

## Part I: Research Question

1. Can we use the Market Basket Analysis model to identify the key associations of customer purchases?
2. This study aims to prepare data and use the Market Basket Analysis model to analyze customers' purchases and identify the key associations, providing recommendations.

## Part II: Method Justification

1. The Market Basket Analysis is a modeling technique used by retailers to increase sales by better understanding customer purchasing patterns. The Market Basket Analysis analyzes the data set such as purchase transactions history to reveal product groupings and products likely to be purchased together.(TechTarget 2021) In Market Basket Analysis, association rules are used to predict the likelihood of products being purchased together. Associations rules count the frequency of items that occur together, finding association that occurs far more often than expected.(TechTarget 2021)
2. Transaction in the Dataset like list of purchase items in one transaction as follows:
  - i. Apple Lightning to Digital AV Adapter
  - ii. TP-Link AC1750 Smart WiFi Router
  - iii. Apple Pencil

## Assumption:

The underlying assumption in Market Basket Analysis is that joint occurrence of two or more products in most baskets implies that these products are complements in the purchase. Therefore, the purchase of one goes lead to the purchase of others; in this study. (WordPress 2021)

In [201...

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from mlxtend.frequent_patterns import apriori, association_rules
from mlxtend.preprocessing import TransactionEncoder
import seaborn as sns
```

In [206...

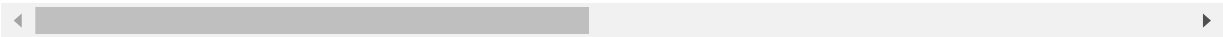
```
# Load the data set.
df = pd.read_csv(r"teleco_market_basket.csv")

# Display Data
df
```

Out[206...

|       | Item01                                | Item02                           | Item03                | Item04                       | Item05                    | Item06       | Item07                       | Item08                              | Item09                        |
|-------|---------------------------------------|----------------------------------|-----------------------|------------------------------|---------------------------|--------------|------------------------------|-------------------------------------|-------------------------------|
| 0     | NaN                                   | NaN                              | NaN                   | NaN                          | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |
| 1     | Logitech M510 Wireless mouse          | HP 63 Ink                        | HP 65 ink             | nonda USB C to USB Adapter   | 10ft iPhone Charger Cable | HP 902XL ink | Creative Pebble 2.0 Speakers | Cleaning Gel Universal Dust Cleaner | Micro Center 32GB Memory card |
| 2     | NaN                                   | NaN                              | NaN                   | NaN                          | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |
| 3     | Apple Lightning to Digital AV Adapter | TP-Link AC1750 Smart WiFi Router | Apple Pencil          | NaN                          | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |
| 4     | NaN                                   | NaN                              | NaN                   | NaN                          | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |
| ...   | ...                                   | ...                              | ...                   | ...                          | ...                       | ...          | ...                          | ...                                 | ...                           |
| 14997 | Falcon Dust Off Compressed Gas        | NaN                              | NaN                   | NaN                          | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |
| 14998 | NaN                                   | NaN                              | NaN                   | NaN                          | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |
| 14999 | HP 63XL Ink                           | Apple USB-C Charger cable        | NaN                   | NaN                          | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |
| 15000 | NaN                                   | NaN                              | NaN                   | NaN                          | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |
| 15001 | Apple Pencil                          | SanDisk Ultra 128GB card         | RUNMUS Gaming Headset | TopMate C5 Laptop Cooler pad | NaN                       | NaN          | NaN                          | NaN                                 | NaN                           |

15002 rows × 20 columns



In [226...

```
# Drop null rows
df_clean = df.dropna(how='all').fillna(0)

# Convert to List
transactions = list(df_clean.values)

# Clean Nan per row
for i in range(0, len(transactions)):
    transactions[i] = transactions[i][~pd.isnull(transactions[i])]

df_clean = pd.DataFrame(transactions)

# Save clean copy after Data preparation.
df_clean.to_csv("prepared_dataset.csv")
```

```
# Display Cleaned transactions
df_clean
```

Out[226...

|      | 0   | 1                                    | 2                            | 3                          | 4                                  | 5                         | 6                            | 7                                   | 8                             |
|------|---|--------------------------------------|------------------------------|----------------------------|------------------------------------|---------------------------|------------------------------|-------------------------------------|-------------------------------|
| 0    | Logitech M510 Wireless mouse              | HP 63 Ink                            | HP 65 ink                    | nonda USB C to USB Adapter | 10ft iPhone Charger Cable          | HP 902XL ink              | Creative Pebble 2.0 Speakers | Cleaning Gel Universal Dust Cleaner | Micro Center 32GB Memory card |
| 1    | Apple Lightning to Digital AV Adapter     | TP-Link AC1750 Smart WiFi Router     | Apple Pencil                 | None                       | None                               | None                      | None                         | None                                | None                          |
| 2    | UNEN Mfi Certified 5-pack Lightning Cable | None                                 | None                         | None                       | None                               | None                      | None                         | None                                | None                          |
| 3    | Cat8 Ethernet Cable                       | HP 65 ink                            | None                         | None                       | None                               | None                      | None                         | None                                | None                          |
| 4    | Dust-Off Compressed Gas 2 pack            | Screen Mom Screen Cleaner kit        | Moread HDMI to VGA Adapter   | HP 62XL Tri-Color ink      | Apple USB-C Charger cable          | None                      | None                         | None                                | None                          |
| ...  | ...                                       | ...                                  | ...                          | ...                        | ...                                | ...                       | ...                          | ...                                 | ...                           |
| 7496 | SanDisk 32GB Ultra SDHC card              | Vsco 70 pack stickers                | SanDisk 128GB microSDXC card | None                       | None                               | None                      | None                         | None                                | None                          |
| 7497 | Apple Lightning to Digital AV Adapter     | Nylon Braided Lightning to USB cable | Apple Pencil                 | USB 2.0 Printer cable      | ARRIS SURFboard SB8200 Cable Modem | Apple USB-C Charger cable | None                         | None                                | None                          |
| 7498 | Falcon Dust Off Compressed Gas            | None                                 | None                         | None                       | None                               | None                      | None                         | None                                | None                          |
| 7499 | HP 63XL Ink                               | Apple USB-C Charger cable            | None                         | None                       | None                               | None                      | None                         | None                                | None                          |

|      | 0            | 1                        | 2                     | 3                            | 4    | 5    | 6    | 7    | 8    |
|------|--------------|--------------------------|-----------------------|------------------------------|------|------|------|------|------|
| 7500 | Apple Pencil | SanDisk Ultra 128GB card | RUNMUS Gaming Headset | TopMate C5 Laptop Cooler pad | None | None | None | None | None |

7501 rows × 20 columns

In [208...

```
# Display one transaction
df_clean.head(1)
```

Out[208...

|   | 0                            | 1         | 2         | 3                          | 4                         | 5            | 6                            | 7                                   | 8                             | 9                                       | 10                           |
|---|------------------------------|-----------|-----------|----------------------------|---------------------------|--------------|------------------------------|-------------------------------------|-------------------------------|---|------------------------------|
| 0 | Logitech M510 Wireless mouse | HP 63 Ink | HP 65 ink | nonda USB C to USB Adapter | 10ft iPhone Charger Cable | HP 902XL ink | Creative Pebble 2.0 Speakers | Cleaning Gel Universal Dust Cleaner | Micro Center 32GB Memory card | YUNSONG 3pack 6ft Nylon Lightning Cable | TopMate C5 Laptop Cooler pad |

In [223...

```
# Instantiate transaction encoder
encoder = TransactionEncoder().fit(transactions)

# One-hot encode itemsets by applying fit and transform
onehot = encoder.transform(transactions)
```

In [213...

```
# Convert one-hot encoded data to DataFrame
onehot = pd.DataFrame(onehot, columns = encoder.columns_)

print(onehot.head())
```

```
10ft iPhone Charger Cable 10ft iPhone Charger Cable 2 Pack \
0                        True                        False
1                        False                        False
2                        False                        False
3                        False                        False
4                        False                        False

3 pack Nylon Braided Lightning Cable 3A USB Type C Cable 3 pack 6FT \
0                        False                        True
1                        False                        False
2                        False                        False
3                        False                        False
4                        False                        False

5pack Nylon Braided USB C cables ARRIS SURFboard SB8200 Cable Modem \
0                        False                        False
1                        False                        False
2                        False                        False
```

|   |       |       |
|---|-------|-------|
| 3 | False | False |
| 4 | False | False |

|   |                              |                        |
|---|------------------------------|------------------------|
|   | Anker 2-in-1 USB Card Reader | Anker 4-port USB hub \ |
| 0 | False                        | False                  |
| 1 | False                        | False                  |
| 2 | False                        | False                  |
| 3 | False                        | False                  |
| 4 | False                        | False                  |

|   |                             |   |
|---|-----------------------------|---|
|   | Anker USB C to HDMI Adapter | Apple Lightning to Digital AV Adapter ... \ |
| 0 | False                       | False ...                                   |
| 1 | False                       | True ...                                    |
| 2 | False                       | False ...                                   |
| 3 | False                       | False ...                                   |
| 4 | False                       | False ...                                   |

|   |                     |                         |                  |
|---|---------------------|-------------------------|------------------|
|   | hP 65 Tri-color ink | iFixit Pro Tech Toolkit | iPhone 11 case \ |
| 0 | False               | False                   | False            |
| 1 | False               | False                   | False            |
| 2 | False               | False                   | False            |
| 3 | False               | False                   | False            |
| 4 | False               | False                   | False            |

|   |                         |                    |                  |
|---|-------------------------|--------------------|------------------|
|   | iPhone 12 Charger cable | iPhone 12 Pro case | iPhone 12 case \ |
| 0 | False                   | False              | False            |
| 1 | False                   | False              | False            |
| 2 | False                   | False              | False            |
| 3 | False                   | False              | False            |
| 4 | False                   | False              | False            |

|   |                      |           |                |                              |
|---|----------------------|-----------|----------------|------------------------------|
|   | iPhone Charger Cable | Anker 6ft | iPhone SE case | nonda USB C to USB Adapter \ |
| 0 |                      | False     | False          | True                         |
| 1 |                      | False     | False          | False                        |
| 2 |                      | False     | False          | False                        |
| 3 |                      | False     | False          | False                        |
| 4 |                      | False     | False          | False                        |

|   |                       |
|---|-----------------------|
|   | seenda Wireless mouse |
| 0 | False                 |
| 1 | False                 |
| 2 | False                 |
| 3 | False                 |
| 4 | False                 |

[5 rows x 119 columns]

```
In [214... # Generate frequent itemsets
frequent_itemsets = apriori(onehot, min_support = 0.01, use_colnames = True, max_len
```

```
In [215... # Generate association rules
rules = association_rules(frequent_itemsets, metric = 'lift', min_threshold = 1.00)
```

```
In [216... rules
```

Out[216...

|            | antecedents                        | consequents                        | antecedent support | consequent support | support  | confidence | lift     | leverage |
|------------|------------------------------------|------------------------------------|--------------------|--------------------|----------|------------|----------|----------|
| <b>0</b>   | (Dust-Off Compressed Gas 2 pack)   | (10ft iPhone Charger Cable 2 Pack) | 0.238368           | 0.050527           | 0.023064 | 0.096756   | 1.914955 | 0.011020 |
| <b>1</b>   | (10ft iPhone Charger Cable 2 Pack) | (Dust-Off Compressed Gas 2 pack)   | 0.050527           | 0.238368           | 0.023064 | 0.456464   | 1.914955 | 0.011020 |
| <b>2</b>   | (10ft iPhone Charger Cable 2 Pack) | (HP 61 ink)                        | 0.050527           | 0.163845           | 0.010132 | 0.200528   | 1.223888 | 0.001853 |
| <b>3</b>   | (HP 61 ink)                        | (10ft iPhone Charger Cable 2 Pack) | 0.163845           | 0.050527           | 0.010132 | 0.061839   | 1.223888 | 0.001853 |
| <b>4</b>   | (10ft iPhone Charger Cable 2 Pack) | (Screen Mom Screen Cleaner kit)    | 0.050527           | 0.129583           | 0.015198 | 0.300792   | 2.321232 | 0.008651 |
| ...        | ...                                | ...                                | ...                | ...                | ...      | ...        | ...      | ...      |
| <b>301</b> | (TopMate C5 Laptop Cooler pad)     | (USB 2.0 Printer cable)            | 0.076523           | 0.170911           | 0.013332 | 0.174216   | 1.019340 | 0.000253 |
| <b>302</b> | (TopMate C5 Laptop Cooler pad)     | (VIVO Dual LCD Monitor Desk mount) | 0.076523           | 0.174110           | 0.015198 | 0.198606   | 1.140693 | 0.001875 |
| <b>303</b> | (VIVO Dual LCD Monitor Desk mount) | (TopMate C5 Laptop Cooler pad)     | 0.174110           | 0.076523           | 0.015198 | 0.087289   | 1.140693 | 0.001875 |
| <b>304</b> | (VicTsing Wireless mouse)          | (VIVO Dual LCD Monitor Desk mount) | 0.028130           | 0.174110           | 0.010265 | 0.364929   | 2.095966 | 0.005368 |
| <b>305</b> | (VIVO Dual LCD Monitor Desk mount) | (VicTsing Wireless mouse)          | 0.174110           | 0.028130           | 0.010265 | 0.058959   | 2.095966 | 0.005368 |

306 rows × 9 columns



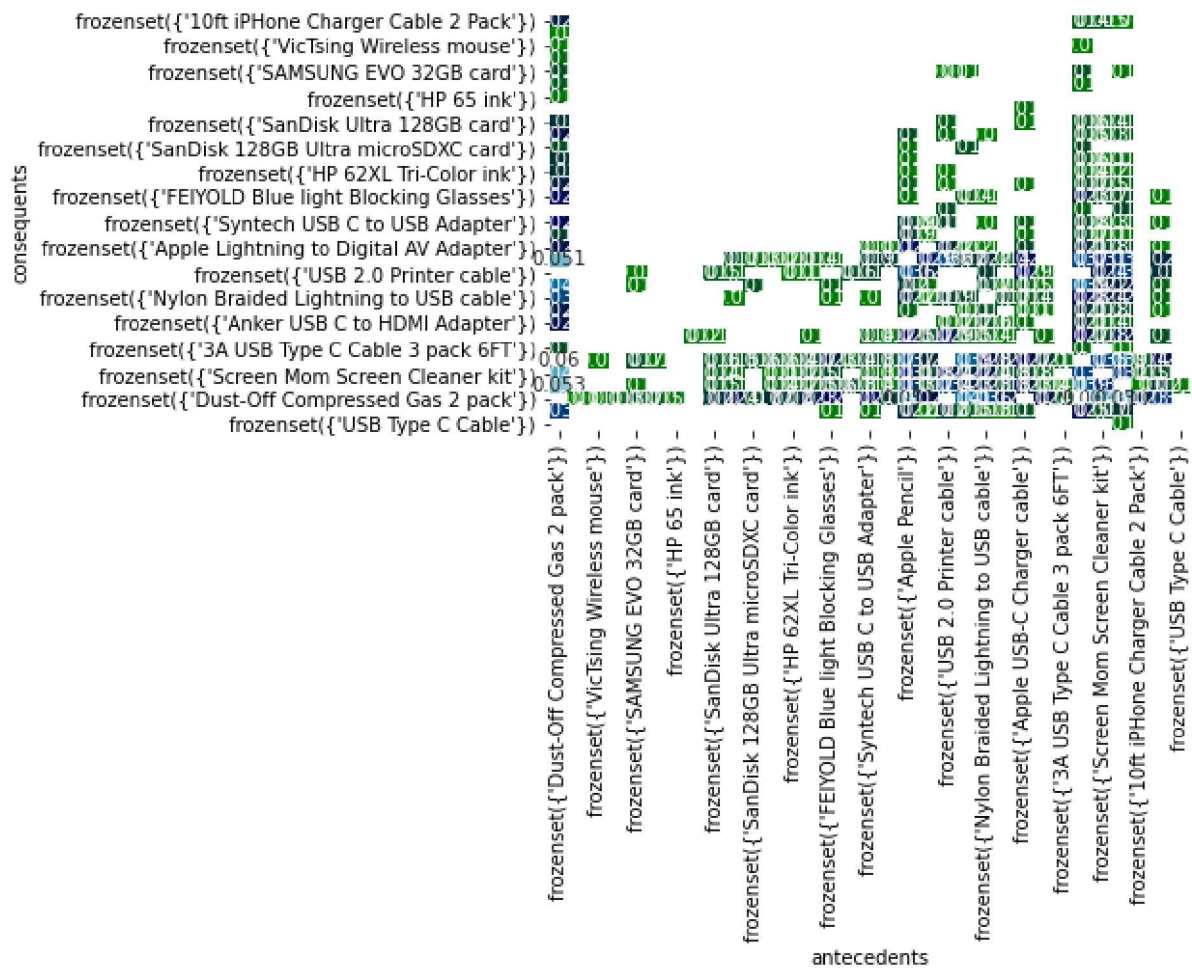
In [217...

```
# Transform antecedent, consequent, and support columns into matrix
support_table = rules.pivot(index='consequents', columns='antecedents', values='support')

# Generate heatmap
sns.heatmap(support_table, annot=True, cbar=False, cmap='ocean')
```

Out[217...

```
<AxesSubplot:xlabel='antecedents', ylabel='consequents'>
```



```
In [218... # Showing the top rules by Support
rules.sort_values(by = 'support', ascending = False, inplace = True)
rules.head(10)
```

Out[218...

|     | antecedents                        | consequents                        | antecedent support | consequent support | support  | confidence | lift     | leverage |
|-----|------------------------------------|------------------------------------|--------------------|--------------------|----------|------------|----------|----------|
| 162 | (Dust-Off Compressed Gas 2 pack)   | (VIVO Dual LCD Monitor Desk mount) | 0.238368           | 0.174110           | 0.059725 | 0.250559   | 1.439085 | 0.018223 |
| 163 | (VIVO Dual LCD Monitor Desk mount) | (Dust-Off Compressed Gas 2 pack)   | 0.174110           | 0.238368           | 0.059725 | 0.343032   | 1.439085 | 0.018223 |
| 131 | (HP 61 ink)                        | (Dust-Off Compressed Gas 2 pack)   | 0.163845           | 0.238368           | 0.052660 | 0.321400   | 1.348332 | 0.013604 |
| 130 | (Dust-Off Compressed Gas 2 pack)   | (HP 61 ink)                        | 0.238368           | 0.163845           | 0.052660 | 0.220917   | 1.348332 | 0.013604 |
| 61  | (Apple Pencil)                     | (Dust-Off Compressed Gas 2 pack)   | 0.179709           | 0.238368           | 0.050927 | 0.283383   | 1.188845 | 0.008090 |



|            | antecedents                      | consequents                      | antecedent support | consequent support | support  | confidence | lift     | leverage |
|------------|----------------------------------|----------------------------------|--------------------|--------------------|----------|------------|----------|----------|
| <b>60</b>  | (Dust-Off Compressed Gas 2 pack) | (Apple Pencil)                   | 0.238368           | 0.179709           | 0.050927 | 0.213647   | 1.188845 | 0.008090 |
| <b>155</b> | (Screen Mom Screen Cleaner kit)  | (Dust-Off Compressed Gas 2 pack) | 0.129583           | 0.238368           | 0.047994 | 0.370370   | 1.553774 | 0.017105 |
| <b>154</b> | (Dust-Off Compressed Gas 2 pack) | (Screen Mom Screen Cleaner kit)  | 0.238368           | 0.129583           | 0.047994 | 0.201342   | 1.553774 | 0.017105 |
| <b>152</b> | (SanDisk Ultra 64GB card)        | (Dust-Off Compressed Gas 2 pack) | 0.098254           | 0.238368           | 0.040928 | 0.416554   | 1.747522 | 0.017507 |
| <b>153</b> | (Dust-Off Compressed Gas 2 pack) | (SanDisk Ultra 64GB card)        | 0.238368           | 0.098254           | 0.040928 | 0.171700   | 1.747522 | 0.017507 |

In [227...

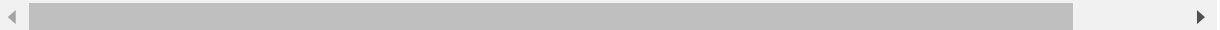
```
# Showing the top rules by Support
rules.sort_values(by='lift', ascending = False, inplace = True)
rules.head(10)
```

Out[227...

|            | antecedents                            | consequents                            | antecedent support | consequent support | support  | confidence | lift     | leverage |
|------------|--|--|--------------------|--------------------|----------|------------|----------|----------|
| <b>265</b> | (SanDisk 128GB Ultra microSDXC card)   | (SanDisk Ultra 64GB card)              | 0.049460           | 0.098254           | 0.015998 | 0.323450   | 3.291994 | 0.011138 |
| <b>264</b> | (SanDisk Ultra 64GB card)              | (SanDisk 128GB Ultra microSDXC card)   | 0.098254           | 0.049460           | 0.015998 | 0.162822   | 3.291994 | 0.011138 |
| <b>23</b>  | (Nylon Braided Lightning to USB cable) | (Anker USB C to HDMI Adapter)          | 0.095321           | 0.068391           | 0.016131 | 0.169231   | 2.474464 | 0.009612 |
| <b>22</b>  | (Anker USB C to HDMI Adapter)          | (Nylon Braided Lightning to USB cable) | 0.068391           | 0.095321           | 0.016131 | 0.235867   | 2.474464 | 0.009612 |
| <b>231</b> | (Logitech M510 Wireless mouse)         | (Nylon Braided Lightning to USB cable) | 0.071457           | 0.095321           | 0.016664 | 0.233209   | 2.446574 | 0.009853 |
| <b>230</b> | (Nylon Braided Lightning to USB cable) | (Logitech M510 Wireless mouse)         | 0.095321           | 0.071457           | 0.016664 | 0.174825   | 2.446574 | 0.009853 |



|           | antecedents                        | consequents                        | antecedent support | consequent support | support  | confidence | lift     | leverage |
|-----------|------------------------------------|------------------------------------|--------------------|--------------------|----------|------------|----------|----------|
| <b>4</b>  | (10ft iPhone Charger Cable 2 Pack) | (Screen Mom Screen Cleaner kit)    | 0.050527           | 0.129583           | 0.015198 | 0.300792   | 2.321232 | 0.008651 |
| <b>5</b>  | (Screen Mom Screen Cleaner kit)    | (10ft iPhone Charger Cable 2 Pack) | 0.129583           | 0.050527           | 0.015198 | 0.117284   | 2.321232 | 0.008651 |
| <b>21</b> | (Logitech M510 Wireless mouse)     | (Anker USB C to HDMI Adapter)      | 0.071457           | 0.068391           | 0.011199 | 0.156716   | 2.291481 | 0.006311 |
| <b>20</b> | (Anker USB C to HDMI Adapter)      | (Logitech M510 Wireless mouse)     | 0.068391           | 0.071457           | 0.011199 | 0.163743   | 2.291481 | 0.006311 |



In [228...

```
# Showing the top rules by Support
rules.sort_values(by = 'confidence', ascending = False, inplace = True)
rules.head(10)
```

Out[228...

|            | antecedents                           | consequents                        | antecedent support | consequent support | support  | confidence | lift     | leverage |
|------------|---------------------------------------|------------------------------------|--------------------|--------------------|----------|------------|----------|----------|
| <b>1</b>   | (10ft iPhone Charger Cable 2 Pack)    | (Dust-Off Compressed Gas 2 pack)   | 0.050527           | 0.238368           | 0.023064 | 0.456464   | 1.914955 | 0.011020 |
| <b>127</b> | (FEIYOLD Blue light Blocking Glasses) | (Dust-Off Compressed Gas 2 pack)   | 0.065858           | 0.238368           | 0.027596 | 0.419028   | 1.757904 | 0.011898 |
| <b>152</b> | (SanDisk Ultra 64GB card)             | (Dust-Off Compressed Gas 2 pack)   | 0.098254           | 0.238368           | 0.040928 | 0.416554   | 1.747522 | 0.017507 |
| <b>9</b>   | (3A USB Type C Cable 3 pack 6FT)      | (Dust-Off Compressed Gas 2 pack)   | 0.042528           | 0.238368           | 0.017064 | 0.401254   | 1.683336 | 0.006927 |
| <b>167</b> | (iPhone Charger Cable Anker 6ft)      | (Dust-Off Compressed Gas 2 pack)   | 0.025730           | 0.238368           | 0.010265 | 0.398964   | 1.673729 | 0.004132 |
| <b>278</b> | (SanDisk Ultra 64GB card)             | (VIVO Dual LCD Monitor Desk mount) | 0.098254           | 0.174110           | 0.039195 | 0.398915   | 2.291162 | 0.022088 |
| <b>143</b> | (Premium Nylon USB Cable)             | (Dust-Off Compressed Gas 2 pack)   | 0.051060           | 0.238368           | 0.020131 | 0.394256   | 1.653978 | 0.007960 |

|     | antecedents                            | consequents                      | antecedent support | consequent support | support  | confidence | lift     | leverage |
|-----|--|----------------------------------|--------------------|--------------------|----------|------------|----------|----------|
| 165 | (VicTsing Wireless mouse)              | (Dust-Off Compressed Gas 2 pack) | 0.028130           | 0.238368           | 0.010932 | 0.388626   | 1.630358 | 0.004227 |
| 129 | (Falcon Dust Off Compressed Gas)       | (Dust-Off Compressed Gas 2 pack) | 0.059992           | 0.238368           | 0.022797 | 0.380000   | 1.594172 | 0.008497 |
| 141 | (Nylon Braided Lightning to USB cable) | (Dust-Off Compressed Gas 2 pack) | 0.095321           | 0.238368           | 0.035729 | 0.374825   | 1.572463 | 0.013007 |

## Part V: Data Summary and Implications

### The Summary:

1. Summarize the significance.

i. Support: indicate the item popularity in the transactions and measure the percentage appearing in the transactions. For example, the top support item in the study is 0.059 mean significance appearing in about 6% of all the transactions.

ii. Lift: indicate how likely the consequent item appears in the purchase transaction if the antecedent item is included in the same purchase transaction. For example, the top Lift item in the study is 3.29, which is greater than one, meaning significance there is a very likely purchase of the consequent item if the antecedent item is purchased.

iii. Confidence: indicate how likely the consequent item appears in the purchase transaction if the antecedent item is included in the same purchase transaction and measured in percentage. For example, the top Confidence item in the study is 0.45, meaning significance in about 45 % percent that the consequent item will be purchased if the antecedent item is purchased.

2. The study found that the Market Basket Analysis is a perfect practical significance tool to analyze the purchase history and define the associations between the purchased items, improving the business decision and increasing sales. For example, the results show (Dust-Off Compressed Gas 2 pack) and (VIVO Dual LCD Monitor Desk mount) items together appear in 6% in the purchase transactions and the significant relation between (SanDisk 128GB Ultra microSDXC card) and (SanDisk Ultra 64GB card) items in the purchase history. About 45 % percent that the (Dust-Off Compressed Gas 2 pack) item will appear in the transaction if the customer purchase (10ft iPhone Charger Cable 2 Pack) item, the Market team could use the top items for support, lift. Confidence items list analyzes and defines customer behavior and characteristics and improves marketing plans and offers, which support increased sales.

3. Actionable recommendations:

The telecommunications providers could use the algorithm to define the associations between the purchased items and define the customer characteristics, targeting the marketing proposals like offering the associated items together based on the algorithm results. Moreover, the algorithm could improve business decisions and increase sales. The Market team could use the top items for support, lift, and Confidence lists as reports as valuable information and recommendation to improve marketing plans and offers, which support increased sales. For example, the market team could use the top list of confidence and lift to create offers for the items together in one offer and use the top of the support list to increase the number of items available in the store. Both recommendations will improve the sales.

## Acknowledge Sources:

Towards Data Science. (2021, November 17) Market Basket Analysis. [Web Site]. Retrieved from <https://towardsdatascience.com/market-basket-analysis-on-online-retail-data-24ee7214a762>

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WordPress. (2021, November 17) Market Basket Analysis. [Web Site]. Retrieved from <https://sarahtianhua.wordpress.com/portfolio/market-basket-analysis/>