Notebook

January 31, 2025

[41]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
from sklearn.linear_model import Lasso, Ridge
from sklearn.ensemble import RandomForestRegressor
import warnings
warnings.filterwarnings('ignore')
```

[42]:
```
fact_table = pd.read_excel("case-study-data.xlsx", sheet_name = "Fact_table",␣
 ↪engine='openpyxl')
trans_dim = pd.read_excel("case-study-data.xlsx", sheet_name = "Trans_dim",␣
 ↪engine='openpyxl')
item_dim = pd.read_excel("case-study-data.xlsx", sheet_name = "Item_dim",␣
 ↪engine='openpyxl')
customer_dim = pd.read_excel("case-study-data.xlsx", sheet_name =␣
 ↪"Customer_dim", engine='openpyxl')
time_dim = pd.read_excel("case-study-data.xlsx", sheet_name = "Time_dim",␣
 ↪engine='openpyxl')
store_dim =  pd.read_excel("case-study-data.xlsx", sheet_name = "Store_dim",␣
 ↪engine='openpyxl')

print("data has been loaded successfully!!")
```

```
data has been loaded successfully!!
```

[43]:
```
fact_trans = pd.merge(fact_table, trans_dim,on= 'payment_key')
fact_trans_item = pd.merge(fact_trans, item_dim, on='item_key')
fact_trans_item_cust = pd.merge(fact_trans_item, customer_dim, on=␣
 ↪'customer_key')
fact_trans_item_cust_time = pd.merge(fact_trans_item_cust, time_dim, on=␣
 ↪'time_key')
```

```
fact_trans_item_cust_time_store = pd.merge(fact_trans_item_cust_time,␣
 ↪store_dim, on= 'store_key')
```

[44]:
```
fact_trans_item_cust_time_store.head(5)
```

[44]:
```
  payment_key customer_key time_key item_key store_key  quantity_sold  /
0        P025      C005440   T01562   I00264     S0035              1
1        P002      C002862   T02119   I00264     S0008              7
2        P001      C000360   T04322   I00091     S0024              4
3        P013      C001636   T02225   I00174     S0037             11
4        P039      C000641   T04425   I00241     S0009              6

    unit_x  unit_price_x  total_price trans_type  …      week month quarter  /
0       Ct          15.0         15.0       card  …  2nd Week     7      Q3
1       Ct          15.0        105.0       card  …  3rd Week     2      Q1
2  bottles           7.5         30.0       cash  …  2nd Week     1      Q1
3       oz          18.0        198.0       card  …  3rd Week     6      Q2
4       ct          12.0         72.0     mobile  …  1st Week     1      Q1

   year store_size                                          location  /
0  2016      large                                 Boira, Dhaka road
1  2016     medium                                          9 A road
2  2020      large  H-607,R-10 Baitul Aman Housing Society, Rajshahi
3  2019      small                                        Hill town
4  2019      small                 Infront of Mohonpur jame mosjid

        city    upazila_y district_y  division_y
0     Khulna        Boira     Khulna      Khulna
1  Sunamganj    Jamalganj  Sunamganj      Sylhet
2   Rajshahi     Rajshahi   Rajshahi    Rajshahi
3  Rangamati  Baghaichari  Rangamati  Chittagong
4  Sunamganj     Tahirpur  Sunamganj      Sylhet

[5 rows x 39 columns]
```

[45]:
```
fact_trans_item_cust_time_store.columns
```

[45]:
```
Index(['payment_key', 'customer_key', 'time_key', 'item_key', 'store_key',
       'quantity_sold', 'unit_x', 'unit_price_x', 'total_price', 'trans_type',
       'bank_name', 'item_name', 'item_type', 'unit_price_y', 'man_country',
       'supplier', 'stock_quantity', 'unit_y', 'name', 'contact_no', 'nid',
       'address', 'street', 'upazila_x', 'district_x', 'division_x', 'date',
       'hour', 'day', 'week', 'month', 'quarter', 'year', 'store_size',
       'location', 'city', 'upazila_y', 'district_y', 'division_y'],
      dtype='object')
```

[46]:
```
filtered_dataset = fact_trans_item_cust_time_store[(fact_trans_item_cust_time_store['item_key'].isin(['I00181', 'I00177']))]
filtered_dataset.head(3)
```

[46]:

	payment_key	customer_key	time_key	item_key	store_key	quantity_sold	/
315	P038	C007749	T02557	I00177	S0033	8	
420	P037	C004979	T01094	I00177	S0025	7	
758	P028	C004041	T00930	I00177	S0004	4	

	unit_x	unit_price_x	total_price	trans_type	…	week	month	quarter	/
315	ct	35.0	280.0	mobile	…	2nd Week	12	Q4	
420	ct	35.0	245.0	mobile	…	1st Week	2	Q1	
758	ct	35.0	140.0	card	…	1st Week	8	Q3	

	year	store_size	location	/
315	2014	small	House-255, Block-F, RD-01, Bashundhara R/A	
420	2018	medium	H#607,R#10,Baitul Aman Housing Society, Adabar…	
758	2019	medium	Palli Bidhut, Nabi Nagor, Savar	

	city	upazila_y	district_y	division_y
315	Dhaka	Bashundhara R/A	Dhaka	Dhaka
420	Dhaka	Mohammadpur	Dhaka	Dhaka
758	Dhaka	Savar	Dhaka	Dhaka

[3 rows x 39 columns]

0.0.1 Data cleaning

[47]:
```
filtered_dataset.isna().sum()
```

[47]:

payment_key	0
customer_key	0
time_key	0
item_key	0
store_key	0
quantity_sold	0
unit_x	0
unit_price_x	0
total_price	0
trans_type	0
bank_name	45
item_name	0
item_type	0
unit_price_y	0
man_country	0
supplier	0

```
stock_quantity     0
unit_y             0
name               2
contact_no         0
nid                0
address            0
street            24
upazila_x          0
district_x         0
division_x         0
date               0
hour               0
day                0
week               0
month              0
quarter            0
year               0
store_size         0
location           0
city               0
upazila_y          0
district_y         0
division_y         0
dtype: int64
```

[48]:
```
mode_street= filtered_dataset['street'].mode()[0]
filtered_dataset['street'].fillna(mode_street, inplace=True)
```

[49]:
```
mode_name= filtered_dataset['name'].mode()[0]
filtered_dataset['name'].fillna(mode_name, inplace=True)
```

[50]:
```
mode_bank= filtered_dataset['bank_name'].mode()[0]
filtered_dataset['bank_name'].fillna(mode_bank, inplace=True)
```

[51]:
```
filtered_dataset.isna().sum()
```

[51]:
```
payment_key       0
customer_key      0
time_key          0
item_key          0
store_key         0
quantity_sold     0
unit_x            0
unit_price_x      0
total_price       0
trans_type        0
bank_name         0
```

```
item_name          0
item_type          0
unit_price_y       0
man_country        0
supplier           0
stock_quantity     0
unit_y             0
name               0
contact_no         0
nid                0
address            0
street             0
upazila_x          0
district_x         0
division_x         0
date               0
hour               0
day                0
week               0
month              0
quarter            0
year               0
store_size         0
location           0
city               0
upazila_y          0
district_y         0
division_y         0
dtype: int64
```

0.0.2 Key insights of dataset

[52]:
```
filtered_dataset.describe().T
```

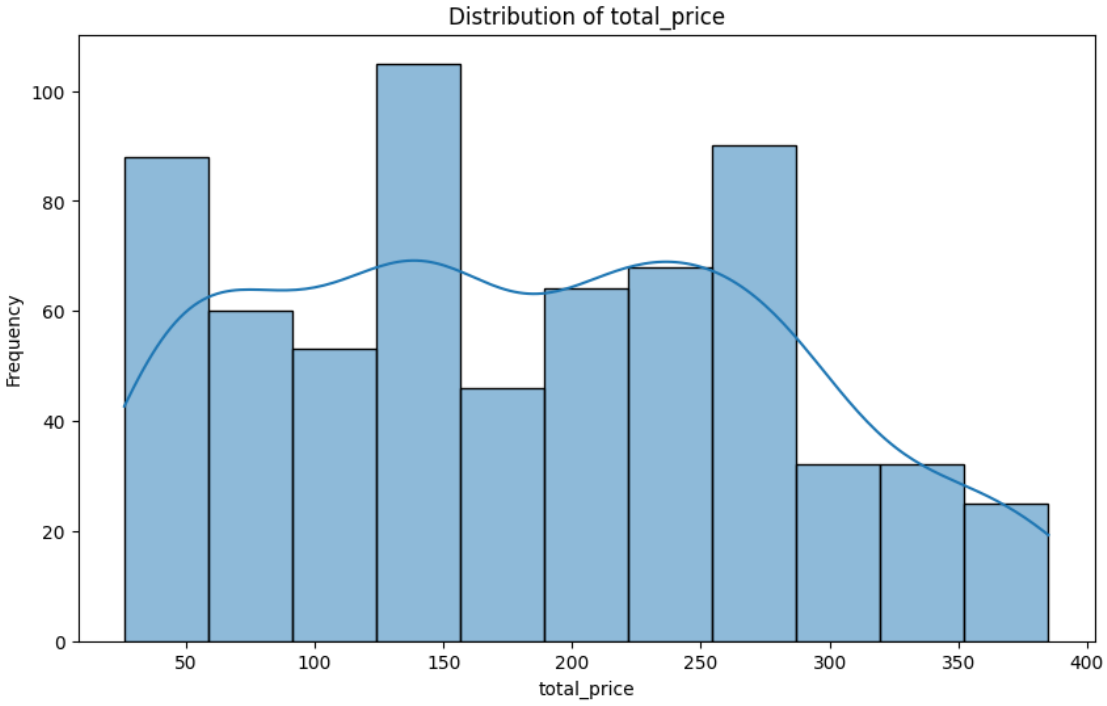
[52]:

	count	mean	std	min	25%	/
quantity_sold	663.0	6.022624e+00	3.150951e+00	1.000000e+00	3.000000e+00	
unit_price_x	663.0	3.065611e+01	4.500687e+00	2.600000e+01	2.600000e+01	
total_price	663.0	1.836561e+02	9.979553e+01	2.600000e+01	1.040000e+02	
unit_price_y	663.0	3.065611e+01	4.500687e+00	2.600000e+01	2.600000e+01	
stock_quantity	663.0	4.220814e+01	6.000916e+00	3.600000e+01	3.600000e+01	
contact_no	663.0	8.801749e+12	1.462665e+08	8.801510e+12	8.801619e+12	
nid	663.0	5.527299e+12	2.584920e+12	1.003268e+12	3.393087e+12	
hour	663.0	1.143288e+01	7.064738e+00	0.000000e+00	5.000000e+00	
day	663.0	1.556109e+01	8.786428e+00	1.000000e+00	8.000000e+00	
month	663.0	6.416290e+00	3.505521e+00	1.000000e+00	3.000000e+00	
year	663.0	2.016925e+03	1.959649e+00	2.014000e+03	2.015000e+03	

	50%	75%	max
quantity_sold	6.000000e+00	9.000000e+00	1.100000e+01
unit_price_x	3.500000e+01	3.500000e+01	3.500000e+01
total_price	1.750000e+02	2.600000e+02	3.850000e+02
unit_price_y	3.500000e+01	3.500000e+01	3.500000e+01
stock_quantity	4.800000e+01	4.800000e+01	4.800000e+01
contact_no	8.801753e+12	8.801867e+12	8.801999e+12
nid	5.536637e+12	7.673237e+12	9.996686e+12
hour	1.200000e+01	1.800000e+01	2.300000e+01
day	1.600000e+01	2.300000e+01	3.100000e+01
month	6.000000e+00	9.000000e+00	1.200000e+01
year	2.017000e+03	2.019000e+03	2.021000e+03

0.0.3 Visualization of the distribution of total_price

[53]:
```
plt.figure(figsize=(10, 6))
sns.histplot(filtered_dataset['total_price'], kde=True)
plt.title('Distribution of total_price')
plt.xlabel('total_price')
plt.ylabel('Frequency')
plt.show()
```



0.0.4 Sales Performance

[54]:
```
total_sales = filtered_dataset['total_price'].sum()
average_sales = filtered_dataset['total_price'].mean()
total_quantity_sold = filtered_dataset['quantity_sold'].sum()

print(f"Total Sales: {total_sales}")
print(f"Average Sales: {average_sales}")
print(f"Total Quantity Sold: {total_quantity_sold}")
```

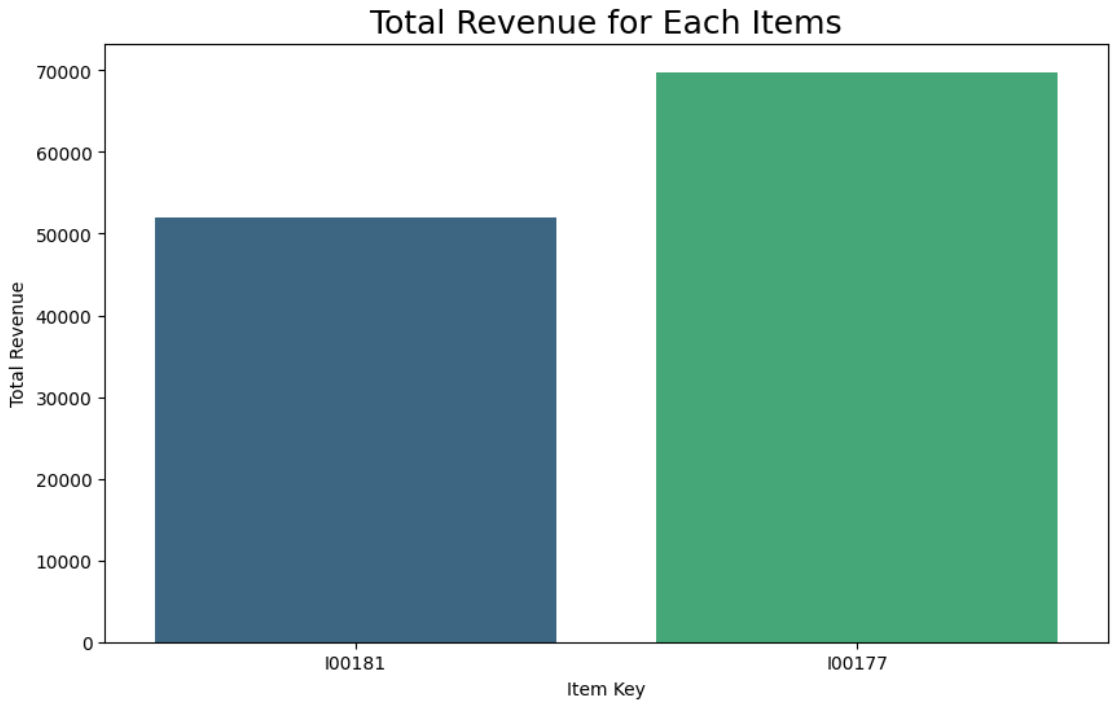
```
Total Sales: 121764.0
Average Sales: 183.65610859728505
Total Quantity Sold: 3993
```

0.0.5 Calculating total revenue for each product

Top performing Item: **I00177**

[55]:
```
I00181_total_rev = filtered_dataset[filtered_dataset['item_key'] ==␣
 ↪'I00181']['total_price'].sum()
I00177_total_rev = filtered_dataset[filtered_dataset['item_key'] ==␣
 ↪'I00177']['total_price'].sum()
data = {
    'Item Key': ['I00181', 'I00177'],
    'Total Revenue': [I00181_total_rev, I00177_total_rev]
}
df = pd.DataFrame(data)
print(df)

plt.figure(figsize=(10, 6))
sns.barplot(x='Item Key',
            y='Total Revenue',
            data=df,
            palette='viridis')
plt.title('Total Revenue for Each Items', fontsize = 18)
plt.xlabel('Item Key')
plt.ylabel('Total Revenue')
plt.show()
```

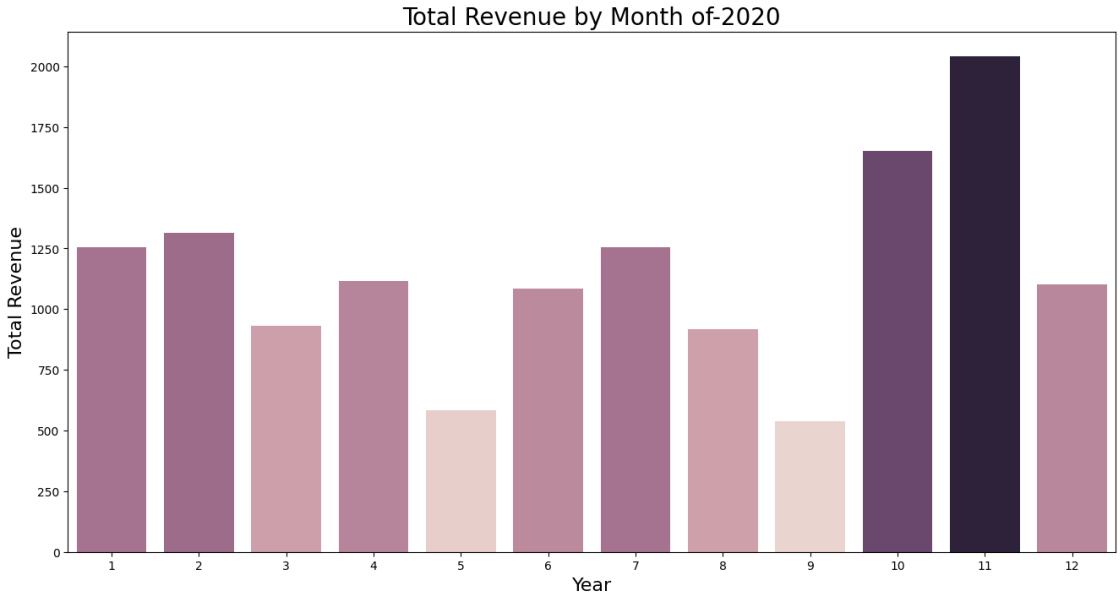
```
  Item Key  Total Revenue
0   I00181        51974.0
1   I00177        69790.0
```



0.0.6 Find out the total revenue by month of a specific year

- In 2020, we have best revenue on November, December

[56]:
```
def rev_by_year(year):
    rev_data = filtered_dataset[['year', 'month','total_price']]
    rev_data1 = rev_data.groupby(['year', 'month'], as_index=␣
 ↪False)['total_price'].sum()
    x = rev_data1[rev_data1['year'] == year]

    plt.figure(figsize=(16, 8))
    sns.barplot(x='month',
            y='total_price',
            data=x,
            hue= 'total_price',
            legend=False,
            ) # palette='viridis'
    plt.title(f'Total Revenue by Month of-{year}', fontsize = 20)
    plt.xlabel('Year', fontsize = 16)
    plt.ylabel('Total Revenue', fontsize = 16)
    # plt.xticks(rotation=45)
    return plt.show()

rev_by_year(2020)
```



0.0.7 Unit Sales Trend Over the Years

- Best Year for I00177: 2016
-

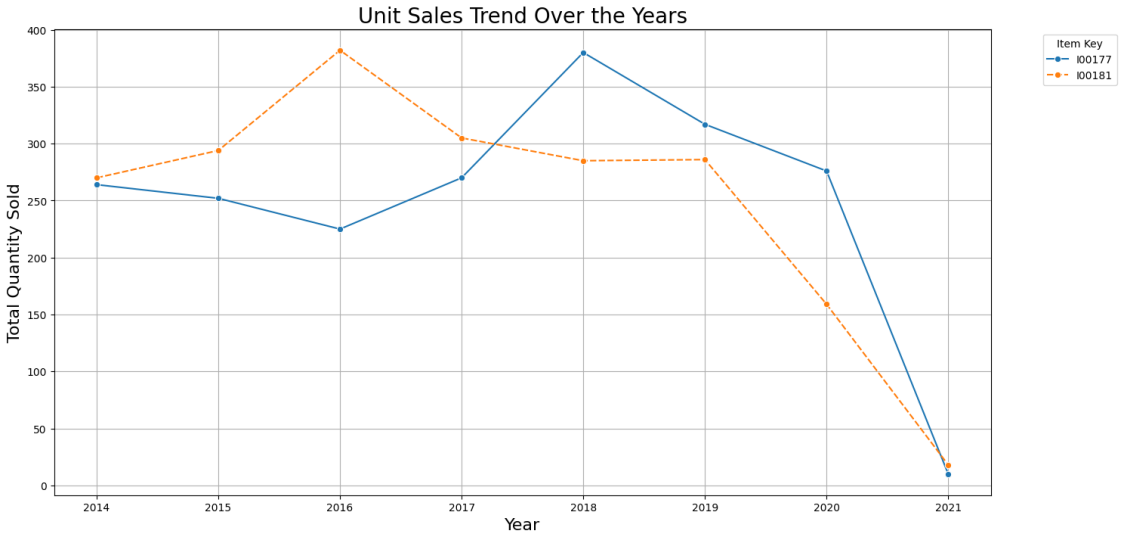
0.1 Bad year for I00177: 2020

- Best Year for I00181: 2018
- Bad year for I00181: 2016

[57]:
```
unit_sales_trend = filtered_dataset.groupby(['year',␣
 ↪'item_key'])['quantity_sold'].sum().reset_index()
unit_sales_trend_years = unit_sales_trend.pivot(index='item_key',␣
 ↪columns='year', values='quantity_sold').fillna(0)
print(unit_sales_trend_years.T)
plt.figure(figsize=(16, 8))
sns.lineplot(data=unit_sales_trend_years.T, marker='o')
plt.title('Unit Sales Trend Over the Years', fontsize=20)
plt.xlabel('Year', fontsize=16)
plt.ylabel('Total Quantity Sold', fontsize=16)
plt.legend(title='Item Key', bbox_to_anchor=(1.05, 1), loc='upper left')
plt.grid(True)
plt.show()
```

```
item_key  I00177  I00181
year
2014         264     270
```

2015	252	294
2016	225	382
2017	270	305
2018	380	285
2019	317	286
2020	276	159
2021	10	18

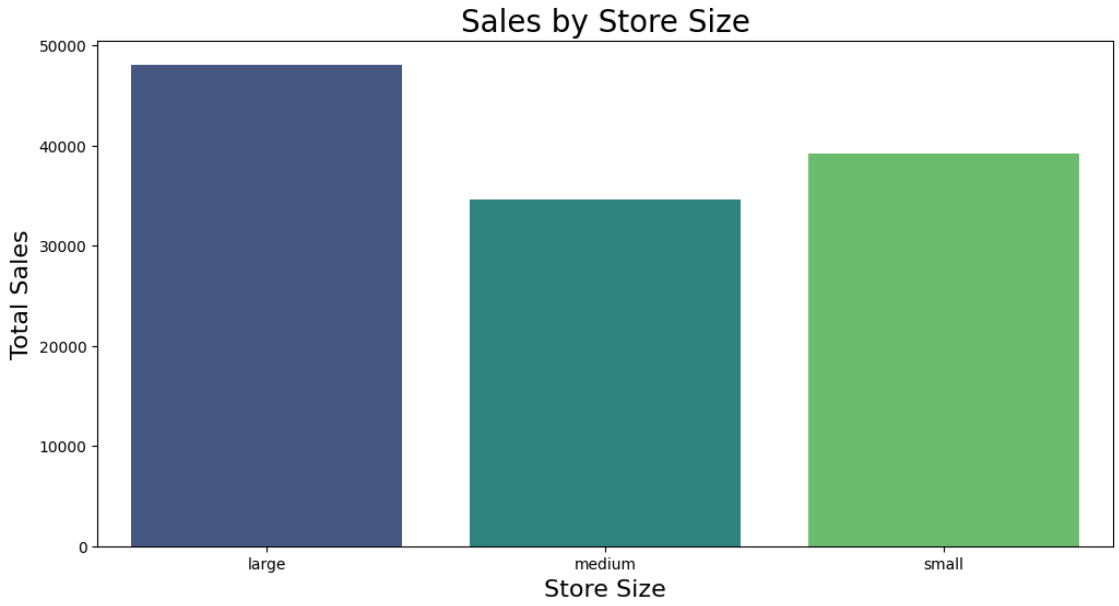


0.1.1 Sales by store size

- Most sales by store size: Large
- Underperforming store size: Medium

[58]:
```
sales_by_store_size = filtered_dataset.groupby('store_size')['total_price'].
 ↪sum().reset_index()
print(sales_by_store_size)
plt.figure(figsize=(12, 6))
sns.barplot(x='store_size', y='total_price', data=sales_by_store_size,␣
 ↪palette='viridis')
plt.title('Sales by Store Size', fontsize=20)
plt.xlabel('Store Size', fontsize=16)
plt.ylabel('Total Sales', fontsize=16)
plt.show()
```

```
  store_size  total_price
0      large      48065.0
1     medium      34565.0
2      small      39134.0
```

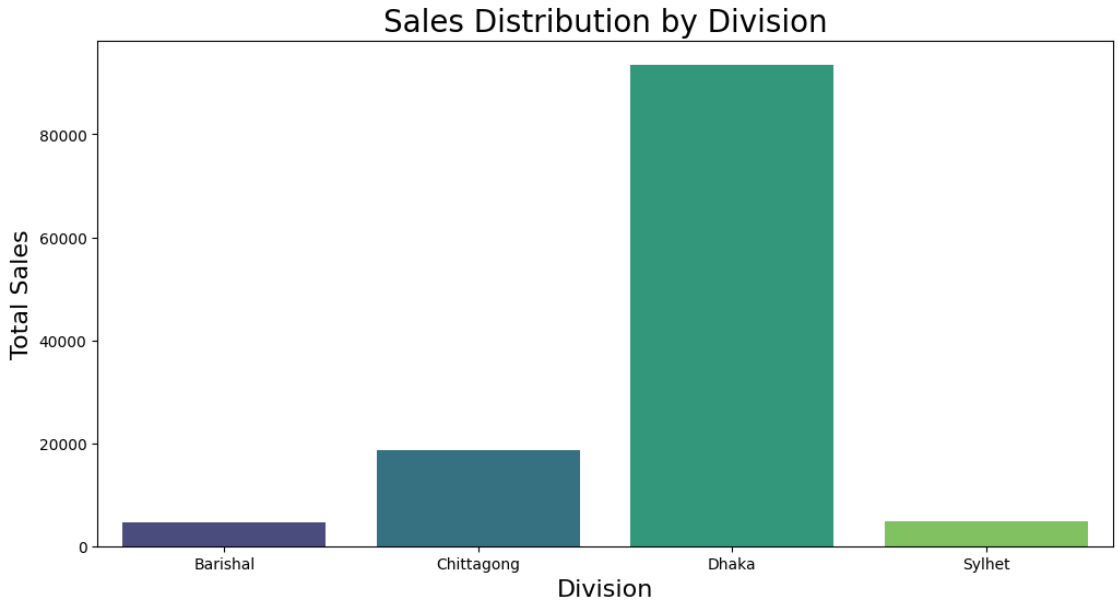


0.1.2 Sales distribution by division

- Most sales generated in: Dhaka
- Lowest sales generated in: Barishal

[59]:
```
sales_by_division = filtered_dataset.groupby('division_x')['total_price'].sum().
 ↪reset_index()
print(sales_by_division)
plt.figure(figsize=(12, 6))
sns.barplot(x='division_x', y='total_price', data=sales_by_division,␣
 ↪palette='viridis')
plt.title('Sales Distribution by Division', fontsize=20)
plt.xlabel('Division', fontsize=16)
plt.ylabel('Total Sales', fontsize=16)
plt.show()
```

```
   division_x  total_price
0    Barishal       4611.0
1  Chittagong      18739.0
2       Dhaka      93554.0
3      Sylhet       4860.0
```



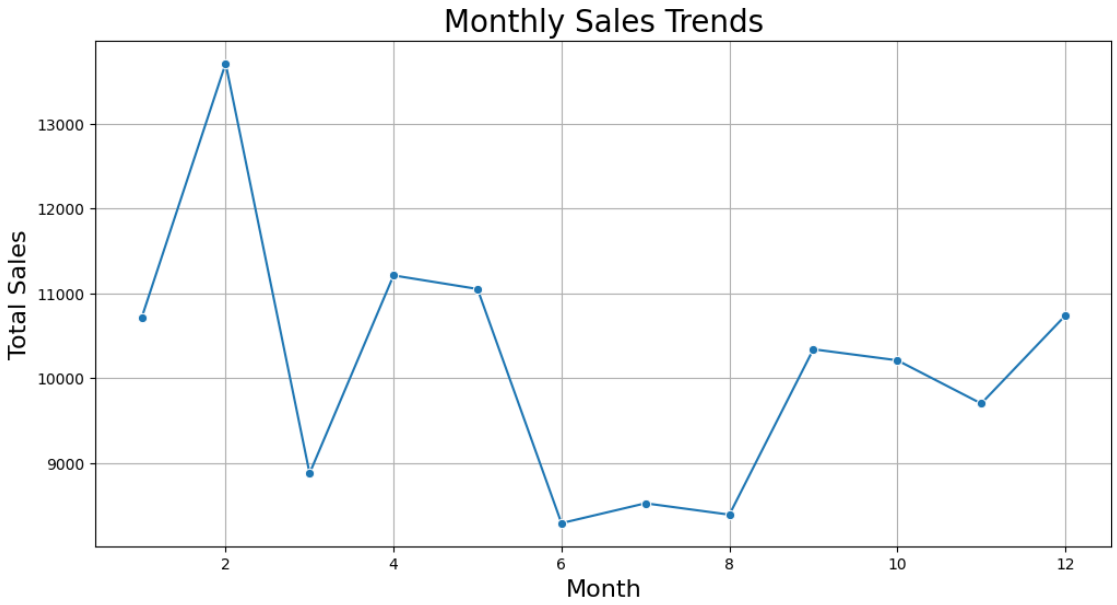
0.1.3 Monthly sales trends

- Best month for sales: February
- Bad month for sales: June

[60]:
```
monthly_sales = filtered_dataset.groupby('month')['total_price'].sum().
↪reset_index()
print(monthly_sales)
plt.figure(figsize=(12, 6))
sns.lineplot(x='month', y='total_price', data=monthly_sales, marker='o')
plt.title('Monthly Sales Trends', fontsize=20)
plt.xlabel('Month', fontsize=16)
plt.ylabel('Total Sales', fontsize=16)
plt.grid(True)
plt.show()
```

```
    month  total_price
0       1      10714.0
1       2      13711.0
2       3       8878.0
3       4      11212.0
4       5      11052.0
5       6       8291.0
6       7       8525.0
7       8       8391.0
8       9      10341.0
9      10      10211.0
10     11       9701.0
```

```
11      12      10737.0
```

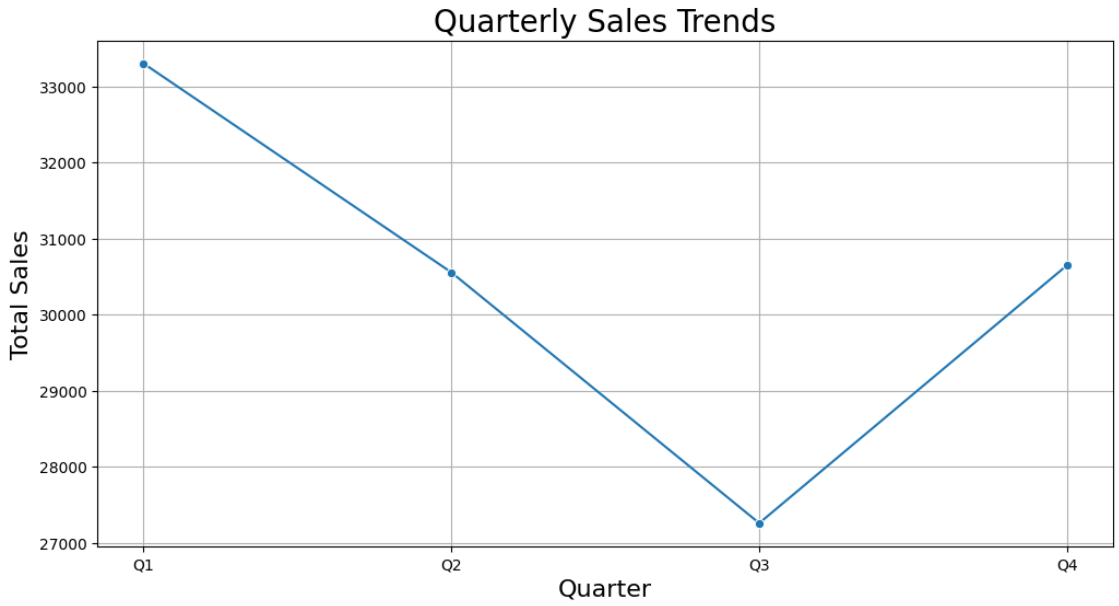


0.1.4 Quarterly sales trends

- Best quarter for sales: Q1
- Bad quarter for sales: Q3

[61]:
```
quarterly_sales = filtered_dataset.groupby('quarter')['total_price'].sum().
↪reset_index()
print(quarterly_sales)
plt.figure(figsize=(12, 6))
sns.lineplot(x='quarter', y='total_price', data= quarterly_sales, marker='o')
plt.title('Quarterly Sales Trends', fontsize=20)
plt.xlabel('Quarter', fontsize=16)
plt.ylabel('Total Sales', fontsize=16)
plt.grid(True)
plt.show()
```

```
  quarter  total_price
0      Q1      33303.0
1      Q2      30555.0
2      Q3      27257.0
3      Q4      30649.0
```

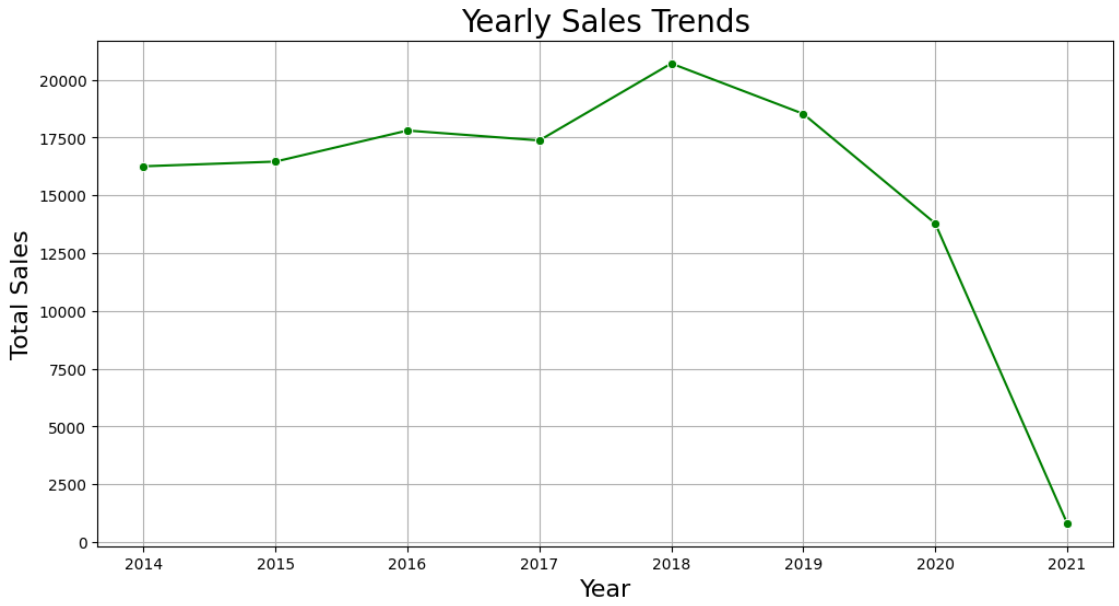


0.1.5 Yearly sales trend

- Best year in terms of sales: 2018
- Worst year in terms of sales: 2020

[62]:
```
yearly_sale = filtered_dataset.groupby('year')['total_price'].sum().
 ↪reset_index()
print(yearly_sale)
plt.figure(figsize=(12, 6))
sns.lineplot(x='year', y='total_price', data= yearly_sale, marker='o', color =␣
 ↪'green')
plt.title('Yearly Sales Trends', fontsize=20)
plt.xlabel('Year', fontsize=16)
plt.ylabel('Total Sales', fontsize=16)
plt.grid(True)
plt.show()
```

```
   year  total_price
0  2014      16260.0
1  2015      16464.0
2  2016      17807.0
3  2017      17380.0
4  2018      20710.0
5  2019      18531.0
6  2020      13794.0
7  2021        818.0
```

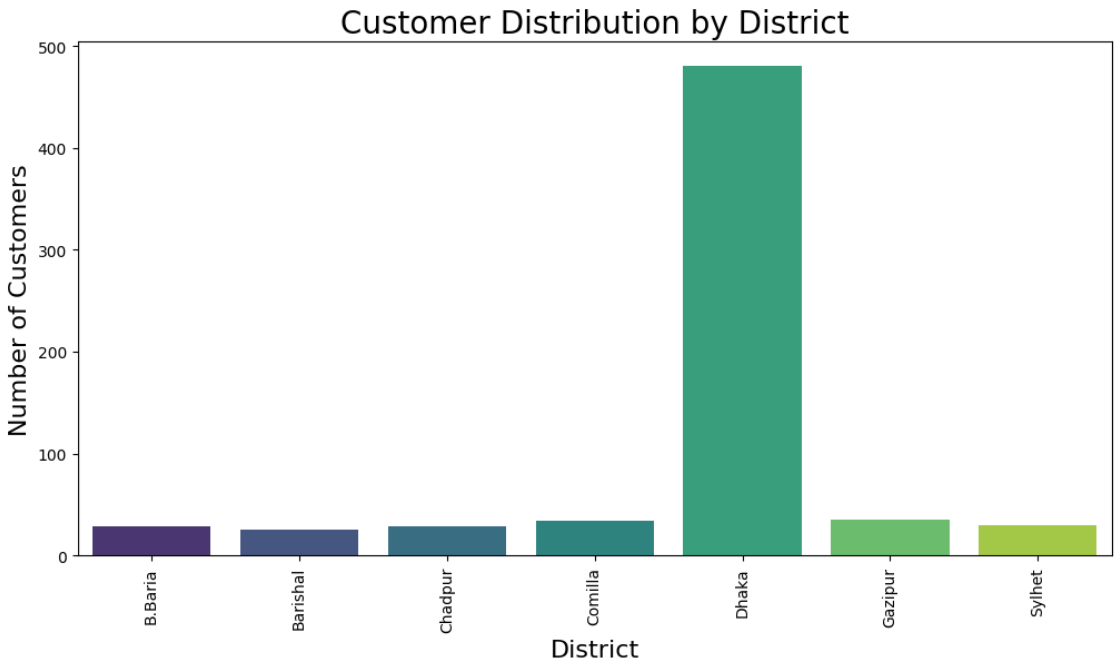


0.1.6 Customer distribution by district

- Best district in terms of customer distribution: Dhaka
- Underperforming district in terms of customer distribution: Barishal

[63]:
```
customer_distribution = filtered_dataset.groupby('district_x')['customer_key'].
 ↪count().reset_index()
print(customer_distribution)
plt.figure(figsize=(12, 6))
sns.barplot(x='district_x', y='customer_key', data=customer_distribution,␣
 ↪palette='viridis')
plt.title('Customer Distribution by District', fontsize=20)
plt.xlabel('District', fontsize=16)
plt.ylabel('Number of Customers', fontsize=16)
plt.xticks(rotation=90)
plt.show()
```

```
  district_x  customer_key
0    B.Baria            29
1   Barishal            26
2    Chadpur            29
3    Comilla            34
4      Dhaka           480
5    Gazipur            35
6     Sylhet            30
```

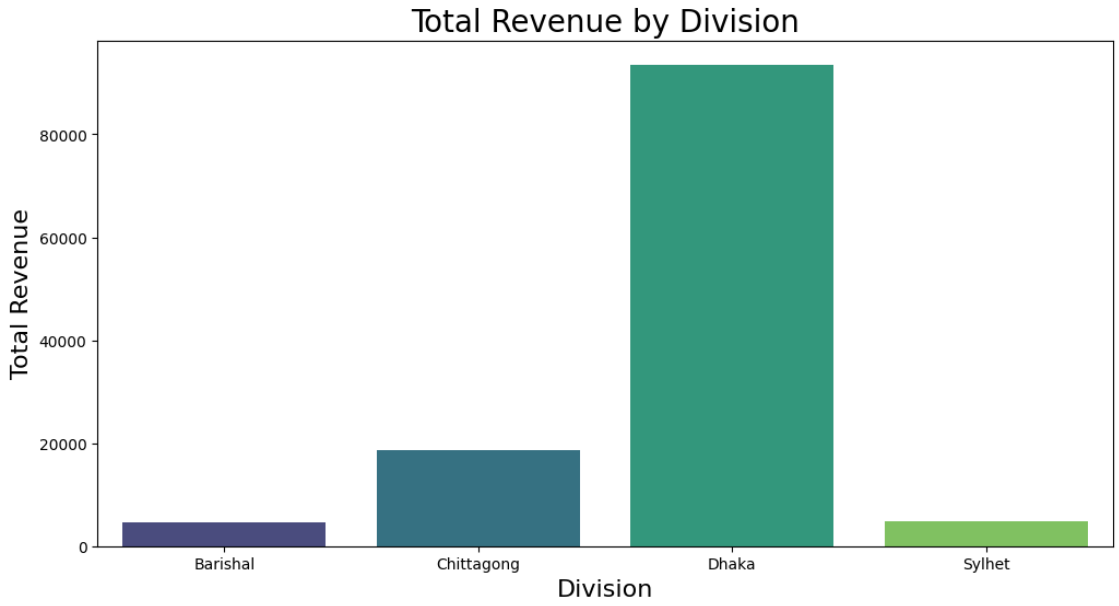


0.1.7 Total revenue by division

- Best district in terms of revenue: Dhaka
- Underperforming district in terms of revenue: Barishal

[64]:
```
total_revenue_by_division = filtered_dataset.
 ↪groupby('division_x')['total_price'].sum().reset_index()
print(total_revenue_by_division)

plt.figure(figsize=(12, 6))
sns.barplot(x='division_x', y='total_price', data=total_revenue_by_division,␣
 ↪palette='viridis')
plt.title('Total Revenue by Division', fontsize=20)
plt.xlabel('Division', fontsize=16)
plt.ylabel('Total Revenue', fontsize=16)
# plt.xticks(rotation=45)
plt.show()
```

```
   division_x  total_price
0    Barishal       4611.0
1  Chittagong      18739.0
2       Dhaka      93554.0
3      Sylhet       4860.0
```



0.1.8 Find the store_size-wise quarterly total sales price of all stores

Q1: - Best: Small ,Large - Underperforming: Medium

Q2: - Best: Large - Underperforming: Medium

Q2: - Best: Large - Underperforming: Medium

[65]:
```
mask_1 = filtered_dataset.groupby(['quarter', 'store_size'])['total_price'].
  ↪sum().reset_index()
print(f'this is avg total price data: /n {mask_1}')

sns.barplot(x='quarter',
            y='total_price',
            hue='store_size',
            data=mask_1,
            palette= 'viridis')
plt.title('Total Price by Quarter and Store Size')
plt.show()
```

```
this is avg total price data:
    quarter store_size  total_price
0       Q1      large      12073.0
1       Q1     medium       9107.0
2       Q1      small      12123.0
3       Q2      large      12093.0
4       Q2     medium       8763.0
5       Q2      small       9699.0
6       Q3      large       9739.0
```

```
7        Q3     medium       9359.0
8        Q3      small       8159.0
9        Q4      large      14160.0
10       Q4     medium       7336.0
11       Q4      small       9153.0
```

0.1.9 Year wise customer engagement for each division

2014 - Best Division: Barishal - Underperforming: Rangpur

2015 - Best Division: Chitagong - Underperforming: Rangpur

2016 - Best Division: Khulna - Underperforming: Barishal

2017 - Best Division: Rangpur - Underperforming: Sylhet

2018 - Best Division: Dhaka - Underperforming: Chitagong

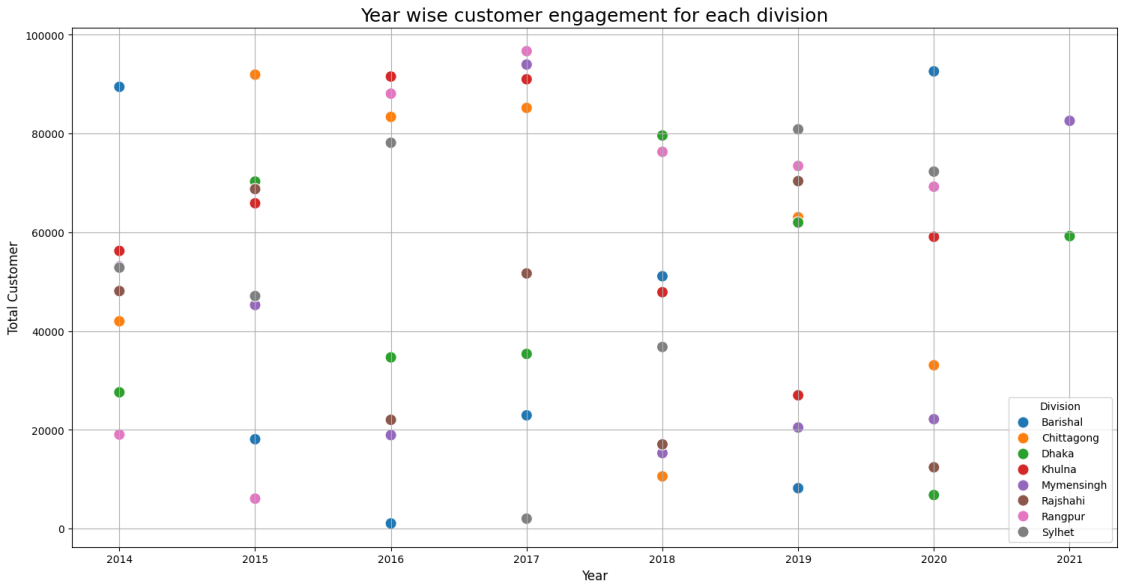
2019 - Best Division: Sylhet - Underperforming: Barishal

2020 - Best Division: Barishal - Underperforming: Dhaka

[66]:
```
yearly_custo_num = filtered_dataset.groupby(['year', 'division_y'],␣
  ↪as_index=False)['customer_key'].idxmax()
print(yearly_custo_num)
plt.figure(figsize=(18, 9))
sns.scatterplot(
    data=yearly_custo_num,
    x='year',
    y='customer_key',
    hue='division_y',
    palette='tab10',
    s=120
)

plt.title('Year wise customer engagement for each division', fontsize=18)
plt.xlabel('Year', fontsize=12)
plt.ylabel('Total Customer', fontsize=12)
plt.legend(title='Division')
plt.grid()
plt.show()
```

	year	division_y	customer_key
0	2014	Barishal	89462
1	2014	Chittagong	41995
2	2014	Dhaka	27608
3	2014	Khulna	56243
4	2014	Mymensingh	53136
5	2014	Rajshahi	48113
6	2014	Rangpur	19042
7	2014	Sylhet	52862
8	2015	Barishal	18105
9	2015	Chittagong	91934
10	2015	Dhaka	70286
11	2015	Khulna	65885
12	2015	Mymensingh	45289
13	2015	Rajshahi	68762
14	2015	Rangpur	6073
15	2015	Sylhet	47097
16	2016	Barishal	1049
17	2016	Chittagong	83376
18	2016	Dhaka	34683
19	2016	Khulna	91548
20	2016	Mymensingh	18937
21	2016	Rajshahi	22034
22	2016	Rangpur	88080
23	2016	Sylhet	78140
24	2017	Barishal	22945
25	2017	Chittagong	85200

26	2017	Dhaka	35382
27	2017	Khulna	91004
28	2017	Mymensingh	93977
29	2017	Rajshahi	51677
30	2017	Rangpur	96692
31	2017	Sylhet	2021
32	2018	Barishal	51111
33	2018	Chittagong	10581
34	2018	Dhaka	79617
35	2018	Khulna	47880
36	2018	Mymensingh	15298
37	2018	Rajshahi	17068
38	2018	Rangpur	76306
39	2018	Sylhet	36786
40	2019	Barishal	8191
41	2019	Chittagong	63061
42	2019	Dhaka	61992
43	2019	Khulna	26998
44	2019	Mymensingh	20477
45	2019	Rajshahi	70375
46	2019	Rangpur	73448
47	2019	Sylhet	80861
48	2020	Barishal	92600
49	2020	Chittagong	33085
50	2020	Dhaka	6808
51	2020	Khulna	59094
52	2020	Mymensingh	22169
53	2020	Rajshahi	12419
54	2020	Rangpur	69240
55	2020	Sylhet	72300
56	2021	Dhaka	59227
57	2021	Mymensingh	82581



0.1.10 Find out top 10 customer based on the total transaction

C000587 = 266.833333

C002435 = 262.750000

C005221 = 222.300000

C004795 = 208.750000

C002068 = 207.888889

C006063 = 205.500000

C004118 = 205.285714

C003519 = 201.800000

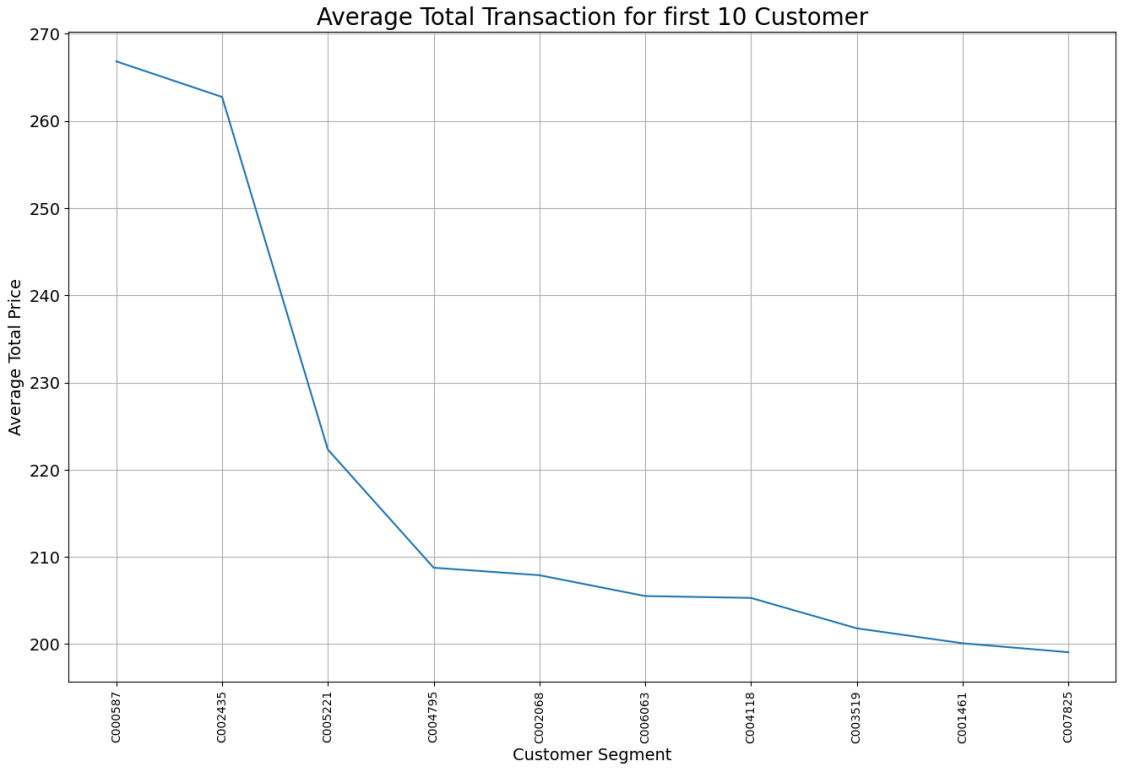
C001461 = 200.083333

C007825 = 199.055556

[67]:
```
x = fact_trans_item_cust_time_store[['customer_key', 'total_price']]
avg = x.groupby('customer_key')['total_price'].mean().reset_index()
avg.columns = ['Customer Segment', 'Average Total Price']
y = avg.sort_values(by='Average Total Price', ascending= False).iloc[:10]
print(y)
plt.figure(figsize=(16,10))
sns.lineplot(x='Customer Segment',
             y='Average Total Price',
             data=y,
             )
```

```
plt.title('Average Total Transaction for first 10 Customer', fontsize=20)
plt.xlabel('Customer Segment', fontsize=14)
plt.xticks(rotation=90, fontsize=10)
plt.ylabel('Average Total Price', fontsize=14)
plt.yticks(fontsize=14)
plt.grid(True)
plt.show()
```

	Customer Segment	Average Total Price
586	C000587	266.833333
2434	C002435	262.750000
5219	C005221	222.300000
4793	C004795	208.750000
2067	C002068	207.888889
6061	C006063	205.500000
4117	C004118	205.285714
3518	C003519	201.800000
1460	C001461	200.083333
7823	C007825	199.055556



0.1.11 What is the total revenue generated by each store?

Top 5 most revenue generated store: store_key total_price

S0039= 6409.0

S0024= 5065.0

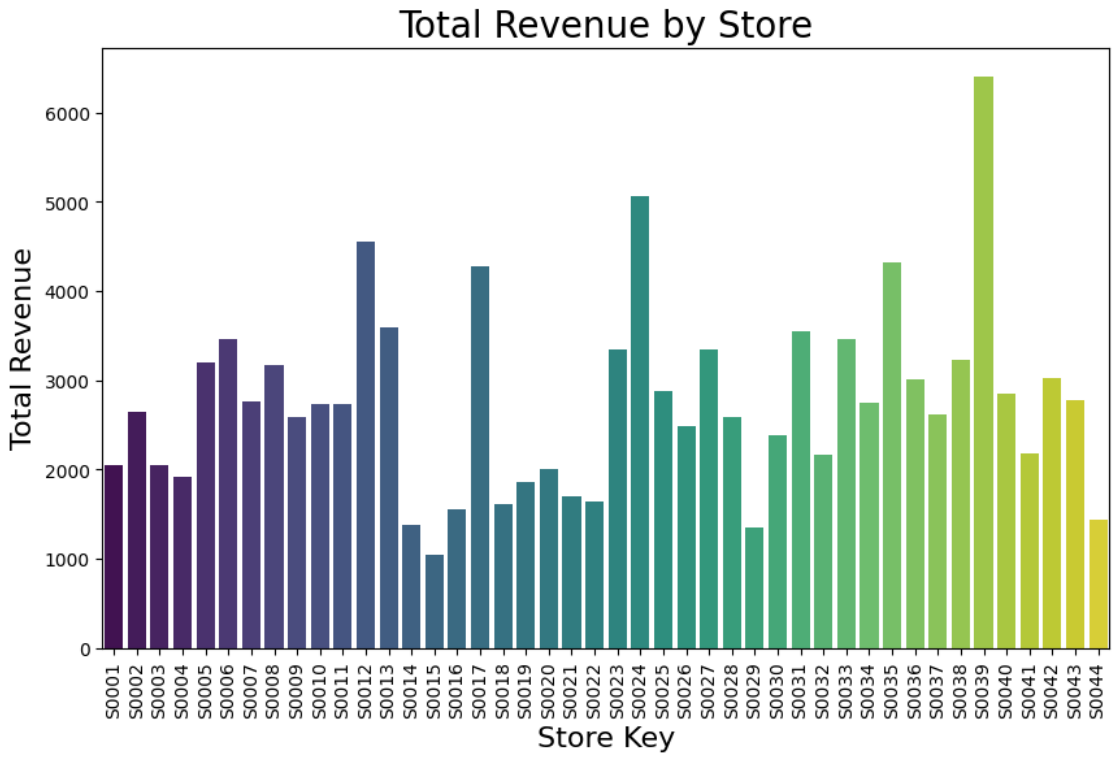
S0012= 4551.0

S0035= 4327.0

S0017= 4279.0

[68]:
```
store_rev = filtered_dataset[['store_key', 'total_price']]
store_rev_data = store_rev.groupby('store_key')['total_price'].sum().
 ↪reset_index()
print(store_rev_data.sort_values(by= 'total_price', ascending= False).head(5))

plt.figure(figsize=(10, 6))
sns.barplot(x='store_key',
            y='total_price',
            data=store_rev_data,
            hue='store_key',
            palette='viridis',
            )

plt.title('Total Revenue by Store', fontsize = 20)
plt.xlabel('Store Key', fontsize = 16)
plt.ylabel('Total Revenue', fontsize = 16)
plt.xticks(rotation=90)
plt.show()
```

```
   store_key  total_price
38     S0039       6409.0
23     S0024       5065.0
11     S0012       4551.0
34     S0035       4327.0
16     S0017       4279.0
```



0.1.12 Average Revenue per Division

Division Average Total Price

Chittagong= 203.684783

Dhaka= 181.658252

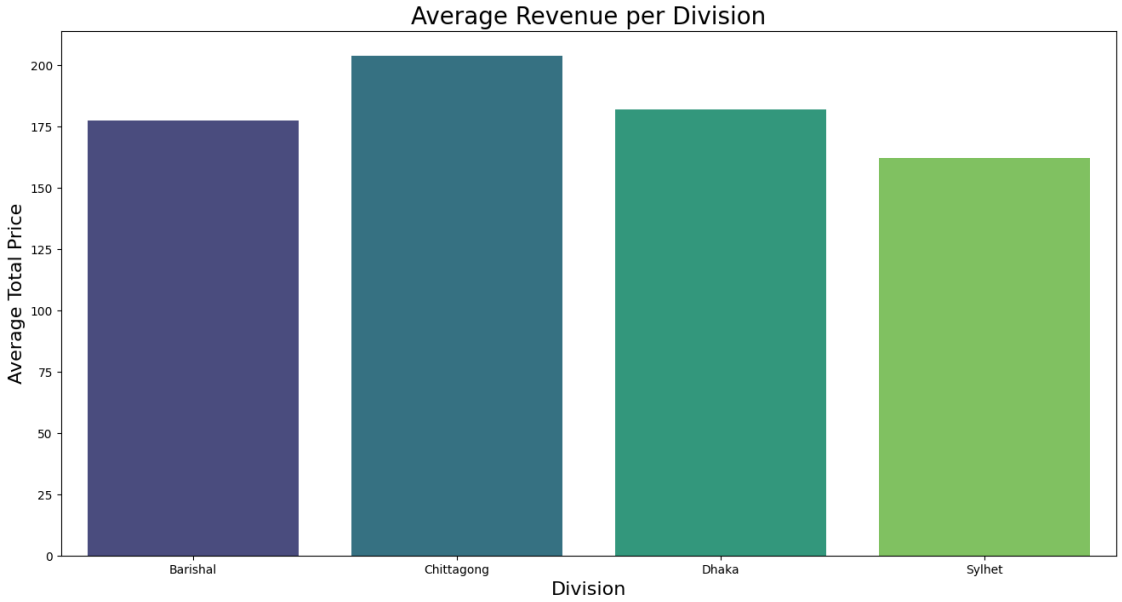
Barishal= 177.346154

Sylhet= 162.000000

[69]:
```
avg_price_div = filtered_dataset.groupby('division_x')['total_price'].mean().
  ↪reset_index()
avg_price_div.columns = ['Division', 'Average Total Price']
print(avg_price_div.sort_values(by= 'Average Total Price', ascending= False))

plt.figure(figsize=(16, 8))
sns.barplot(x='Division',
            y='Average Total Price',
            data=avg_price_div,
            palette='viridis')
plt.title('Average Revenue per Division', fontsize=20)
plt.xlabel('Division', fontsize=16)
plt.ylabel('Average Total Price', fontsize=16)
```

```
plt.show()
```

```
     Division  Average Total Price
1  Chittagong           203.684783
2       Dhaka           181.658252
0    Barishal           177.346154
3      Sylhet           162.000000
```



Best Performing Store:

store_key - total_price - quantity_sold

S0039 - 6409.0 - 206

S0024 - 5065.0 - 164

S0012 - 4551.0 - 147

S0035 - 4327.0 - 137

S0017 - 4279.0 - 140

Worst Performing Store:

store_key - total_price - quantity_sold

S0015 - 1050.0 - 30

S0029 - 1348.0 - 47

S0014 - 1376.0 - 46

S0044 - 1431.0 - 45

S0016 - 1560.0 - 51

[70]:
```
best_performing_store = filtered_dataset.groupby('store_key').
 ↪agg({'total_price': 'sum', 'quantity_sold': 'sum'}).
 ↪sort_values(by='total_price', ascending=False).head(5)
worst_performing_store = filtered_dataset.groupby('store_key').
 ↪agg({'total_price': 'sum', 'quantity_sold': 'sum'}).
 ↪sort_values(by='total_price', ascending=True).head(5)

print("Best Performing Store:")
print(best_performing_store)
print("**" * 20)
print("Worst Performing Store:")
print(worst_performing_store)
```

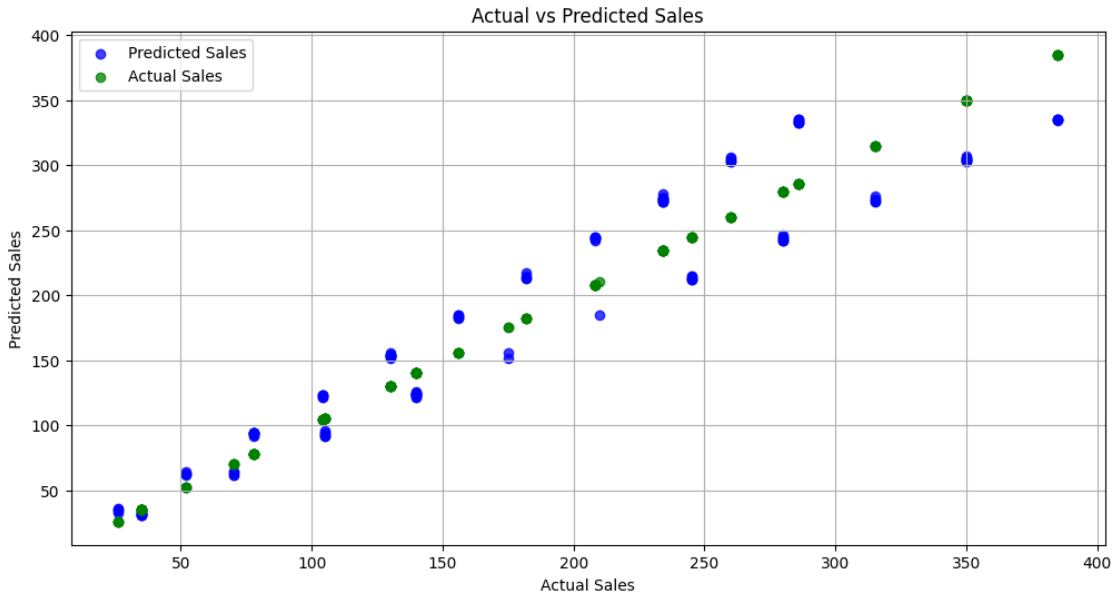
```
Best Performing Store:
           total_price  quantity_sold
store_key
S0039           6409.0            206
S0024           5065.0            164
S0012           4551.0            147
S0035           4327.0            137
S0017           4279.0            140
****************************************
Worst Performing Store:
           total_price  quantity_sold
store_key
S0015           1050.0             30
S0029           1348.0             47
S0014           1376.0             46
S0044           1431.0             45
S0016           1560.0             51
```

0.2 Prescriptive Analysis

[71]:
```
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score

# Step-1: Prepare the data
X = filtered_dataset[['store_size', 'division_x', 'item_type', 'quantity_sold']]
y = filtered_dataset['total_price']
```

```
lb_encoders = {}
label_cols = ['store_size', 'division_x', 'item_type']

for i in label_cols:
    lb_encoders[i] = LabelEncoder()
    X[i] = lb_encoders[i].fit_transform(X[i])

# Step-2: Split the data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

# Step-3: Train the model
model = LinearRegression()
model.fit(X_train, y_train)

# Step-4: Make predictions
y_pred = model.predict(X_test)

# Step-5: Evaluate the model
mae = mean_absolute_error(y_test, y_pred)
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f'Mean Absolute Error: {mae}')
print(f'Mean Squared Error: {mse}')
print(f'R^2 Score: {r2 * 100}')

# Step-6: Plot actual vs predicted values
plt.figure(figsize=(12, 6))
plt.scatter(y_test, y_pred, alpha=0.75, color='blue', label='Predicted Sales')
plt.scatter(y_test, y_test, alpha=0.75, color='green', label='Actual Sales')
plt.xlabel('Actual Sales')
plt.ylabel('Predicted Sales')
plt.title('Actual vs Predicted Sales')
plt.legend()
plt.grid()
plt.show()
```

```
Mean Absolute Error: 27.84361384820898
Mean Squared Error: 981.4425924577711
R^2 Score: 90.44204203896496
```



[72]:
```
type_encoder = lb_encoders['item_type']
type_encoder_mapping = dict(zip(type_encoder.classes_, type_encoder.
  ↪transform(type_encoder.classes_)))
print(type_encoder_mapping)
```

```
{'Food - Chocolate': 0}
```

[73]:
```
div_encoder = lb_encoders['division_x']
div_encoder_mapping = dict(zip(div_encoder.classes_, div_encoder.
  ↪transform(div_encoder.classes_)))
print(div_encoder_mapping)
```

```
{'Barishal': 0, 'Chittagong': 1, 'Dhaka': 2, 'Sylhet': 3}
```

[74]:
```
store_size_encoder = lb_encoders['store_size']
store_size_mapping = dict(zip(store_size_encoder.classes_, store_size_encoder.
  ↪transform(store_size_encoder.classes_)))
print(store_size_mapping)
```

```
{'large': 0, 'medium': 1, 'small': 2}
```

[75]:
```
X.head(5)
```

[75]:

	store_size	division_x	item_type	quantity_sold
315	2	2	0	8
420	1	2	0	7
758	1	2	0	4

```
1049            2            2            0               8
1052            1            2            0               5
```

[ ]:
```
target_revenue = 70000

store_sizes = lb_encoders['store_size'].classes_
divisions = lb_encoders['division_x'].classes_
item_types = lb_encoders['item_type'].classes_

best_combination = None
best_revenue_diff = float('inf')

for store_size in store_sizes:
    for division in divisions:
        for item_type in item_types:
            desired_features = pd.DataFrame({
                'store_size': [lb_encoders['store_size'].
 ↪transform([store_size])[0]],
                'division_x': [lb_encoders['division_x'].
 ↪transform([division])[0]],
                'item_type': [lb_encoders['item_type'].
 ↪transform([item_type])[0]],
                'quantity_sold': [1]
            })

            predicted_revenue = model.predict(desired_features)
            desired_features['quantity_sold'] = target_revenue /␣
 ↪predicted_revenue
            final_predicted_revenue = model.predict(desired_features)
            revenue_diff = abs(target_revenue - final_predicted_revenue[0])
            if revenue_diff < best_revenue_diff:
                best_revenue_diff = revenue_diff
                best_combination = {
                    'store_size': store_size,
                    'division': division,
                    'item_type': item_type,
                    'quantity_sold': desired_features['quantity_sold'].
 ↪values[0],
                    'predicted_revenue': final_predicted_revenue[0]
                }

print(f'Best Combination to Achieve Target Revenue of {target_revenue}:')
print(f'Store Size: {best_combination["store_size"]}')
print(f'Division: {best_combination["division"]}')
print(f'Item Type: {best_combination["item_type"]}')
print(f'Quantity Sold: {best_combination["quantity_sold"]}')
print(f'Predicted Revenue: {best_combination["predicted_revenue"]}')
```

```
Best Combination to Achieve Target Revenue of 70000:
Store Size: small
Division: Sylhet
Item Type: Food - Chocolate
Quantity Sold: 2355.814878453405
Predicted Revenue: 70949.87596469214
```

0.3 Predicting Demand for Inventory Management

[77]:
```
filtered_dataset['date']
```

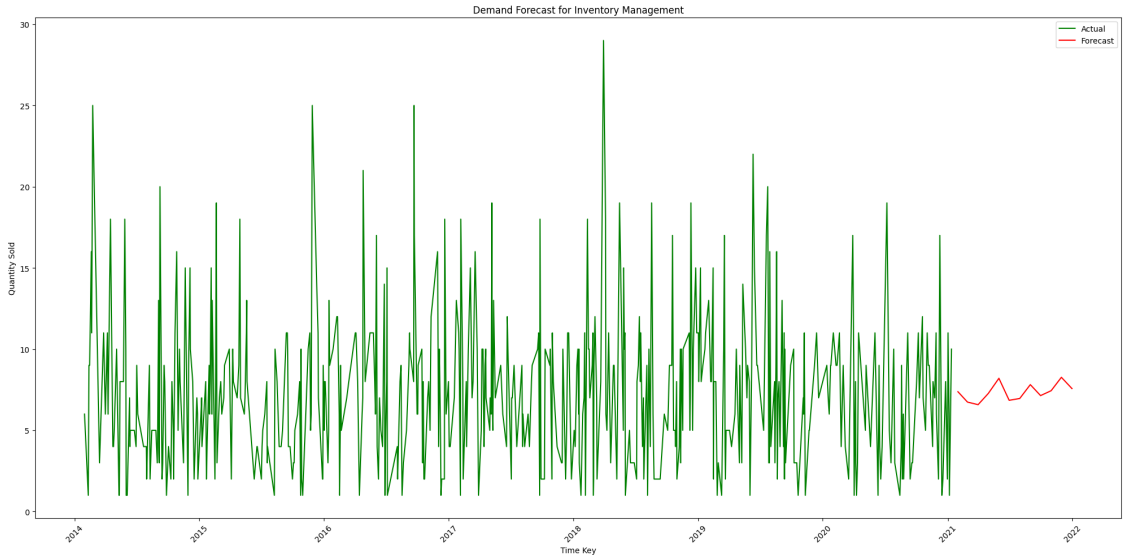
[77]:
```
315      13-12-2014 14:05
420      01-02-2018 23:29
758      02-08-2019 13:07
1049     31-12-2016 19:59
1052     02-09-2015 00:59
               …
98693    11-06-2020 11:44
98800    30-04-2015 14:42
99012    23-01-2018 03:40
99216    14-04-2018 19:53
99679    12-05-2014 21:33
Name: date, Length: 663, dtype: object
```

[78]:
```
# Convert the 'date' column to datetime format
filtered_dataset['date'] = pd.to_datetime(filtered_dataset['date'])
filtered_dataset['date'] = filtered_dataset['date'].dt.date
filtered_dataset['date']
```

[78]:
```
315      2014-12-13
420      2018-02-01
758      2019-08-02
1049     2016-12-31
1052     2015-09-02
            …
98693    2020-06-11
98800    2015-04-30
99012    2018-01-23
99216    2018-04-14
99679    2014-05-12
Name: date, Length: 663, dtype: object
```

0.3.1 Quantity prediction

[79]:
```
from statsmodels.tsa.holtwinters import ExponentialSmoothing

time_series_data = filtered_dataset.groupby('date')['quantity_sold'].sum().
 ↪reset_index()
time_series_data['date'] = pd.to_datetime(time_series_data['date'])

model = ExponentialSmoothing(time_series_data['quantity_sold'], trend='add',␣
 ↪seasonal='add', seasonal_periods=12)
fit = model.fit()

forecast = fit.forecast(steps=12)
forecast_index = pd.date_range(start=time_series_data['date'].iloc[-1],␣
 ↪periods=12, freq='M')

plt.figure(figsize=(20, 10))
plt.plot(time_series_data['date'], time_series_data['quantity_sold'],␣
 ↪label='Actual', color='green')
plt.plot(forecast_index, forecast, label='Forecast', color='red')
plt.title('Demand Forecast for Inventory Management')
plt.xlabel('Time Key')
plt.ylabel('Quantity Sold')
plt.legend()
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



0.3.2 Revenue Forecasting

[80]:
```
time_series_data = filtered_dataset.groupby('date')['total_price'].sum().
 ↪reset_index()
time_series_data['date'] = pd.to_datetime(time_series_data['date'])

model = ExponentialSmoothing(time_series_data['total_price'], trend='add',␣
 ↪seasonal='add', seasonal_periods=12)
fit = model.fit()

forecast = fit.forecast(steps=12)
forecast_index = pd.date_range(start=time_series_data['date'].iloc[-1],␣
 ↪periods=12, freq='M')

plt.figure(figsize=(20, 10))
plt.plot(time_series_data['date'], time_series_data['total_price'],␣
 ↪label='Actual', color='green')
plt.plot(forecast_index, forecast, label='Forecast', color='red')
plt.title('Revenue Forecast for Inventory Management')
plt.xlabel('Time Key')
plt.ylabel('Revenue')
plt.legend()
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```