	24837595	k=36	16736617.08
45	123900	17743720	k=37	16763836.08
20	133959	22395577	k=38	16912039.79
66	137900	15000000	k=39	16863013.13
98	139126	12032014	k=40	16742238.15
83	151082	13100000	k=41	16653403.07
95	152900	12218147	k=42	16547801.74
7	158954	25233543	k=43	16749795.72
51	162900	17212800	k=44	16760318.55
96	162900	12194000	k=45	16658844.8
93	164700	12245998	k=46	16562913.35
36	165319	18483056	k=47	16603767.45
16	165400	22981600	k=48	16736638.96
18	165862	22749232	k=49	16859344.94
39	169730	18216906	k=50	16886496.16
10	170264	24501000	k=51	17035800.16
19	177900	22500000	k=52	17140880.92
81	180433	13177468	k=53	17066099.55
57	180962	16111510	k=54	17048421.96
41	182900	17965500	k=55	17065096.11
68	186900	14972300	k=56	17027724.75
26	189344	19831818	k=57	17076919.37
13	190750	23660000	k=58	17190420.76
17	198900	22859400	k=59	17286505.15
60	200800	15680000	k=60	17259730.07
87	204900	12713394	k=61	17185199.97
55	208900	16304883	k=62	17171001.31
63	212900	15106280	k=63	17138227.95
79	224950	13654113	k=64	17083788.66
11	227900	24268160	k=65	17194317.45
25	232100	20120210	k=66	17238649.15
62	232900	15450000	k=67	17211952.9
34	235462	18521000	k=68	17231203.59
89	250820	12566618	k=69	17163600.9
6	261467	25409952	k=70	17281405.91

67	268900	14978103	k=71	17248965.03
77	271900	13908292	k=72	17202566.79
35	276509	18490719	k=73	17220212.71
59	283900	15700000	k=74	17199669.3
88	283925	12572109	k=75	17137968.49
28	288141	19530159	k=76	17169444.68
92	288209	12278839	k=77	17105930.32
82	303004	13102742	k=78	17054607.4
78	307482	13854856	k=79	17014104.22
5	315900	26900000	k=80	17137677.91
33	322652	18601433	k=81	17155748.96
27	330400	19829500	k=82	17188355.68
1	382703	39080335	k=83	17452114.47
40	386392	18159612	k=84	17460537.06
90	390900	12505200	k=85	17402238.98
29	399119	19379153	k=86	17425226.35
73	408827	14381904	k=87	17390245.63
9	431900	24547800	k=88	17471581.48
69	440030	14897125	k=89	17442655
74	466278	14362103	k=90	17408426.64
47	524828	17599468	k=91	17410526
30	538807	18687601	k=92	17424407.25
42	560996	17910045	k=93	17429629.16
15	613761	23138062	k=94	17490357.17
43	710900	17834390	k=95	17493978.57
2	733719	35218364	k=96	17678607.58
3	805730	29104017	k=97	17796395.31
50	812184	17388751	k=98	17792235.67
14	827400	23640652	k=99	17851310.59
58	871926	16063684	k=100	17833434.32

c- The sorted list of Original ChopShop calculated absolute distances with its k-nearest neighbors.

Rank	Sorted Distance from ChopShop	Sales	k	Predicted Sales
25	2033.34	20120210	k=1	20120210
11	2166.66	24268160	k=2	22194185
62	2833.34	15450000	k=3	19946123.33
79	5116.66	13654113	k=4	18373120.75
34	5395.34	18521000	k=5	18402696.6
63	17166.66	15106280	k=6	17853293.83
89	20753.34	12566618	k=7	17098054.43
55	21166.66	16304883	k=8	16998908
87	25166.66	12713394	k=9	16522739.78
60	29266.66	15680000	k=10	16438465.8
17	31166.66	22859400	k=11	17022187.09

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6	31400.34	25409952	k=12	17721167.5
67	38833.34	14978103	k=13	17510162.54
13	39316.66	23660000	k=14	17949436.64
26	40722.66	19831818	k=15	18074928.73
77	41833.34	13908292	k=16	17814513.94
68	43166.66	14972300	k=17	17647324.88
35	46442.34	18490719	k=18	17694180.11
41	47166.66	17965500	k=19	17708460.11
57	49104.66	16111510	k=20	17628612.6
81	49633.66	13177468	k=21	17416653.33
19	52166.66	22500000	k=22	17647714.55
59	53833.34	15700000	k=23	17563031.3
88	53858.34	12572109	k=24	17355076.21
28	58074.34	19530159	k=25	17442079.52
92	58142.34	12278839	k=26	17243493.35
10	59802.66	24501000	k=27	17512289.89
39	60336.66	18216906	k=28	17537454.75
18	64204.66	22749232	k=29	17717171.21
16	64666.66	22981600	k=30	17892652.17
36	64747.66	18483056	k=31	17911697.45
93	65366.66	12245998	k=32	17734644.34
51	67166.66	17212800	k=33	17718830.88
96	67166.66	12194000	k=34	17556335.85
7	71112.66	25233543	k=35	17775684.63
82	72937.34	13102742	k=36	17645880.67
95	77166.66	12218147	k=37	17499185.16
78	77415.34	13854856	k=38	17403281.76
83	78984.66	13100000	k=39	17292941.21
5	85833.34	26900000	k=40	17533117.68
98	90940.66	12032014	k=41	17398944.41
66	92166.66	15000000	k=42	17341826.69
33	92585.34	18601433	k=43	17371119.86
20	96107.66	22395577	k=44	17485312.07
27	100333.34	19829500	k=45	17537405.13
45	106166.66	17743720	k=46	17541890.24
8	106334.66	24837595	k=47	17697118
100	108890.66	11391678	k=48	17565754.67
12	111166.66	23800000	k=49	17692984.16
24	114266.66	20853300	k=50	17756190.48
71	117265.66	14465847	k=51	17691673.94
4	118666.66	26916180	k=52	17869068.29
48	118966.66	17519030	k=53	17862463.79
46	121823.66	17637400	k=54	17858295.94
23	124392.66	21422141	k=55	17923093.13
70	126550.66	14790123	k=56	17867147.23
21	127166.66	22181607	k=57	17942839.51
54	129196.66	16364050	k=58	17915619

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84	134166.66	12894700	k=59	17830518.68
53	135166.66	16981741	k=60	17816372.38
72	136846.66	14407413	k=61	17760487.8
85	138222.66	12884000	k=62	17681834.77
49	139829.66	17519000	k=63	17679250.1
65	140945.66	15067804	k=64	17638446.25
86	143000.66	12809921	k=65	17564161.25
99	145341.66	11965564	k=66	17479334.02
61	148865.66	15629700	k=67	17451727.54
44	149166.66	17816450	k=68	17457091.1
31	152018.66	18678000	k=69	17474785.43
91	152635.66	12498000	k=70	17403688.5
1	152636.34	39080335	k=71	17708993.38
40	156325.34	18159612	k=72	17715251.97
52	156404.66	17063477	k=73	17706323.55
90	160833.34	12505200	k=74	17636038.09
75	167166.66	14130500	k=75	17589297.59
94	169031.66	12228168	k=76	17518756.41
29	169052.34	19379153	k=77	17542917.4
22	171466.66	21523650	k=78	17593952.44
73	178760.34	14381904	k=79	17553293.59
56	184166.66	16154000	k=80	17535802.43
76	187536.66	13987843	k=81	17492000.46
80	193962.66	13552485	k=82	17443957.59
64	201012.66	15100000	k=83	17415717.13
37	201666.66	18386262	k=84	17427271.24
9	201833.34	24547800	k=85	17511042.16
38	203566.66	18248030	k=86	17519611.79
69	209963.34	14897125	k=87	17489468.26
32	222166.66	18625033	k=88	17502372.41
97	230096.66	12187523	k=89	17442655
74	236211.34	14362103	k=90	17408426.64
47	294761.34	17599468	k=91	17410526
30	308740.34	18687601	k=92	17424407.25
42	330929.34	17910045	k=93	17429629.16
15	383694.34	23138062	k=94	17490357.17
43	480833.34	17834390	k=95	17493978.57
2	503652.34	35218364	k=96	17678607.58
3	575663.34	29104017	k=97	17796395.31
50	582117.34	17388751	k=98	17792235.67
14	597333.34	23640652	k=99	17851310.59
58	641859.34	16063684	k=100	17833434.32

- 4- Selecting the optimal k value, set at 15 for the dataset, and predicting the anticipated ranking of each restaurant in the upcoming list of the top 100 restaurants in 2021.

Rank	Restaurant	Sales	Average Check	City	State	Meals Served
1	Carmine's (Times Square)	39080335.00	40.00	New York	N.Y.	469803.00
2	The Boathouse Orlando	35218364.00	43.00	Orlando	Fla.	820819.00
3	Old Ebbitt Grill	29104017.00	33.00	Washington	D.C.	892830.00
4	LAVO Italian Restaurant & Nightclub	26916180.00	90.00	New York	N.Y.	198500.00
5	Bryant Park Grill & Cafe	26900000.00	62.00	New York	N.Y.	403000.00
6	Gibsons Bar & Steakhouse	25409952.00	80.00	Chicago	Ill.	348567.00
7	Top of the World at the STRAT	25233543.00	103.00	Las Vegas	Nev.	246054.00
8	Maple & Ash	24837595.00	99.00	Chicago	Ill.	210832.00
9	Balthazar	24547800.00	87.00	New York	N.Y.	519000.00
10	Smith & Wollensky	24501000.00	107.00	New York	N.Y.	257364.00
11	Angus Barn	24268160.00	75.00	Raleigh	N.C.	315000.00
12	Prime 112	23800000.00	135.00	Miami Beach	Fla.	206000.00
13	Joe's Seafood, Prime Steak & Stone Crab	23660000.00	86.00	Washington	D.C.	277850.00
14	Junior's (Times Square)	23640652.00	23.00	New York	N.Y.	914500.00
15	The Hamilton	23138062.00	33.00	Washington	D.C.	700861.00
16	Joe's Seafood, Prime Steak & Stone Crab	22981600.00	91.00	Chicago	Ill.	252500.00
17	Joe's Seafood, Prime Steak & Stone Crab	22859400.00	81.00	Las Vegas	Nev.	286000.00
18	Gibsons Italia	22749232.00	108.00	Chicago	Ill.	252962.00
19	Komodo	22500000.00	98.00	Miami	Fla.	265000.00
20	Buddakan	22395577.00	67.00	New York	N.Y.	221059.00
21	Bazaar Meat by Jose Andres	22181607.00	119.00	Las Vegas	Nev.	190000.00
22	SW Steakhouse	21523650.00	149.00	Las Vegas	Nev.	145700.00
23	St. Elmo Steak House	21422141.00	99.00	Indianapolis	Ind.	192774.00
24	RPM Steak	20853300.00	102.00	Chicago	Ill.	202900.00
25	Slapfish	20276874.60	194.00	Huntington Beach	Calif.	959026.00
26	Mon Ami Gabi	20120210.00	76.00	Las Vegas	Nev.	319200.00
27	Gibsons Bar & Steakhouse	19831818.00	81.00	Oak Brook	Ill.	276444.00
28	Paddlefish	19829500.00	48.00	Orlando	Fla.	417500.00
29	Taste of Texas	19530159.00	55.00	Houston	Texas	375241.00
30	Parc	19379153.00	35.00	Philadelphia	Pa.	486219.00
31	Bob Chinn's Crab House	18687601.00	48.00	Wheeling	Ill.	625907.00
32	Quality Meats	18678000.00	115.00	New York	N.Y.	165148.00
33	Del Posto	18625033.00	194.00	New York	N.Y.	95000.00
34	Shooters Waterfront	18601433.00	57.00	Ft. Lauderdale	Fla.	409752.00
35	Bottega Louie	18521000.00	36.00	Los Angeles	Calif.	322562.00
36	Le Diplomate	18490719.00	38.00	Washington	D.C.	363609.00
37	Gibsons Bar & Steakhouse	18483056.00	79.00	Rosemont	Ill.	252419.00
38	Lavo Italian Restaurant & Lounge	18386262.00	97.00	Las Vegas	Nev.	115500.00
39	Prime Steakhouse	18248030.00	173.00	Las Vegas	Nev.	113600.00
40	Makoto	18216906.00	54.00	Bal Harbour	Fla.	256830.00
41	Original Joe's Westlake	18159612.00	35.00	Daly City	Calif.	473492.00
42	Original ChopShop	18074928.73	69.05	Plano	Texas	317166.66
43	Shaw's Crab House	17965500.00	72.00	Chicago	Ill.	270000.00
44	Founding Farmers (Washington, D.C.)	17910045.00	33.00	Washington	D.C.	648096.00
45	Junior's (49th Street)	17834390.00	22.00	New York	N.Y.	798000.00
46	Chops Lobster Bar	17816450.00	106.00	Atlanta	Ga.	168000.00
47	Chicago Cut Steakhouse	17743720.00	95.00	Chicago	Ill.	211000.00
48	Swift & Sons	17637400.00	119.00	Chicago	Ill.	195343.00
49	Harris Ranch Inn & Restaurant	17599468.00	29.00	Coalinga	Calif.	611928.00
50	Sparks Steak House	17519030.00	100.00	New York	N.Y.	198200.00
51	Quality Italian	17519000.00	95.00	New York	N.Y.	177337.00
52	Frankenmuth Bavarian Inn	17388751.00	19.00	Frankenmuth	Mich.	899284.00
53	Tavern on the Green	17212800.00	76.00	New York	N.Y.	250000.00
54	Abe & Louie's	17063477.00	106.00	Boston	Mass.	160762.00
55	Rusty Pelican	16981741.00	98.00	Miami	Fla.	182000.00
56	Beauty & Essex (New York City)	16364050.00	90.00	New York	N.Y.	187970.00
57	Grand Central Oyster Bar	16304883.00	62.00	New York	N.Y.	296000.00
58	Delmonico Steakhouse	16154000.00	103.00	Las Vegas	Nev.	133000.00
59	Portland City Grill	16111510.00	83.00	Portland	Ore.	268062.00
60	Zehnder's of Frankenmuth	16063684.00	17.00	Frankenmuth	Mich.	959026.00
61	Melt Shop	16011961.40	17.00	New York	N.Y.	87100.00
62	The Rustic Inn	15700000.00	43.00	Ft. Lauderdale	Fla.	371000.00
63	Harry Caray's Italian Steakhouse	15680000.00	59.00	Chicago	Ill.	287900.00
64	Keens Steakhouse	15629700.00	97.00	New York	N.Y.	168301.00
65	The Lobster House	15450000.00	43.00	Cape May	N.J.	320000.00
66	China Live	15106280.00	54.00	San Francisco	Calif.	300000.00
67	Prime & Provisions	15100000.00	130.00	Chicago	Ill.	116154.00
68	Carmine's (Las Vegas)	15067804.00	45.00	Las Vegas	Nev.	176221.00
69	Swan	15000000.00	78.00	Miami	Fla.	225000.00
70	15th Street Fisheries	14978103.00	69.00	Fort Lauderdale	Fla.	356000.00
71	Atlanta Fish Market	14972300.00	57.00	Atlanta	Ga.	274000.00
72	Acme Feed & Seed	14897125.00	22.00	Nashville	Tenn.	527130.00
73	Hugo's Frog Bar & Fish House	14790123.00	80.00	Chicago	Ill.	190616.00
74	Cliff House	14465847.00	40.00	San Francisco	Calif.	199901.00
75	Castaway Burbank	14407413.00	60.00	Burbank	Calif.	180320.00
76	Matt's El Rancho	14381904.00	29.00	Austin	Texas	495927.00
77	Timberline Steaks and Grille	14362103.00	37.00	Denver	Colo.	553378.00
78	Beauty & Essex (Las Vegas)	14130500.00	99.00	Las Vegas	Nev.	150000.00
79	Carmine's (Atlantic City)	13987843.00	39.00	Atlantic City	N.J.	129630.00
80	Junior's (Brooklyn)	13908292.00	23.00	New York	N.Y.	359000.00
81	Quartino Ristorante & Wine Bar	13854856.00	32.00	Chicago	Ill.	394582.00
82	Paradise Cove Beach Cafe	13654113.00	39.00	Malibu	Calif.	312050.00
83	BOA Steakhouse	13552485.00	110.00	West Hollywood	Calif.	123204.00
84	Original Joe's	13177468.00	45.00	San Francisco	Calif.	267533.00
85	Founding Farmers (McLean, Va.)	13102742.00	38.00	McLean	Va.	390104.00
86	Siena Tavern	13100000.00	55.00	Chicago	Ill.	238182.00
87	Girl & the Goat	12894700.00	82.00	Chicago	Ill.	183000.00
88	Tavern on Rush	12884000.00	72.00	Chicago	Ill.	178944.00
89	Harry & Izzy's Circle Centre	12809921.00	66.00	Indianapolis	Ind.	174166.00
90	Scoma's	12713394.00	65.00	San Francisco	Calif.	292000.00
91	Farmers Fishers Bakers	12572109.00	37.00	Washington	D.C.	371025.00
92	Southern Steak & Oyster	12566618.00	39.00	Nashville	Tenn.	337920.00
93	Big Texan Steak Ranch	12505200.00	24.00	Amarillo	Texas	478000.00
94	Park Avenue Summer (Autumn, Winter, Spring)	12498000.00	84.00	New York	N.Y.	164531.00
95	Farmers & Distillers	12278839.00	36.00	Washington	D.C.	375309.00
96	Virgil's Real Barbecue	12245998.00	31.00	New York	N.Y.	251800.00
97	Carmine's (Washington, D.C.)	12228168.00	39.00	Washington	D.C.	148135.00
98	Franciscan Crab Restaurant	12218147.00	59.00	San Francisco	Calif.	240000.00
99	George's at the Cove	12194000.00	80.00	La Jolla	Calif.	250000.00
100	Le Coucou	12187523.00	95.00	New York	N.Y.	87070.00

Inference and Report

To summarize the key points of statistical and visual analytics, restaurants that experience high sales and a low count of meals served are attributed to their expensive menu, whereas restaurants that experience low sales and high meals served counts are due to low prices. Generally, there is an inverse relationship between counts of meals served and sales. New York City, leading in sales among all U.S. cities and the most frequently appearing city in the list, exhibits varying counts of meals served among its restaurants based on precise locations. For instance, restaurants located in the Times Square area served many meals and had high sales at the same time. This means that popular areas in cities can have both high meals served counts and high sales. The k-nearest neighbor analysis applied assumptions about meals served counts to predict sales and rankings for three restaurants in the top 100 list of 2021. Projections for Slapfish, Melt Shop, and Original ChopShop at $k=15$ indicate respective sales of \$20,276,874.6, \$16,011,961.4, and \$18,074,928.73, with rankings of 25th, 61st, and 42nd. While commendable, none entered the top 10, highlighting the need for enhanced efforts to boost sales.

Things restaurants can do to increase sales:

- Improve their online presence by advertising online and interact with users.
- Improve food and service quality.
- Participate and offer discounts in special events.
- Relocate the store in a more populated area such as Times Square.

The rankings for the three forecasted restaurants are respectable, especially surpassing 40 others; however, Melt Shop, which secured the 61st position and stands as the last among the forecasted restaurants, had the potential to enhance its sales and meals served counts by relocating to the Times Square area. This suggestion comes from the fact that Times Square is recognized as the busiest area in New York City.