Assignment 2

In [1]:

```
import pandas as pd
import folium
from folium import Choropleth, Circle, Marker
from folium.plugins import HeatMap
from h3 import h3
import seaborn as sns
import matplotlib.pyplot as plt
```

In [2]:

```
data_orders_path = '/data/lab/STA326_Assignment2/datasets/data_orders.csv'
data_orders = pd.read_csv(data_orders_path)
```

In [3]:

```
data_orders.head()
```

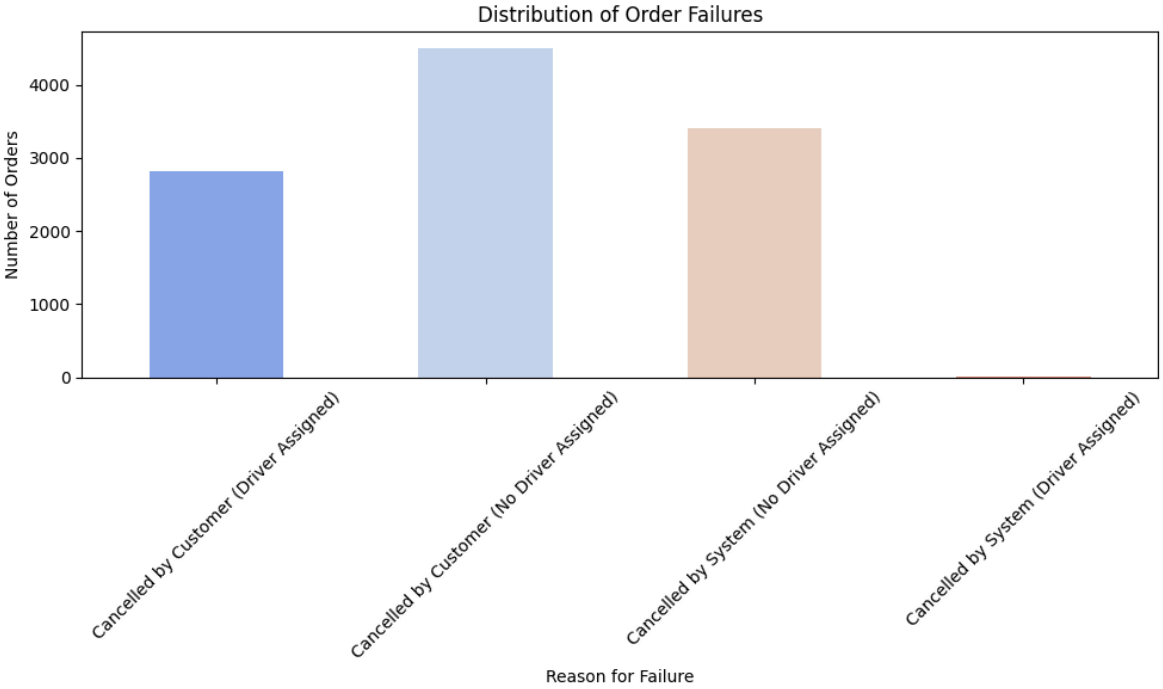
Out[3]:

	order_datetime	origin_longitude	origin_latitude	m_order_eta	order_gk
0	18:08:07	-0.978916	51.456173	60.0	3000583041974
1	20:57:32	-0.950385	51.456843	NaN	3000583116437
2	12:07:50	-0.969520	51.455544	477.0	3000582891479
3	13:50:20	-1.054671	51.460544	658.0	3000582941169
4	21:24:45	-0.967605	51.458236	NaN	3000583140877

Q1

In [4]:

```
def categorize_failure(row):
    if row['order_status_key'] == 4:
        return 'Cancelled by Customer (No Driver Assigned)' if row['is_driver_as
    elif row['order_status_key'] == 9:
        return 'Cancelled by System (No Driver Assigned)' if row['is_driver_assi
    else:
        return 'Other'

data_orders['failure_category'] = data_orders.apply(categorize_failure, axis=1)

plt.figure(figsize=(10, 6))

sns.countplot(
    data=data_orders,
    x='failure_category',
    hue='failure_category',
    palette='coolwarm',
    width=0.5,
    legend=False
)

plt.legend([],[], frameon=False)

plt.title('Distribution of Order Failures')
plt.xlabel('Reason for Failure')
plt.ylabel('Number of Orders')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()

most_frequent_failure = data_orders['failure_category'].value_counts().idxmax()
print(f"The category with the most failed orders is: {most_frequent_failure}")
```



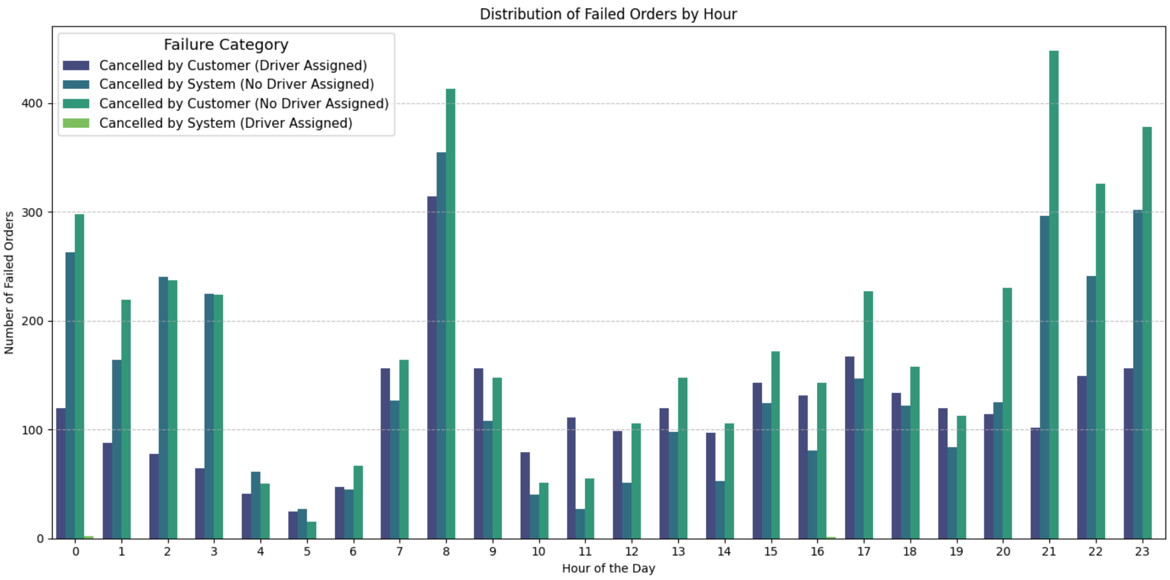
```
The category with the most failed orders is: Cancelled by Customer (No Driver Ass
igned)
```

Q2

In [5]:

```
data_orders['order_datetime'] = pd.to_datetime(data_orders['order_datetime'])
data_orders['hour'] = data_orders['order_datetime'].dt.hour

def categorize_failure(row):
    if row['order_status_key'] == 4:
        return 'Cancelled by Customer' + (' (Driver Assigned)' if row['is_driver
    elif row['order_status_key'] == 9:
        return 'Cancelled by System' + (' (Driver Assigned)' if row['is_driver_a
    else:
        return 'Other'

data_orders['failure_category'] = data_orders.apply(categorize_failure, axis=1)

plt.figure(figsize=(14, 7))
sns.countplot(data=data_orders, x='hour', hue='failure_category', palette='virid
plt.title('Distribution of Failed Orders by Hour')
plt.xlabel('Hour of the Day')
plt.ylabel('Number of Failed Orders')
plt.legend(title='Failure Category', title_fontsize='13', fontsize='11')
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.tight_layout()
plt.show()

hourly_failure_counts = data_orders.groupby(['hour', 'failure_category']).size()
max_failure_hours = hourly_failure_counts.idxmax().to_dict()
```

```
total_max_failure_hour = hourly_failure_counts.sum(axis=1).idxmax()

print("Each failure category's peak hour:")
for category, hour in max_failure_hours.items():
    print(f"{category}: Most failures at {hour} hour.")

print(f"\nOverall, the hour with the most failures is: {total_max_failure_hour}.
```



```
Each failure category's peak hour:
Cancelled by Customer (Driver Assigned): Most failures at 8 hour.
Cancelled by Customer (No Driver Assigned): Most failures at 21 hour.
Cancelled by System (Driver Assigned): Most failures at 0 hour.
Cancelled by System (No Driver Assigned): Most failures at 8 hour.

Overall, the hour with the most failures is: 8.
```

Analysis of the result

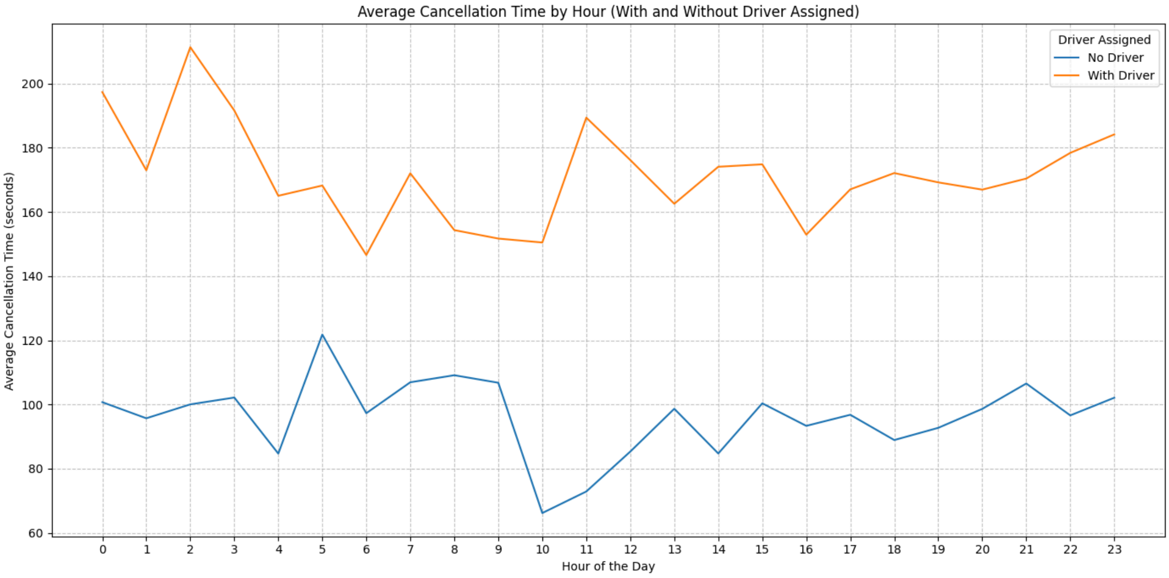
Analyzing the provided data trends, we can observe distinct patterns in order cancellations: 'Cancelled by Customer (Driver Assigned)' peaks at 8 AM, aligning with the morning rush when customers may cancel due to delayed drivers or urgent commutes. 'Cancelled by Customer (No Driver Assigned)' surges at 9 PM, possibly when plans change post-evening activities. 'Cancelled by System (Driver Assigned)' hits a high at midnight, likely due to a shortage of drivers. 'Cancelled by System (No Driver Assigned)' also peaks at 8 AM, indicating system cancellations due to an inability to assign drivers during the morning demand spike.

Overall, the most significant failure rate occurs at 8 AM, suggesting a critical need for strategic adjustments during the morning peak hours.

Q3

In [6]:

```
cancelled_orders = data_orders[data_orders['order_status_key'].isin([4, 9])]

# 通过IQR方法来分析数据中的异常值
def remove_outliers(df, column_name):
    Q1 = df[column_name].quantile(0.25)
    Q3 = df[column_name].quantile(0.75)
    IQR = Q3 - Q1
    lower_bound = Q1 - 1.5 * IQR
    upper_bound = Q3 + 1.5 * IQR
    return df[(df[column_name] >= lower_bound) & (df[column_name] <= upper_bound

data_orders['hour'] = pd.to_datetime(data_orders['order_datetime']).dt.hour
cancelled_orders = data_orders[data_orders['order_status_key'].isin([4, 9])]

filtered_orders_no_driver = remove_outliers(
    cancelled_orders[cancelled_orders['is_driver_assigned_key'] == 0],
    'cancellations_time_in_seconds'
)
filtered_orders_with_driver = remove_outliers(
    cancelled_orders[cancelled_orders['is_driver_assigned_key'] == 1],
    'cancellations_time_in_seconds'
)

average_cancellation_time_no_driver = filtered_orders_no_driver.groupby('hour')[
average_cancellation_time_with_driver = filtered_orders_with_driver.groupby('hou

plt.figure(figsize=(14, 7))
sns.lineplot(data=average_cancellation_time_no_driver, label='No Driver')
sns.lineplot(data=average_cancellation_time_with_driver, label='With Driver')
plt.title('Average Cancellation Time by Hour (With and Without Driver Assigned)'
plt.xlabel('Hour of the Day')
plt.ylabel('Average Cancellation Time (seconds)')
plt.xticks(range(24))
plt.legend(title='Driver Assigned')
plt.grid(True, linestyle='--', alpha=0.7)
plt.tight_layout()
plt.show()

if average_cancellation_time_no_driver.mean() > average_cancellation_time_with_d
    print("On average, orders cancelled without a driver assigned take longer th
else:
    print("On average, orders cancelled with a driver assigned take longer than
```

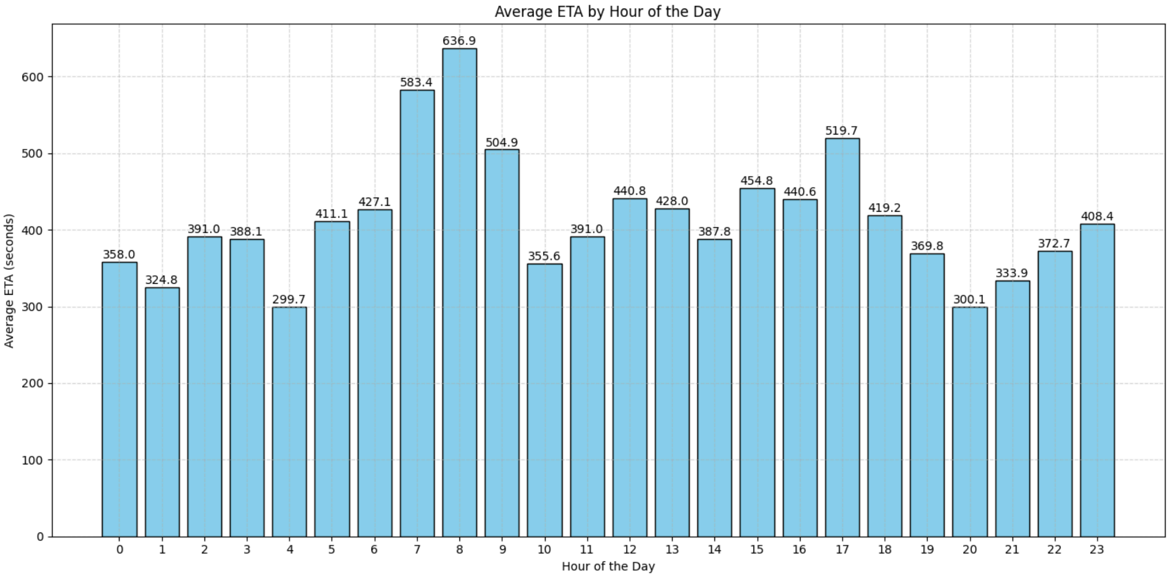


```
On average, orders cancelled with a driver assigned take longer than those withou
t a driver.
```

Q4

In [7]:

```
average_eta_by_hour = data_orders.groupby('hour')['m_order_eta'].mean()

plt.figure(figsize=(14, 7))
bars = plt.bar(average_eta_by_hour.index, average_eta_by_hour.values, color='sky

for bar in bars:
    yval = bar.get_height()
    plt.text(bar.get_x() + bar.get_width()/2, yval + 1, round(yval, 1), ha='cent

plt.title('Average ETA by Hour of the Day')
plt.xlabel('Hour of the Day')
plt.ylabel('Average ETA (seconds)')
plt.xticks(range(24))
plt.grid(True, linestyle='--', alpha=0.5)
plt.tight_layout()
plt.show()
```



By the plot, the tow peak happens at morning peak and evening peak when great traffic jam occurs. Thus it always takes lots of time before order arrive

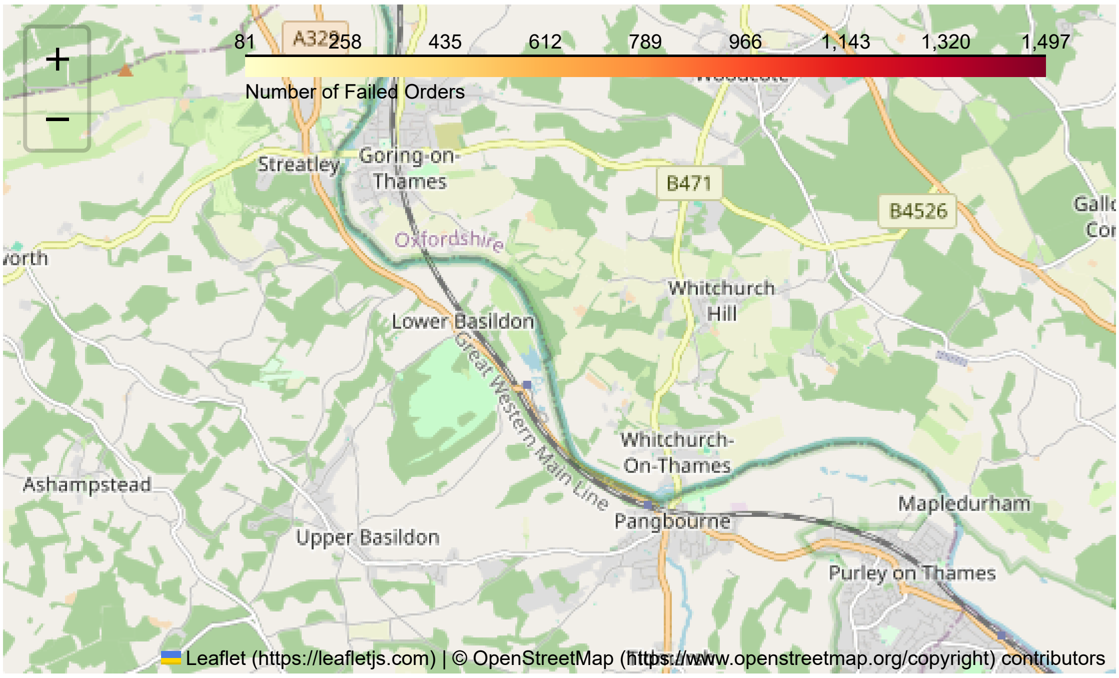
Q5

In [8]:

```
import pandas as pd
import folium
from h3 import h3
import branca.colormap as cm

data_orders_path = '/data/lab/STA326_Assignment2/datasets/data_orders.csv'
data_orders = pd.read_csv(data_orders_path)

data_orders['h3_index'] = data_orders.apply(
    lambda row: h3.geo_to_h3(row['origin_latitude'], row['origin_longitude'], 8)
)

h3_counts = data_orders['h3_index'].value_counts().reset_index()
h3_counts.columns = ['h3_index', 'order_count']

h3_counts.sort_values('order_count', ascending=False, inplace=True)

total_orders = h3_counts['order_count'].sum()
```

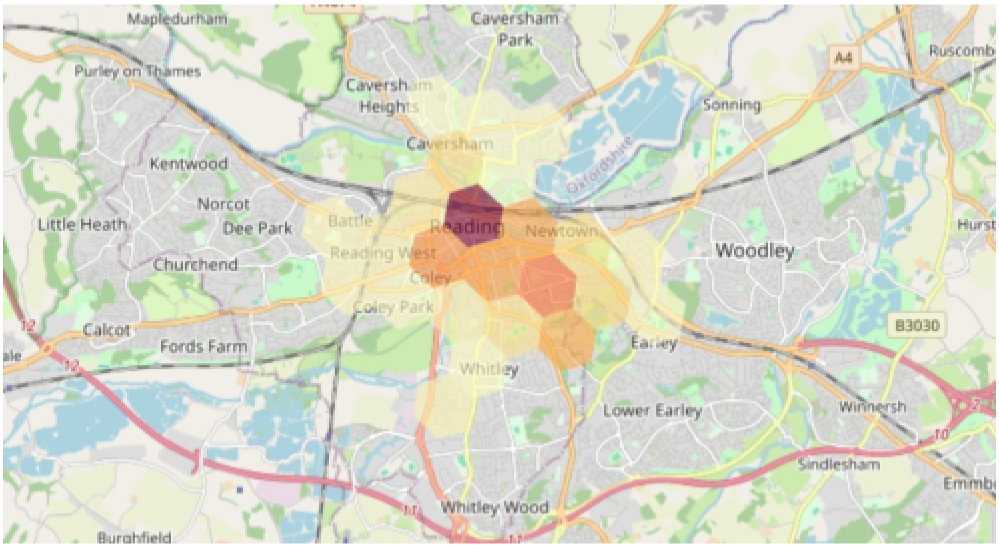
```
eighty_percent_threshold = total_orders * 0.8
cumulative_orders = 0
h3_indices_80_percent = []

for index, row in h3_counts.iterrows():
    cumulative_orders += row['order_count']
    h3_indices_80_percent.append(row['h3_index'])
    if cumulative_orders >= eighty_percent_threshold:
        break

h3_indices_80_percent_df = h3_counts[h3_counts['h3_index'].isin(h3_indices_80_pe

color_scale = cm.linear.YlOrRd_09.scale(
    h3_indices_80_percent_df['order_count'].min(),
    h3_indices_80_percent_df['order_count'].max()
)
color_scale.caption = 'Number of Failed Orders'

map_center = [data_orders['origin_latitude'].mean(), data_orders['origin_longitu
folium_map = folium.Map(location=map_center, zoom_start=12)

def add_hexagon_to_map(h3_index, folium_map_obj, count):
    hex_boundary = list(map(lambda coords: list(coords), h3.h3_to_geo_boundary(h
    hex_boundary.append(hex_boundary[0])
    folium.Polygon(
        locations=hex_boundary,
        color=None,
        fill=True,
        fill_color=color_scale(count),
        fill_opacity=0.6,
        popup=f'Order Count: {count}'
    ).add_to(folium_map_obj)

for h3_index in h3_indices_80_percent:
    count = h3_counts.loc[h3_counts['h3_index'] == h3_index, 'order_count'].iloc
    add_hexagon_to_map(h3_index, folium_map, count)

folium_map.add_child(color_scale)

folium_map
```

Out[8]:



In [15]:

```
import matplotlib.image as mpimg

map_file_path = '/data/lab/STA326_Assignment2/result.html'
folium_map.save(map_file_path)

img = mpimg.imread('/data/lab/STA326_Assignment2/result.jpg')
plt.imshow(img)
plt.axis('off')
plt.show()

print("Due to display problems when converting web pages to PDF, the Hexagons re
```



```
Due to display problems when converting web pages to PDF, the Hexagons results ca
nnot be displayed correctly in the PDF, so a separate picture of the results is s
hown here.
```