Data Understanding

In [1]:
```
#importing libraries
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
import numpy as np
import pandas as pd
import boto3

from sklearn.preprocessing import MinMaxScaler
from scipy.stats import norm
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import RobustScaler
from sklearn.metrics import r2_score
from sklearn.metrics import mean_absolute_error
```

In [2]:
```
pip install xgboost
```

```
Looking in indexes: https://pypi.org/simple, https://pip.repos.neuron.amazonaw
s.com
Requirement already satisfied: xgboost in /home/ec2-user/anaconda3/envs/python
3/lib/python3.10/site-packages (1.7.5)
Requirement already satisfied: numpy in /home/ec2-user/anaconda3/envs/python3/l
ib/python3.10/site-packages (from xgboost) (1.22.3)
Requirement already satisfied: scipy in /home/ec2-user/anaconda3/envs/python3/l
ib/python3.10/site-packages (from xgboost) (1.10.0)
Note: you may need to restart the kernel to use updated packages.
```

In [3]:
```
#pd.options.display.max_columns = None
pd.set_option('display.max_columns', None)
```

In [4]:
```
s3_csv_path = f's3://group5-porter-delivery-estimation/data/dataset.csv'

df = pd.read_csv(s3_csv_path)
```

In [5]:
```
#Information of the data
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 197428 entries, 0 to 197427
Data columns (total 14 columns):
 #   Column                    Non-Null Count   Dtype  
---  ------                    --------------   -----  
 0   market_id                 196441 non-null  float64
 1   created_at                197428 non-null  object 
 2   actual_delivery_time      197421 non-null  object 
 3   store_id                  197428 non-null  object 
 4   store_primary_category    192668 non-null  object 
 5   order_protocol            196433 non-null  float64
 6   total_items               197428 non-null  int64  
 7   subtotal                  197428 non-null  int64  
 8   num_distinct_items        197428 non-null  int64  
 9   min_item_price            197428 non-null  int64  
 10  max_item_price            197428 non-null  int64  
 11  total_onshift_partners    181166 non-null  float64
 12  total_busy_partners       181166 non-null  float64
 13  total_outstanding_orders  181166 non-null  float64
dtypes: float64(5), int64(5), object(4)
memory usage: 21.1+ MB
None
```

In [6]:
```
#First 3 rows of table

df.loc[:df.index[2]]
```

Out[6]:

	market_id	created_at	actual_delivery_time	store_id	store_prima
0	1.0	2015-02-06 22:24:17	2015-02-06 23:27:16	df263d996281d984952c07998dc54358	
1	2.0	2015-02-10 21:49:25	2015-02-10 22:56:29	f0ade77b43923b38237db569b016ba25	
2	3.0	2015-01-22 20:39:28	2015-01-22 21:09:09	f0ade77b43923b38237db569b016ba25	

In [7]:
```
#year,month and day for 'created_at'

df[['year', 'month', 'day']] = df['created_at'].str.split('-', expand=True)
df['day'] = df['day'].str.split(' ', expand=True)[0]
df[['year', 'month', 'day']] = df[['year', 'month', 'day']].astype(int)
```

In [8]:
```
#created_at & actual_delivery_time into date_time format conversion
df['created_at'] = pd.to_datetime(df['created_at'])
df['actual_delivery_time'] = pd.to_datetime(df['actual_delivery_time'])
```

In [9]:
```
#feature'time_taken(mins)' created to store the time taken for delivery in minut
df['time_taken(mins)'] = (df['actual_delivery_time'] - df['created_at']).astype(
```

In [10]:
```
#created_at and actual_deivery_time dropping
df = df.drop(columns=['created_at', 'actual_delivery_time'])
```

In [11]:
```
#make a copy for exploration
df_=df.copy()
```

Exploratory Data Analysis

In [12]:
```
#missing values percentage in each category
percent_missing = df_.isnull().sum() * 100 / len(df_)
missing_value_df = pd.DataFrame({'%age of missing value': percent_missing})
missing_value_df.index.name = 'feature'
missing_value_df = missing_value_df.reset_index()
```

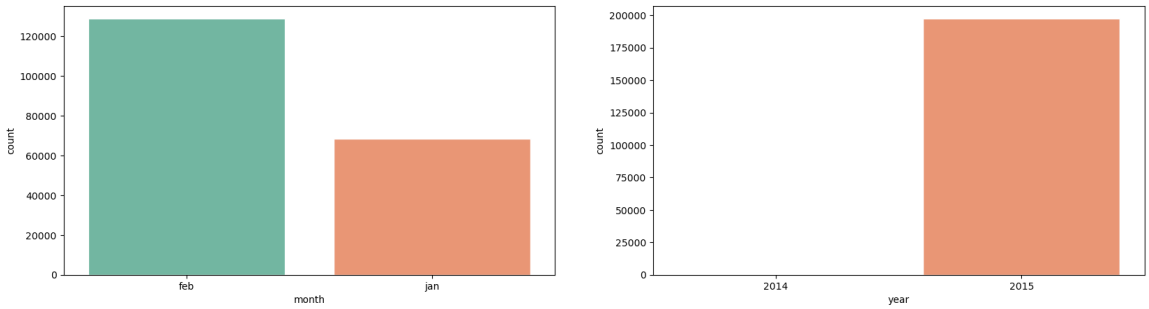
In [13]:
```
#categorical and numerical features splitting
categorical_feature = []
numerical_feature = []

for col in df.columns:
    if df[col].dtype == 'object' or df[col].dtype == 'category':
        categorical_feature.append(col)
    else:
        numerical_feature.append(col)
```

In [14]:
```
# total number of order from each market
store_count = df_.groupby('market_id')['store_id'].count()
plt.bar(store_count.index, store_count.values, color='yellow')
plt.xlabel('Market ID')
plt.ylabel('Store Count')
plt.title('Store Count by Market ID')
plt.show()
```

In [15]:
```
#Analysing what was the frequency of orders in each month and in year 2014 and 2
df_['month']=df_['month'].map({1:'jan',2:'feb',3:'oct'})
```

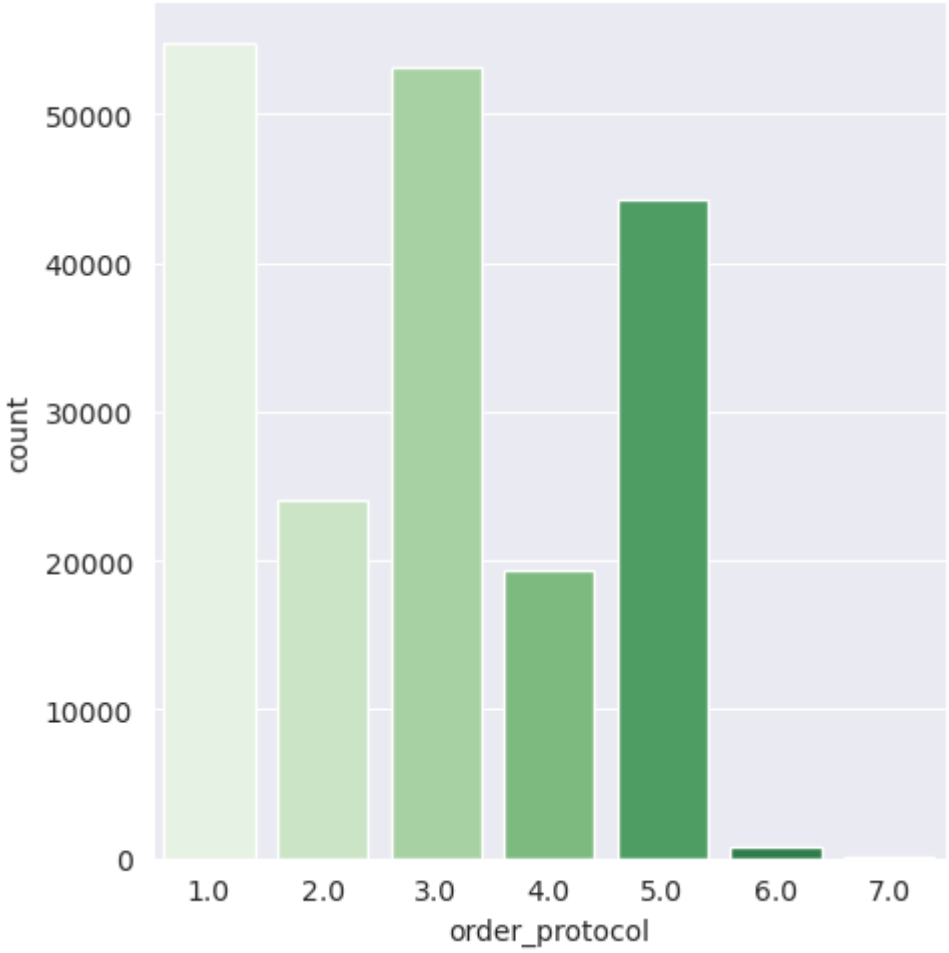
```
fig=plt.figure(figsize=(20,5))
ax=[None for _ in range(2)]
ax[0]=plt.subplot2grid((1,2),(0,0))
ax[1]=plt.subplot2grid((1,2),(0,1))
sns.set_style('darkgrid')
sns.countplot(x='month',data=df_,palette='Set2',ax=ax[0])
sns.countplot(x='year',data=df_,palette='Set2',ax=ax[1])
```

Out[15]: <AxesSubplot: xlabel='year', ylabel='count'>



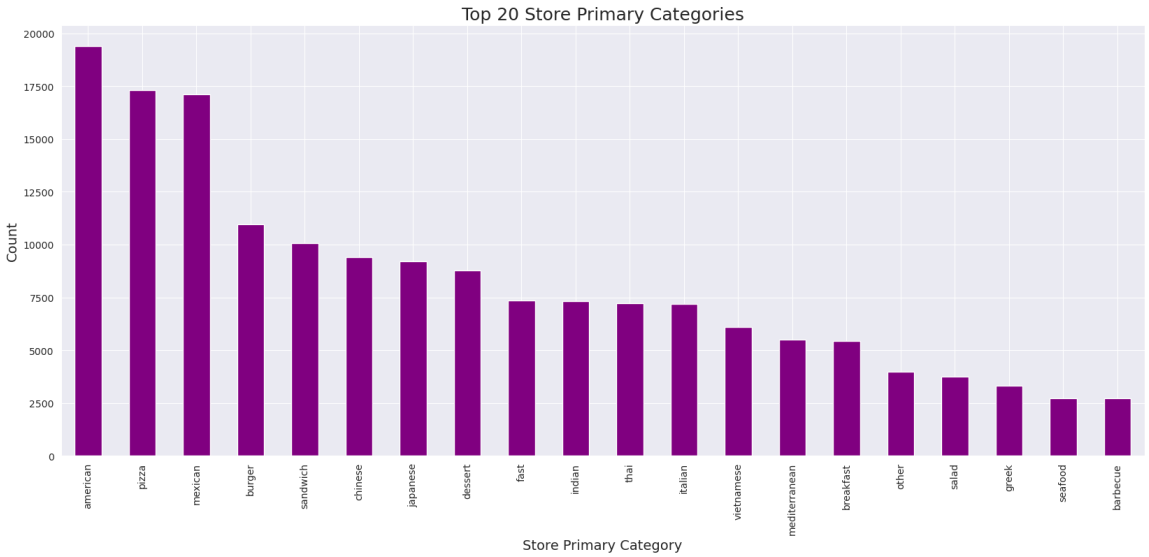
In [16]:
```
#ways in which different orders are placed(i.e., order protocol with most number
sns.catplot(x='order_protocol', kind='count', data=df_, palette='Greens')
```

Out[16]: <seaborn.axisgrid.FacetGrid at 0x7f07681ba7a0>



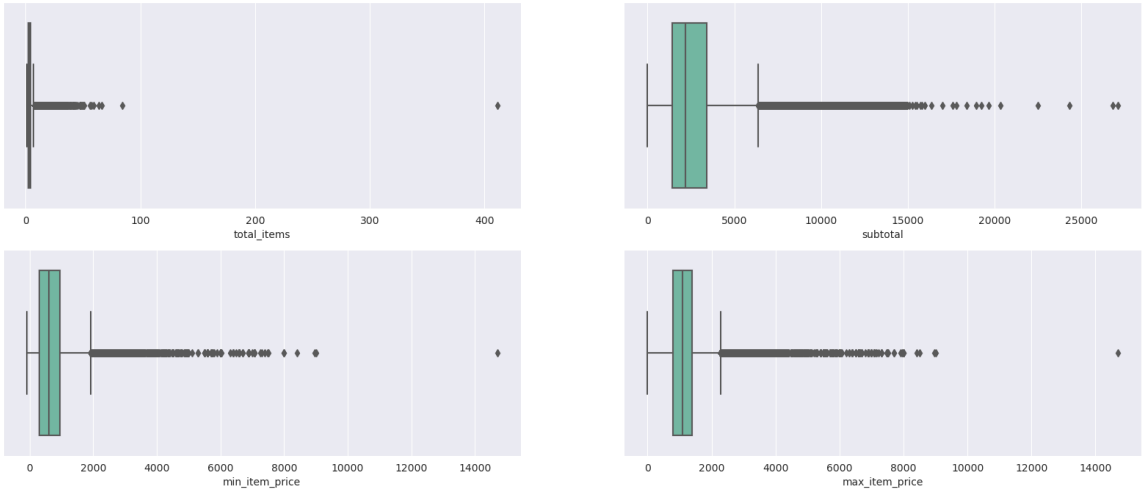
In [17]:
```
#top 20 i.e., most ordered category
fig, ax = plt.subplots(figsize=(20, 8))
df_['store_primary_category'].value_counts().sort_values(ascending=False)[:20].p
ax.set_xlabel('Store Primary Category', fontsize=14)
ax.set_ylabel('Count', fontsize=14)
```

```
ax.set_title('Top 20 Store Primary Categories', fontsize=18)
plt.show()
```



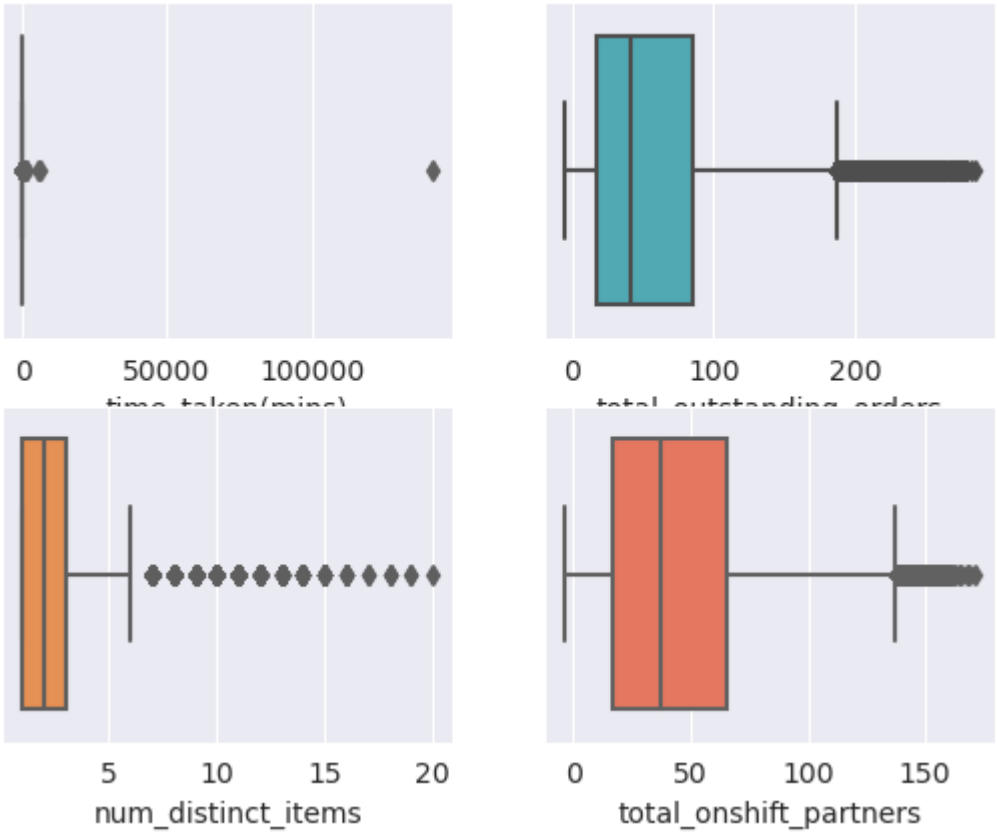
In [18]:
```
#Analysis of the numerical features
fig, axes = plt.subplots(nrows=2, ncols=2, figsize=(20, 8))
sns.boxplot(x='total_items', data=df_, palette='Set2', ax=axes[0, 0])
sns.boxplot(x='subtotal', data=df_, palette='Set2', ax=axes[0, 1])
sns.boxplot(x='min_item_price', data=df_, palette='Set2', ax=axes[1, 0])
sns.boxplot(x='max_item_price', data=df_, palette='Set2', ax=axes[1, 1])
```

Out[18]: <AxesSubplot: xlabel='max_item_price'>

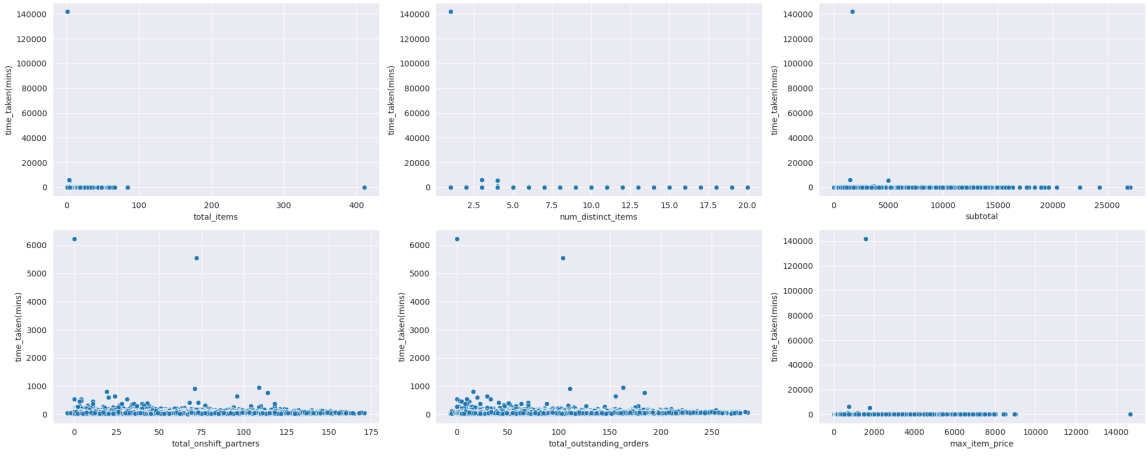


In [19]:
```
#fig=plt.figure(figsize=(20,8))
ax=[None for _ in range(4)]
ax[0]=plt.subplot2grid((2,2),(0,0))
ax[1]=plt.subplot2grid((2,2),(0,1))
ax[2]=plt.subplot2grid((2,2),(1,0))
ax[3]=plt.subplot2grid((2,2),(1,1))
sns.boxplot(x='time_taken(mins)',data=df_,palette='PuBu',ax=ax[0])
sns.boxplot(x='total_outstanding_orders',data=df_,palette='YlGnBu',ax=ax[1])
sns.boxplot(x='num_distinct_items',data=df_,palette='Oranges',ax=ax[2])
sns.boxplot(x='total_onshift_partners',data=df_,palette='Reds',ax=ax[3])
```

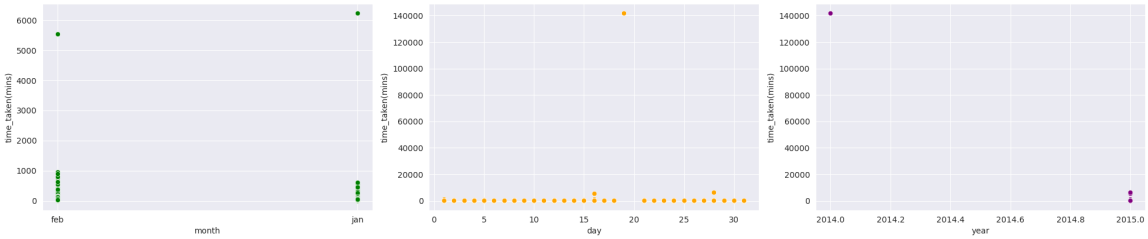
Out[19]: <AxesSubplot: xlabel='total_onshift_partners'>



In [20]:
```
#bivariate analysis: to see how the other features are correlated with delivery
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(20, 8))
sns.scatterplot(x='total_items', y='time_taken(mins)', data=df_, ax=axes[0, 0])
sns.scatterplot(x='num_distinct_items', y='time_taken(mins)', data=df_, ax=axes[
sns.scatterplot(x='subtotal', y='time_taken(mins)', data=df_, ax=axes[0, 2])
sns.scatterplot(x='total_onshift_partners', y='time_taken(mins)', data=df_, ax=a
sns.scatterplot(x='total_outstanding_orders', y='time_taken(mins)', data=df_, ax
sns.scatterplot(x='max_item_price', y='time_taken(mins)', data=df_, ax=axes[1, 2
plt.tight_layout()
```

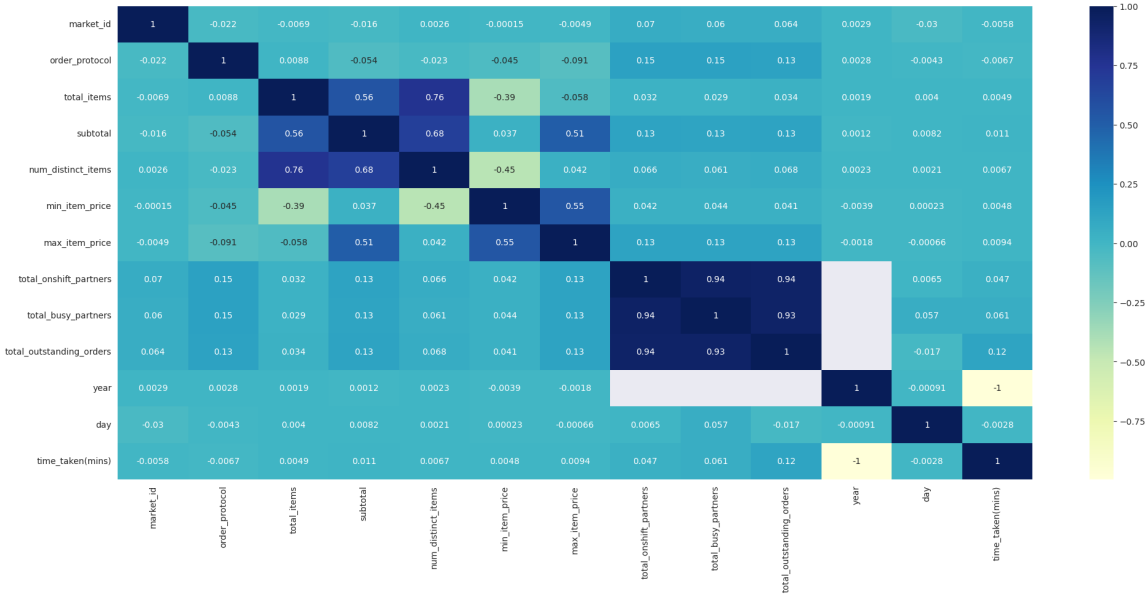


In [21]:
```
fig=plt.figure(figsize=(20,8))
ax=[None for _ in range(3)]
ax[0]=plt.subplot2grid((2,3),(0,0))
ax[1]=plt.subplot2grid((2,3),(0,1))
ax[2]=plt.subplot2grid((2,3),(0,2))
sns.scatterplot(x='month',y='time_taken(mins)',data=df_,color='green',ax=ax[0])
sns.scatterplot(x='day',y='time_taken(mins)',data=df_,color='orange',ax=ax[1])
sns.scatterplot(x='year',y='time_taken(mins)',data=df_,color='purple',ax=ax[2])
plt.tight_layout()
```



In [22]:
```
#correlation heatmap
plt.figure(figsize=(24,10))
sns.heatmap(df_.corr(), cmap='YlGnBu', annot=True, annot_kws={'size':10})
```

Out[22]: <AxesSubplot: >



In [23]:
```
abs_corr = abs(df_.corr()['time_taken(mins)'])
sorted_corr = abs_corr.sort_values(ascending=False)
print(sorted_corr)
```

```
time_taken(mins)            1.000000
year                        0.996474
total_outstanding_orders    0.122261
total_busy_partners         0.060615
total_onshift_partners      0.046952
subtotal                    0.011203
max_item_price              0.009411
num_distinct_items          0.006743
order_protocol              0.006662
market_id                   0.005781
total_items                 0.004906
min_item_price              0.004764
day                         0.002843
Name: time_taken(mins), dtype: float64
```

Data Prepocessing

In [24]:
```
df_.isna().sum()
```

Out[24]:
```
market_id                 987
store_id                    0
store_primary_category   4760
order_protocol            995
total_items                 0
subtotal                    0
num_distinct_items          0
min_item_price              0
max_item_price              0
total_onshift_partners  16262
total_busy_partners     16262
total_outstanding_orders  16262
year                        0
month                       1
day                         0
time_taken(mins)            7
dtype: int64
```

In [25]:
```
#imputing null values
df_['market_id']=np.where(df_['market_id'].isnull(),df_['market_id'].mode()[0],c
df_['store_primary_category']=np.where(df_['store_primary_category'].isnull(),df
df_['order_protocol']=np.where(df_['order_protocol'].isnull(),df['order_protocol
df_['total_onshift_partners']=np.where(df_['total_onshift_partners'].isnull(),df
df_['total_busy_partners']=np.where(df_['total_busy_partners'].isnull(),df['tota
df_['total_outstanding_orders']=np.where(df_['total_outstanding_orders'].isnull(
df_['time_taken(mins)']=np.where(df_['time_taken(mins)'].isnull(),df['time_taker
```

In [26]:
```
df_.describe()
```

Out[26]:

	market_id	order_protocol	total_items	subtotal	num_distinct_items	min_it
count	197428.000000	197428.000000	197428.000000	197428.000000	197428.000000	1974
mean	2.973813	2.872865	3.196391	2682.331402	2.670791	6
std	1.522616	1.505888	2.666546	1823.093688	1.630255	5
min	1.000000	1.000000	1.000000	0.000000	1.000000	-
25%	2.000000	1.000000	2.000000	1400.000000	1.000000	2
50%	3.000000	3.000000	3.000000	2200.000000	2.000000	5
75%	4.000000	4.000000	4.000000	3395.000000	3.000000	9
max	6.000000	7.000000	411.000000	27100.000000	20.000000	147

In [27]:
```
#we can see that in min_item_price column the min is -86, since it describes the
df_ = df_[df_['min_item_price'] >= 0]
```

In [28]:
```
#similarly total_outstanding_order describe the number of pending orders and aga
df_ = df_[df_['total_outstanding_orders'] >= 0]
```

In [29]:
```
#same goes for total_busy_partners and total_onshift_partners
mask = (df_['total_onshift_partners'] >= 0) & (df_['total_busy_partners'] >= 0)
df_ = df_[mask]
```

In [30]:
```
#separating categorical and numerical_variables
df_num = df_.select_dtypes(include=np.number)
```

```
df_cat = df_.select_dtypes(include='object')
```

In [31]:
```
df_.select_dtypes(include=np.number).head()
```

Out[31]:

	market_id	order_protocol	total_items	subtotal	num_distinct_items	min_item_price	max_it
0	1.0	1.0	4	3441	4	557	
1	2.0	2.0	1	1900	1	1400	
2	3.0	1.0	1	1900	1	1900	
3	3.0	1.0	6	6900	5	600	
4	3.0	1.0	3	3900	3	1100	

In [32]:
```
#applying log_transformation on df_num
time_taken=df_num['time_taken(mins)']
df_num.drop('time_taken(mins)',axis=1,inplace=True)
df_num = np.log1p(df_num)
```

In [33]:
```
#encoding categorical features
df_.select_dtypes(include='object').head(3)
```

Out[33]:

	store_id	store_primary_category	month
0	df263d996281d984952c07998dc54358	american	feb
1	f0ade77b43923b38237db569b016ba25	mexican	feb
2	f0ade77b43923b38237db569b016ba25	american	jan

In [34]:
```
df_cat.drop('store_id',axis=1,inplace=True)
encoder=LabelEncoder()
for feature in df_cat.columns:
    df_cat[feature]=encoder.fit_transform(df_cat[feature])
```

In [35]:
```
#concatenating back the numerical and categorical features
df_new_ = df_num.join(df_cat)
```

In [36]:
```
df_new_.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 197334 entries, 0 to 197427
Data columns (total 14 columns):
 #   Column                    Non-Null Count   Dtype  
---  ------                    --------------   -----  
 0   market_id                 197334 non-null  float64
 1   order_protocol            197334 non-null  float64
 2   total_items               197334 non-null  float64
 3   subtotal                  197334 non-null  float64
 4   num_distinct_items        197334 non-null  float64
 5   min_item_price            197334 non-null  float64
 6   max_item_price            197334 non-null  float64
 7   total_onshift_partners    197334 non-null  float64
 8   total_busy_partners       197334 non-null  float64
 9   total_outstanding_orders  197334 non-null  float64
 10  year                      197334 non-null  float64
 11  day                       197334 non-null  float64
 12  store_primary_category    197334 non-null  int64  
 13  month                     197334 non-null  int64  
dtypes: float64(12), int64(2)
memory usage: 26.6 MB
```

In [37]:
```
X=df_new_.copy()
y=time_taken
```

In [38]:
```
#train test split
train_mask = np.random.rand(len(X)) < 0.3
X_train, X_test = X[train_mask], X[~train_mask]
y_train, y_test = y[train_mask], y[~train_mask]
```

In [39]:
```
from xgboost import XGBRegressor
xgb=XGBRegressor()
xgb.fit(X_train,y_train)
```

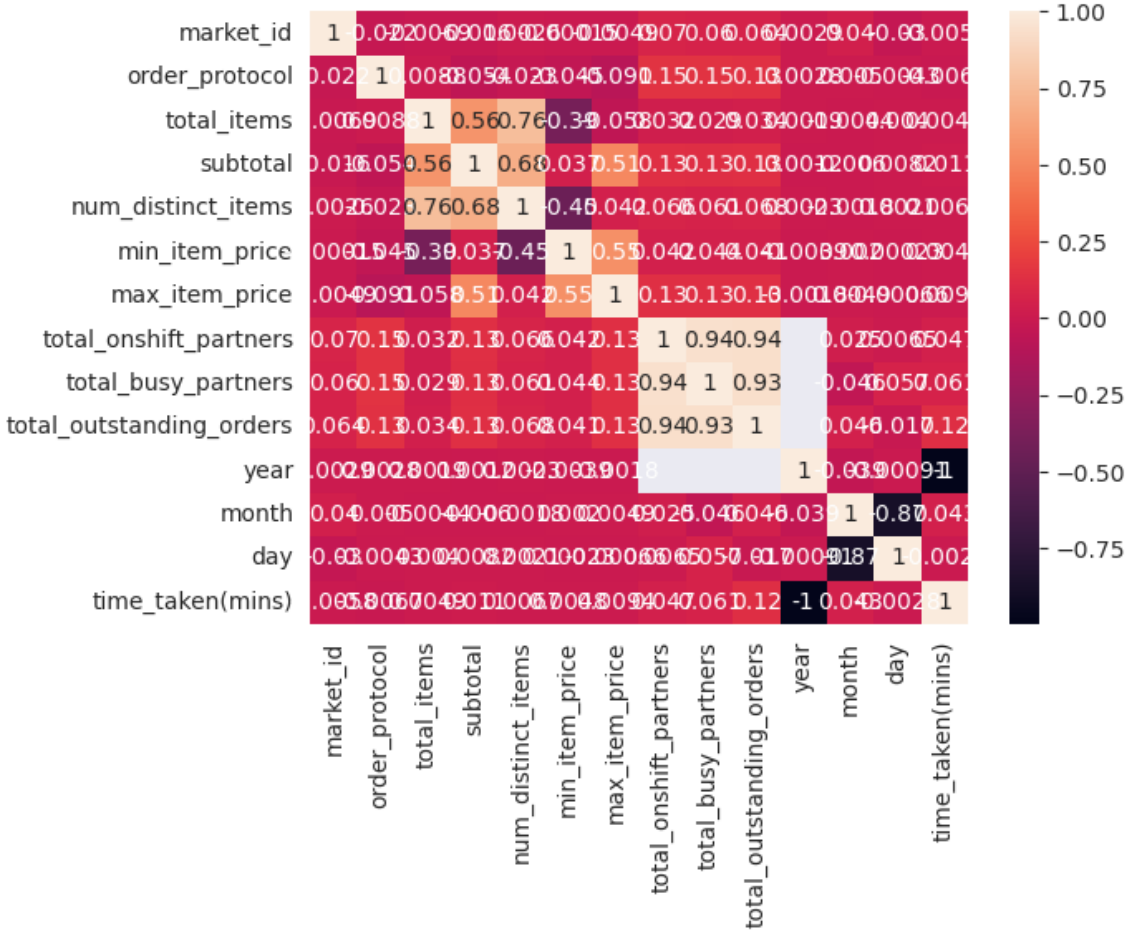
Out[39]:
```
XGBRegressor(base_score=None, booster=None, callbacks=None,
             colsample_bylevel=None, colsample_bynode=None,
             colsample_bytree=None, early_stopping_rounds=None,
             enable_categorical=False, eval_metric=None, feature_ty
pes=None,
             gamma=None, gpu_id=None, grow_policy=None, importance_
type=None,
             interaction_constraints=None, learning_rate=None, max_
bin=None,
```

In [40]:
```
y_pred=xgb.predict(X_test)
print('Mean absolute error:{}'.format(mean_absolute_error(y_test,y_pred)))
print('r2_score:{}'.format(r2_score(y_test,y_pred)))
```

```
Mean absolute error:12.828135421180502
r2_score:0.0005755778642763685
```

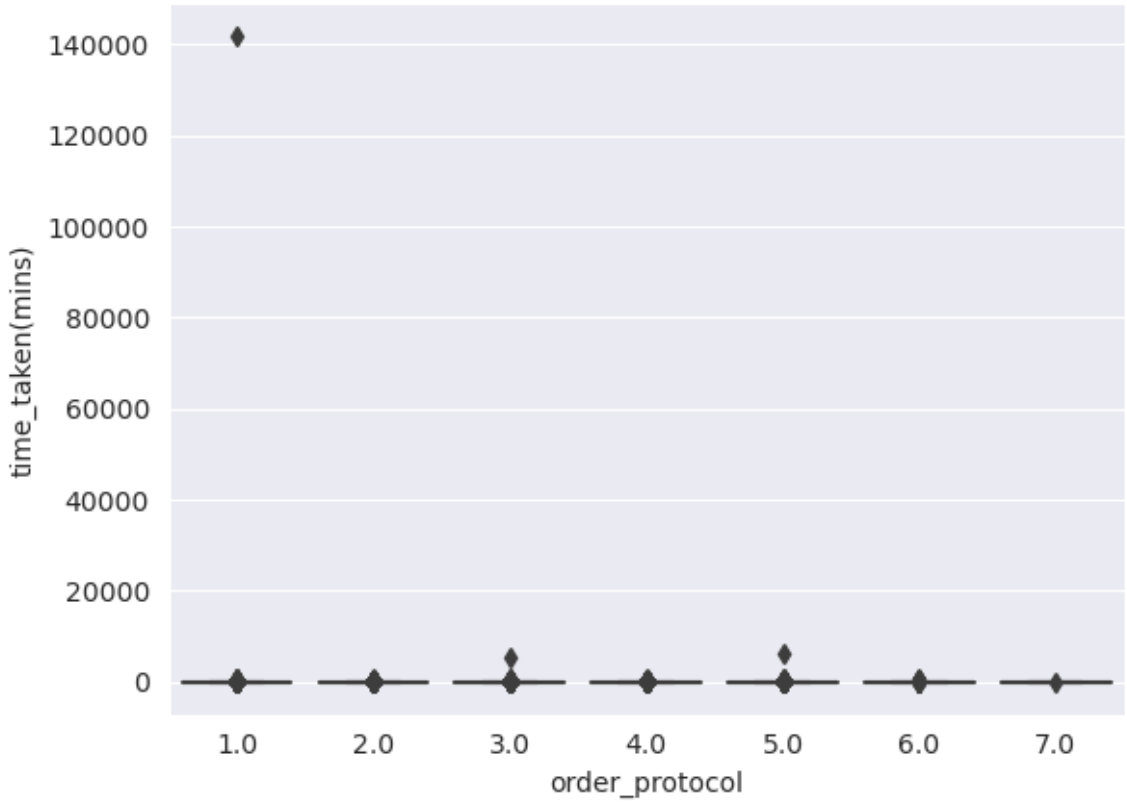
Factors Influencing Delivery Time:

In [41]:
```
import seaborn as sns
import matplotlib.pyplot as plt

# Visualize correlation between features
corr_matrix = df.corr()
sns.heatmap(corr_matrix, annot=True)
plt.show()
```



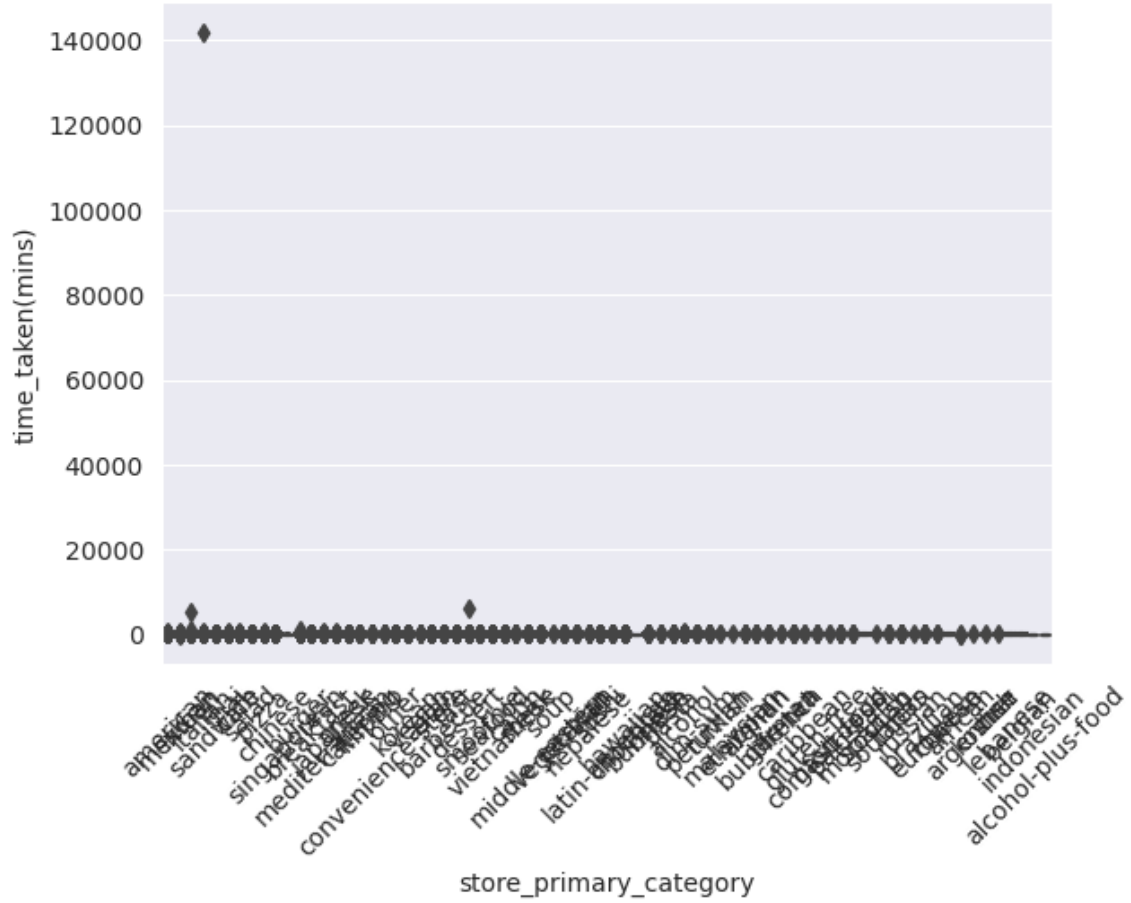
Impact of Order Protocol:

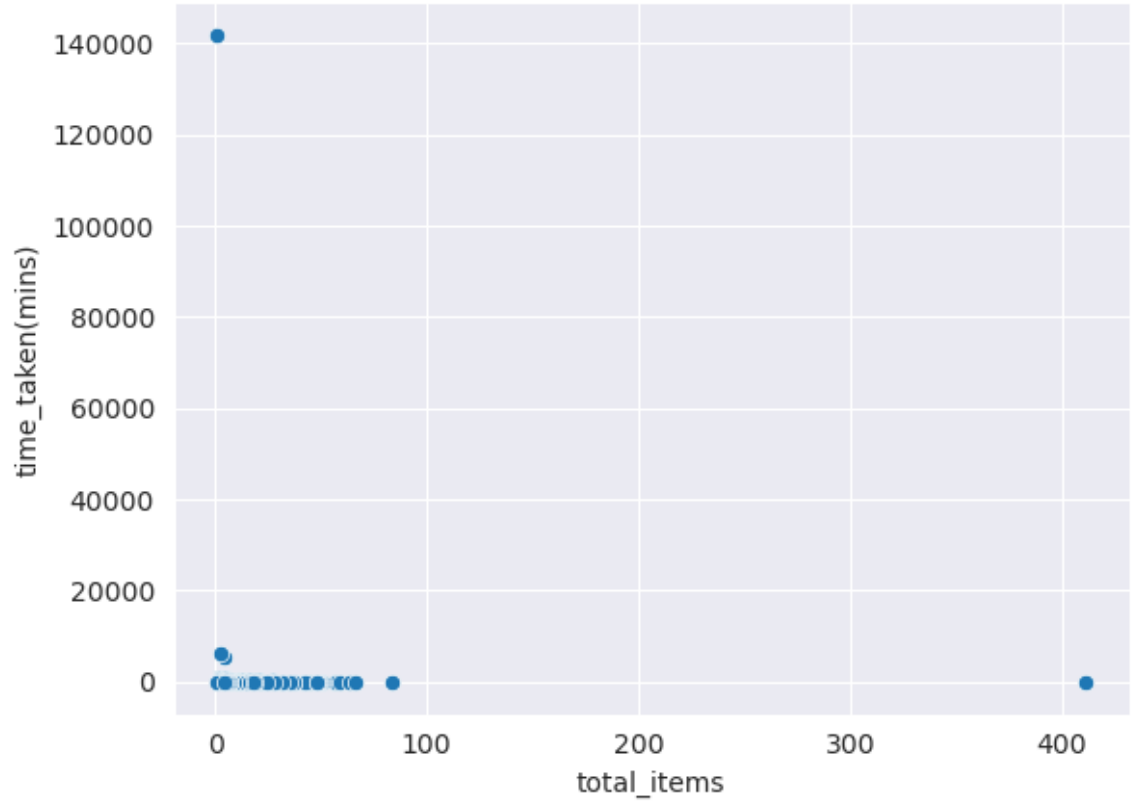
In [42]:
```
import seaborn as sns
import matplotlib.pyplot as plt

# Compare delivery time distribution based on order protocols
sns.boxplot(data=df, x='order_protocol', y='time_taken(mins)')
plt.show()
```



Restaurant Category and Order Size:

In [43]:
```
import seaborn as sns
import matplotlib.pyplot as plt

# Compare delivery time distribution based on restaurant category
sns.boxplot(data=df, x='store_primary_category', y='time_taken(mins)')
plt.xticks(rotation=45)
plt.show()

# Compare delivery time distribution based on order size
sns.scatterplot(data=df, x='total_items', y='time_taken(mins)')
plt.show()
```

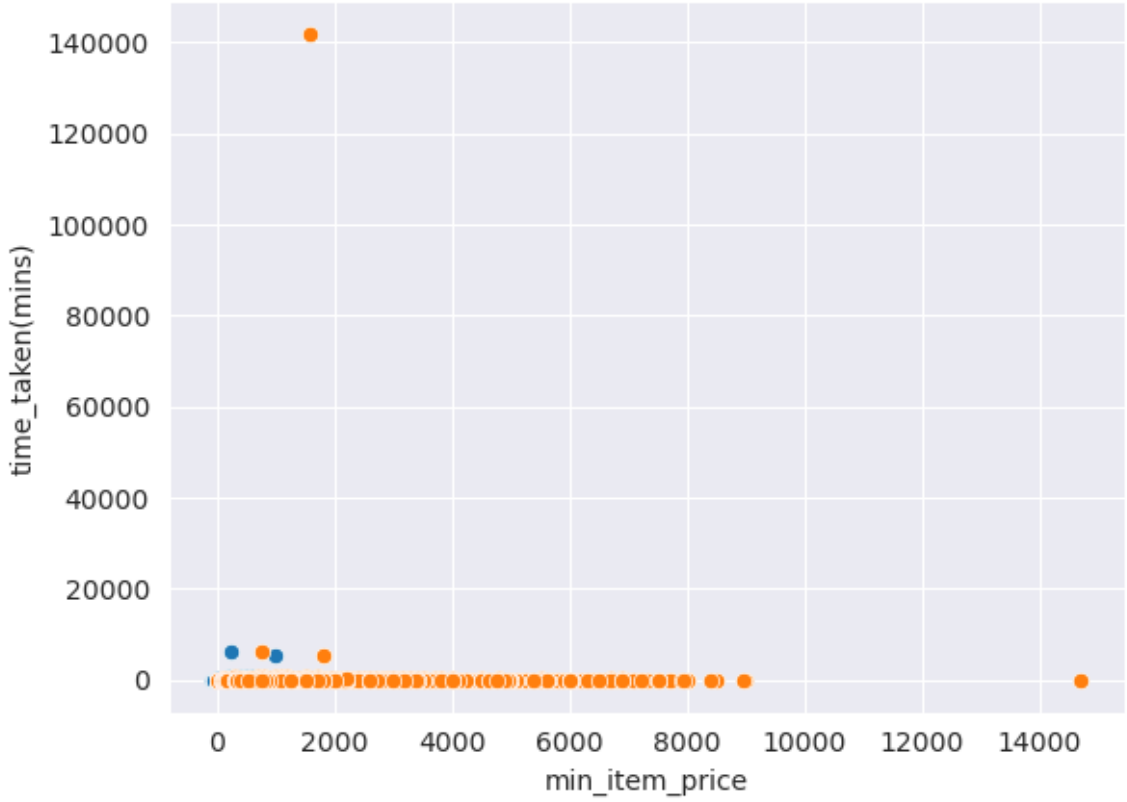




Prices of Items in an Order:

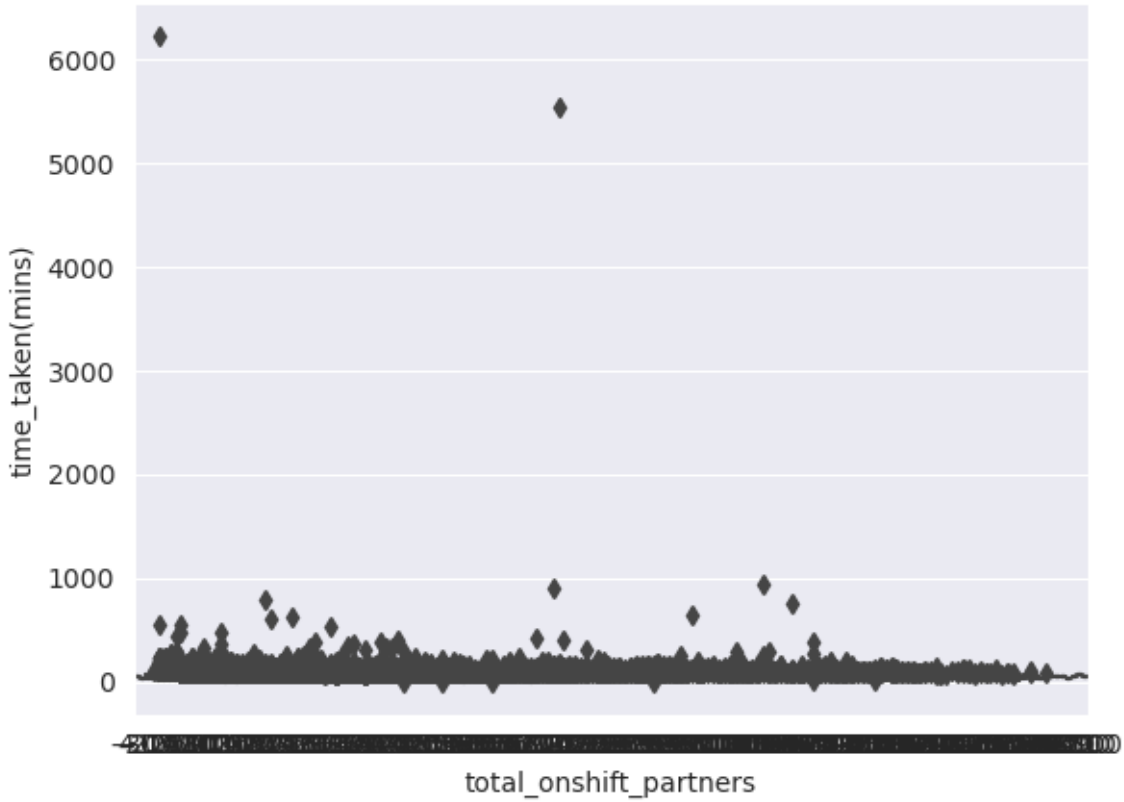
In [44]:
```
import seaborn as sns

# Analyze relationship between item prices and delivery time
```

```
sns.scatterplot(data=df, x='min_item_price', y='time_taken(mins)')
sns.scatterplot(data=df, x='max_item_price', y='time_taken(mins)')
plt.show()
```



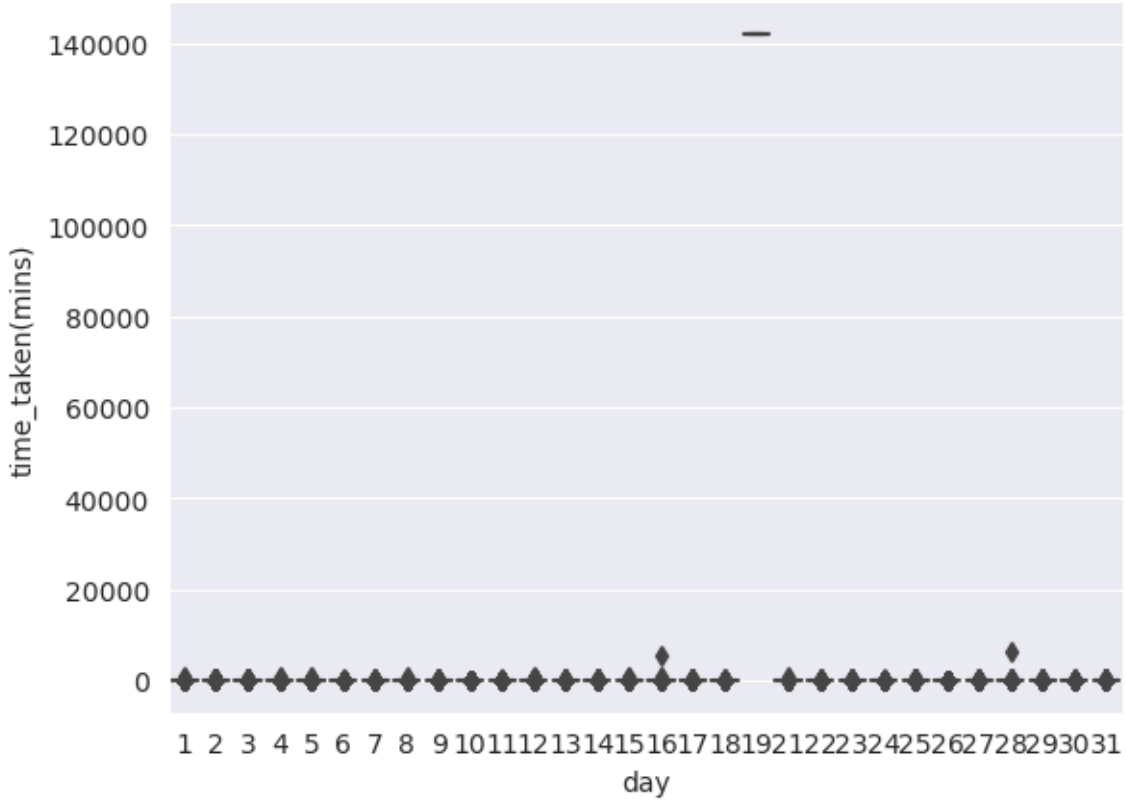
On-Shift and Busy Delivery Partners:

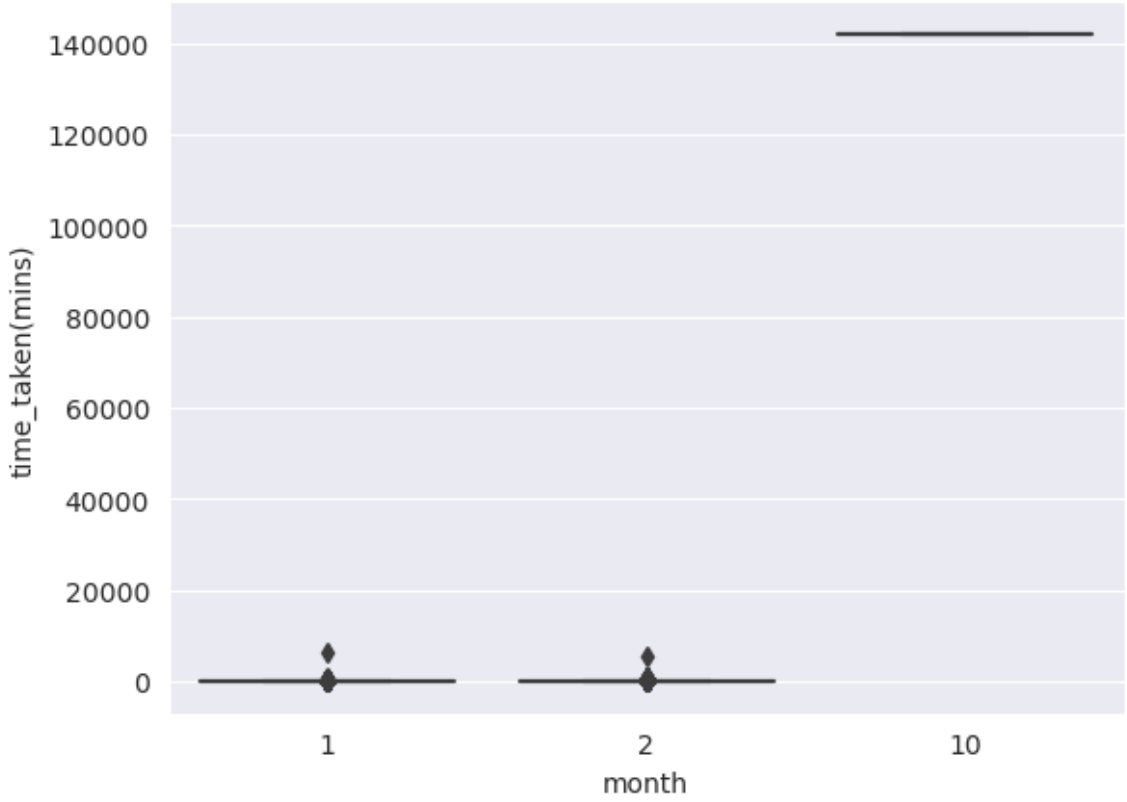
In [45]:
```
import seaborn as sns
import matplotlib.pyplot as plt

# Compare delivery time distribution based on number of on-shift and busy delive
sns.boxplot(data=df, x='total_onshift_partners', y='time_taken(mins)')
plt.show()
```



Seasonal and Time-Based Trends:

In [46]:
```
# Compare delivery time distribution based on day of the week
sns.boxplot(data=df, x='day', y='time_taken(mins)')
plt.show()

# Compare delivery time distribution based on month of the year
sns.boxplot(data=df, x='month', y='time_taken(mins)')
plt.show()
```

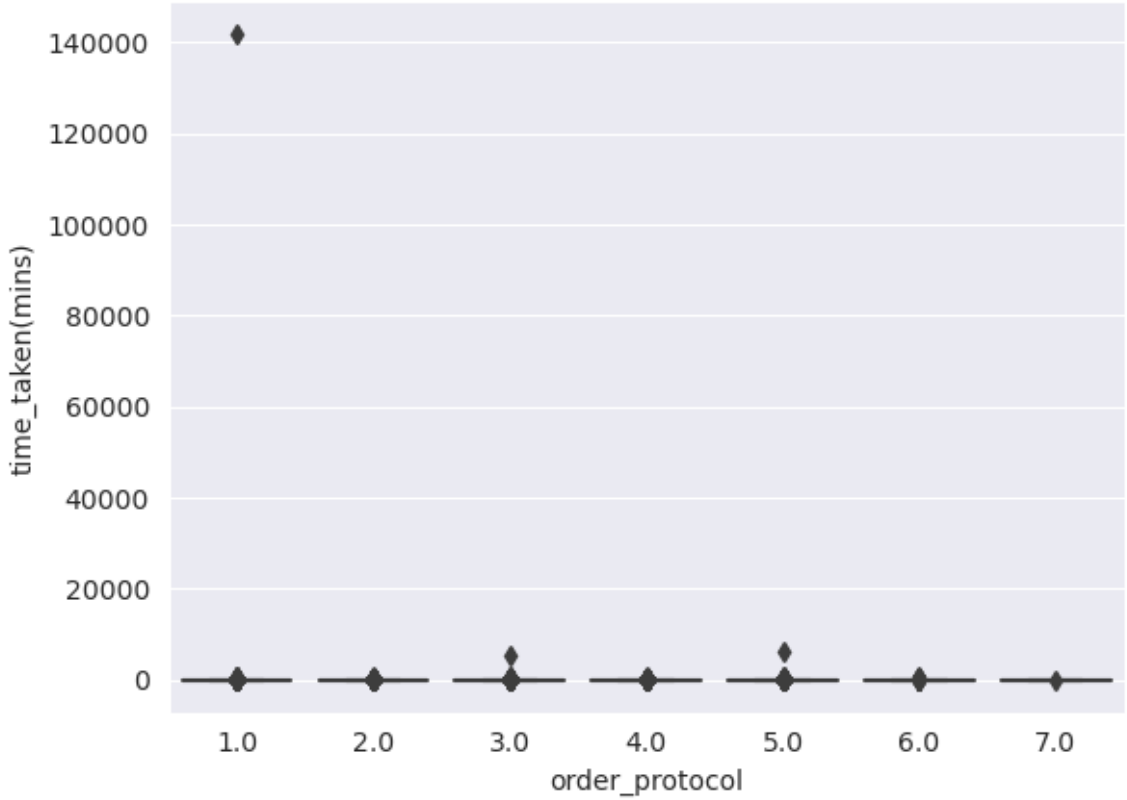


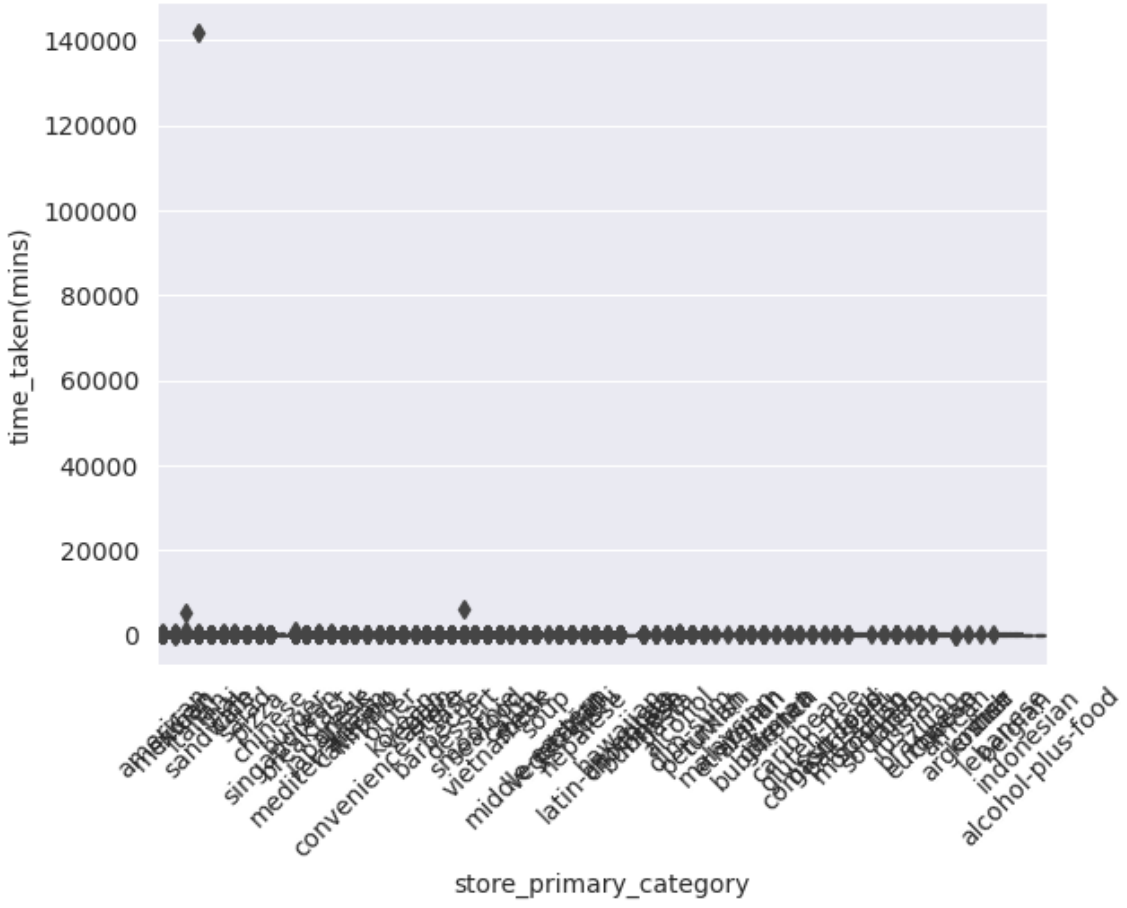


Customer Behavior Patterns:

In [47]:
```
# Compare delivery time distribution based on order protocols or restaurant cate
sns.boxplot(data=df, x='order_protocol', y='time_taken(mins)')
plt.show()

sns.boxplot(data=df, x='store_primary_category', y='time_taken(mins)')
```

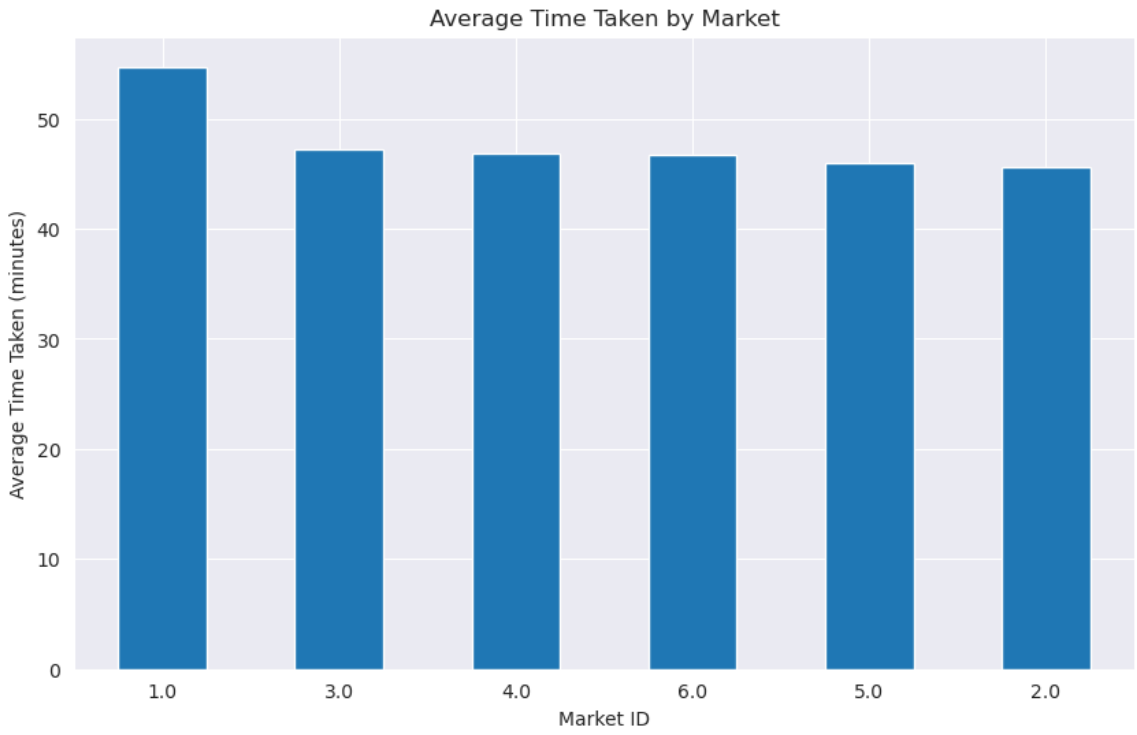
```
plt.xticks(rotation=45)
plt.show()
```





Comparison of Markets Based on time taken

In [48]:
```
import pandas as pd
import matplotlib.pyplot as plt

# Assuming your data is stored in a DataFrame called 'df'
# Convert time_taken column to numeric format
df['time_taken(mins)'] = pd.to_numeric(df['time_taken(mins)'], errors='coerce')

# Group data by market and calculate average time taken
average_time_taken = df.groupby('market_id')['time_taken(mins)'].mean()

# Sort the average time taken in descending order
average_time_taken = average_time_taken.sort_values(ascending=False)

# Create a bar plot to compare the time taken for different markets
plt.figure(figsize=(10, 6))
average_time_taken.plot(kind='bar')
plt.xlabel('Market ID')
plt.ylabel('Average Time Taken (minutes)')
plt.title('Average Time Taken by Market')
plt.xticks(rotation=0)
plt.show()
```



In [ ]: