

```
In [1]: import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
```

A1. Exploring Smartcard Types

```
In [2]: df = pd.read_csv("monthly_smartcard_replacements.csv")
df
```

```
Out[2]:
```

	Month	Transaction	Smartcard.Type	Action.Reason	Number.of.transactions
0	2019-03	Replace Smartcard	Photo Identification Card	Change Customer Details	156
1	2019-03	Replace Smartcard	Driver Licence Card	Destroyed	110
2	2019-03	Replace Smartcard	Industry Authority Card	Lost In Mail - Imu	48
3	2019-03	Replace Smartcard	Marine Licence Ind Card	Managers Approval	8
4	2019-03	Replace Smartcard	Marine Licence Ind Card	Lost In Mail - Imu	7
...
5787	2020-11	Replace Smartcard	Photo Identification Card	Remove Gender From Smartcard	1
5788	2020-12	Replace Smartcard	Marine Licence Ind Card	Stolen	1
5789	2021-07	Replace Smartcard	Marine Licence Ind Card	Stolen	1
5790	2021-07	Replace Smartcard	Photo Identification Card	Merged	1
5791	2021-12	Replace Smartcard	Driver Licence Card	Transition Laminate To Smartcard	2

5792 rows × 5 columns

1. How many different (unique) smartcard types are recorded in the 'Smartcard.Type' column? What are those different smartcard types and how many instances are recorded for each type?

Code Explanation:

1. Count the occurrences of each unique value in the "Smartcard.Type" column, and store it into a variable.
2. Display that variable

```
In [3]: unique_smartcard_types = df['Smartcard.Type'].value_counts()
unique_smartcard_types
```

```
Out[3]: Driver Licence Card      1896
Photo Identification Card    1631
Industry Authority Card     1218
Marine Licence Ind Card     1047
Name: Smartcard.Type, dtype: int64
```

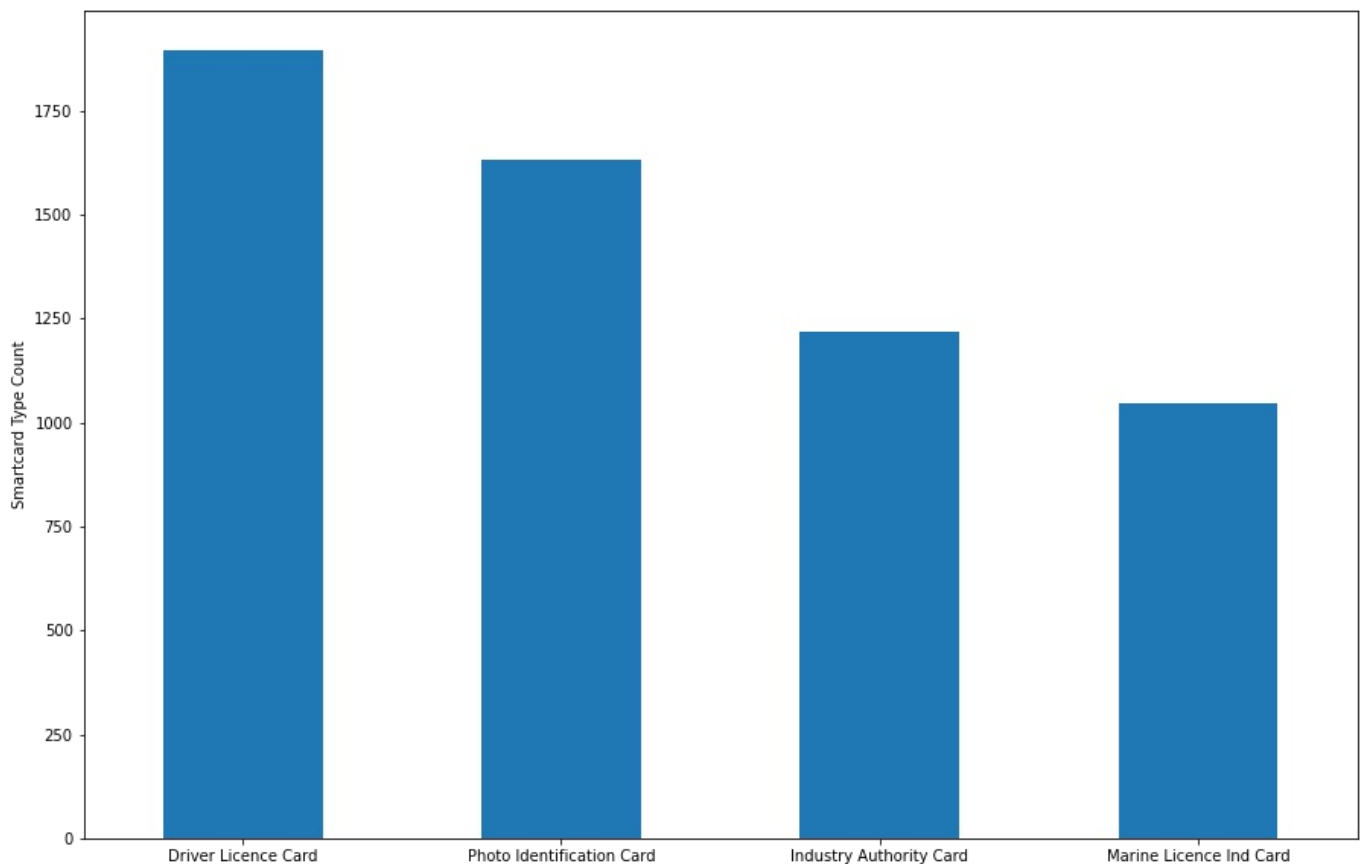
So there are **4** different smartcard types and the instances of each type are written above.

2. Plot a barchart of the smartcard types with the bars showing the count of each smartcard type. Which smartcard type is replaced the most?

Code Explanation:

1. Make the figure size of the plot to 15 units in width and 10 units in height
2. Using the 'plot' method on "unique_smartcard_types" to create a bar plot, 'kind='bar' makes it so that a bar plot is created
3. Set the x-axis labels to be displayed horizontally
4. Add a label to the y-axis
5. Display the plot

```
In [4]: plt.figure(figsize=(15, 10))
unique_smartcard_types.plot(kind='bar')
plt.xticks(rotation=0)
plt.ylabel('Smartcard Type Count')
plt.show()
```



From the bar graph, we can see that the **"Driver Licence Card"** Smartcard Type is replaced the most.

3. Calculate the percentage of records for each smartcard type.

Code Explanation:

1. Calculate the percentage of each smartcard type in "unique_smartcard_types" by taking each smartcard type and dividing it by the total amount of smartcards and then multiplying it by 100
2. Display the values

```
In [5]: smartcard_type_percentage = ( unique_smartcard_types / len(df)) * 100
```

So, the percentage of records for each smartcard type is:

```
In [6]: smartcard_type_percentage
```

```
Out[6]: Driver Licence Card      32.734807
Photo Identification Card      28.159530
Industry Authority Card       21.029006
Marine Licence Ind Card       18.076657
Name: Smartcard.Type, dtype: float64
```

A2. Exploring Reasons for Smartcard Replacement

1. Convert data type of column 'Month' to a datetime format. Hint: Use pandas.to_datetime function to convert the type of 'Month' column to a datetime format as shown in one of your applied sessions.

Code Explanation:

1. Use the pd.to_datetime() function to convert the 'Month' column in the DataFrame 'df' to a datetime format.
2. Display the dataframe to check the new "Month" column.

```
In [7]: df['Month'] = pd.to_datetime(df['Month'])
df
```

Out[7]:		Month	Transaction	Smartcard.Type	Action.Reason	Number.of.transactions
	0	2019-03-01	Replace Smartcard	Photo Identification Card	Change Customer Details	156
	1	2019-03-01	Replace Smartcard	Driver Licence Card	Destroyed	110
	2	2019-03-01	Replace Smartcard	Industry Authority Card	Lost In Mail - Imu	48
	3	2019-03-01	Replace Smartcard	Marine Licence Ind Card	Managers Approval	8
	4	2019-03-01	Replace Smartcard	Marine Licence Ind Card	Lost In Mail - Imu	7

	5787	2020-11-01	Replace Smartcard	Photo Identification Card	Remove Gender From Smartcard	1
	5788	2020-12-01	Replace Smartcard	Marine Licence Ind Card	Stolen	1
	5789	2021-07-01	Replace Smartcard	Marine Licence Ind Card	Stolen	1
	5790	2021-07-01	Replace Smartcard	Photo Identification Card	Merged	1
	5791	2021-12-01	Replace Smartcard	Driver Licence Card	Transition Laminate To Smartcard	2

5792 rows × 5 columns

2. What are the different reasons for smartcard replacements in the given data and how many instances are observed for each reason? Hint: Check the 'Action.Reason' column.

Code Explanation:

1. Count the occurrences of each unique value in the "Action.Reason" column, and store it into a variable.
2. Display the variable

```
In [8]: count_action_reason = df['Action.Reason'].value_counts()
count_action_reason
```

```
Out[8]: Lost                    539
Managers Approval              532
Change Customer Details        521
Lost In Mail - Imu             519
Stolen                         471
Destroyed                     379
Condition Change               364
Faulty                        344
Damaged                       342
Product Exists Othr Surrend Void Cancel 321
Facial Image Is Not A True Likeness  304
Transition Laminate To Smartcard    256
Merged                        200
Court Order Issued X3 Or X4 Condition 137
Da/dgd Smartcard Replacement Fee Exempt 134
Expired                       133
Marine Licence Transition       132
Defective                      88
Disaster Relief                48
Remove Gender From Smartcard     28
Name: Action.Reason, dtype: int64
```

3. What is the total number of months in which 100 or more smartcard replacements are reported due to being "Faulty"?

Code Explanation:

1. Create a new DataFrame 'faulty_action' by filtering rows where the 'Action.Reason' column has the value 'Faulty'
2. Group the 'faulty_action' DataFrame by the 'Month' column, and then calculate the sum of 'Number.of.transactions' for each of the months
3. filter 'faulty_by_month' to include only months with 100 or more "faulty" transactions
4. Count the number of months in the 'months_with_100_or_more' series by calculating the length of it
5. Display the total number of months in which 100 or more smartcard replacements are reported due to being Faulty

```
In [9]: faulty_action = df[df['Action.Reason'] == 'Faulty']
faulty_by_month = faulty_action.groupby('Month')['Number.of.transactions'].sum()
months_with_100_or_more = faulty_by_month[faulty_by_month >= 100]
number_of_months = len(months_with_100_or_more)
print("total number of months in which 100 or more smartcard replacements are reported due to being Faulty: ",
```

total number of months in which 100 or more smartcard replacements are reported due to being Faulty: 57

A3. Investigating Annual Smartcard Replacements

1. Create a new column named 'Year' extracting the year from the 'Month' column.

Code Explanation:

1. the .dt.year accessor extracts the year value from the datetime values in the 'Month' column.
2. Display the dataframe to check the newly made column.

```
In [10]: df['Year'] = df['Month'].dt.year
df
```

```
Out[10]:
```

	Month	Transaction	Smartcard.Type	Action.Reason	Number.of.transactions	Year
0	2019-03-01	Replace Smartcard	Photo Identification Card	Change Customer Details	156	2019
1	2019-03-01	Replace Smartcard	Driver Licence Card	Destroyed	110	2019
2	2019-03-01	Replace Smartcard	Industry Authority Card	Lost In Mail - Imu	48	2019
3	2019-03-01	Replace Smartcard	Marine Licence Ind Card	Managers Approval	8	2019
4	2019-03-01	Replace Smartcard	Marine Licence Ind Card	Lost In Mail - Imu	7	2019
...
5787	2020-11-01	Replace Smartcard	Photo Identification Card	Remove Gender From Smartcard	1	2020
5788	2020-12-01	Replace Smartcard	Marine Licence Ind Card	Stolen	1	2020
5789	2021-07-01	Replace Smartcard	Marine Licence Ind Card	Stolen	1	2021
5790	2021-07-01	Replace Smartcard	Photo Identification Card	Merged	1	2021
5791	2021-12-01	Replace Smartcard	Driver Licence Card	Transition Laminate To Smartcard	2	2021

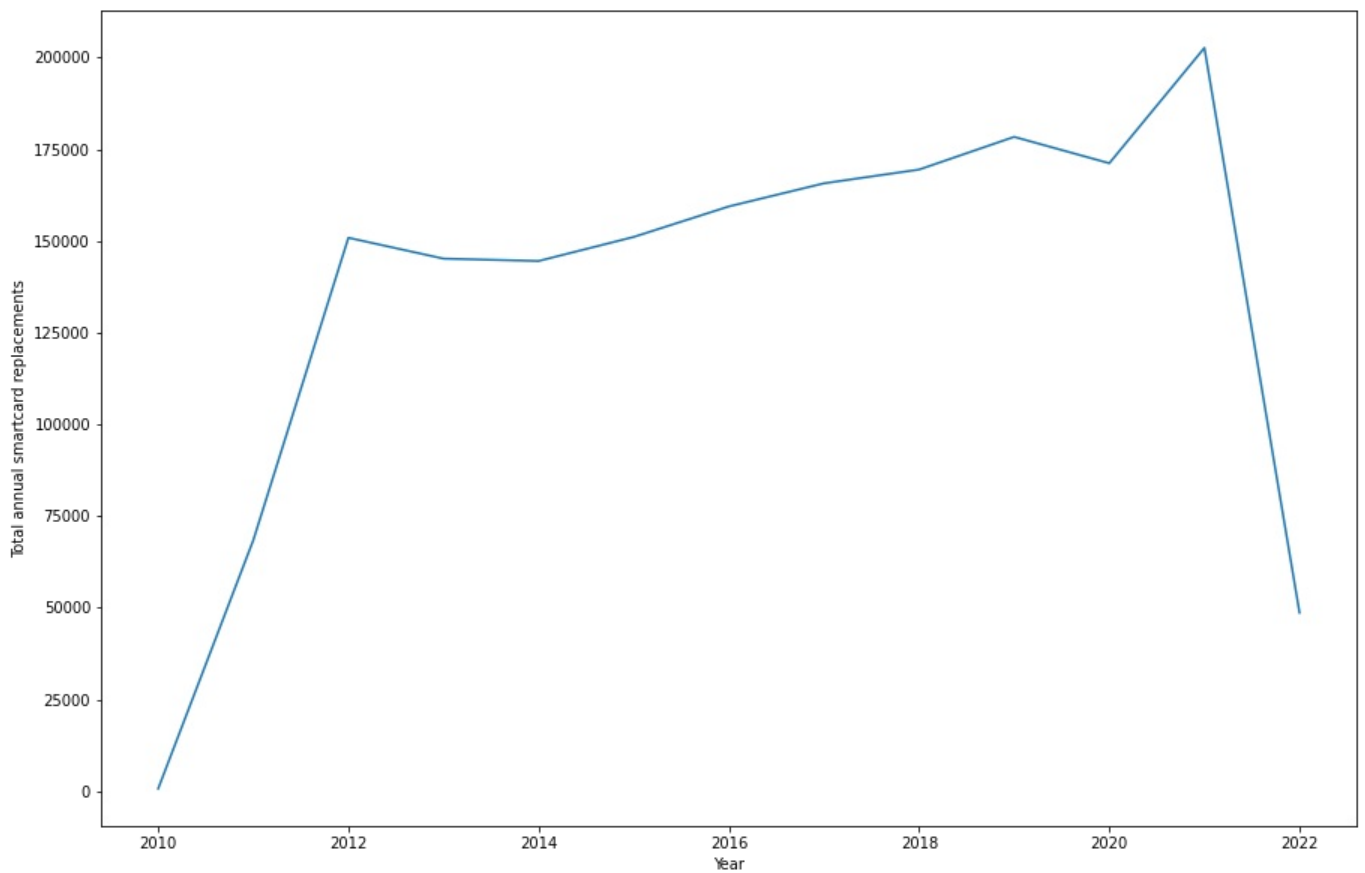
5792 rows × 6 columns

2. Create a line plot showing the total number of annual smartcard replacements (number of transactions) against year.

Code Explanation:

1. Make the figure size for the plot to 15 units in width and 10 units in height
2. Group the DataFrame 'df' by the 'Year' column and calculate the sum of 'Number.of.transactions' for each of the years
3. Create a line plot using the 'plot' method on 'no_annual_replacements', # kind='line' makes it so that a line plot is created
4. Add a label to the x-axis
5. Add a label to the y-axis
6. Display the plot

```
In [11]: plt.figure(figsize=(15, 10))
no_annual_replacements = df.groupby('Year')['Number.of.transactions'].sum()
no_annual_replacements.plot(kind='line')
plt.xlabel('Year')
plt.ylabel('Total annual smartcard replacements')
plt.show()
```



3. Explain the trend as observed from the chart. Are there any years that are different from others and if so, what is the reason behind it?

```
In [12]: no_annual_replacements
```

```
Out[12]: Year
2010      671
2011    68418
2012   150886
2013   145192
2014   144549
2015   151109
2016   159427
2017   165726
2018   169477
2019   178395
2020   171206
2021   202671
2022    48648
Name: Number.of.transactions, dtype: int64
```

Yes, there are years that are different from others. Starting from:

2010: This year only had 671 Total Smartcard Transactions. This would indicate that Smartcards were still in their beginning stages/newly introduced in the transportation system and perhaps not used by many commuters back then.

2011: We can see a huge increase of Total Smartcard Transactions in 2011, this shows that more people began to adopt the smartcard system and as a result, more people means that there will be much more Smartcard Transactions.

2012-2019: We can see the Total number of Smartcard Transactions keep increasing from 2012-2019, this indicates that the smartcard system is popularized and keeps improving every year. The consistency in the numbers also show that the Smartcard Systems became an essential part of commuting in queensland.

2020: The impact of the COVID-19 pandemic likely affected with the reduction in replacements in 2020. Lockdowns and COVID limitations likely led to fewer smartcard replacements as total utilizations were lower.

2021: The rapid rise of transactions in 2021 could be from the improvements/upgrades of the overall smartcard systems, and especially after the COVID limitations started getting lighter, the transportation department may have gotten a sudden surge of demands from many people who worked from home during the lockdown and had to go back commuting to the office.

2022: The sudden drop of transactions could mean that the smartcard systems have been improved so well that the majority of people no longer experience technical/system issues. The rise of other forms of transportation like Uber, or other ride sharing apps could also affect these numbers as it would be more convenient for longer distances for some people.

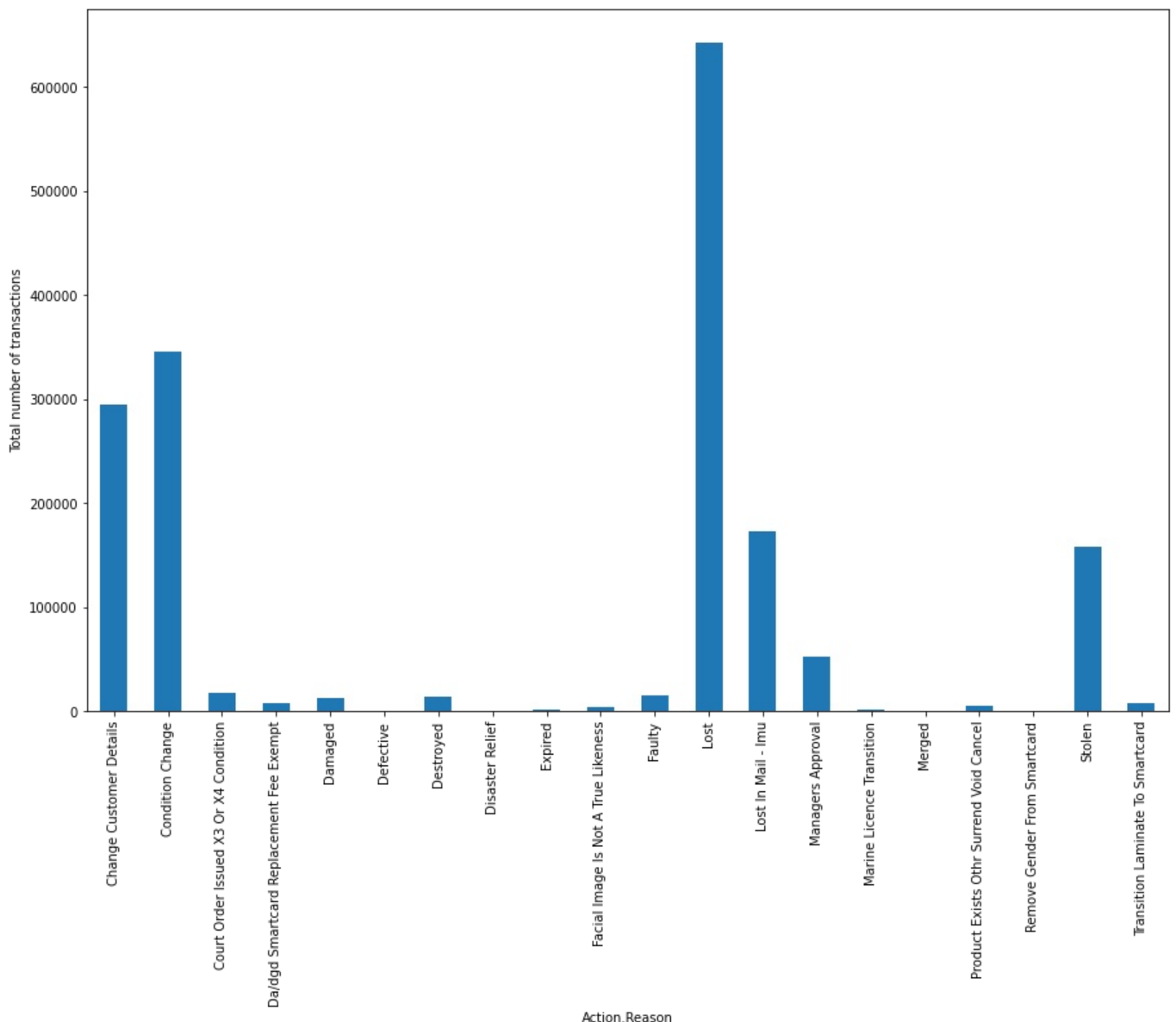
A4. Investigating Reasons for Smartcard Replacement

1. Plot a barchart to display the total number of transactions for each 'Action.Reason' using the available data.

Code Explanation:

1. Make the figure size for the plot to 15 units in width and 10 units in height
2. Group the DataFrame 'df' by the 'Action.Reason' column and calculate the sum of 'Number.of.transactions' for each action.reason
3. Create a bar plot using the 'plot' method on 'action_transactions', kind='bar' specifies that a bar plot should be created
4. Assign the x-label to the plot
5. Assign the y-label to the plot
6. Display the plot

```
In [13]: plt.figure(figsize=(15, 10))
action_transactions = df.groupby('Action.Reason')['Number.of.transactions'].sum()
action_transactions.plot(kind='bar')
plt.xlabel('Action.Reason')
plt.ylabel('Total number of transactions')
plt.show()
```



2. What are the top three reasons for smartcard replacement?

Code Explanation:

1. Convert the series to a dataframe
2. Select the top three largest total number of transactions of action.reason, The 'nlargest()' function is used to return the top three largest rows based on the 'Number.of.transactions' column
3. Display the 'top_three_reasons' dataframe

```
In [14]: action_transactions = action_transactions.to_frame()
top_three_reasons = action_transactions.nlargest(3, 'Number.of.transactions')
top_three_reasons
```

Out[14]:

Number.of.transactions	
Action.Reason	
Lost	642749
Condition Change	344905
Change Customer Details	294435

The top three reasons for smartcard replacements are:

1. Lost
2. Condition Change
3. Change Customer Details

3. Total number of transactions of which 'Action.Reason' is between 1000 and 2000?

Code Explanation:

1. Filter the 'action_transactions' dataframe
2. Filters the 'Number.of.transactions' column values to retrieve rows with values between 1000 and 2000

```
In [15]: filtered_action_transactions = action_transactions[(action_transactions['Number.of.transactions'] >= 1000) & (a
filtered_action_transactions
```

Out[15]:

Number.of.transactions	
Action.Reason	
Marine Licence Transition	1822

A5. Investigating Reasons over Annual Smartcard Replacement

1. Find out the annual number of transactions for each 'Action.Reason' across different years for which data is available

Code Explanation:

1. Group the dataframe 'df' by 'Year' and 'Action.Reason', and find the sum of 'Number.of.transactions' for each combinations
2. Reset the index of the 'annual_transaction_reason' DataFrame
3. Create a pivot table using the 'pivot' function, The table will have 'Year' as columns, and 'Action.Reason' as index/rows, and 'Number.of.transactions' as values
4. Displaying the resulting pivot table

```
In [16]: annual_transaction_reason = df.groupby(['Year', 'Action.Reason'])['Number.of.transactions'].sum()
annual_transaction_reason = annual_transaction_reason.reset_index()
the_table = annual_transaction_reason.pivot(columns='Year', values='Number.of.transactions', index='Action.Reason')
the_table
```

Out[16]:

Action.Reason	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Change Customer Details	84.0	12265.0	28446.0	28603.0	28188.0	28267.0	27730.0	26837.0	27083.0	26856.0	24934.0	28593.0	6549.0
Condition Change	39.0	7408.0	18136.0	21262.0	23426.0	27316.0	33056.0	40274.0	41440.0	42143.0	38585.0	41637.0	10183.0
Court Order Issued X3 Or X4 Condition	7.0	1014.0	2085.0	2219.0	2244.0	1928.0	1634.0	1450.0	1145.0	1148.0	1085.0	1082.0	254.0
Da/dgd Smartcard Replacement Fee Exempt	3.0	3212.0	1118.0	215.0	224.0	262.0	299.0	385.0	438.0	527.0	554.0	651.0	124.0
Damaged	9.0	1660.0	2709.0	1685.0	1281.0	1096.0	1046.0	747.0	670.0	674.0	689.0	627.0	134.0
Defective	1.0	120.0	243.0	156.0	123.0	30.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Destroyed	NaN	320.0	750.0	645.0	699.0	1025.0	1278.0	1402.0	1394.0	1612.0	1961.0	2563.0	744.0
Disaster Relief	NaN	18.0	4.0	123.0	2.0	7.0	NaN	27.0	8.0	80.0	NaN	NaN	44.0
Expired	NaN	3.0	7.0	16.0	13.0	36.0	45.0	78.0	92.0	154.0	227.0	902.0	455.0
Facial Image Is Not A True Likeness	NaN	174.0	381.0	339.0	311.0	334.0	376.0	371.0	395.0	389.0	463.0	590.0	149.0
Faulty	265.0	1596.0	4199.0	2519.0	2003.0	1472.0	1100.0	549.0	347.0	293.0	209.0	253.0	71.0
Lost	124.0	26325.0	57727.0	52220.0	49599.0	52237.0	55953.0	56800.0	60463.0	65467.0	66765.0	79211.0	19858.0
Lost In Mail - lmu	14.0	1986.0	6002.0	8333.0	14173.0	16777.0	17784.0	18667.0	18317.0	19784.0	18639.0	27262.0	4814.0
Managers Approval	13.0	2551.0	8803.0	9311.0	6576.0	5738.0	4071.0	3128.0	2800.0	3231.0	2814.0	2848.0	671.0
Marine Licence Transition	NaN	55.0	94.0	99.0	86.0	120.0	165.0	190.0	208.0	243.0	235.0	264.0	63.0
Merged	NaN	9.0	23.0	28.0	27.0	25.0	29.0	19.0	26.0	53.0	94.0	142.0	32.0
Product Exists Othr Surrend Void Cancel	NaN	260.0	1489.0	1178.0	1033.0	543.0	341.0	181.0	154.0	135.0	129.0	144.0	41.0
Remove Gender From Smartcard	NaN	NaN	NaN	NaN	NaN	NaN	NaN	8.0	8.0	3.0	4.0	20.0	4.0
Stolen	48.0	7929.0	17132.0	15384.0	13966.0	13561.0	14218.0	14200.0	14079.0	15150.0	13243.0	15144.0	4302.0
Transition Laminate To Smartcard	64.0	1513.0	1538.0	857.0	575.0	335.0	302.0	413.0	410.0	453.0	576.0	738.0	156.0

2. For each action reason determine the number of years during which the number of annual transactions exceeds 10000.

Code Explanation:

1. Create an empty dictionary to store action reasons and their corresponding years
2. Iterate through each action reason in the index/row of the table
3. Iterate through each year in the columns of the pivot table
4. Check if the number of transactions for the action reason in the given year is greater than 10000
5. Store the list of years in the action_dict with the action reason as the key
6. Iterate through the action_dict to use information
7. Count the number of years for which the condition is met
8. Print the action reason, corresponding years, and the total count of years

In [17]:

```
action_dict = {}

for action_reason in the_table.index:
    list_of_years = []

    for year in the_table.columns:
        if the_table.loc[action_reason, year] > 10000:
            list_of_years.append(year)

    action_dict[action_reason] = list_of_years
```



```
for key, value in action_dict.items():
    year_count = len(value)
    print(f"{key} = {value}, in which there are {year_count} years in total during which the number of annual t
```

Change Customer Details = [2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021], in which there are 11 years in total during which the number of annual transactions exceeds 10000.

Condition Change = [2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022], in which there are 11 years in total during which the number of annual transactions exceeds 10000.

Court Order Issued X3 Or X4 Condition = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Da/dgd Smartcard Replacement Fee Exempt = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Damaged = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Defective = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Destroyed = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Disaster Relief = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Expired = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Facial Image Is Not A True Likeness = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Faulty = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Lost = [2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022], in which there are 12 years in total during which the number of annual transactions exceeds 10000.

Lost In Mail - Imu = [2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021], in which there are 8 years in total during which the number of annual transactions exceeds 10000.

Managers Approval = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Marine Licence Transition = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Merged = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Product Exists Othr Surrend Void Cancel = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Remove Gender From Smartcard = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

Stolen = [2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021], in which there are 10 years in total during which the number of annual transactions exceeds 10000.

Transition Laminate To Smartcard = [], in which there are 0 years in total during which the number of annual transactions exceeds 10000.

3. Which action reasons have at least one year where the number of annual transactions exceeds 10000?

Code Explanation:

1. Create an empty list to store action reasons with at least one year
2. Iterate through each key-value pair in the action_dict dictionary
3. Get the count of years for which the condition is met
4. Check if the year_count is greater than or equal to 1
5. If condition is met, add the action reason to the at_least_one list
6. Display the resulting list of action reasons

```
In [18]: at_least_one = []

for key, value in action_dict.items():
    year_count = len(value)
    if year_count >= 1:
        at_least_one.append(key)

at_least_one
```

```
Out[18]: ['Change Customer Details',
          'Condition Change',
          'Lost',
          'Lost In Mail - Imu',
          'Stolen']
```

Therefore, The action.reasons that have at least one year where the number of annual transactions exceeds 10000 are: **Change Customer Details, Condition Change, Lost, Lost In Mail - Imu, Stolen.**

4. Create a histogram to analyse the distribution of the annual number of transactions per action reason as calculated in A5.1. Explain any observations and provide comments on the distribution.

Code Explanation:

1. Create a histogram for every action.reason
2. Iterate through each row of the table using iterrows()
3. Create a new figure and axis for each action reason
4. Create a histogram using the values in the current row
5. Add a grid to the plot
6. Set the title, x-label, y-label of the plot
7. Display the plot for the current action reason

```
In [19]: for index, row in the_table.iterrows():
          fig, axes = plt.subplots()

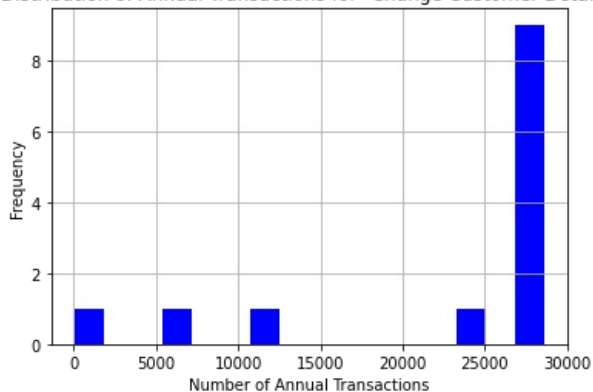
          axes.hist(row, bins=16, color='blue')

          axes.grid(True)

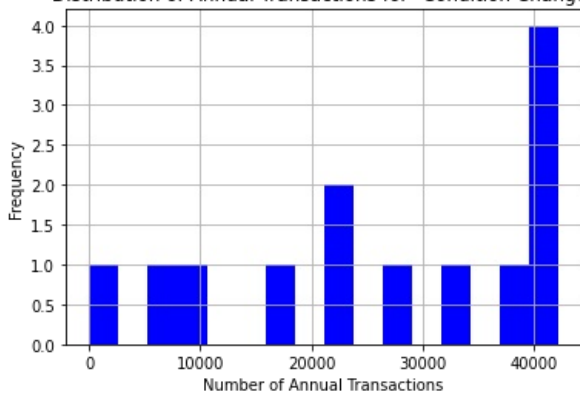
          axes.set_title(f'Distribution of Annual Transactions for "{index}"')
          axes.set_xlabel('Number of Annual Transactions')
          axes.set_ylabel('Frequency')

          plt.show()
```

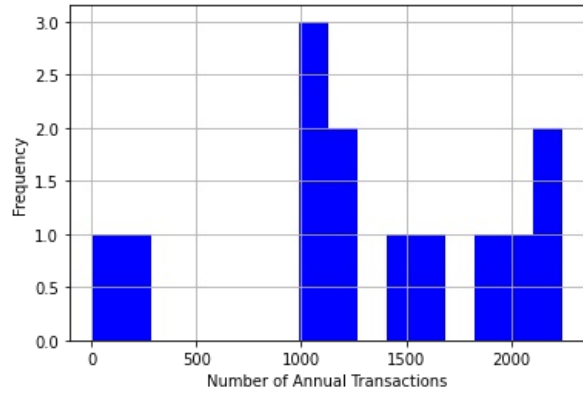
Distribution of Annual Transactions for "Change Customer Details"



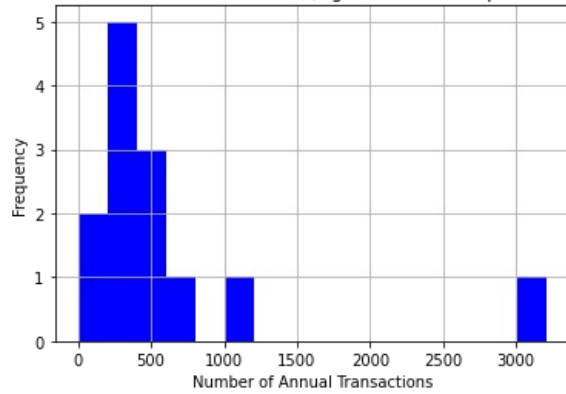
Distribution of Annual Transactions for "Condition Change"



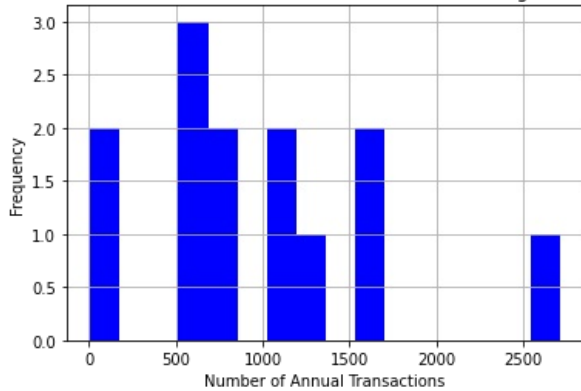
Distribution of Annual Transactions for "Court Order Issued X3 Or X4 Condition"



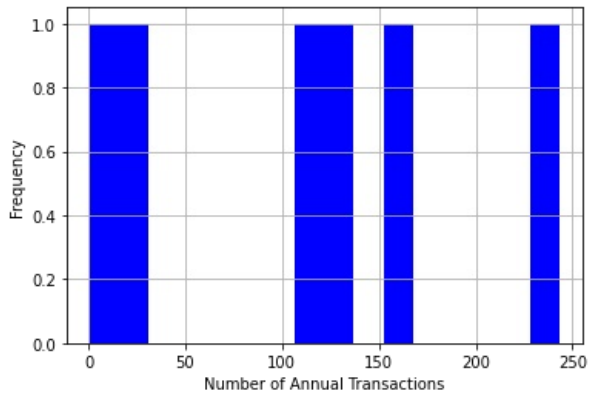
Distribution of Annual Transactions for "Da/dgd Smartcard Replacement Fee Exempt"

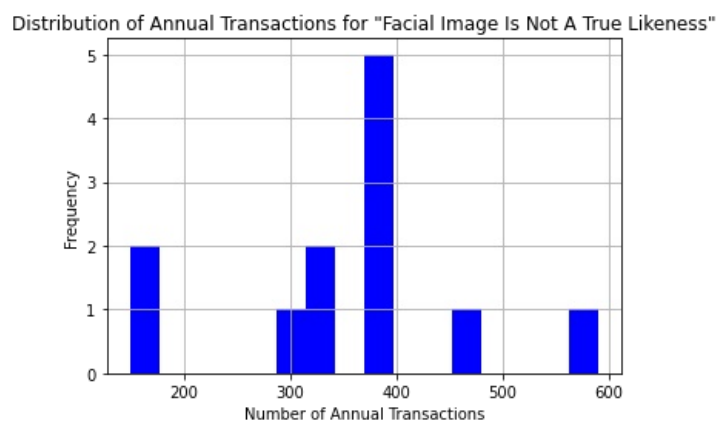
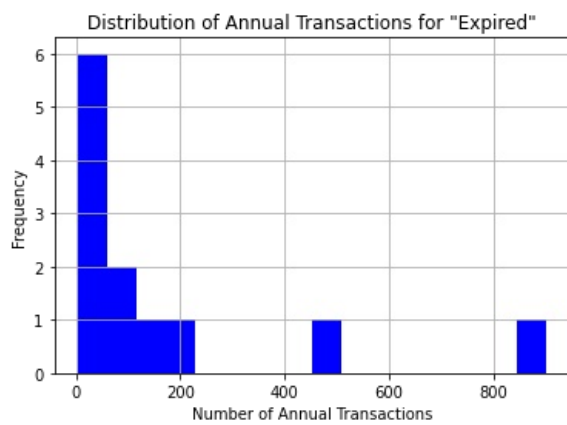
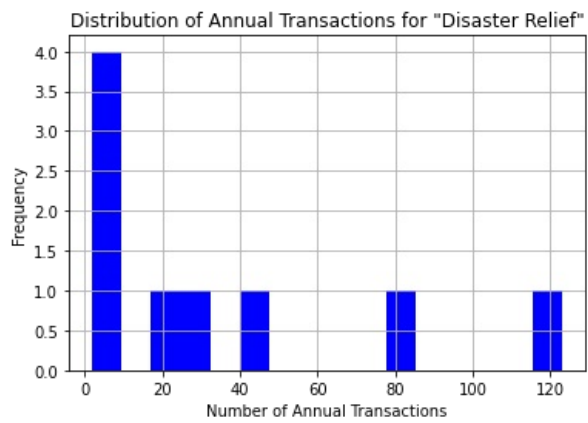
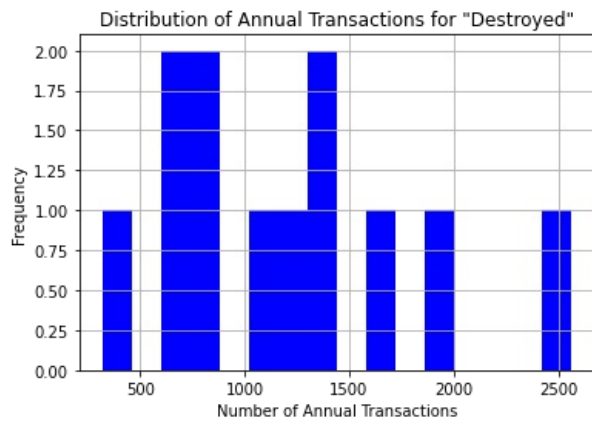


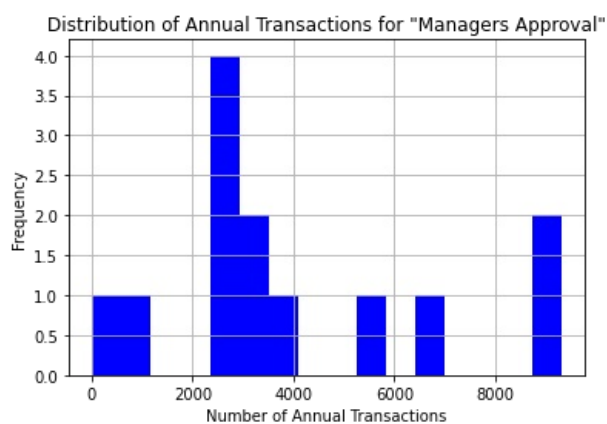
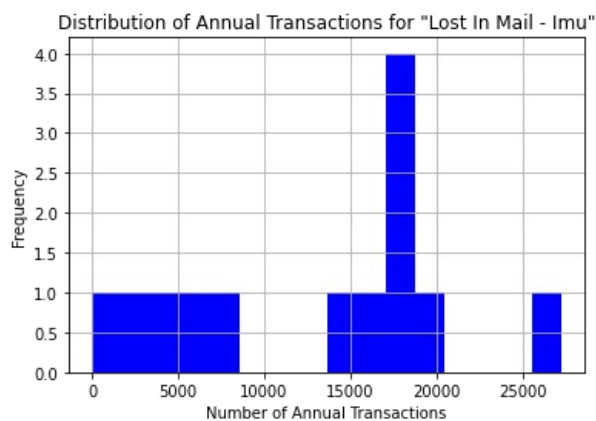
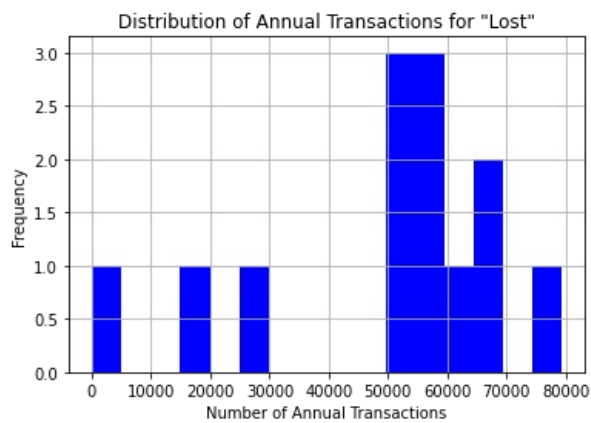
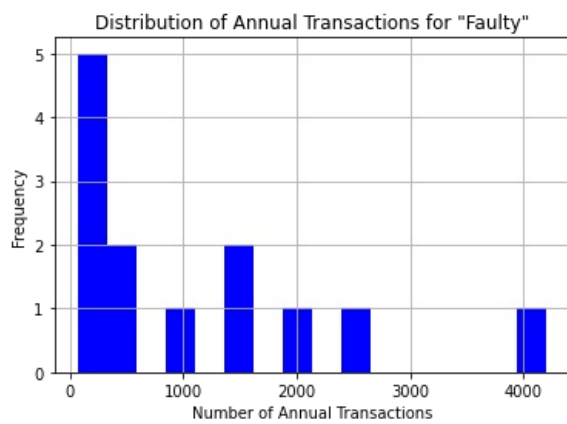
Distribution of Annual Transactions for "Damaged"



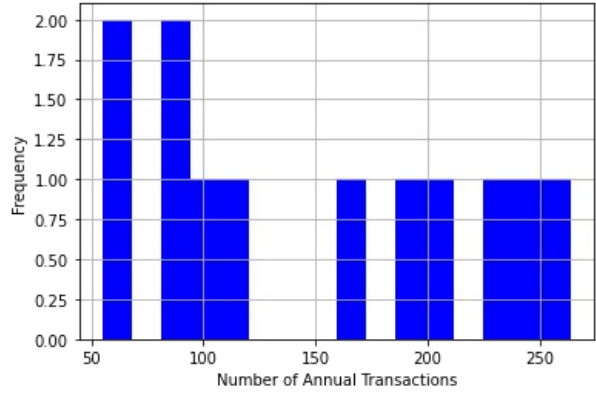
Distribution of Annual Transactions for "Defective"



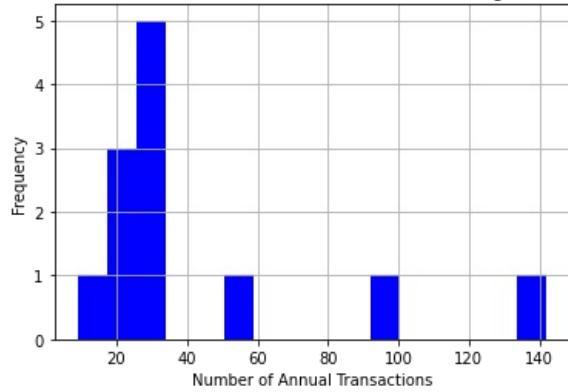




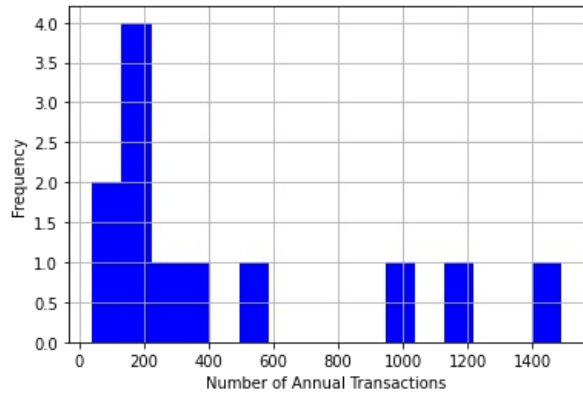
Distribution of Annual Transactions for "Marine Licence Transition"



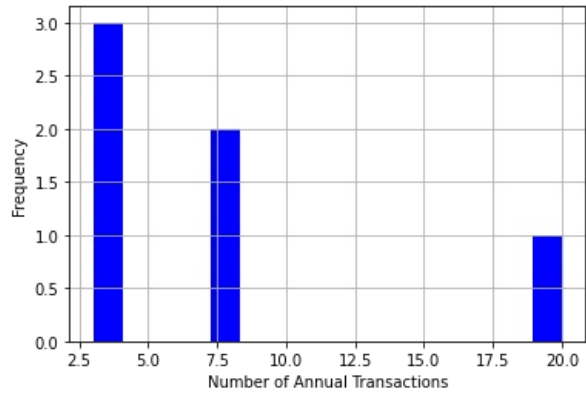
Distribution of Annual Transactions for "Merged"

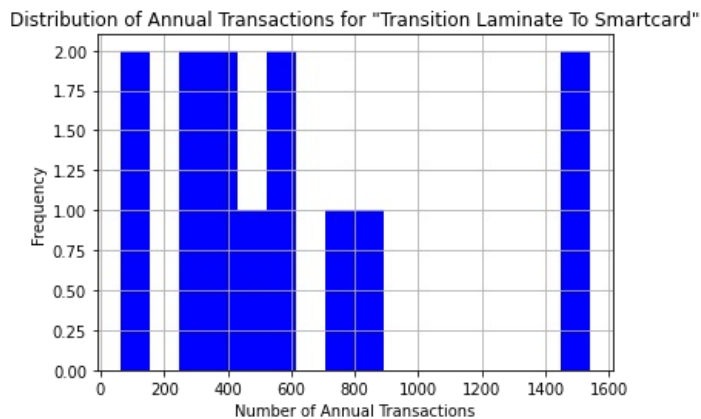
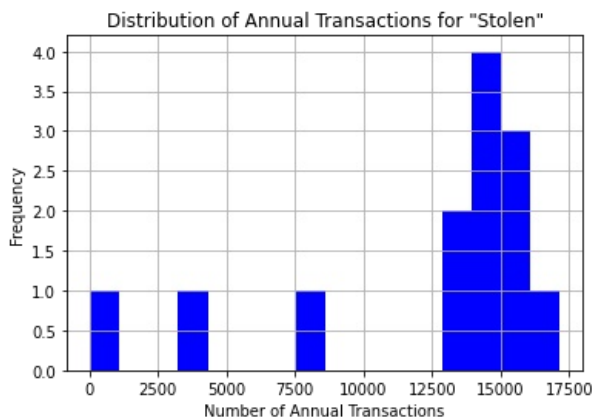


Distribution of Annual Transactions for "Product Exists Othr Surrent Void Cancel"



Distribution of Annual Transactions for "Remove Gender From Smartcard"





Observations and comments on the distributions:

Change Customer Details: Most years have transaction counts between 26,000 and 28,000, which shows a consistent and stable trend in this range for the "Change Customer Details" action/reason, which indicates that it consistently has a significant amount of annual transactions. We also see a peak frequency greater than 8 for that particular range. It seems to be one of the biggest reasons for smartcard transactions throughout the years.

Condition Change: We can observe from the plot that the distribution is more spread out, although there is a notable frequency peak of 4 in the 40,000 and 42,000 range. This indicates that the total number of transactions each year kept changing, which is true when we see the steady increase in transactions from 2010-2021. It also seems to be one of the biggest reasons for smartcard transactions throughout the years.

Court Order Issued X3 Or X4 Condition: The plot shows a consistent distribution between the range of 1000 and 2000, with a frequency peak of 3 in that range. This shows that this action/reason didn't really have any significant changes and stayed stable throughout the years. It seems to be a moderate reason for smartcard transactions throughout the years.

Da/dgd Smartcard Replacement Fee Exempt: The plot shows a distribution that is heavily skewed between the range of 0 and 700 with a notable peak of 5 in that range. It indicates that this action/reason is stable and consistent within that range and hasn't had many major changes throughout the years. It also seems to be a small reason for smartcard transactions throughout the years.

Damaged: Most years have transaction counts between 500 and 1600, with a peak of 3 within that range. This indicates that it wasn't a major reason for the total number of transactions since there are other reasons that've reached 20,000 transaction counts within the same year. It also seems to be a moderate reason for smartcard transactions throughout the years.

Defective: The plot shows that annual transactions for this action/reason stayed between the range of 0-250, and it only has a peak of 1. It seems to be a very small reason of smartcard transactions throughout the years.

Destroyed: The plot shows that annual transactions for this action/reason stayed between the range of 600-1400 for the most part, with a peak of 2 within the range. It also seems to be a moderate reason for smartcard transactions throughout the years.

Disaster Relief: Most years have transaction counts between 0 and 120, with a peak of 4 within that range. It seems to be a very small

reason of smartcard transactions throughout the years.

Expired: Most years have transaction counts between 0 and 220, with a peak of 6 within that range. It also seems to be a very small reason of smartcard transactions throughout the years.

Facial Image Is Not A True Likeness: The plot shows that annual transactions for this action/reason stayed between the range of 300-400 for the most part, with a peak of 5 within the range. It also seems to be a small reason for smartcard transactions throughout the years.

Faulty: The plot shows that annual transactions for this action/reason stayed between the range of 0-500 for the most part, with a peak of 5 within the range. It also seems to be a small reason for smartcard transactions throughout the years.

Lost: Most years have transaction counts between 50,000 and 70,000, which shows a consistent and stable trend in this range for the "Lost" action/reason, which indicates that it consistently has a significant amount of annual transactions. We also see a peak frequency of 3 for the particular range. It seems to be one of the biggest reasons for smartcard transactions throughout the years.

Lost In Mail - Imu: Most years have transaction counts between 15,000 and 20,000, which indicates that it consistently has a significant amount of annual transactions. We also see a peak frequency of 4 for the particular range. It seems to be a big reason for smartcard transactions throughout the years.

Managers Approval: The plot shows a consistent distribution between the range of 2200 and 4000, with a frequency peak of 4 in that range. This shows that this action/reason had some stability throughout the years but there were years where the number of transactions peaked to greater than 8000. It seems to be a moderately high reason for smartcard transactions throughout the years.

Marine Licence Transition: The plot shows a distribution that is between the range of 50 and 250 with a peak of 2 in that range. It indicates that this action/reason is stable and consistent within that range and hasn't had many major changes throughout the years. It also seems to be a very small reason for smartcard transactions throughout the years.

Merged: The plot shows a distribution that is heavily skewed between the range of 10 and 35 with a notable peak of 5 in that range. It indicates that this action/reason is stable within that range and hasn't had many major changes throughout the years. It also seems to be a very small reason for smartcard transactions throughout the years.

Product Exists Othr Surrend Void Cancel: Most years have transaction counts between 40 and 400, with a peak of 4 within that range. It also seems to be a very small reason of smartcard transactions throughout the years.

Remove Gender From Smartcard: Most years have transaction counts between 4 and 20, with a peak of 3 within that range. It also seems to be a very small reason of smartcard transactions throughout the years.

Stolen: We can observe from the plot that the distribution is heavily skewed towards the 12500 - 17500 range, although there is a notable frequency peak of 4 in the range. It also seems to be a moderately high reason for smartcard transactions throughout the years.

Transition Laminate To Smartcard: Most years have transaction counts between 100 and 600, with a peak of 2 within that range. It also seems to be a small reason of smartcard transactions throughout the years.