In [168…
```
###GANESH  BABU KAMMA
```

In [167…
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

import statsmodels
import statsmodels.api as sm
import sklearn
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler
import statsmodels.api as sm
from sklearn.metrics import r2_score
from sklearn.metrics import mean_squared_error
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import accuracy_score
from sklearn import preprocessing
import warnings
warnings.filterwarnings('ignore')
```

In [ ]:

In [ ]:

In [ ]:

In [130…
```
Delivery_time_Data=pd.read_csv('porter_data_1.csv')
Delivery_time_Data.head()
```

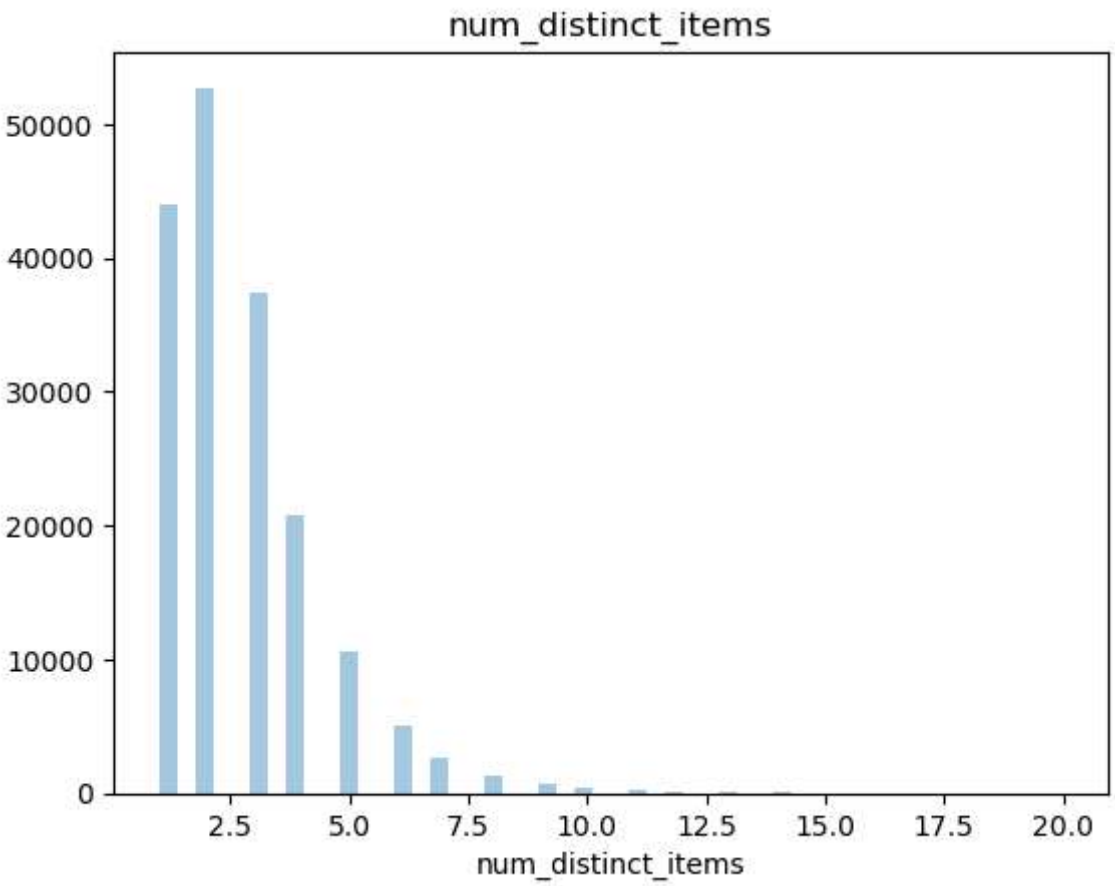
Out[130…

	market_id	created_at	actual_delivery_time	store_primary_category	order_protocol	tota
0	1.0	2015-02-06 22:24:17	2015-02-06 23:11:17	4	1.0	
1	2.0	2015-02-10 21:49:25	2015-02-10 22:33:25	46	2.0	
2	2.0	2015-02-16 00:11:35	2015-02-16 01:06:35	36	3.0	
3	1.0	2015-02-12 03:36:46	2015-02-12 04:35:46	38	1.0	
4	1.0	2015-01-27 02:12:36	2015-01-27 02:58:36	38	1.0	

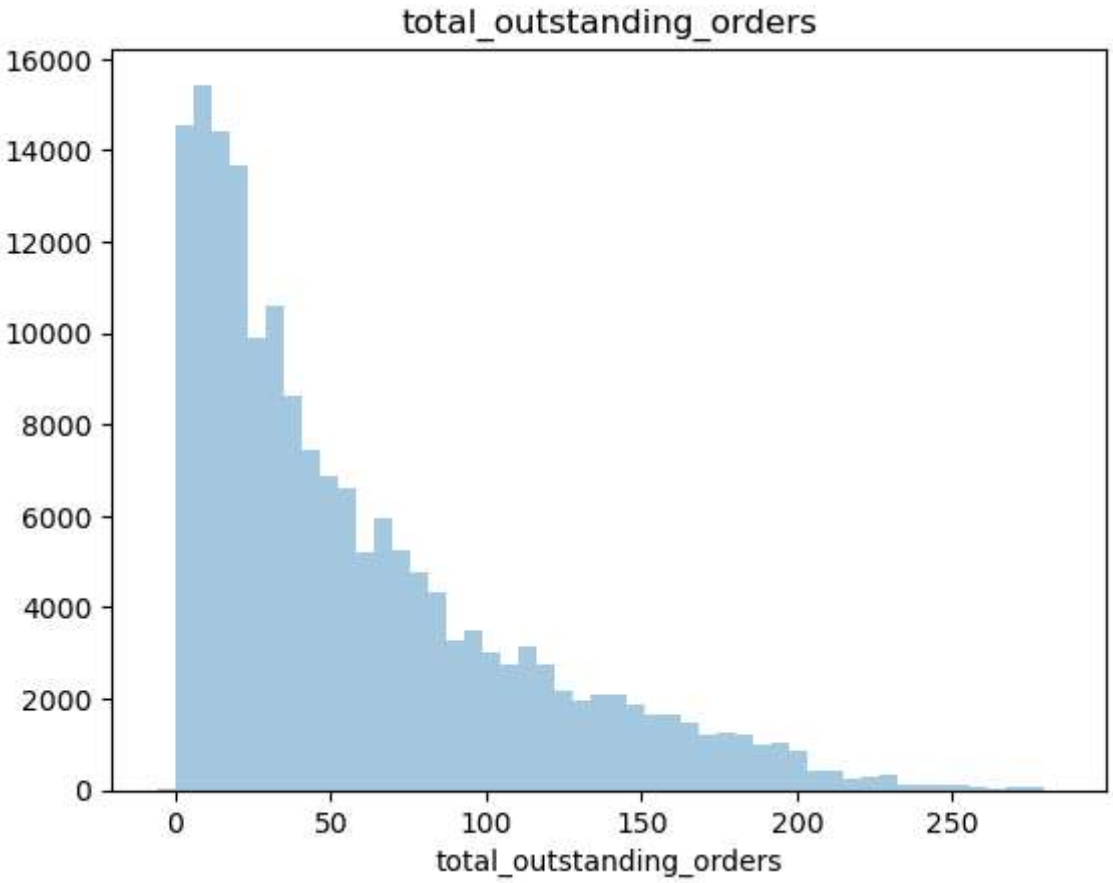
In [131…
```
Delivery_time_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 175777 entries, 0 to 175776
Data columns (total 14 columns):
 #   Column                    Non-Null Count   Dtype  
---  ------                    --------------   -----  
 0   market_id                 175777 non-null  float64
 1   created_at                175777 non-null  object 
 2   actual_delivery_time      175777 non-null  object 
 3   store_primary_category    175777 non-null  int64  
 4   order_protocol            175777 non-null  float64
 5   total_items               175777 non-null  int64  
 6   subtotal                  175777 non-null  int64  
 7   num_distinct_items        175777 non-null  int64  
 8   min_item_price            175777 non-null  int64  
 9   max_item_price            175777 non-null  int64  
 10  total_onshift_dashers     175777 non-null  float64
 11  total_busy_dashers        175777 non-null  float64
 12  total_outstanding_orders  175777 non-null  float64
 13  distance                  175777 non-null  float64
dtypes: float64(6), int64(6), object(2)
memory usage: 18.8+ MB
```

In [132…
```
sns.distplot(Delivery_time_Data['num_distinct_items'],kde=False)
plt.title('num_distinct_items')
plt.show()
```

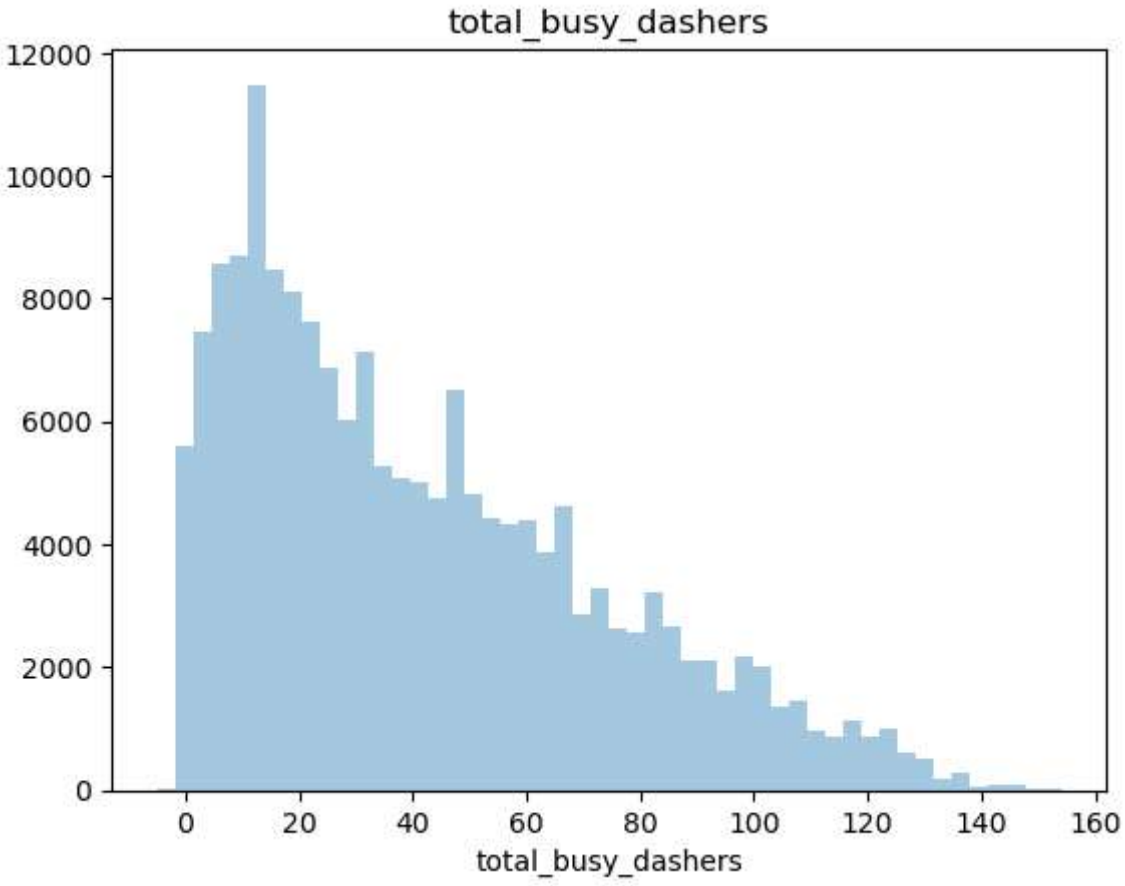


In [7]:
```
sns.distplot(Delivery_time_Data['total_outstanding_orders'],kde=False)
plt.title('total_outstanding_orders')
plt.show()
```



In [ ]:
```
```

In [8]:
```
sns.distplot(Delivery_time_Data['total_busy_dashers'],kde=False)
plt.title('total_busy_dashers')
plt.show()
```



In [9]:
```
Delivery_time_Data.describe()
```

Out[9]:

	market_id	store_primary_category	order_protocol	total_items	subtota
count	175777.000000	175777.000000	175777.000000	175777.000000	175777.000000
mean	2.743726	35.887949	2.911752	3.204976	2697.111147
std	1.330963	20.728254	1.513128	2.674055	1828.554893
min	1.000000	0.000000	1.000000	1.000000	0.000000
25%	2.000000	18.000000	1.000000	2.000000	1412.000000
50%	2.000000	38.000000	3.000000	3.000000	2224.000000
75%	4.000000	55.000000	4.000000	4.000000	3410.000000
max	6.000000	72.000000	7.000000	411.000000	26800.000000

In [10]:
```
Delivery_time_Data.columns
```

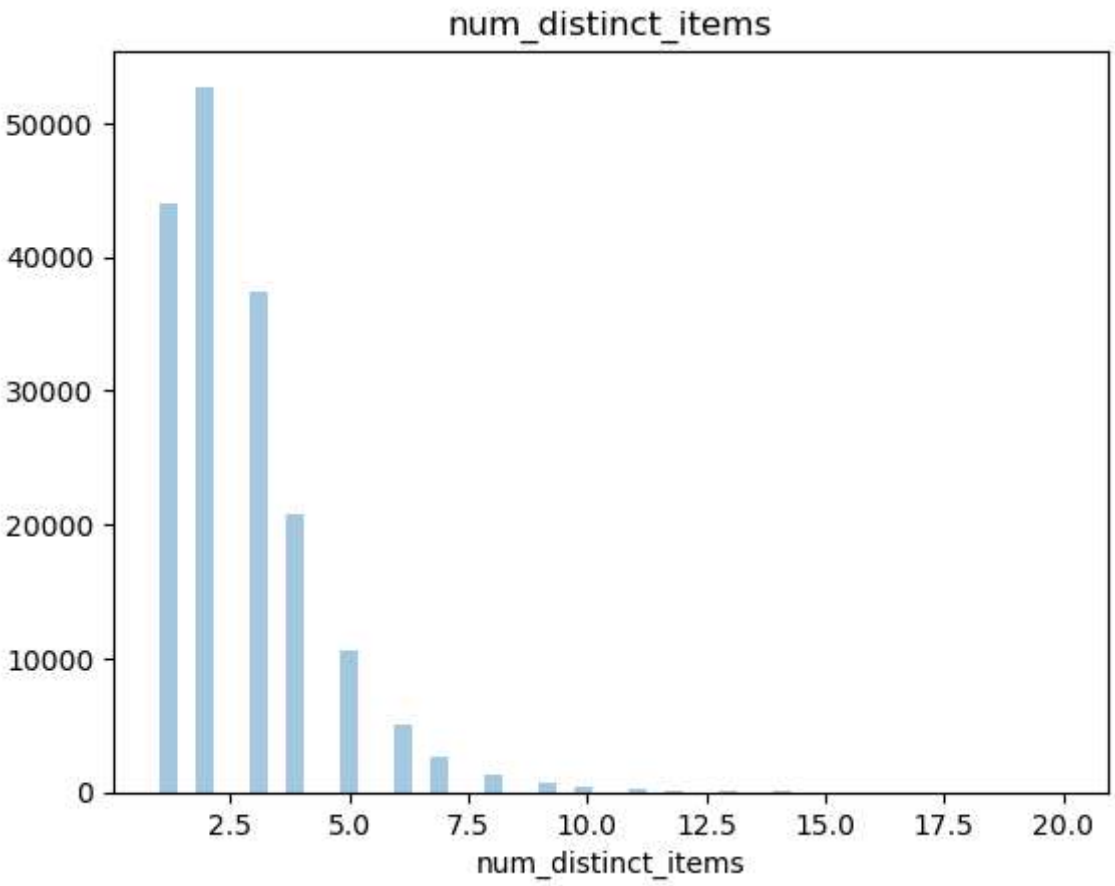
Out[10]:
```
Index(['market_id', 'created_at', 'actual_delivery_time',
       'store_primary_category', 'order_protocol', 'total_items', 'subtotal',
       'num_distinct_items', 'min_item_price', 'max_item_price',
       'total_onshift_dashers', 'total_busy_dashers',
       'total_outstanding_orders', 'distance'],
      dtype='object')
```

In [11]:
```
Delivery_time_Data.describe()
```

Out[11]:

	market_id	store_primary_category	order_protocol	total_items	subtota
count	175777.000000	175777.000000	175777.000000	175777.000000	175777.000000
mean	2.743726	35.887949	2.911752	3.204976	2697.111147
std	1.330963	20.728254	1.513128	2.674055	1828.554893
min	1.000000	0.000000	1.000000	1.000000	0.000000
25%	2.000000	18.000000	1.000000	2.000000	1412.000000
50%	2.000000	38.000000	3.000000	3.000000	2224.000000
75%	4.000000	55.000000	4.000000	4.000000	3410.000000
max	6.000000	72.000000	7.000000	411.000000	26800.000000

In [10]:
```
sns.distplot(Delivery_time_Data['num_distinct_items'],kde=False)
plt.title('num_distinct_items')
plt.show()
```

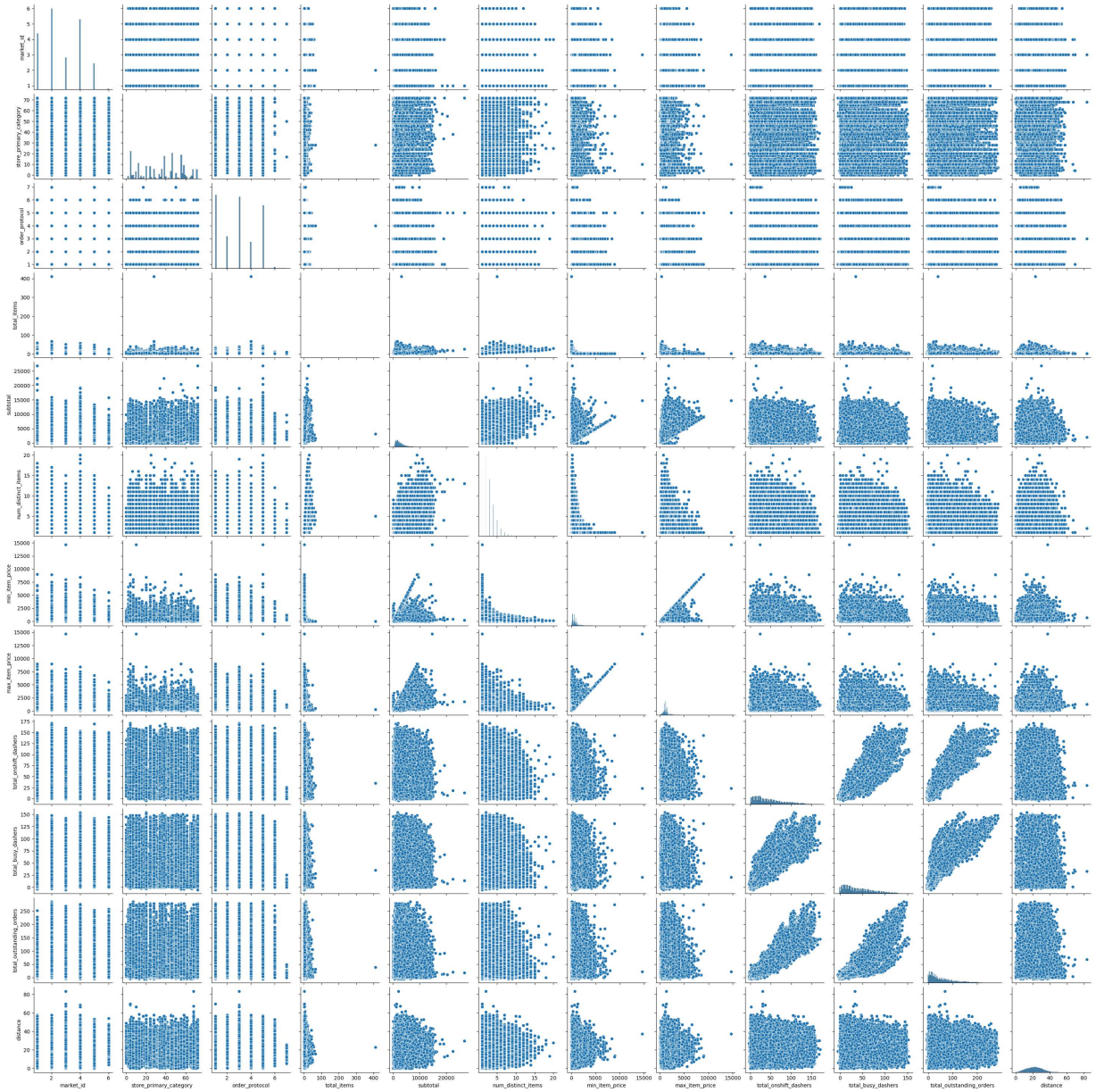


In [11]:
```
Delivery_time_Data.describe(exclude=np.number).T
```

Out[11]:

	count	unique	top	freq
created_at	175777	162649	2015-02-11 19:50:43	6
actual_delivery_time	175777	160344	2015-02-14 03:01:28	5

In [12]:
```
sns.pairplot(Delivery_time_Data)
plt.show()
```



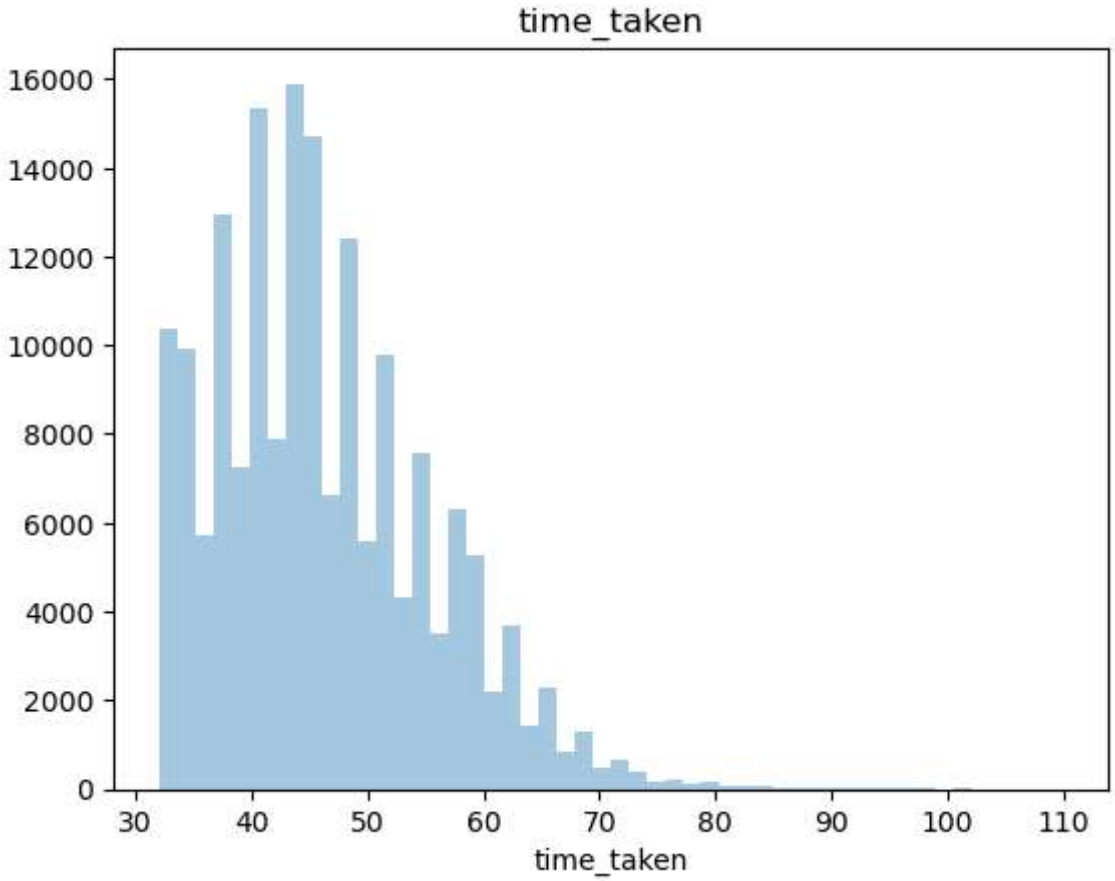
In [133…

```
 Delivery_time_Data['created_at_time_format'] = pd.to_datetime(Delivery_time_Data['
 Delivery_time_Data['actual_delivery_time_format'] = pd.to_datetime(Delivery_time_D
 Delivery_time_Data['time_taken'] = (Delivery_time_Data['actual_delivery_time_forma
Delivery_time_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 175777 entries, 0 to 175776
Data columns (total 17 columns):
 #   Column                        Non-Null Count   Dtype
---  ------                        --------------   -----
 0   market_id                     175777 non-null  float64
 1   created_at                    175777 non-null  object
 2   actual_delivery_time          175777 non-null  object
 3   store_primary_category        175777 non-null  int64
 4   order_protocol                175777 non-null  float64
 5   total_items                   175777 non-null  int64
 6   subtotal                      175777 non-null  int64
 7   num_distinct_items            175777 non-null  int64
 8   min_item_price                175777 non-null  int64
 9   max_item_price                175777 non-null  int64
 10  total_onshift_dashers         175777 non-null  float64
 11  total_busy_dashers            175777 non-null  float64
 12  total_outstanding_orders      175777 non-null  float64
 13  distance                      175777 non-null  float64
 14  created_at_time_format        175777 non-null  datetime64[ns]
 15  actual_delivery_time_format   175777 non-null  datetime64[ns]
 16  time_taken                    175777 non-null  float64
dtypes: datetime64[ns](2), float64(7), int64(6), object(2)
memory usage: 22.8+ MB
```

In [134…

```
sns.distplot(Delivery_time_Data['time_taken'],kde=False)
plt.title('time_taken')
plt.show()
```



In [ ]:
```
plt.figure(figsize=(20, 12))
plt.subplot(2,3,1)
sns.boxplot(x = 'actual_delivery_time', y = 'time_taken', data = Delivery_time_Data
plt.subplot(2,3,2)
sns.boxplot(x = 'created_at', y = 'time_taken', data = Delivery_time_Data)
plt.show()
```

In [12]:
```
Delivery_time_Data.describe().T
```

Out[12]:

	count	mean	std	min	25%	50%	75
market_id	175777.0	2.743726	1.330963	1.0	2.00	2.00	4.
store_primary_category	175777.0	35.887949	20.728254	0.0	18.00	38.00	55.
order_protocol	175777.0	2.911752	1.513128	1.0	1.00	3.00	4.
total_items	175777.0	3.204976	2.674055	1.0	2.00	3.00	4.
subtotal	175777.0	2697.111147	1828.554893	0.0	1412.00	2224.00	3410.
num_distinct_items	175777.0	2.675060	1.625681	1.0	1.00	2.00	3.
min_item_price	175777.0	684.965433	519.882924	-86.0	299.00	595.00	942.
max_item_price	175777.0	1160.158616	560.828571	0.0	799.00	1095.00	1395.
total_onshift_dashers	175777.0	44.918664	34.544724	-4.0	17.00	37.00	66.
total_busy_dashers	175777.0	41.861381	32.168505	-5.0	15.00	35.00	63.
total_outstanding_orders	175777.0	58.230115	52.731043	-6.0	17.00	41.00	85.
distance	175777.0	21.843090	8.748712	0.0	15.36	21.76	28.

In [135…
```
 Delivery_time_Data['created_at_time_format'] = pd.to_datetime(Delivery_time_Data['
 Delivery_time_Data['actual_delivery_time_format'] = pd.to_datetime(Delivery_time_D
 Delivery_time_Data['time_taken'] = (Delivery_time_Data['actual_delivery_time_forma
Delivery_time_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 175777 entries, 0 to 175776
Data columns (total 17 columns):
 #   Column                        Non-Null Count   Dtype
---  ------                        --------------   -----
 0   market_id                     175777 non-null  float64
 1   created_at                    175777 non-null  object
 2   actual_delivery_time          175777 non-null  object
 3   store_primary_category        175777 non-null  int64
 4   order_protocol                175777 non-null  float64
 5   total_items                   175777 non-null  int64
 6   subtotal                      175777 non-null  int64
 7   num_distinct_items            175777 non-null  int64
 8   min_item_price                175777 non-null  int64
 9   max_item_price                175777 non-null  int64
 10  total_onshift_dashers         175777 non-null  float64
 11  total_busy_dashers            175777 non-null  float64
 12  total_outstanding_orders      175777 non-null  float64
 13  distance                      175777 non-null  float64
 14  created_at_time_format        175777 non-null  datetime64[ns]
 15  actual_delivery_time_format   175777 non-null  datetime64[ns]
 16  time_taken                    175777 non-null  float64
dtypes: datetime64[ns](2), float64(7), int64(6), object(2)
memory usage: 22.8+ MB
```

In [ ]:

In [136…

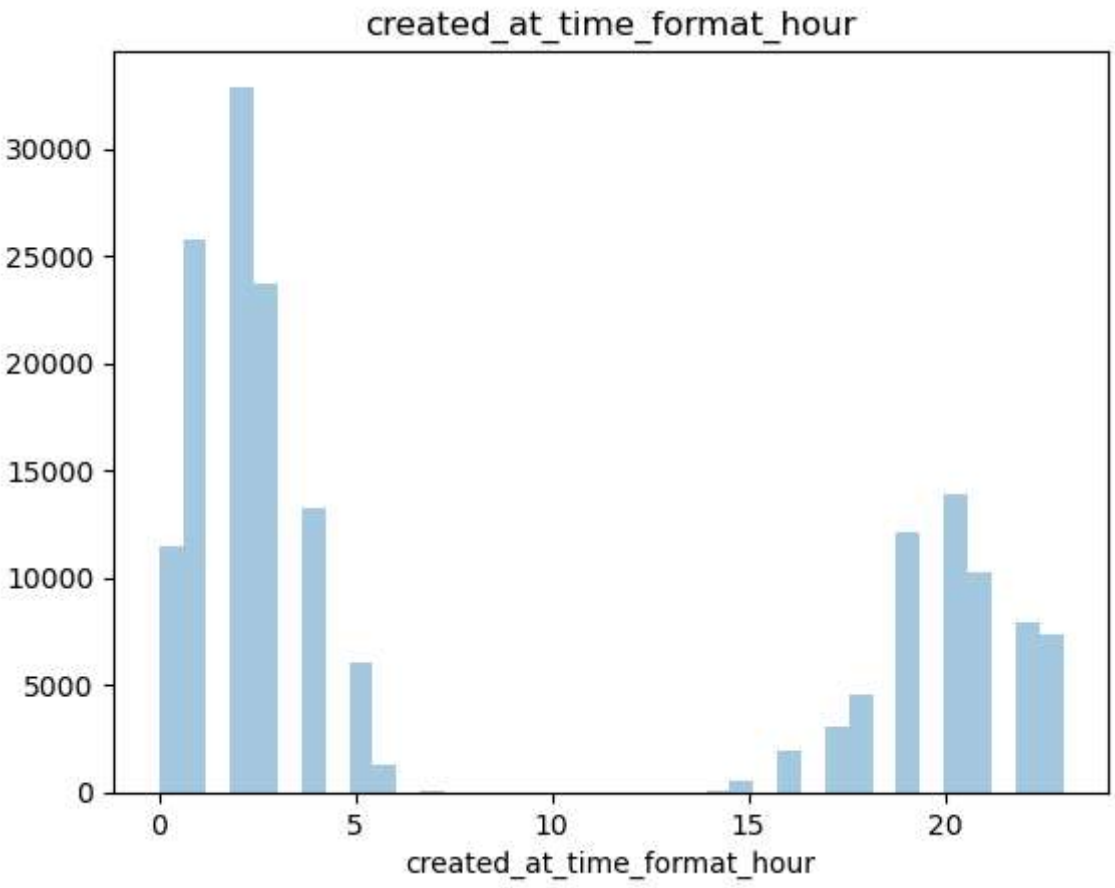
```
def extract_date_features(data):
    data["created_at_time_format_day"] = data.created_at_time_format.dt.day
    data["created_at_time_format_hour"] = data.created_at_time_format.dt.hour
    data["created_at_time_format_day_name"] = data.created_at_time_format.dt.day_na
    data["created_at_time_format_weekday"] = data.created_at_time_format.dt.weekday
    data['created_at_time_format_day_of_week'] = data.created_at_time_format.dt.day
    data['created_at_time_format_is_weekend'] = np.where(data['created_at_time_form

extract_date_features(Delivery_time_Data)
Delivery_time_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 175777 entries, 0 to 175776
Data columns (total 23 columns):
 #   Column                              Non-Null Count   Dtype
---  ------                              --------------   -----
 0   market_id                           175777 non-null  float64
 1   created_at                          175777 non-null  object
 2   actual_delivery_time                175777 non-null  object
 3   store_primary_category              175777 non-null  int64
 4   order_protocol                      175777 non-null  float64
 5   total_items                         175777 non-null  int64
 6   subtotal                            175777 non-null  int64
 7   num_distinct_items                  175777 non-null  int64
 8   min_item_price                      175777 non-null  int64
 9   max_item_price                      175777 non-null  int64
 10  total_onshift_dashers               175777 non-null  float64
 11  total_busy_dashers                  175777 non-null  float64
 12  total_outstanding_orders            175777 non-null  float64
 13  distance                            175777 non-null  float64
 14  created_at_time_format              175777 non-null  datetime64[ns]
 15  actual_delivery_time_format         175777 non-null  datetime64[ns]
 16  time_taken                          175777 non-null  float64
 17  created_at_time_format_day          175777 non-null  int32
 18  created_at_time_format_hour         175777 non-null  int32
 19  created_at_time_format_day_name     175777 non-null  object
 20  created_at_time_format_weekday      175777 non-null  int32
 21  created_at_time_format_day_of_week  175777 non-null  int32
 22  created_at_time_format_is_weekend   175777 non-null  int32
dtypes: datetime64[ns](2), float64(7), int32(5), int64(6), object(3)
memory usage: 27.5+ MB
```

In [137…

```
sns.distplot(Delivery_time_Data['created_at_time_format_hour'],kde=False)
plt.title('created_at_time_format_hour')
plt.show()
```



In [138…

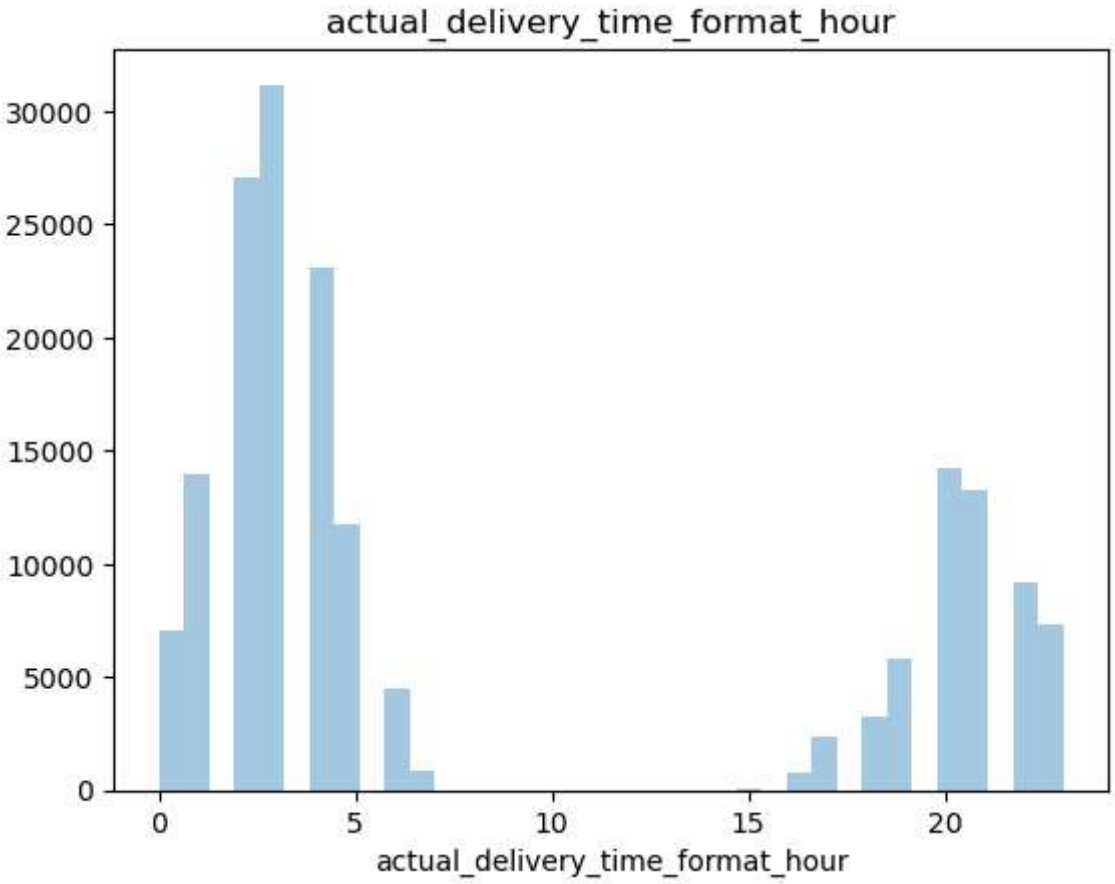
```
def extract_date_features(data):
    data["actual_delivery_time_format_day"] = data.actual_delivery_time_format.dt.d
    data["actual_delivery_time_format_hour"] = data.actual_delivery_time_format.dt.
    data["actual_delivery_time_format_day_name"] = data.actual_delivery_time_format
    data["actual_delivery_time_format_weekday"] = data.actual_delivery_time_format.
    data['actual_delivery_time_format_day_of_week'] = data.actual_delivery_time_for
    data['actual_delivery_time_format_is_weekend'] = np.where(data['actual_delivery

extract_date_features(Delivery_time_Data)
Delivery_time_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 175777 entries, 0 to 175776
Data columns (total 29 columns):
 #   Column                                 Non-Null Count   Dtype
---  ------                                 --------------   -----
 0   market_id                              175777 non-null  float64
 1   created_at                             175777 non-null  object
 2   actual_delivery_time                   175777 non-null  object
 3   store_primary_category                 175777 non-null  int64
 4   order_protocol                         175777 non-null  float64
 5   total_items                            175777 non-null  int64
 6   subtotal                               175777 non-null  int64
 7   num_distinct_items                     175777 non-null  int64
 8   min_item_price                         175777 non-null  int64
 9   max_item_price                         175777 non-null  int64
 10  total_onshift_dashers                  175777 non-null  float64
 11  total_busy_dashers                     175777 non-null  float64
 12  total_outstanding_orders               175777 non-null  float64
 13  distance                               175777 non-null  float64
 14  created_at_time_format                 175777 non-null  datetime64[ns]
 15  actual_delivery_time_format            175777 non-null  datetime64[ns]
 16  time_taken                             175777 non-null  float64
 17  created_at_time_format_day             175777 non-null  int32
 18  created_at_time_format_hour            175777 non-null  int32
 19  created_at_time_format_day_name        175777 non-null  object
 20  created_at_time_format_weekday         175777 non-null  int32
 21  created_at_time_format_day_of_week     175777 non-null  int32
 22  created_at_time_format_is_weekend      175777 non-null  int32
 23  actual_delivery_time_format_day        175777 non-null  int32
 24  actual_delivery_time_format_hour       175777 non-null  int32
 25  actual_delivery_time_format_day_name   175777 non-null  object
 26  actual_delivery_time_format_weekday    175777 non-null  int32
 27  actual_delivery_time_format_day_of_week  175777 non-null  int32
 28  actual_delivery_time_format_is_weekend   175777 non-null  int32
dtypes: datetime64[ns](2), float64(7), int32(10), int64(6), object(4)
memory usage: 32.2+ MB
```

In [139…

```
sns.distplot(Delivery_time_Data['actual_delivery_time_format_hour'],kde=False)
plt.title('actual_delivery_time_format_hour')
plt.show()
```



In [17]:
```
# Convert 'Category' column to categorical type
Delivery_time_Data['actual_delivery_time_format_is_weekend'] = Delivery_time_Data['
Delivery_time_Data.info()
```

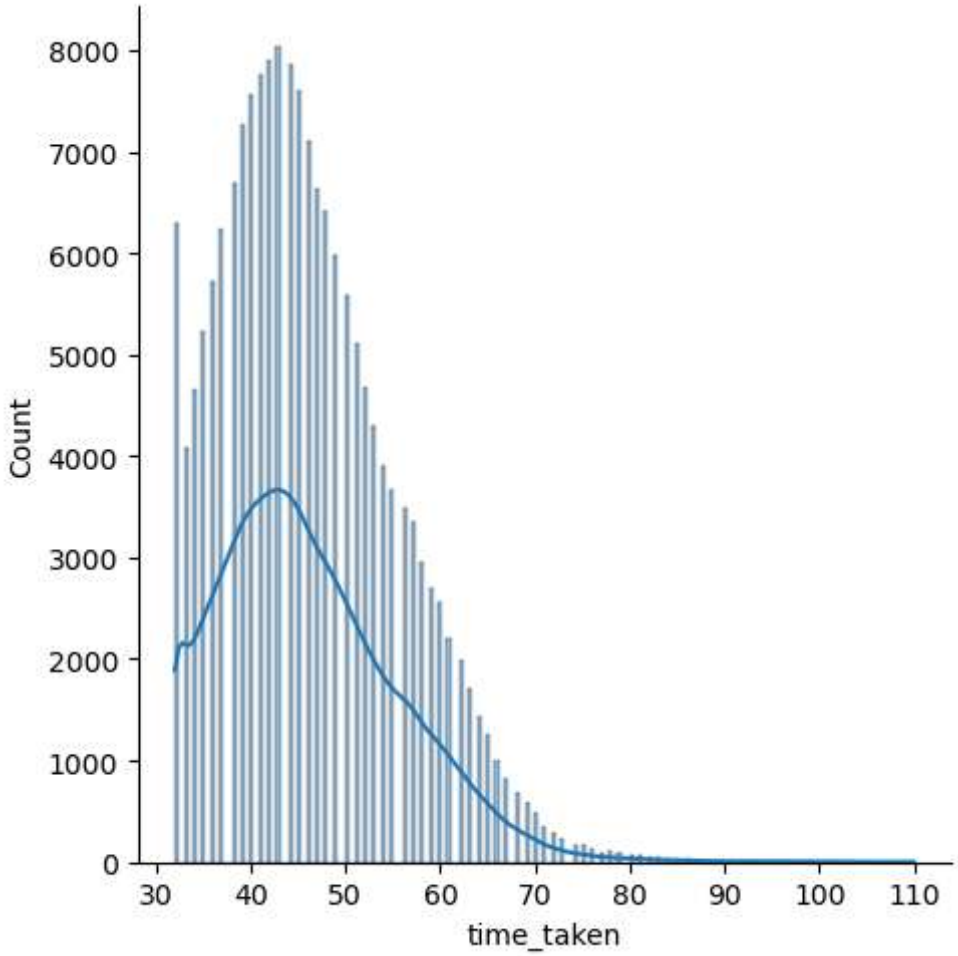
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 175777 entries, 0 to 175776
Data columns (total 29 columns):
 #   Column                                Non-Null Count   Dtype
---  ------                                --------------   -----
 0   market_id                             175777 non-null  float64
 1   created_at                            175777 non-null  object
 2   actual_delivery_time                  175777 non-null  object
 3   store_primary_category                175777 non-null  int64
 4   order_protocol                        175777 non-null  float64
 5   total_items                           175777 non-null  int64
 6   subtotal                              175777 non-null  int64
 7   num_distinct_items                    175777 non-null  int64
 8   min_item_price                        175777 non-null  int64
 9   max_item_price                        175777 non-null  int64
 10  total_onshift_dashers                 175777 non-null  float64
 11  total_busy_dashers                    175777 non-null  float64
 12  total_outstanding_orders              175777 non-null  float64
 13  distance                              175777 non-null  float64
 14  created_at_time_format                175777 non-null  datetime64[ns]
 15  actual_delivery_time_format           175777 non-null  datetime64[ns]
 16  time_taken                            175777 non-null  float64
 17  created_at_time_format_day            175777 non-null  int32
 18  created_at_time_format_hour           175777 non-null  int32
 19  created_at_time_format_day_name       175777 non-null  object
 20  created_at_time_format_weekday        175777 non-null  int32
 21  created_at_time_format_day_of_week    175777 non-null  int32
 22  created_at_time_format_is_weekend     175777 non-null  int32
 23  actual_delivery_time_format_day       175777 non-null  int32
 24  actual_delivery_time_format_hour      175777 non-null  int32
 25  actual_delivery_time_format_day_name  175777 non-null  object
 26  actual_delivery_time_format_weekday   175777 non-null  int32
 27  actual_delivery_time_format_day_of_week  175777 non-null  int32
 28  actual_delivery_time_format_is_weekend   175777 non-null  category
dtypes: category(1), datetime64[ns](2), float64(7), int32(9), int64(6), object(4)
memory usage: 31.7+ MB
```

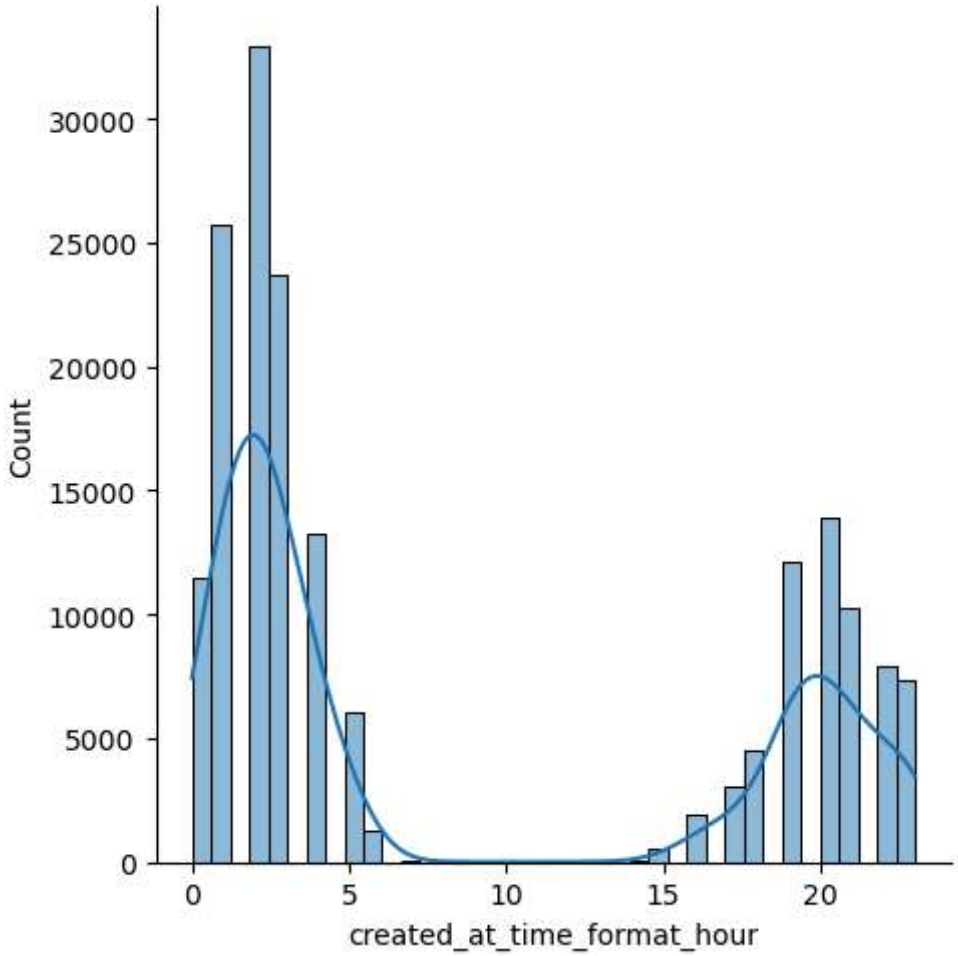
In [ ]:

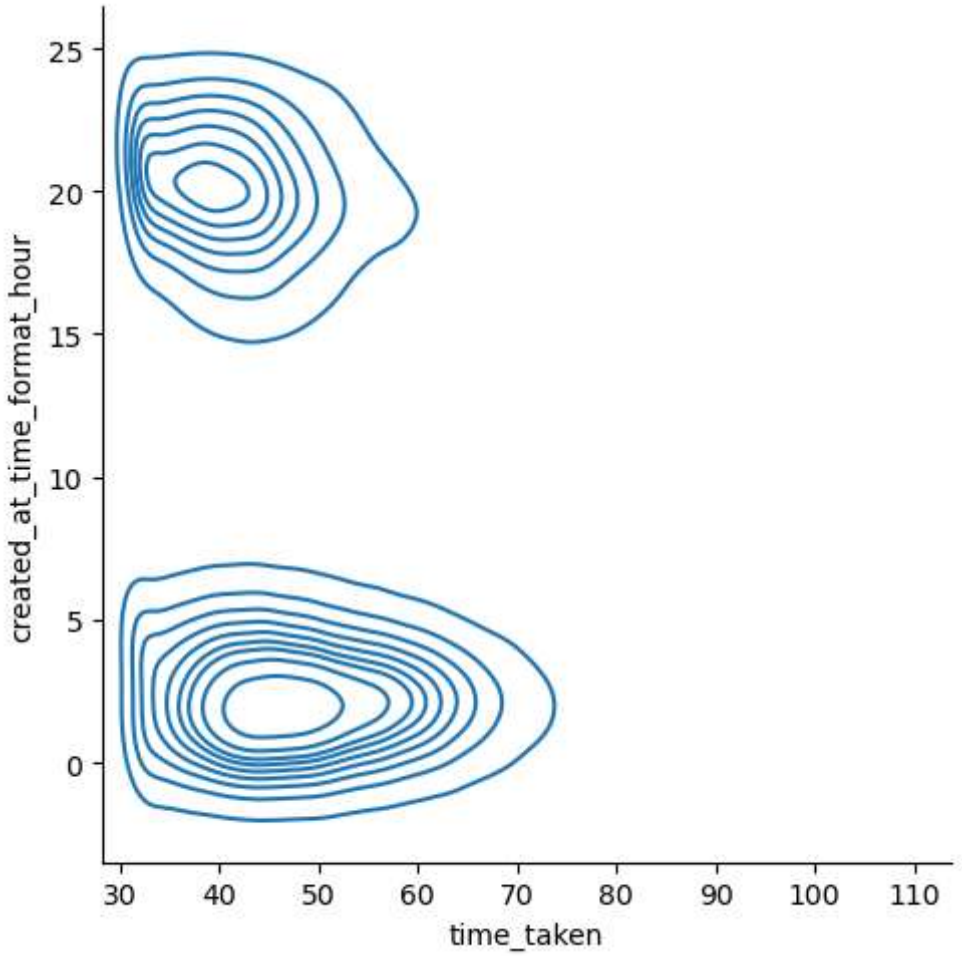
In [141…

```
# Using displot for individual distributions
sns.displot(Delivery_time_Data, x='time_taken', kde=True)
sns.displot(Delivery_time_Data, x='created_at_time_format_hour', kde=True)
plt.show()

# Using displot for joint distribution
sns.displot(Delivery_time_Data, x='time_taken', y='created_at_time_format_hour',
plt.show()
```


8000
7000
6000
5000
4000
3000
2000
1000
0
Count
30
40
50
60
70
80
90
100
110
time_taken


30000
25000
20000
15000
10000
5000
0
Count
0
5
10
15
20
created_at_time_format_hour



In [ ]:

In [25]:
```
print(Delivery_time_Data.columns.tolist())
```

```
['market_id', 'created_at', 'actual_delivery_time', 'store_primary_category', 'order
_protocol', 'total_items', 'subtotal', 'num_distinct_items', 'min_item_price', 'max_
item_price', 'total_onshift_dashers', 'total_busy_dashers', 'total_outstanding_order
s', 'distance', 'created_at_time_format', 'actual_delivery_time_format', 'time_take
n', 'actual_delivery_time_format_day', 'actual_delivery_time_format_hour', 'actual_d
elivery_time_format_day_name', 'actual_delivery_time_format_weekday', 'actual_delive
ry_time_format_day_of_week', 'actual_delivery_time_format_is_weekend']
```

In [ ]:

In [26]:
```
Delivery_time_Data.drop(columns=['actual_delivery_time_format_day', 'actual_deliv
```

In [27]:
```
Delivery_time_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 175777 entries, 0 to 175776
Data columns (total 17 columns):
 #   Column                        Non-Null Count   Dtype
---  ------                        --------------   -----
 0   market_id                     175777 non-null  float64
 1   created_at                    175777 non-null  object
 2   actual_delivery_time          175777 non-null  object
 3   store_primary_category        175777 non-null  int64
 4   order_protocol                175777 non-null  float64
 5   total_items                   175777 non-null  int64
 6   subtotal                      175777 non-null  int64
 7   num_distinct_items            175777 non-null  int64
 8   min_item_price                175777 non-null  int64
 9   max_item_price                175777 non-null  int64
 10  total_onshift_dashers         175777 non-null  float64
 11  total_busy_dashers            175777 non-null  float64
 12  total_outstanding_orders      175777 non-null  float64
 13  distance                      175777 non-null  float64
 14  created_at_time_format        175777 non-null  datetime64[ns]
 15  actual_delivery_time_format   175777 non-null  datetime64[ns]
 16  time_taken                    175777 non-null  float64
dtypes: datetime64[ns](2), float64(7), int64(6), object(2)
memory usage: 22.8+ MB
```

In [34]:
```
print(Delivery_time_Data.columns.tolist())
```

```
['market_id', 'created_at', 'actual_delivery_time', 'store_primary_category', 'order
_protocol', 'total_items', 'subtotal', 'num_distinct_items', 'min_item_price', 'max_
item_price', 'total_onshift_dashers', 'total_busy_dashers', 'total_outstanding_order
s', 'distance', 'created_at_time_format', 'actual_delivery_time_format', 'time_take
n']
```

In [35]:
```
Delivery_time_Data.drop(columns=['created_at', 'actual_delivery_time','created_at
```

In [ ]:
```
```

In [36]:
```
cat_cols=Delivery_time_Data.select_dtypes(include=['object']).columns
num_cols = Delivery_time_Data.select_dtypes(include=np.number).columns.tolist()
print("Categorical Variables:")
print(cat_cols)
print("Numerical Variables:")
print(num_cols)
```

```
Categorical Variables:
Index([], dtype='object')
Numerical Variables:
['market_id', 'store_primary_category', 'order_protocol', 'total_items', 'subtotal',
'num_distinct_items', 'min_item_price', 'max_item_price', 'total_onshift_dashers',
'total_busy_dashers', 'total_outstanding_orders', 'distance', 'time_taken']
```

In [158…
```
Delivery_time_Data = Delivery_time_Data[Delivery_time_Data.total_items <=100]
Delivery_time_Data.describe()
```

Out[158...

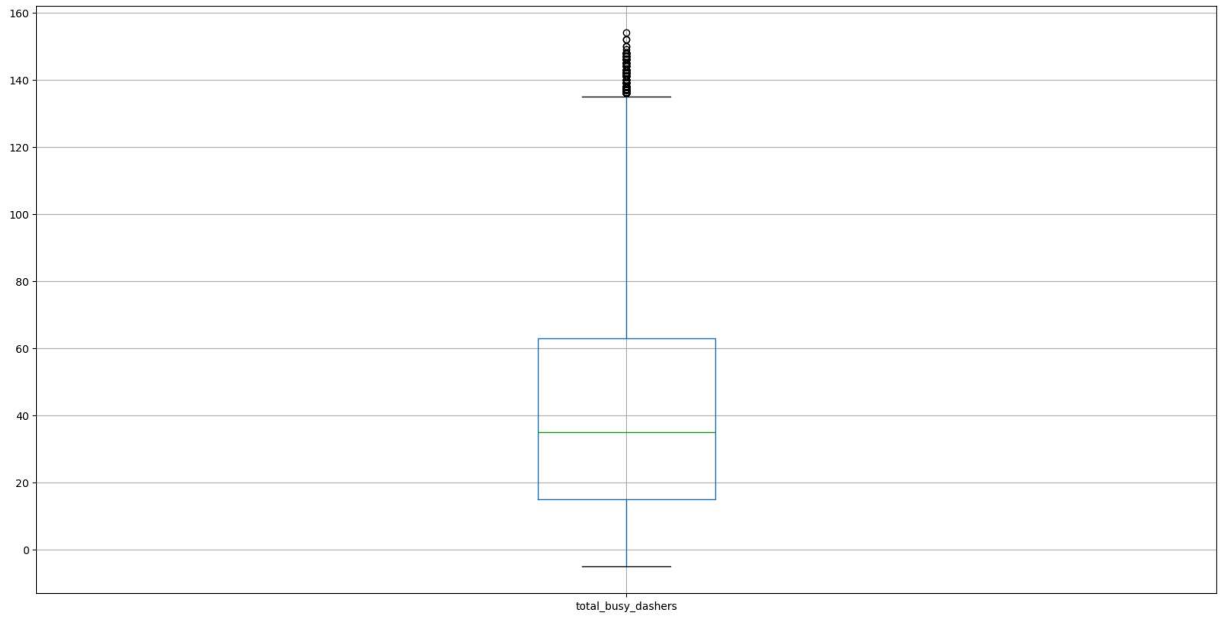
	market_id	store_primary_category	order_protocol	total_items	subtota
count	175776.000000	175776.000000	175776.000000	175776.000000	175776.000000
mean	2.743731	35.887994	2.911746	3.202656	2697.108769
min	1.000000	0.000000	1.000000	1.000000	0.000000
25%	2.000000	18.000000	1.000000	2.000000	1412.000000
50%	2.000000	38.000000	3.000000	3.000000	2224.000000
75%	4.000000	55.000000	4.000000	4.000000	3410.000000
max	6.000000	72.000000	7.000000	66.000000	26800.000000
std	1.330966	20.728305	1.513130	2.490889	1828.559823

8 rows × 25 columns

In [166...

```
    import pandas as pd
import matplotlib.pyplot as plt

# Assuming df is your DataFrame and 'column_name' is the column you want to plot
Delivery_time_Data.boxplot(column=['total_busy_dashers'], figsize=(20,10))
plt.show()
```



In [ ]:

In [ ]:

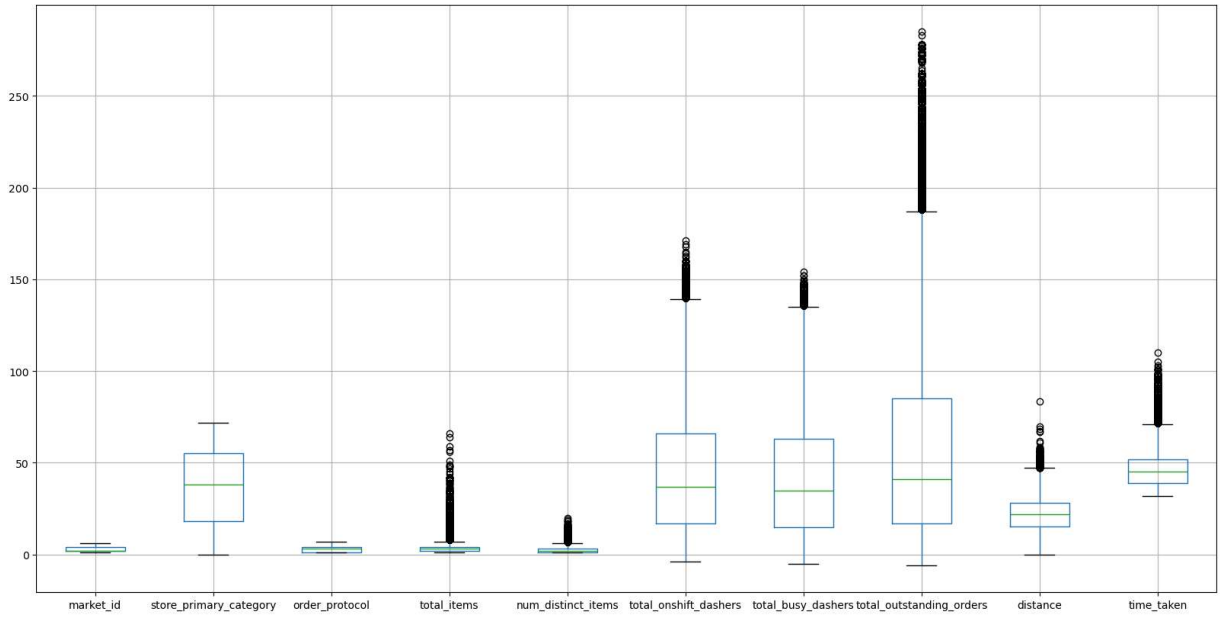
In [ ]:

In [ ]:

In [ ]:

In [159…
```
import pandas as pd
import matplotlib.pyplot as plt

# Assuming df is your DataFrame and 'column_name' is the column you want to plot
Delivery_time_Data.boxplot(column=['market_id', 'store_primary_category', 'order_pr
, figsize=(20,10))
plt.show()
```



In [37]:
```
from sklearn.model_selection import train_test_split

# We specify this so that the train and test data set always have the same rows, re
np.random.seed(0)
df_train, df_test = train_test_split(Delivery_time_Data, train_size = 0.7, test_siz
```

In [38]:
```
from sklearn.preprocessing import MinMaxScaler
```

In [39]:
```
scaler = MinMaxScaler()
```

In [40]:
```
df_train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 123043 entries, 94746 to 38408
Data columns (total 13 columns):
 #   Column                    Non-Null Count   Dtype  
---  ------                    --------------   -----  
 0   market_id                 123043 non-null  float64
 1   store_primary_category    123043 non-null  int64  
 2   order_protocol            123043 non-null  float64
 3   total_items               123043 non-null  int64  
 4   subtotal                  123043 non-null  int64  
 5   num_distinct_items        123043 non-null  int64  
 6   min_item_price            123043 non-null  int64  
 7   max_item_price            123043 non-null  int64  
 8   total_onshift_dashers     123043 non-null  float64
 9   total_busy_dashers        123043 non-null  float64
 10  total_outstanding_orders  123043 non-null  float64
 11  distance                  123043 non-null  float64
 12  time_taken                123043 non-null  float64
dtypes: float64(7), int64(6)
memory usage: 13.1 MB
```

In [ ]:

In [43]:
```
# Apply scaler() to all the columns except the 'yes-no' and 'dummy' variables
num_vars = ['market_id', 'store_primary_category', 'order_protocol', 'total_items',

df_train[num_vars] = scaler.fit_transform(df_train[num_vars])
```

In [44]:
```
df_train.head()
```

Out[44]:

	market_id	store_primary_category	order_protocol	total_items	subtotal	num_dist
94746	0.6	0.333333	0.666667	0.002439	0.066791	
173338	0.6	1.000000	0.666667	0.000000	0.031530	
37592	0.6	0.763889	0.666667	0.000000	0.070896	
42763	0.2	0.388889	0.500000	0.012195	0.017276	
27506	0.2	1.000000	0.000000	0.004878	0.130597	

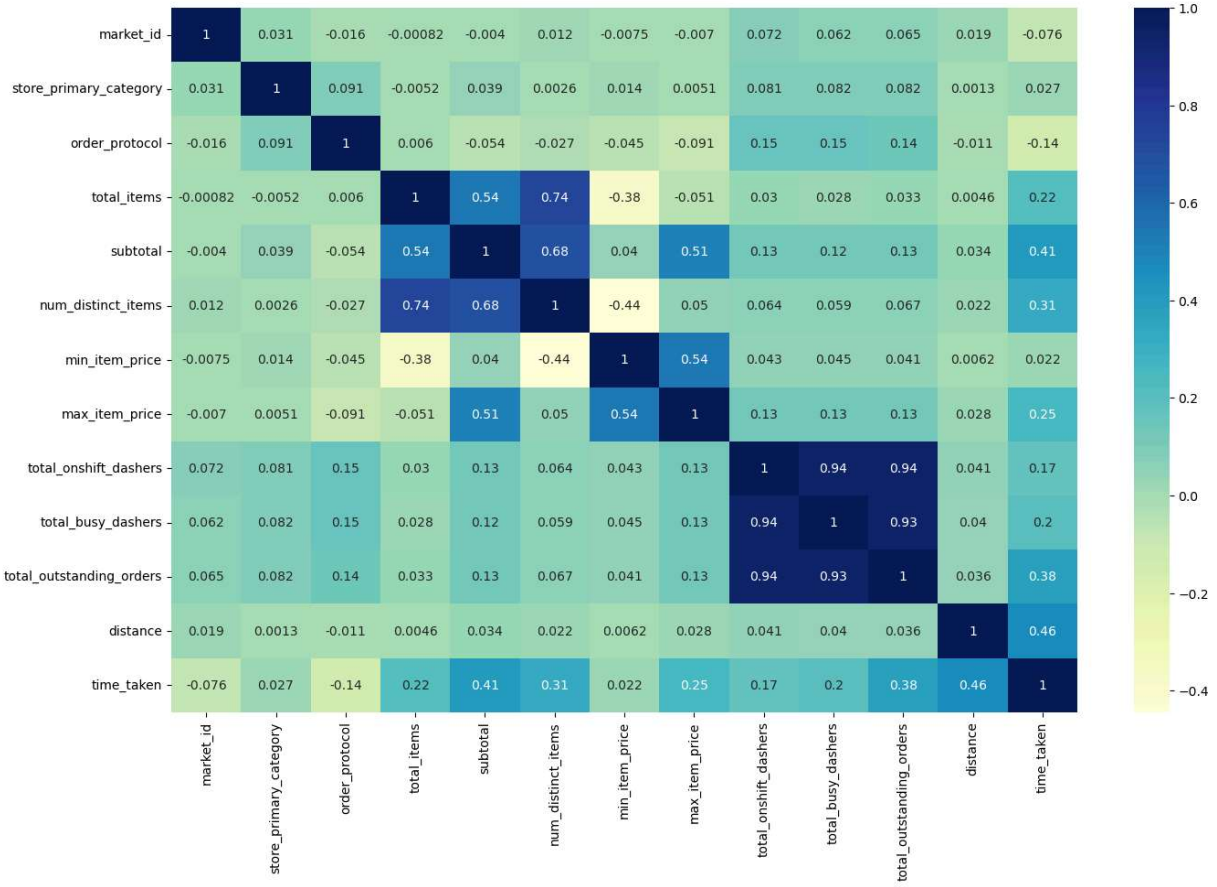
In [45]:
```
df_train.describe()
```

Out[45]:

	market_id	store_primary_category	order_protocol	total_items	subtota
count	123043.000000	123043.000000	123043.000000	123043.000000	123043.000000
mean	0.348849	0.499179	0.318796	0.005381	0.100667
std	0.265612	0.288032	0.252108	0.006695	0.068296
min	0.000000	0.000000	0.000000	0.000000	0.000000
25%	0.200000	0.250000	0.000000	0.002439	0.052873
50%	0.200000	0.527778	0.333333	0.004878	0.082836
75%	0.600000	0.763889	0.500000	0.007317	0.127052
max	1.000000	1.000000	1.000000	1.000000	1.000000

In [ ]:

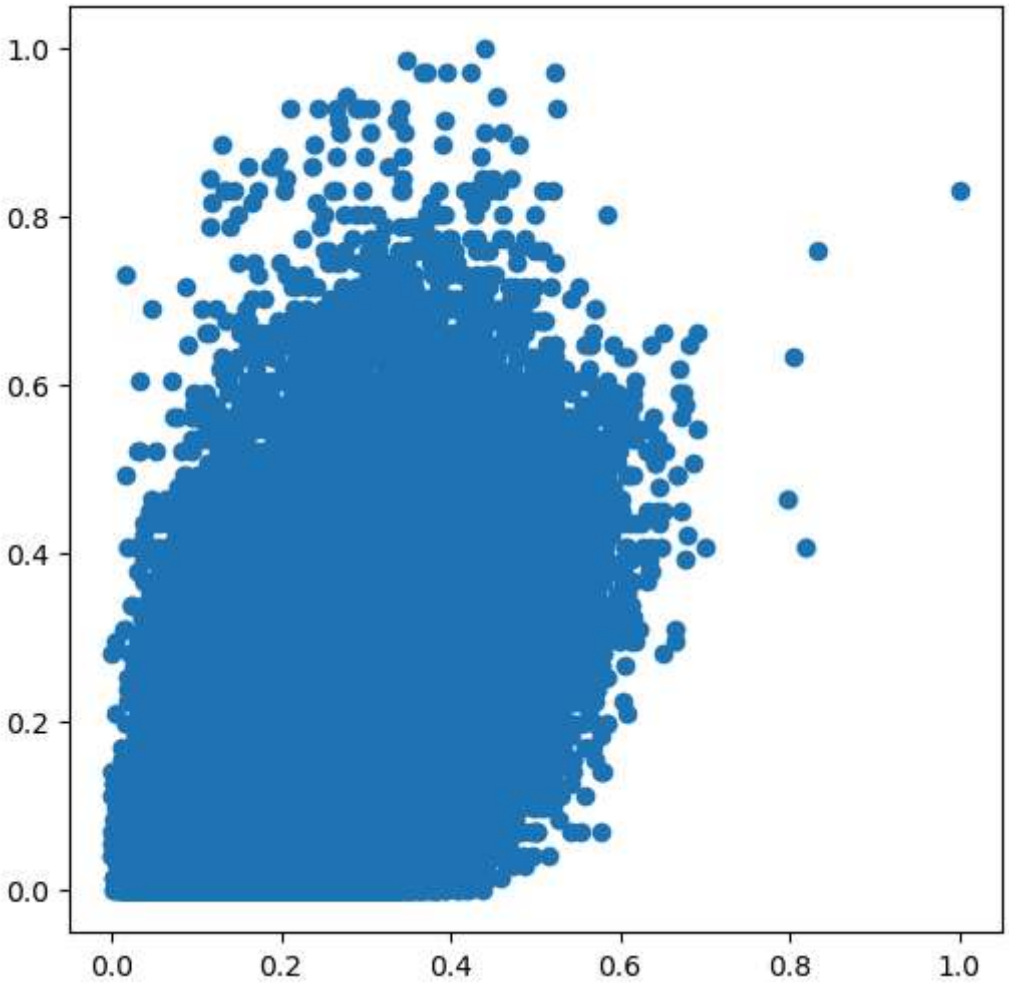
In [46]:
```
plt.figure(figsize = (16, 10))
sns.heatmap(df_train.corr(), annot = True, cmap="YlGnBu")
plt.show()
```



In [ ]:

In [47]:
```
plt.figure(figsize=[6,6])
plt.scatter(df_train.distance, df_train.time_taken)
```

```
plt.show()
```



In [ ]:

In [48]:
```
y_train = df_train.pop('time_taken')
X_train = df_train
```

In [ ]:

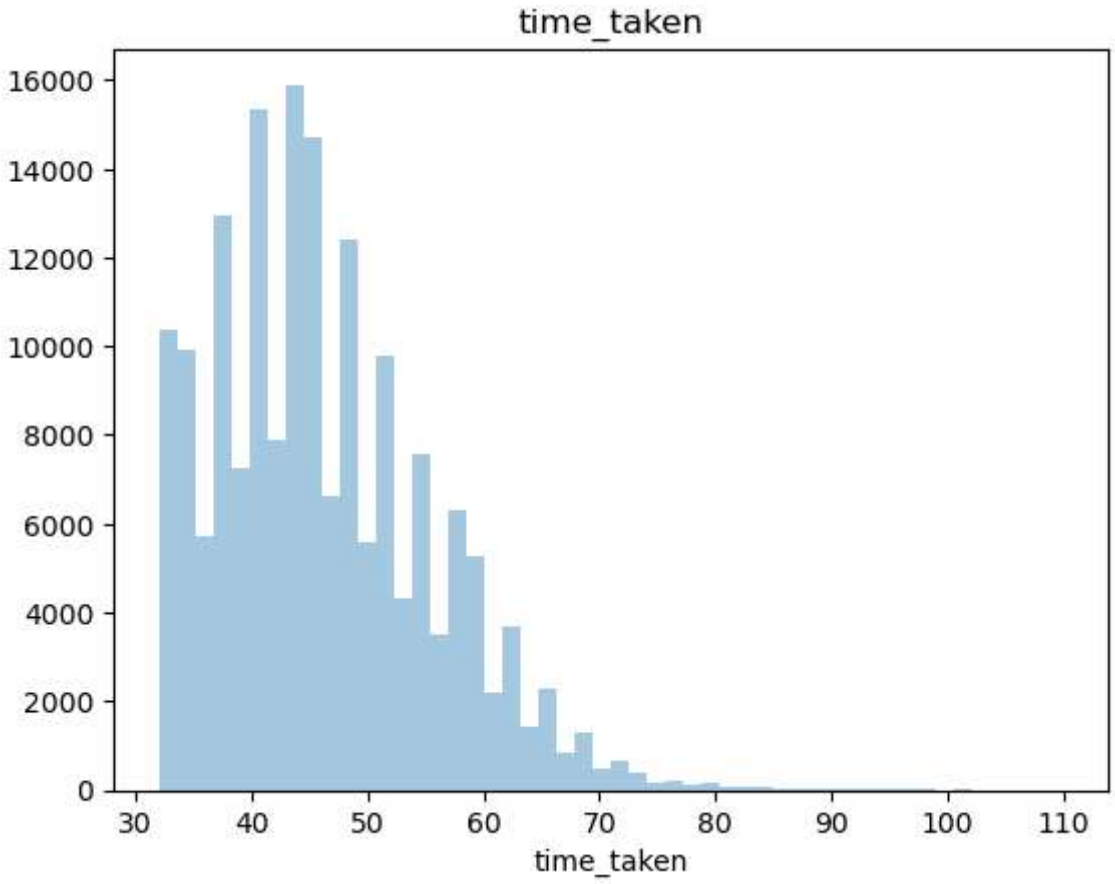
In [49]:
```
import statsmodels.api as sm

# Add a constant
X_train_lm = sm.add_constant(X_train[['distance']])

# Create a first fitted model
lr = sm.OLS(y_train, X_train_lm).fit()
```

In [ ]:

In [126…
```
sns.distplot(Delivery_time_Data['time_taken'],kde=False)
plt.title('time_taken')
plt.show()
```



In [ ]:

In [ ]:

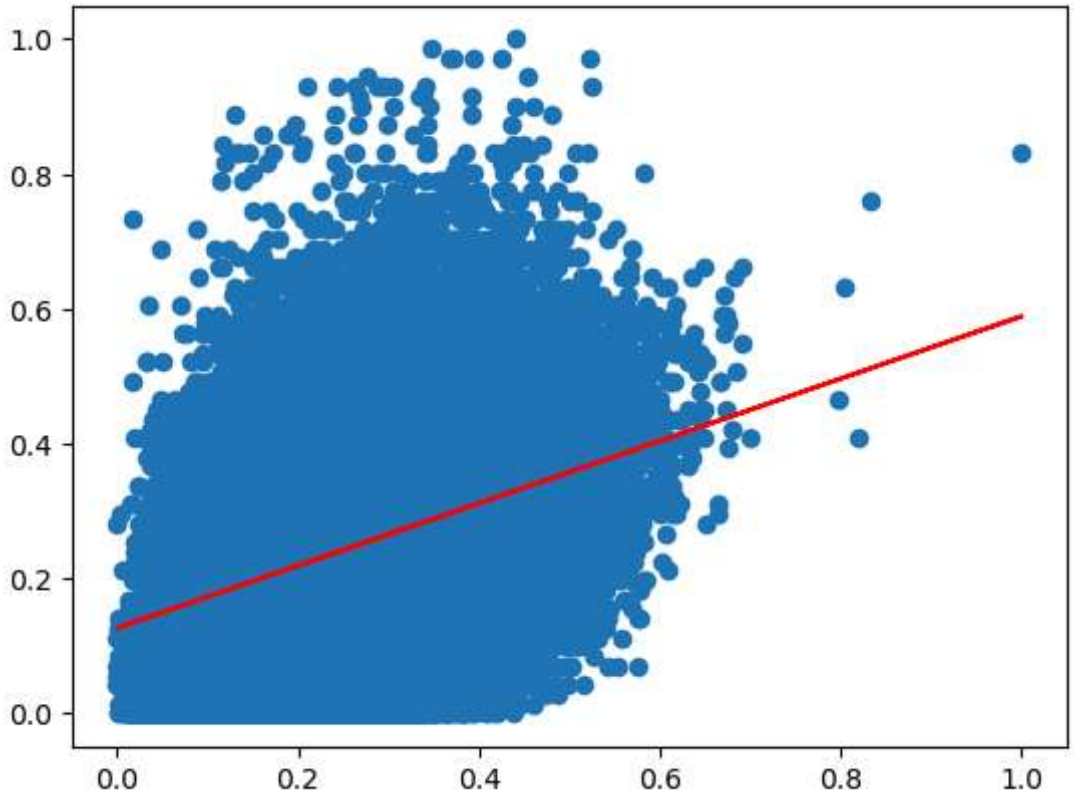
In [ ]:

In [50]:
```
lr.params
```

Out[50]:
```
const       0.049405
distance    0.575767
dtype: float64
```

In [ ]:

In [51]:
```
# Let's visualise the data with a scatter plot and the fitted regression line
plt.scatter(X_train_lm.iloc[:, 1], y_train)
plt.plot(X_train_lm.iloc[:, 1], 0.127 + 0.462*X_train_lm.iloc[:, 1], 'r')
plt.show()
```



In [52]:
```
print(lr.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             time_taken   R-squared:                       0.211
Model:                            OLS   Adj. R-squared:                  0.211
Method:                 Least Squares   F-statistic:                 3.297e+04
Date:                Wed, 28 May 2025   Prob (F-statistic):               0.00
Time:                        08:18:57   Log-Likelihood:                 89696.
No. Observations:              123043   AIC:                         -1.794e+05
Df Residuals:                  123041   BIC:                         -1.794e+05
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.0494      0.001     55.318      0.000       0.048       0.051
distance       0.5758      0.003    181.578      0.000       0.570       0.582
==============================================================================
Omnibus:                    15005.725   Durbin-Watson:                   2.012
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            23781.191
Skew:                           0.868   Prob(JB):                         0.00
Kurtosis:                       4.274   Cond. No.                         10.2
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly spe
cified.
```

In [53]:
```
# Assign all the feature variables to X
X_train_lm = X_train[['distance', 'total_outstanding_orders']]
```

In [54]:
```
# Build a linear model

import statsmodels.api as sm
X_train_lm = sm.add_constant(X_train_lm)

lr = sm.OLS(y_train, X_train_lm).fit()

lr.params
```

Out[54]:
```
const                       -0.004939
distance                     0.559368
total_outstanding_orders     0.263610
dtype: float64
```

In [55]:
```
# Check the summary
print(lr.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             time_taken   R-squared:                       0.345
Model:                            OLS   Adj. R-squared:                  0.345
Method:                 Least Squares   F-statistic:                 3.238e+04
Date:                Wed, 28 May 2025   Prob (F-statistic):               0.00
Time:                        08:19:54   Log-Likelihood:            1.0111e+05
No. Observations:              123043   AIC:                        -2.022e+05
Df Residuals:                  123040   BIC:                        -2.022e+05
Df Model:                           2
Covariance Type:            nonrobust
================================================================================
                               coef    std err          t      P>|t|      [0.025
0.975]
--------------------------------------------------------------------------------
const                       -0.0049      0.001     -5.591      0.000      -0.007
-0.003
distance                     0.5594      0.003    193.426      0.000       0.554
0.565
total_outstanding_orders     0.2636      0.002    158.359      0.000       0.260
0.267
==============================================================================
Omnibus:                    10843.309   Durbin-Watson:                   2.008
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            16325.192
Skew:                           0.688   Prob(JB):                         0.00
Kurtosis:                       4.137   Cond. No.                         10.4
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly spe
cified.
```

In [ ]:

In [56]:
```
# Assign all the feature variables to X
X_train_lm = X_train[['distance', 'total_outstanding_orders','total_items', 'subtot
```

In [57]:
```
# Build a linear model

import statsmodels.api as sm
X_train_lm = sm.add_constant(X_train_lm)

lr = sm.OLS(y_train, X_train_lm).fit()

lr.params
```

Out[57]:
```
const                       -0.063621
distance                     0.545611
total_outstanding_orders     0.231538
total_items                 -0.588802
subtotal                     0.595075
num_distinct_items           0.143784
dtype: float64
```

In [ ]:
```

```

In [58]:
```
# Print the summary of the model

print(lr.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             time_taken   R-squared:                       0.473
Model:                            OLS   Adj. R-squared:                  0.473
Method:                 Least Squares   F-statistic:                 2.211e+04
Date:                Wed, 28 May 2025   Prob (F-statistic):               0.00
Time:                        08:20:21   Log-Likelihood:            1.1453e+05
No. Observations:              123043   AIC:                        -2.290e+05
Df Residuals:                  123037   BIC:                        -2.290e+05
Df Model:                           5
Covariance Type:            nonrobust
================================================================================
========
                               coef    std err          t      P>|t|      [0.025
0.975]
--------------------------------------------------------------------------------
--------
const                       -0.0636      0.001    -73.726      0.000      -0.065
-0.062
distance                     0.5456      0.003    210.276      0.000       0.541
0.551
total_outstanding_orders     0.2315      0.002    153.721      0.000       0.229
0.234
total_items                 -0.5888      0.061     -9.727      0.000      -0.707
-0.470
subtotal                     0.5951      0.005    108.290      0.000       0.584
0.606
num_distinct_items           0.1438      0.005     26.423      0.000       0.133
0.154
==============================================================================
Omnibus:                    11022.401   Durbin-Watson:                   2.001
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            19751.134
Skew:                           0.634   Prob(JB):                         0.00
Kurtosis:                       4.498   Cond. No.                         238.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly spe
cified.
```

In [ ]:

In [59]:
```
# Assign all the feature variables to X
X_train_lm = X_train[ ['market_id', 'store_primary_category', 'order_protocol', 'to
```

In [60]:
```
# Build a linear model

import statsmodels.api as sm
X_train_lm = sm.add_constant(X_train_lm)

lr = sm.OLS(y_train, X_train_lm).fit()

lr.params
```

Out[60]:
```
const                       0.001893
market_id                  -0.045745
store_primary_category      0.004910
order_protocol             -0.066977
total_items                -0.248659
subtotal                    0.482451
num_distinct_items          0.187595
min_item_price              0.048234
max_item_price              0.206059
total_onshift_dashers      -1.030789
total_outstanding_orders    1.296662
distance                    0.559631
dtype: float64
```

In [61]:
```
# Print the summary of the model

print(lr.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             time_taken   R-squared:                       0.812
Model:                            OLS   Adj. R-squared:                  0.811
Method:                 Least Squares   F-statistic:                 4.815e+04
Date:                Wed, 28 May 2025   Prob (F-statistic):               0.00
Time:                        08:21:23   Log-Likelihood:             1.7775e+05
No. Observations:              123043   AIC:                        -3.555e+05
Df Residuals:                  123031   BIC:                        -3.554e+05
Df Model:                          11
Covariance Type:            nonrobust
================================================================================
========
                               coef    std err          t      P>|t|      [0.025
0.975]
--------------------------------------------------------------------------------
--------
const                        0.0019      0.001      2.571      0.010       0.000
0.003
market_id                   -0.0457      0.001    -74.389      0.000      -0.047
-0.045
store_primary_category       0.0049      0.001      8.613      0.000       0.004
0.006
order_protocol              -0.0670      0.001   -101.503      0.000      -0.068
-0.066
total_items                 -0.2487      0.037     -6.661      0.000      -0.322
-0.175
subtotal                     0.4825      0.005    107.191      0.000       0.474
0.491
num_distinct_items           0.1876      0.004     49.450      0.000       0.180
0.195
min_item_price               0.0482      0.007      7.127      0.000       0.035
0.061
max_item_price               0.2061      0.006     31.955      0.000       0.193
0.219
total_onshift_dashers       -1.0308      0.002   -441.856      0.000      -1.035
-1.026
total_outstanding_orders     1.2967      0.003    511.403      0.000       1.292
1.302
distance                     0.5596      0.002    360.369      0.000       0.557
0.563
==============================================================================
Omnibus:                    22808.828   Durbin-Watson:                   1.994
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            59497.669
Skew:                           1.015   Prob(JB):                         0.00
Kurtosis:                       5.735   Cond. No.                         302.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly spe
cified.
```

In [ ]:

In [62]:
```
# Check for the VIF values of the feature variables.
```

```
from statsmodels.stats.outliers_influence import variance_inflation_factor
```

In [68]:
```
# Create a dataframe that will contain the names of all the feature variables and t
vif = pd.DataFrame()
vif['Features'] = X_train_lm.columns
vif['VIF'] = [variance_inflation_factor(X_train_lm.values, i) for i in range(X_trai
vif['VIF'] = round(vif['VIF'], 2)
vif = vif.sort_values(by = "VIF", ascending = False)
vif
```

Out[68]:

	Features	VIF
0	const	20.33
9	total_busy_dashers	7.79
10	total_outstanding_orders	7.76
6	num_distinct_items	3.98
5	subtotal	3.57
4	total_items	2.36
8	max_item_price	2.30
7	min_item_price	2.16
3	order_protocol	1.05
2	store_primary_category	1.02
1	market_id	1.01
11	distance	1.00

In [71]:
```
# Dropping highly correlated variables and insignificant variables

X = X_train.drop('total_busy_dashers',axis=1)
```

In [72]:
```
# Build a second fitted model
X_train_lm = sm.add_constant(X)

lr_3 = sm.OLS(y_train, X_train_lm).fit()
```

In [73]:
```
# Print the summary of the model

print(lr_3.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             time_taken   R-squared:                       0.812
Model:                            OLS   Adj. R-squared:                  0.811
Method:                 Least Squares   F-statistic:                 4.815e+04
Date:                Wed, 28 May 2025   Prob (F-statistic):               0.00
Time:                        08:25:54   Log-Likelihood:            1.7775e+05
No. Observations:              123043   AIC:                        -3.555e+05
Df Residuals:                  123031   BIC:                        -3.554e+05
Df Model:                          11
Covariance Type:            nonrobust
================================================================================
========
                               coef    std err          t      P>|t|      [0.025
0.975]
--------------------------------------------------------------------------------
--------
const                        0.0019      0.001      2.571      0.010       0.000
0.003
market_id                   -0.0457      0.001    -74.389      0.000      -0.047
-0.045
store_primary_category       0.0049      0.001      8.613      0.000       0.004
0.006
order_protocol              -0.0670      0.001   -101.503      0.000      -0.068
-0.066
total_items                 -0.2487      0.037     -6.661      0.000      -0.322
-0.175
subtotal                     0.4825      0.005    107.191      0.000       0.474
0.491
num_distinct_items           0.1876      0.004     49.450      0.000       0.180
0.195
min_item_price               0.0482      0.007      7.127      0.000       0.035
0.061
max_item_price               0.2061      0.006     31.955      0.000       0.193
0.219
total_onshift_dashers       -1.0308      0.002   -441.856      0.000      -1.035
-1.026
total_outstanding_orders     1.2967      0.003    511.403      0.000       1.292
1.302
distance                     0.5596      0.002    360.369      0.000       0.557
0.563
==============================================================================
Omnibus:                    22808.828   Durbin-Watson:                   1.994
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            59497.669
Skew:                           1.015   Prob(JB):                         0.00
Kurtosis:                       5.735   Cond. No.                         302.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly spe
cified.
```

In [74]:
```
# Calculate the VIFs again for the new model
vif = pd.DataFrame()
vif['Features'] = X_train_lm.columns
vif['VIF'] = [variance_inflation_factor(X_train_lm.values, i) for i in range(X_trai
```

```
vif['VIF'] = round(vif['VIF'], 2)
vif = vif.sort_values(by = "VIF", ascending = False)
vif
```

Out[74]:

	Features	VIF
0	const	20.47
9	total_onshift_dashers	8.12
10	total_outstanding_orders	8.07
6	num_distinct_items	3.98
5	subtotal	3.57
4	total_items	2.36
8	max_item_price	2.30
7	min_item_price	2.16
3	order_protocol	1.05
2	store_primary_category	1.02
1	market_id	1.01
11	distance	1.00

In [ ]:

In [122…
```
X = X_train.drop(['total_items'],axis=1)
```

In [123…
```
# Build a second fitted model
X_train_lm = sm.add_constant(X)

lr_3 = sm.OLS(y_train, X_train_lm).fit()
```

In [125…
```
# Print the summary of the model

print(lr_3.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             time_taken   R-squared:                       0.834
Model:                            OLS   Adj. R-squared:                  0.834
Method:                 Least Squares   F-statistic:                 5.620e+04
Date:                Wed, 28 May 2025   Prob (F-statistic):               0.00
Time:                        08:52:15   Log-Likelihood:            1.8557e+05
No. Observations:              123043   AIC:                        -3.711e+05
Df Residuals:                  123031   BIC:                        -3.710e+05
Df Model:                          11
Covariance Type:            nonrobust
================================================================================
========
                               coef    std err          t      P>|t|      [0.025
0.975]
--------------------------------------------------------------------------------
--------
const                        0.0015      0.001      2.128      0.033       0.000
0.003
market_id                   -0.0468      0.001    -81.124      0.000      -0.048
-0.046
store_primary_category       0.0054      0.001     10.089      0.000       0.004
0.006
order_protocol              -0.0635      0.001   -102.564      0.000      -0.065
-0.062
subtotal                     0.4784      0.004    116.090      0.000       0.470
0.486
num_distinct_items           0.1723      0.003     53.402      0.000       0.166
0.179
min_item_price               0.0502      0.006      7.912      0.000       0.038
0.063
max_item_price               0.2208      0.006     37.187      0.000       0.209
0.232
total_onshift_dashers       -0.8421      0.003   -320.203      0.000      -0.847
-0.837
total_busy_dashers          -0.0021   1.59e-05   -129.354      0.000      -0.002
-0.002
total_outstanding_orders     1.4425      0.003    547.851      0.000       1.437
1.448
distance                     0.5613      0.001    385.174      0.000       0.558
0.564
==============================================================================
Omnibus:                    23126.342   Durbin-Watson:                   1.997
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            59158.221
Skew:                           1.036   Prob(JB):                         0.00
Kurtosis:                       5.693   Cond. No.                     2.58e+03
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly spe
cified.
[2] The condition number is large, 2.58e+03. This might indicate that there are
strong multicollinearity or other numerical problems.
```

In [118…

```
# Calculate the VIFs again for the new model
vif = pd.DataFrame()
```

```
vif['Features'] = X_train_lm.columns
vif['VIF'] = [variance_inflation_factor(X_train_lm.values, i) for i in range(X_trai
vif['VIF'] = round(vif['VIF'], 2)
vif = vif.sort_values(by = "VIF", ascending = False)
vif
```

Out[118…

	Features	VIF
0	const	20.19
8	total_onshift_dashers	11.71
9	total_busy_dashers	11.25
10	total_outstanding_orders	9.89
4	subtotal	3.40
5	num_distinct_items	3.27
7	max_item_price	2.22
6	min_item_price	2.15
3	order_protocol	1.05
2	store_primary_category	1.02
1	market_id	1.01
11	distance	1.00

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [75]:
```
# Import LabelEncoder from sklearn
from sklearn.preprocessing import LabelEncoder

def label_encoding(df):
    categorical_columns = df.select_dtypes(include='object').columns
    label_encoder = LabelEncoder()
    df[categorical_columns] = df[categorical_columns].apply(lambda col: label_encod

label_encoding(Delivery_time_Data)
Delivery_time_Data.head()
```

Out[75]:

	market_id	store_primary_category	order_protocol	total_items	subtotal	num_distinct_it
0	1.0	4	1.0	4	3441	
1	2.0	46	2.0	1	1900	
2	2.0	36	3.0	4	4771	
3	1.0	38	1.0	1	1525	
4	1.0	38	1.0	2	3620	

In [ ]:

In [76]:
```
df_train, df_test = train_test_split(Delivery_time_Data,train_size=0.7,random_state
print(df_train.shape)
print(df_test.shape)
```

```
(123043, 13)
(52734, 13)
```

In [ ]:

In [77]:
```
scaler= MinMaxScaler()
num_vars =['market_id','store_primary_category','order_protocol','total_items','sub
```

In [78]:
```
df_test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 52734 entries, 139667 to 3735
Data columns (total 13 columns):
 #   Column                   Non-Null Count  Dtype
---  ------                   --------------  -----
 0   market_id                52734 non-null  float64
 1   store_primary_category   52734 non-null  int64
 2   order_protocol           52734 non-null  float64
 3   total_items              52734 non-null  int64
 4   subtotal                 52734 non-null  int64
 5   num_distinct_items       52734 non-null  int64
 6   min_item_price           52734 non-null  int64
 7   max_item_price           52734 non-null  int64
 8   total_onshift_dashers    52734 non-null  float64
 9   total_busy_dashers       52734 non-null  float64
 10  total_outstanding_orders 52734 non-null  float64
 11  distance                 52734 non-null  float64
 12  time_taken               52734 non-null  float64
dtypes: float64(7), int64(6)
memory usage: 5.6 MB
```

In [ ]:

In [79]:
```
df_train[num_vars]=scaler.fit_transform(df_train[num_vars])
```

In [80]:
```
df_train.head()
```

Out[80]:

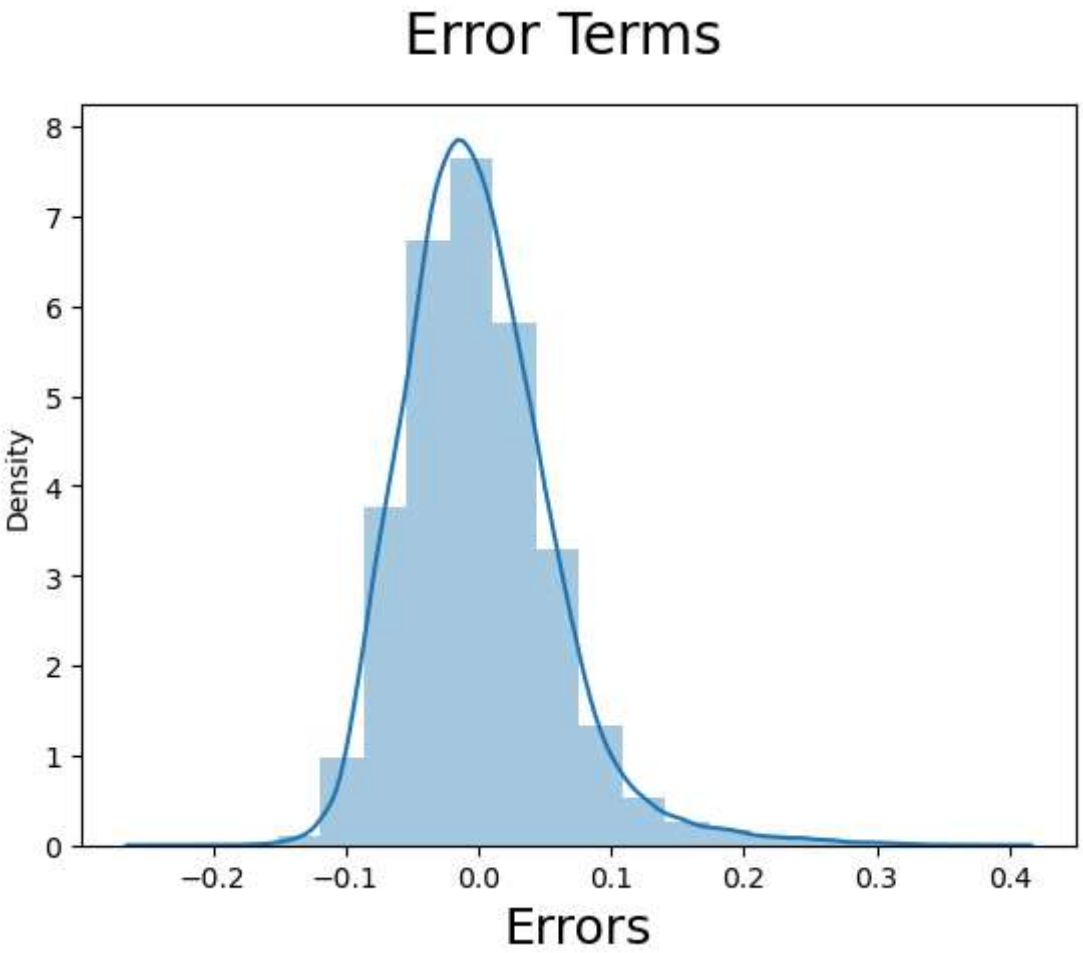
	market_id	store_primary_category	order_protocol	total_items	subtotal	num_dist
94746	0.6	0.333333	0.666667	0.002439	0.066791	
173338	0.6	1.000000	0.666667	0.000000	0.031530	
37592	0.6	0.763889	0.666667	0.000000	0.070896	
42763	0.2	0.388889	0.500000	0.012195	0.017276	
27506	0.2	1.000000	0.000000	0.004878	0.130597	

In [ ]:

In [87]:
```
y_train_time_taken = lr_3.predict(X_train_lm)
```

In [88]:
```
# Plot the histogram of the error terms
fig = plt.figure()
sns.distplot((y_train - y_train_time_taken), bins = 20)
fig.suptitle('Error Terms', fontsize = 20)                  # Plot heading
plt.xlabel('Errors', fontsize = 18)                         # X-label
```

Out[88]: Text(0.5, 0, 'Errors')



In [ ]:

In [91]:
```
num_vars =['market_id','store_primary_category','order_protocol','total_items','sub

df_test[num_vars] = scaler.transform(df_test[num_vars])
```

In [92]:
```
df_test.describe()
```

Out[92]:

	market_id	store_primary_category	order_protocol	total_items	subtotal	r
count	52734.000000	52734.000000	52734.000000	52734.000000	52734.000000	
mean	0.348504	0.496728	0.318226	0.005372	0.100573	
std	0.267545	0.287561	0.252375	0.006099	0.068075	
min	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	0.200000	0.236111	0.000000	0.002439	0.052239	
50%	0.200000	0.527778	0.333333	0.004878	0.083022	
75%	0.600000	0.763889	0.500000	0.007317	0.127425	
max	1.000000	1.000000	1.000000	0.141463	0.839552	

In [93]:
```
y_test = df_test.pop('time_taken')
X_test = df_test
```

In [94]:
```
# Adding constant variable to test dataframe
X_test_m4 = sm.add_constant(X_test)
```

In [98]:
```
# Creating X_test_m4 dataframe by dropping variables from X_test_m4
X_test_m4 = X_test_m4.drop('total_busy_dashers', axis = 1)
```

In [ ]:

In [ ]:

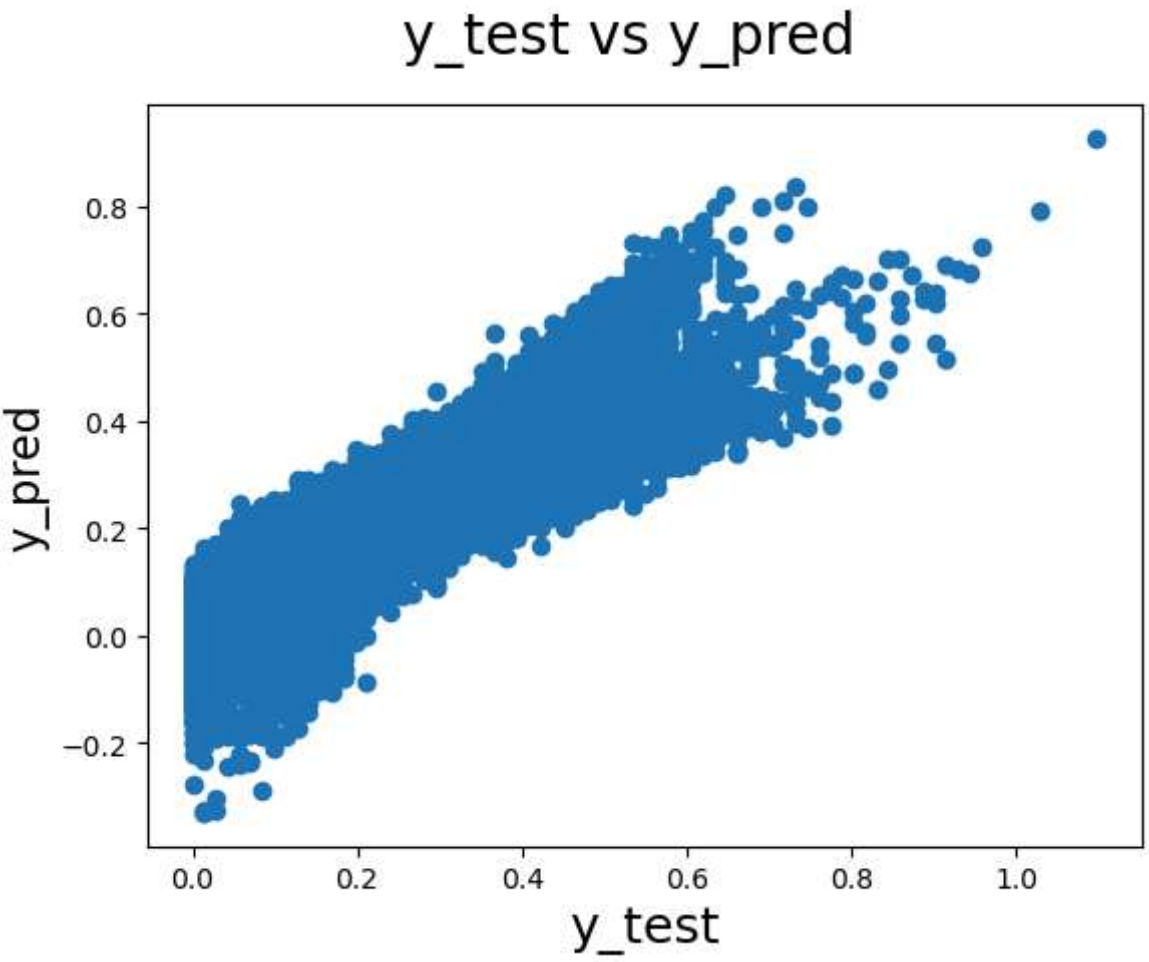
In [99]:
```
# Making predictions using the fourth model

y_pred_m4 = lr_3.predict(X_test_m4)
```

In [100…
```
# Plotting y_test and y_pred to understand the spread

fig = plt.figure()
plt.scatter(y_test, y_pred_m4)
fig.suptitle('y_test vs y_pred', fontsize = 20)              # Plot heading
plt.xlabel('y_test', fontsize = 18)                          # X-label
plt.ylabel('y_pred', fontsize = 16)
```

Out[100…
```
Text(0, 0.5, 'y_pred')
```



In [101…
```
r2_score(y_train,y_train_pred)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[101], line 1
----> 1 r2_score(y_train,y_train_pred)

NameError: name 'y_train_pred' is not defined
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: