Maximize revenue

May 16, 2024

1 Maximizing Revenue for Taxi Cab Drivers through Payment Type Analysis

1.0.1 Problem Statement

In the fast-paced taxi booking sector, making the most of revenue is essential for long-term success and driver happiness. Our goal is to use data-driven insights to maximise revenue streams for taxi drivers in order to meet this need. Our research aims to determine whether payment methods have an impact on fare pricing by focusing on the relationship between payment type and fare amount.

1.0.2 Objective

This project's main goal is to run an A/B test to examine the realtionship between the total fare and the method of payment. We use Python hypothesis and descriptive statistics to extract useful information that can help taxi drivers generate more cash. In particular, we want to find out if there is a big difference in the fares for those who pay with credit cards versus those who pay with cash.

1.0.3 Research Question

Is there a relationship between total fare amount and payment type and can we nudge customers towards payment methods that generate higher revenue for drivers, without negatively impacting customer experience?

1.1 Importing Libraries

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as st
import warnings
import statsmodels.api as sm
warnings.filterwarnings('ignore')
```

1.2 Loading the dataset

[34]:
```
df = pd.read_csv('yellow_tripdata_2020-01.csv')
df.head()
```

[34]:

	VendorID	tpep_pickup_datetime	tpep_dropoff_datetime	passenger_count	trip_distance	RatecodeID	store_and_fwd_flag	PULocationID	DOLocationID	payment_type	fare_amount	extra	mta_tax	tip_amount	tolls_amount	improvement_surcharge	total_amount	congestion_surcharge
0	1.0	2020-01-01 00:28:15	2020-01-01 00:33:03	1.0	1.2	1.0	N	238	239	1.0	6.0	3.0	0.5	1.47	0.0	0.3	11.27	2.5
1	1.0	2020-01-01 00:35:39	2020-01-01 00:43:04	1.0	1.2	1.0	N	239	238	1.0	7.0	3.0	0.5	1.50	0.0	0.3	12.30	2.5
2	1.0	2020-01-01 00:47:41	2020-01-01 00:53:52	1.0	0.6	1.0	N	238	238	1.0	6.0	3.0	0.5	1.00	0.0	0.3	10.80	2.5
3	1.0	2020-01-01 00:55:23	2020-01-01 01:00:14	1.0	0.8	1.0	N	238	151	1.0	5.5	0.5	0.5	1.36	0.0	0.3	8.16	0.0
4	2.0	2020-01-01 00:01:58	2020-01-01 00:04:16	1.0	0.0	1.0	N	193	193	2.0	3.5	0.5	0.5	0.00	0.0	0.3	4.80	0.0

1.3 Exploratory Data Analysis

[3]:
```
df.shape
```

[3]:
```
(6405008, 18)
```

[35]:
```
df.dtypes
```

[35]:
```
VendorID                float64
tpep_pickup_datetime     object
tpep_dropoff_datetime    object
passenger_count         float64
trip_distance           float64
RatecodeID              float64
store_and_fwd_flag       object
```

```
PULocationID               int64
DOLocationID               int64
payment_type             float64
fare_amount              float64
extra                    float64
mta_tax                  float64
tip_amount               float64
tolls_amount             float64
improvement_surcharge    float64
total_amount             float64
congestion_surcharge     float64
dtype: object
```

[36]:
```
df['tpep_pickup_datetime'] = pd.to_datetime(df['tpep_pickup_datetime'])
df['tpep_dropoff_datetime'] = pd.to_datetime(df['tpep_dropoff_datetime'])
```

[37]:
```
df.dtypes
```

[37]:
```
VendorID                        float64
tpep_pickup_datetime     datetime64[ns]
tpep_dropoff_datetime    datetime64[ns]
passenger_count                 float64
trip_distance                   float64
RatecodeID                      float64
store_and_fwd_flag               object
PULocationID                      int64
DOLocationID                      int64
payment_type                    float64
fare_amount                     float64
extra                           float64
mta_tax                         float64
tip_amount                      float64
tolls_amount                    float64
improvement_surcharge           float64
total_amount                    float64
congestion_surcharge            float64
dtype: object
```

[38]:
```
df['duration'] = df['tpep_dropoff_datetime'] - df['tpep_pickup_datetime']
df['duration'] = df['duration'].dt.total_seconds()/60
df
```

[38]:
```
          VendorID tpep_pickup_datetime tpep_dropoff_datetime  passenger_count  \
0              1.0  2020-01-01 00:28:15   2020-01-01 00:33:03              1.0
1              1.0  2020-01-01 00:35:39   2020-01-01 00:43:04              1.0
2              1.0  2020-01-01 00:47:41   2020-01-01 00:53:52              1.0
3              1.0  2020-01-01 00:55:23   2020-01-01 01:00:14              1.0
```

```
4             2.0  2020-01-01 00:01:58   2020-01-01 00:04:16             1.0
…             …                  …                   …               …
6405003       NaN  2020-01-31 22:51:00   2020-01-31 23:22:00             NaN
6405004       NaN  2020-01-31 22:10:00   2020-01-31 23:26:00             NaN
6405005       NaN  2020-01-31 22:50:07   2020-01-31 23:17:57             NaN
6405006       NaN  2020-01-31 22:25:53   2020-01-31 22:48:32             NaN
6405007       NaN  2020-01-31 22:44:00   2020-01-31 23:06:00             NaN

         trip_distance  RatecodeID store_and_fwd_flag  PULocationID  \
0                 1.20         1.0                  N           238
1                 1.20         1.0                  N           239
2                 0.60         1.0                  N           238
3                 0.80         1.0                  N           238
4                 0.00         1.0                  N           193
…                 …          …                  …           …
6405003           3.24         NaN                NaN           237
6405004          22.13         NaN                NaN           259
6405005          10.51         NaN                NaN           137
6405006           5.49         NaN                NaN            50
6405007          11.60         NaN                NaN           179

         DOLocationID  payment_type  fare_amount  extra  mta_tax  tip_amount  \
0                 239           1.0         6.00   3.00      0.5        1.47
1                 238           1.0         7.00   3.00      0.5        1.50
2                 238           1.0         6.00   3.00      0.5        1.00
3                 151           1.0         5.50   0.50      0.5        1.36
4                 193           2.0         3.50   0.50      0.5        0.00
…                 …             …           …      …         …          …
6405003           234           NaN        17.59   2.75      0.5        0.00
6405004            45           NaN        46.67   2.75      0.5        0.00
6405005           169           NaN        48.85   2.75      0.0        0.00
6405006            42           NaN        27.17   2.75      0.0        0.00
6405007           205           NaN        54.56   2.75      0.5        0.00

         tolls_amount  improvement_surcharge  total_amount  \
0                0.00                    0.3         11.27
1                0.00                    0.3         12.30
2                0.00                    0.3         10.80
3                0.00                    0.3          8.16
4                0.00                    0.3          4.80
…                …                       …           …
6405003          0.00                    0.3         21.14
6405004         12.24                    0.3         62.46
6405005          0.00                    0.3         51.90
6405006          0.00                    0.3         30.22
6405007          0.00                    0.3         58.11
```

```
         congestion_surcharge   duration
0                         2.5   4.800000
1                         2.5   7.416667
2                         2.5   6.183333
3                         0.0   4.850000
4                         0.0   2.300000
…                         …        …
6405003                   0.0  31.000000
6405004                   0.0  76.000000
6405005                   0.0  27.833333
6405006                   0.0  22.650000
6405007                   0.0  22.000000

[6405008 rows x 19 columns]
```

[39]:
```
df =␣
↪df[['passenger_count','payment_type','fare_amount','trip_distance','duration']]
df
```

[39]:
```
         passenger_count  payment_type  fare_amount  trip_distance   duration
0                    1.0           1.0         6.00           1.20   4.800000
1                    1.0           1.0         7.00           1.20   7.416667
2                    1.0           1.0         6.00           0.60   6.183333
3                    1.0           1.0         5.50           0.80   4.850000
4                    1.0           2.0         3.50           0.00   2.300000
…                    …             …           …              …         …
6405003              NaN           NaN        17.59           3.24  31.000000
6405004              NaN           NaN        46.67          22.13  76.000000
6405005              NaN           NaN        48.85          10.51  27.833333
6405006              NaN           NaN        27.17           5.49  22.650000
6405007              NaN           NaN        54.56          11.60  22.000000

[6405008 rows x 5 columns]
```

[40]:
```
df.isnull().sum()
```

[40]:
```
passenger_count    65441
payment_type       65441
fare_amount            0
trip_distance          0
duration               0
dtype: int64
```

[41]:
```
(65441 / len(df)) * 100
```

[41]:
```
1.021716132126611
```

[42]:
```
df.dropna(inplace = True)
```

[43]:
```
df['passenger_count']  = df['passenger_count'].astype('int64')
df['payment_type']  = df['payment_type'].astype('int64')
```

[44]:
```
df[df.duplicated()]
```

[44]:

	passenger_count	payment_type	fare_amount	trip_distance	duration
2056	1	2	7.0	0.00	0.000000
2441	1	1	52.0	0.00	0.200000
2446	2	1	9.5	1.70	13.066667
2465	1	1	4.0	0.40	3.083333
3344	1	1	6.0	1.20	5.350000
…	…	…	…	…	…
6339558	1	2	8.0	1.63	8.800000
6339559	1	1	8.5	1.81	8.016667
6339560	1	2	6.5	0.98	6.900000
6339562	1	1	11.0	2.10	14.233333
6339565	1	2	8.5	1.61	9.633333

[3331706 rows x 5 columns]

[45]:
```
df.drop_duplicates(inplace = True)
```

[46]:
```
df.shape
```

[46]:
```
(3007861, 5)
```

[47]:
```
df['passenger_count'].value_counts(normalize = True)
```

[47]:
```
passenger_count
1    0.581981
2    0.190350
3    0.066360
5    0.062937
6    0.039272
4    0.036046
0    0.023033
7    0.000009
9    0.000006
8    0.000006
Name: proportion, dtype: float64
```

[48]:
```
df['payment_type'].value_counts(normalize = True)
```

[48]:
```
payment_type
1    6.782670e-01
2    3.075731e-01
```

```
3    8.721480e-03
4    5.438084e-03
5    3.324622e-07
Name: proportion, dtype: float64
```

[49]:
```
df = df[df['payment_type']  < 3]
df = df[(df['passenger_count'] > 0) & (df['passenger_count']  < 6)]
```

[19]:
```
df.shape
```

[19]:
```
(2780283, 5)
```

[50]:
```
df['payment_type'].replace([1,2],['Card','Cash'],inplace=True)
df
```

[50]:

	passenger_count	payment_type	fare_amount	trip_distance	duration
0	1	Card	6.0	1.20	4.800000
1	1	Card	7.0	1.20	7.416667
2	1	Card	6.0	0.60	6.183333
3	1	Card	5.5	0.80	4.850000
4	1	Cash	3.5	0.00	2.300000
…	…	…	…	…	…
6339555	3	Card	10.0	2.09	14.800000
6339561	1	Card	17.5	4.11	21.500000
6339563	1	Card	13.0	2.13	19.000000
6339564	1	Card	12.5	2.55	16.283333
6339566	1	Card	0.0	0.00	1.066667

[2780283 rows x 5 columns]

[51]:
```
df.describe()
```

[51]:

	passenger_count	fare_amount	trip_distance	duration
count	2.780283e+06	2.780283e+06	2.780283e+06	2.780283e+06
mean	1.733386e+00	1.780567e+01	4.536729e+00	2.415478e+01
std	1.176652e+00	1.506997e+01	4.895890e+00	9.260031e+01
min	1.000000e+00	-5.000000e+02	-2.218000e+01	-2.770367e+03
25%	1.000000e+00	9.000000e+00	1.500000e+00	9.883333e+00
50%	1.000000e+00	1.300000e+01	2.730000e+00	1.573333e+01
75%	2.000000e+00	2.100000e+01	5.470000e+00	2.336667e+01
max	5.000000e+00	4.265000e+03	2.628800e+02	8.525117e+03

[52]:
```
df = df[df['fare_amount'] > 0]
df = df[df['trip_distance'] > 0]
df = df[df['duration'] > 0]
df
```

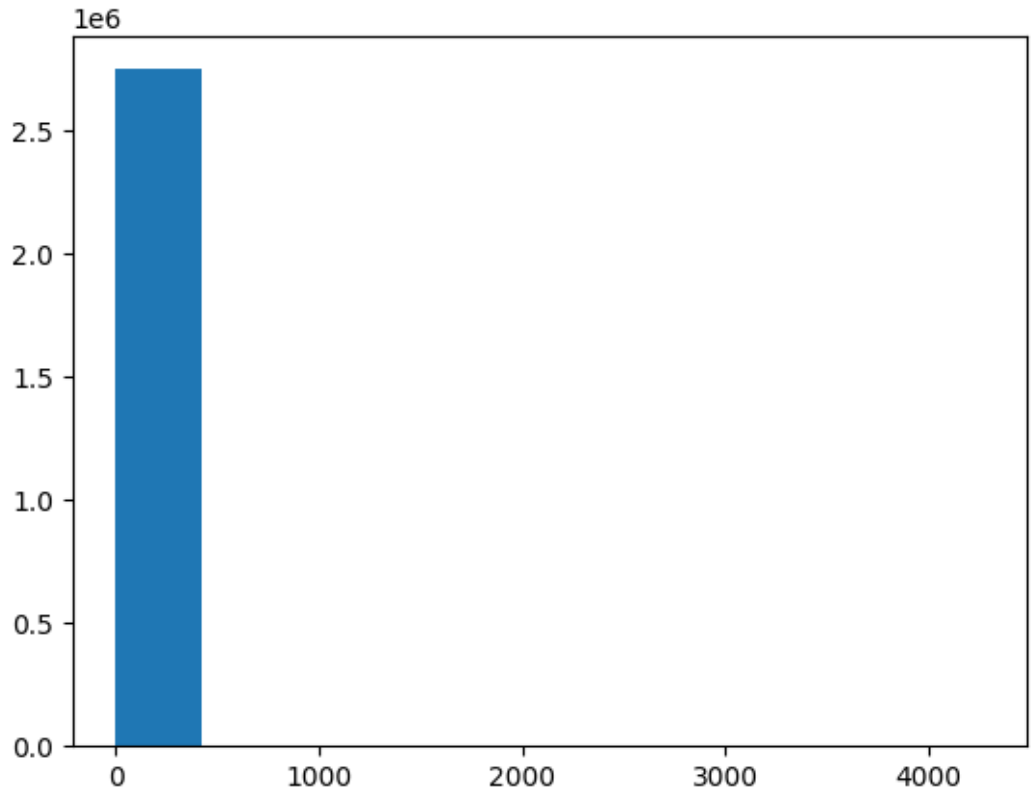
[52]:

	passenger_count	payment_type	fare_amount	trip_distance	duration
0	1	Card	6.0	1.20	4.800000
1	1	Card	7.0	1.20	7.416667
2	1	Card	6.0	0.60	6.183333
3	1	Card	5.5	0.80	4.850000
5	1	Cash	2.5	0.03	0.883333
…	…	…	…	…	…
6339550	4	Card	10.5	2.40	12.383333
6339555	3	Card	10.0	2.09	14.800000
6339561	1	Card	17.5	4.11	21.500000
6339563	1	Card	13.0	2.13	19.000000
6339564	1	Card	12.5	2.55	16.283333

[2748932 rows x 5 columns]

[53]:
```
plt.hist(df['fare_amount'])
```

[53]:
```
(array([2.748913e+06, 1.600000e+01, 1.000000e+00, 0.000000e+00,
        1.000000e+00, 0.000000e+00, 0.000000e+00, 0.000000e+00,
        0.000000e+00, 1.000000e+00]),
 array([1.000000e-02, 4.265090e+02, 8.530080e+02, 1.279507e+03,
        1.706006e+03, 2.132505e+03, 2.559004e+03, 2.985503e+03,
        3.412002e+03, 3.838501e+03, 4.265000e+03]),
 <BarContainer object of 10 artists>)
```



[54]:
```
for col in ['fare_amount', 'trip_distance','duration']:
    q1 = df[col].quantile(0.25)
    q3 = df[col].quantile(0.75)
    IQR = q3 - q1

    lower_bound = q1 - 1.5 * IQR
    upper_bound = q3 + 1.5 * IQR

    df = df[(df[col] >= lower_bound) & (df[col] <= upper_bound)]
```

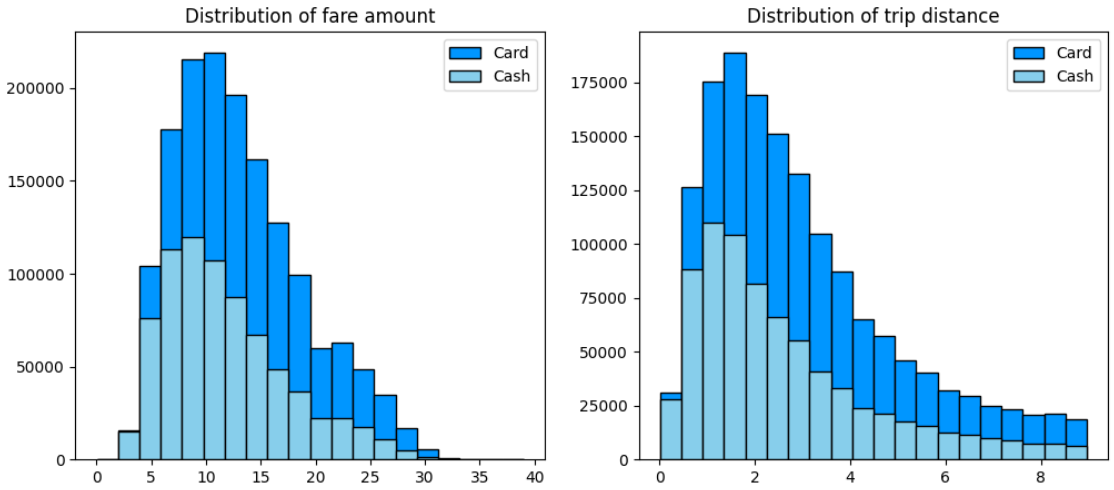
[55]:
```
df
```

[55]:

	passenger_count	payment_type	fare_amount	trip_distance	duration
0	1	Card	6.0	1.20	4.800000
1	1	Card	7.0	1.20	7.416667
2	1	Card	6.0	0.60	6.183333
3	1	Card	5.5	0.80	4.850000
5	1	Cash	2.5	0.03	0.883333
…	…	…	…	…	…
6339550	4	Card	10.5	2.40	12.383333
6339555	3	Card	10.0	2.09	14.800000
6339561	1	Card	17.5	4.11	21.500000
6339563	1	Card	13.0	2.13	19.000000
6339564	1	Card	12.5	2.55	16.283333

[2297908 rows x 5 columns]

[26]:
```
plt.figure(figsize = (12,5))
plt.subplot(1,2,1)
plt.title('Distribution of fare amount')
plt.hist(df[df['payment_type'] == 'Card']['fare_amount'], histtype =␣
 ↪'barstacked', bins = 20, edgecolor = 'k', color = '#0096FF', label = 'Card')
plt.hist(df[df['payment_type'] == 'Cash']['fare_amount'], histtype =␣
 ↪'barstacked', bins = 20, edgecolor = 'k', color = '#87CEEB', label = 'Cash')
plt.legend()

plt.subplot(1,2,2)
plt.title('Distribution of trip distance')
plt.hist(df[df['payment_type'] == 'Card']['trip_distance'], histtype =␣
 ↪'barstacked', bins = 20, edgecolor = 'k', color = '#0096FF', label = 'Card')
plt.hist(df[df['payment_type'] == 'Cash']['trip_distance'], histtype =␣
 ↪'barstacked', bins = 20, edgecolor = 'k', color = '#87CEEB', label = 'Cash')
plt.legend()
plt.show()
```

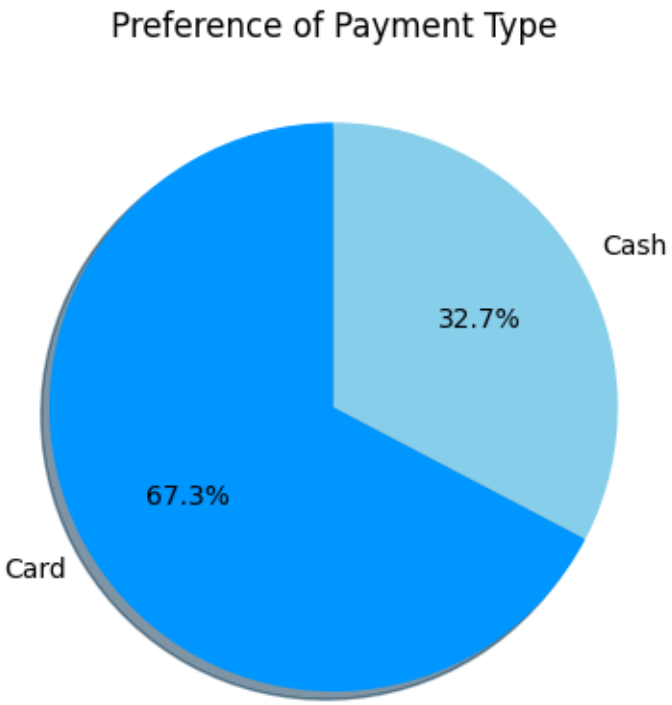


[27]:
```
df.groupby('payment_type').agg({'fare_amount':['mean','std'],'trip_distance':
  ↪['mean','std']})
```

[27]:

	fare_amount		trip_distance	
	mean	std	mean	std
payment_type				
Card	13.112493	5.849281	2.992237	1.99274
Cash	11.758005	5.613038	2.602207	1.91372

[28]:
```
plt.title('Preference of Payment Type')
plt.pie(df['payment_type'].value_counts(normalize = True), labels =␣
  ↪df['payment_type'].value_counts().index,
        startangle = 90, shadow = True, autopct = '%1.1f%%', colors =␣
  ↪['#0096FF','#87CEEB'])
plt.show()
```



[29]:
```
passenger_count = df.
  ↪groupby(['payment_type','passenger_count'])[['passenger_count']].count()
passenger_count.rename(columns = {'passenger_count':'count'}, inplace=True)
passenger_count.reset_index(inplace = True)
```

[30]:
```
passenger_count['perc'] = (passenger_count['count'] / passenger_count['count'].
  ↪sum()) * 100
passenger_count
```

[30]:

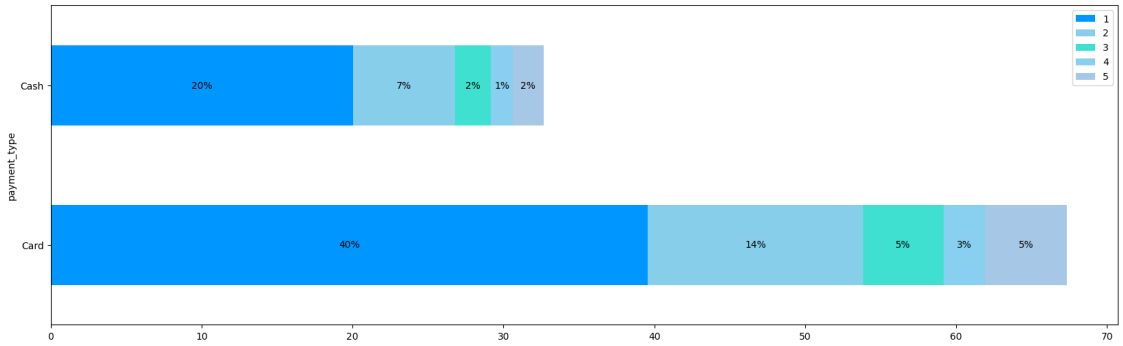
	payment_type	passenger_count	count	perc
0	Card	1	909245	39.568381
1	Card	2	327661	14.259100
2	Card	3	122412	5.327106
3	Card	4	63676	2.771042
4	Card	5	124045	5.398171
5	Cash	1	460550	20.042143
6	Cash	2	155472	6.765806
7	Cash	3	54506	2.371984
8	Cash	4	32715	1.423686
9	Cash	5	47626	2.072581

[31]:
```
df = pd.DataFrame(columns = ['payment_type',1,2,3,4,5])
df['payment_type'] = ['Card','Cash']
df.iloc[0,1:] = passenger_count.iloc[0:5,-1]
df.iloc[1,1:] = passenger_count.iloc[5:,-1]
df
```

[31]:

	payment_type	1	2	3	4	5
0	Card	39.568381	14.2591	5.327106	2.771042	5.398171
1	Cash	20.042143	6.765806	2.371984	1.423686	2.072581

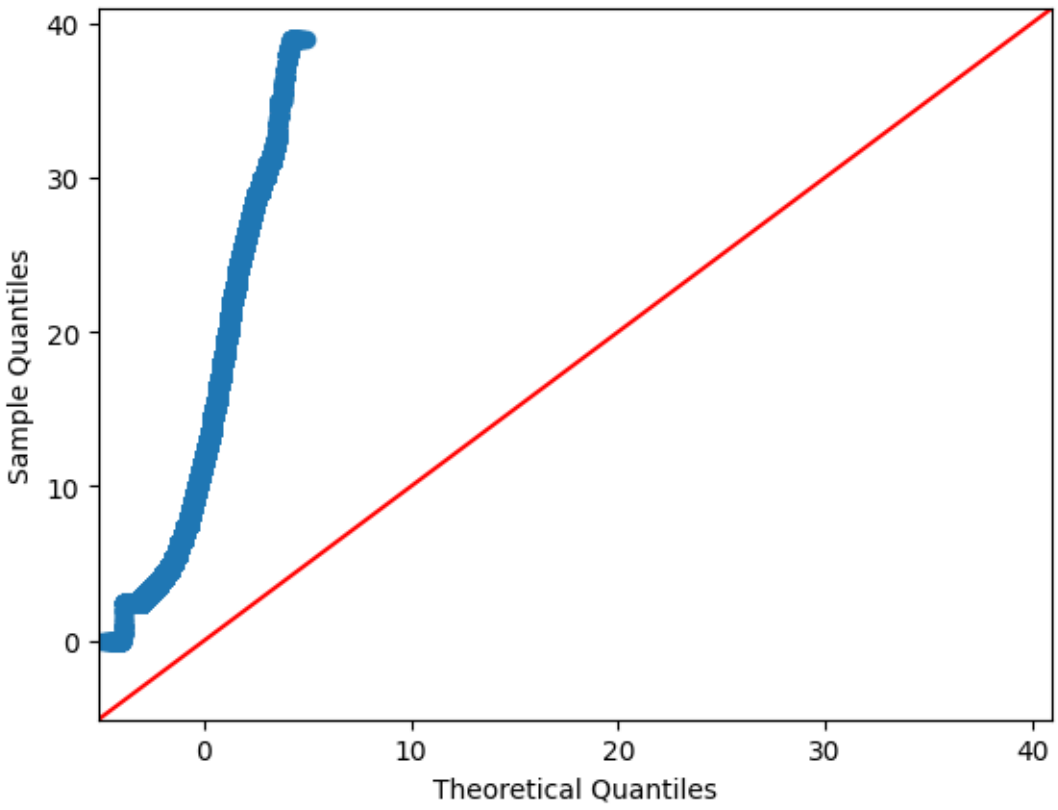
[32]:
```
fig, ax = plt.subplots(figsize = (20, 6))
df.plot(x = 'payment_type', kind = 'barh', stacked = True, ax = ax, color =␣
↪['#0096FF','#87CEEB','#40E0D0','#89CFF0','#A7C7E7'])

for p in ax.patches:
    width = p.get_width()
    height = p.get_height()
    x, y = p.get_xy()
    ax.text(x + width / 2, y + height / 2,
            '{:.0f}%'.format(width),
            horizontalalignment = 'center',
            verticalalignment = 'center')
```



Null hypothesis: There is no difference in average fare between customers who use credit cards and customers who use cash.

Alternative hypothesis: There is a difference in average fare between customers who use credit cards and customers who use cash

[56]:
```
sm.qqplot(df['fare_amount'], line = '45')
plt.show()
```



[57]:
```
card_sample = df[df['payment_type'] == 'Card']['fare_amount']
cash_sample = df[df['payment_type'] == 'Cash']['fare_amount']
```

[58]:
```
t_stats, p_value = st.ttest_ind(a = card_sample, b = cash_sample, equal_var =␣
↪False)
print('T statistic',t_stats,'p-value',p_value)
```

```
T statistic 169.2111527245052 p-value 0.0
```