Introduction

Joe's Stone Crab is a restaurant in Miami Beach, Florida, known for its fresh local seafood and premium cuts of beef prepared by award-winning chefs. The company has grown into a multi-million dollar company and ranked second-highest-grossing independently owned restaurant in the U.S. by Restaurant Business. Of all their products, people fly in the most for their stone crabs. The company provided data from 2020-2023. We are tasked to forecast their sales for 2024.

Data Analysis

Seasonality

Table 1:

	2020	2021	2022	2023	AVG Demand	Seaonal Factor	Busy or Slow
Jan	242	263	282	306	273.25	1.41	Busy
Feb	235	238	255	280	252	1.30	Busy
Mar	232	247	245	270	248.5	1.28	Busy
Apr	178	191	205	210	196	1.01	Busy
May	184	193	210	214	200.25	1.04	Busy
Jun	140	149	160	175	156	0.81	Slow
Jul	145	157	165	182	162.25	0.84	Slow
Aug	152	160	175	193	170	0.88	Slow
Sep	110	122	126	130	122	0.63	Slow
Oct	130	130	148	155	140.75	0.73	Slow
Nov	152	167	173	182	168.5	0.87	Slow
Dec	206	230	235	255	231.5	1.20	Busy

Table 1 shows the demand for every month starting from January to December and it does this for four years. Before calculating the forecast for 2024 we had to find the seasonal factor of each month. To calculate seasonal factors, we need the benchmark and Average demand for all four years. To find AVG demand, we take the average demand for all four years per month. To find the benchmark, we take the average of AVG demand. The benchmark here was 193.416667. To get the seasonal factor of 1.41, I used the equation AVG Demand/ Benchmark (273.25/193.416667). Then I just used the same equation to find the Seasonal factor for the others. Using the seasonal factor we found out that the company is busy during their winter and spring months and slow during the summer and fall months. We can tell this because the seasonality from June to November is less than 1, while all the other months are greater than 1. With the Seasonal Factor, we can start calculating the Forecast for the next year.

Table 2:

Trend Analysis

Year	Period	Demand	S.F	Deseasonal	FIT	FITS	ABS Error	ABS Error^2
Year 1	1	242	1.41	171	171	241	0.63	0.40
	2	235	1.30	180	172	224	11.15	124.29
	3	232	1.28	181	173	222	10.02	100.48
	4	178	1.01	176	174	176	1.95	3.79
	5	184	1.04	178	175	181	3.14	9.83
	6	140	0.81	174	176	142	1.67	2.80
	7	145	0.84	173	177	148	3.15	9.95
	8	152	0.88	173	178	156	4.07	16.60
	9	110	0.63	174	179	113	2.61	6.82
	10	130	0.73	179	179	131	0.62	0.38
	11	152	0.87	174	180	157	5.21	27.11
	12	206	1.20	172	181	217	11.13	123.97
Year 2	13	263	1.41	186	182	258	5.35	28.62
	14	238	1.30	183	183	239	0.86	0.75
	15	247	1.28	192	184	237	10.22	104.44
	16	191	1.01	188	185	188	3.27	10.70
	17	193	1.04	186	186	193	0.21	0.04
	18	149	0.81	185	187	151	1.97	3.87
	19	157	0.84	187	188	158	0.82	0.67
	20	160	0.88	182	189	166	6.20	38.47
	21	122	0.63	193	190	120	2.12	4.49
	22	130	0.73	179	191	139	9.00	81.06
	23	167	0.87	192	192	167	0.25	0.06
	24	230	1.20	192	193	231	0.93	0.86
Year 3	25	282	1.41	200	194	274	8.07	65.15
	26	255	1.30	196	195	254	1.12	1.26
	27	245	1.28	191	196	252	6.58	43.35
	28	205	1.01	202	197	199	5.59	31.30
	29	210	1.04	203	198	205	5.28	27.84
	30	160	0.81	198	199	160	0.26	0.07
	31	165	0.84	197	200	167	2.49	6.18
	32	175	0.88	199	201	176	1.33	1.77
	33	126	0.63	200	202	127	1.15	1.32
	34	148	0.73	203	203	147	0.61	0.37
	35	173	0.87	199	203	177	4.28	18.35
	36	235	1.20	196	204	245	9.72	94.41
Year 4	37	306	1.41	217	205	290	15.79	249.43
	38	280	1.30	215	206	269	11.11	123.45
	39	270	1.28	210	207	266	3.61	13.05
	40	210	1.01	207	208	211	1.08	1.17
	41	214	1.04	207	209	217	2.65	7.04
	42	175	0.81	217	210	170	5.45	29.67
	43	182	0.84	217	211	177	4.85	23.51
	44	193	0.88	220	212	186	6.54	42.81
	45	130	0.63	206	213	134	4.42	19.50
	46	155	0.73	213	214	156	0.77	0.60
	47	182	0.87	209	215	187	5.32	28.32
	48	255	1.20	213	216	259	3.51	12.30
Year 5	49		1.41		217	306		
	50		1.30		218	284		
	51		1.28		219	281		
	52		1.01		220	223		
	53		1.04		221	229		
	54		0.81		222	179		
	55		0.84		223	187		
	56		0.88		224	197		
	57		0.63		225	142		
	58		0.73		226	164		
	59		0.87		227	197		
	60		1.20		228	272		

Table 2 shows the first steps in finding the forecast for the year 2024. We divide the data into 5 years. This data shows us the demand for the first 4 years and the seasonal factor which is the same for all 5 years. We first have to find the deseasonal factor which we found by dividing the demand by the Seasonal Factor. For example, in period 1, the demand was 242, and the seasonal factor was 1.41. We divided 242/1.41 and got 171. We then repeated these steps for the remaining periods until we reached year 5. Since we don't have demand for that year we can't calculate the seasonal factor. After calculating all Deseasonal factors, we have to do a regression analysis to find the coefficients of the y-intercept and the X variable.

Regression Table:

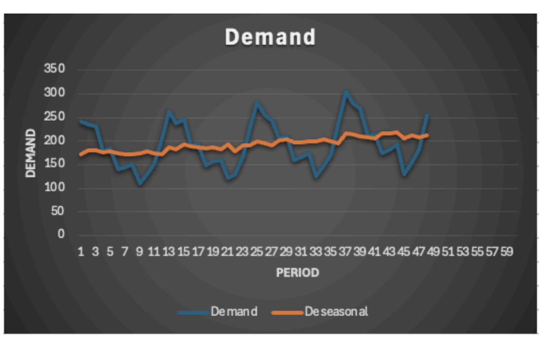
Regression Statistics	
Multiple R	0.931142424
R Square	0.867026214
Adjusted R Square	0.86413548
Standard Error	5.321438529
Observations	48

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	169.8916368	1.560487762	108.870855	3.7654E-57	166.7505379	173.032736	166.7505379	173.032736
X Variable 1	0.9602053	0.055443685	17.3185694	8.7989E-22	0.848602951	1.07180765	0.848602951	1.07180765

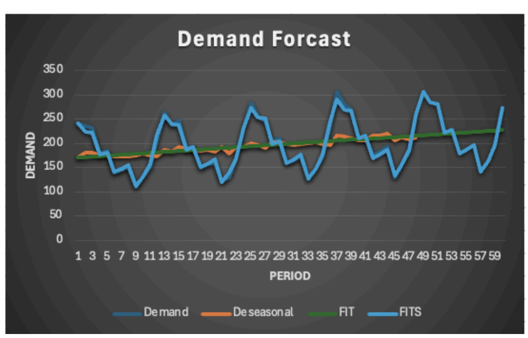
To Find the forecast we need to use the equation FIT = a + bt where a equals the intercept, b equals the X variable and t equals the period. we find the FIT or Forecast including Trend. Using the numbers we got doing a regression analysis we can use the equation FIT = 169.8916368 + (0.9602053 *period) to calculate the FIT for each period. Since FIT doesn't need demand we can calculate it for Year 5. After finding all the periods of FITs, we calculate the FITS which is a Forecast including Trend and Seasonality. So to calculate FITS we multiply the FIT by the seasonal factor to get the forecasted demands. For example, for period 1 the FIT is 171 and the Seasonal factor is 1.41 so 171 x 1.41 = 241.11 which is what Table 2 states. Also, in the Regression table, R squared represents how well the data can be shown in the regression model. Having a 0.86 is good because it means that the relationship between seasonality and period has a very strong positive relationship. This relationship means that there is a positive trend meaning the longer the time the demand the company will get. Below it is shown by Graph 2 since the trend line is going up and every year the peak of the demand keeps increasing over time.

Time Series Seasonal Adjustment

Graph 1:



Graph 2:



Error Table:

MAD	4.34
MAPE	2%
MSE	32.14

After finding every FITS we have completed the forecasting for year 5. Graph 1 shows the demand and the deseasonal factor not including year 5. Graph 2 is similar to graph 1, but includes the forecasted data. Comparing these two graphs shows that Graph 2 picks up from where Graph 1 ended following the trend. Forecasting can have slight errors, so to make sure it's as accurate as possible we calculate Mean Absolute Error which is a measure of the average magnitude of errors between actual and forecasted data, Mean Absolute Percentage Error which is a measure of prediction accuracy of a forecasting method in statistics, and finally Mean Squared Error which is a way to evaluate the quality of a forecasting model. It measures the average of the squared differences between the predicted values and the actual values. MAD being 4.34 and MAPE being at a % means that the forecast has little error in it meaning for the most part it will be accurate. MSE being 32.14 seems high but that's just the average difference squared of all the data and it's low so the forecast is reliable.

Business Recommendations

Based on what we found during the forecasting of year 5, the summer and fall months were slow for the company for the first 4 years and the forecast for year 5 also shows that the summer and fall seasons months will also be slow. We can tell this because the seasonality from June to November is less than 1. With this in mind, before it happens, the company should act. I recommend that since in the summer and fall months business is slow, the business could try to keep the same item that brings in customers for every season. Also since the company is located in Florida and the summer and fall seasons are hotter, the company can incorporate a new item that refreshes the customer or find a new way to prepare the stone crab making it a refreshing meal to cool people down. Doing so could increase demand which in turn increases the seasonality making over 1 meaning the company will be busy throughout the year. Also, the business could reduce staffing and supplies to an agreeable amount, in the months that are slower to reduce costs and in doing so, increase revenue.

Conclusion

While analyzing the data given to me by Mr. Joe I found out that the business is slow from June to November and busy from December to May. The business asked me to forecast 2024 while providing the year 2020-2023. Using these years I found that the forecast is similar to the actual demand given through previous years. The regression analysis showed that the relationship between deseasonality and period was positive meaning the trend line was also positive. Having a positive trend means that the more time is spent the more demand will be asked from the company. It's shown in Graph 2 as the demand peak per year increases as time goes on. The margin of error of the forecast is very low making it a reliable source and forecast. The business should try and make seasonal accommodations to help the slow seasons and possibly make more profit.