In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
np.seterr(divide='ignore', invalid='ignore')
```

Out[1]:
```
{'divide': 'warn', 'over': 'warn', 'under': 'ignore', 'invalid': 'warn'}
```

Finding the Total Cost by Aircraft Type for the entire year and the Aircraft Type with the lowest cost per seat per km

Import excel sheets for Operations, AC Characteristics, City_pairs

In [2]:
```
operations = pd.read_excel(io="Data Science Case study Vindiata.xlsx", sheet_name= "
AC_char = pd.read_excel(io="Data Science Case study Vindiata.xlsx", sheet_name= "AC
city_pairs = pd.read_excel(io="Data Science Case study Vindiata.xlsx", sheet_name= "
```

Dropping Null values and renaming columns

In [3]:
```
operations = operations.dropna(axis=1)
AC_char = AC_char.dropna(axis=1)
city_pairs = city_pairs.dropna(axis=1)

operations.columns = ["Aircraft Type","Jan","Feb","Mar", "Apr", "May", "Jun", "Jul",
city_pairs.columns = ["Origin", "Destination","Passengers","Distance"]
```

Aggregating Operations table for Airline A by Hours Flown for the entire year for each aircraft type.

In [4]:
```
months = operations.columns[1:]

operations=operations.groupby(["Aircraft Type"]).sum()
operations["Hours Flown"]= operations[months].sum(axis=1)
print(operations)
print(AC_char)
print(city_pairs)
```

```
                 Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct  \
Aircraft Type
A320            1240  1245  1230  1255  1205  1215  1230  1220  1270  1270
A330            1820  1826  1808  1838  1778  1790  1808  1796  1856  1856
ATR72            795   799   787   807   767   775   787   779   819   819
B737             985   989   977   997   957   965   977   969  1009  1009
B747             920   923   914   929   899   905   914   908   938   938
Q400             790   794   782   802   762   770   782   774   814   814

                 Nov   Dec  Hours Flown
Aircraft Type
A320            1245  1250        14875
A330            1826  1832        21834
ATR72            799   803         9536
B737             989   993        11816
B747             923   926        11037
Q400             794   798         9476
```

```
                Range (Km)  Ave. Speed (km/h)  Number of Seats  \
Aircraft Type
A320                  5000                800              150
A330                  8000                900              250
B737                  5000                800              150
B747                 10000                900              350
Q400                  1500                750               90
ATR72                 1000                650               75

                Costs per flight hour
Aircraft Type
A320                             5000
A330                             7500
B737                             5100
B747                            12000
Q400                             3500
ATR72                            2750
  Origin Destination  Passengers  Distance
0     AA          BB         420      3000
1     BB          CC         450      6500
2     CC          AA         300       400
3     AA          DD         300      1000
```

Joining the Operations and AC Characteristics Table on Aircraft Type and keeping the relevant columns

In [5]:

```
lowest_cost = operations.join(AC_char, lsuffix='_caller', rsuffix='_other')
lowest_cost= lowest_cost[["Hours Flown","Costs per flight hour","Number of Seats", "
print(lowest_cost)
```

```
  Aircraft Type  Hours Flown  Costs per flight hour  Number of Seats  \
0          A320        14875                   5000              150
1          A330        21834                   7500              250
2         ATR72         9536                   2750               75
3          B737        11816                   5100              150
4          B747        11037                  12000              350
5          Q400         9476                   3500               90

   Ave. Speed (km/h)  Range (Km)
0                800        5000
1                900        8000
2                650        1000
3                800        5000
4                900       10000
5                750        1500
```

Calculating Total Cost for each Aircraft Type

Total Cost = *Hours Flown* Cost per flight hour*

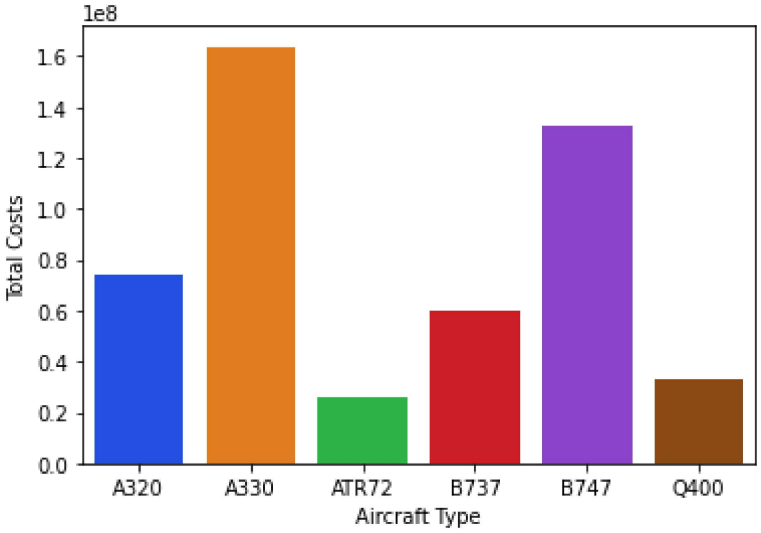
In [6]:

```
lowest_cost["Total Costs"] = lowest_cost["Hours Flown"] * lowest_cost["Costs per fli

print("The Total Cost for the Entire year by Aircraft Type is summarized in the tabl
print(lowest_cost)
fig = sns.barplot(x = lowest_cost["Aircraft Type"], y = lowest_cost["Total Costs"],
```

```
The Total Cost for the Entire year by Aircraft Type is summarized in the table below
  Aircraft Type  Hours Flown  Costs per flight hour  Number of Seats  \
0          A320        14875                   5000              150
1          A330        21834                   7500              250
2         ATR72         9536                   2750               75
3          B737        11816                   5100              150
4          B747        11037                  12000              350
5          Q400         9476                   3500               90
```

```
   Ave. Speed (km/h)  Range (Km)  Total Costs
0                800        5000     74375000
1                900        8000    163755000
2                650        1000     26224000
3                800        5000     60261600
4                900       10000    132444000
5                750        1500     33166000
```



Calculating the Cost per Hour per Km by Aircraft Type

Cost per Seat per Km = Total Costs/(Number of Seats Hours Flown *Average Speed)*

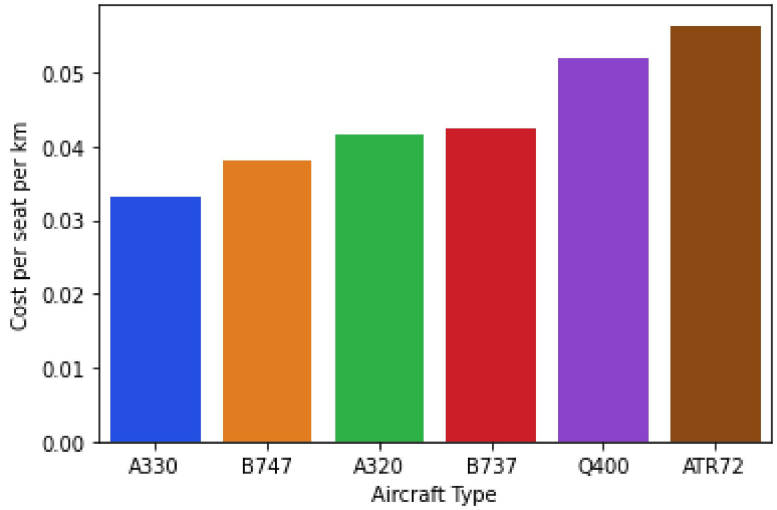
In [7]:

```
lowest_cost["Cost per seat per km"] = round(lowest_cost["Total Costs"]/(lowest_cost[
lowest_cost = lowest_cost.sort_values("Cost per seat per km", ascending=True)
fig = sns.barplot(x = lowest_cost["Aircraft Type"], y = lowest_cost["Cost per seat p


print(f"The lowest Cost per seat per km is of Aircraft Type {lowest_cost.index[0]}")
print(lowest_cost)
```

```
The lowest Cost per seat per km is of Aircraft Type 1
  Aircraft Type  Hours Flown  Costs per flight hour  Number of Seats  \
1          A330        21834                   7500              250
4          B747        11037                  12000              350
0          A320        14875                   5000              150
3          B737        11816                   5100              150
5          Q400         9476                   3500               90
2         ATR72         9536                   2750               75

   Ave. Speed (km/h)  Range (Km)  Total Costs  Cost per seat per km
1                900        8000    163755000                0.0333
4                900       10000    132444000                0.0381
0                800        5000     74375000                0.0417
3                800        5000     60261600                0.0425
5                750        1500     33166000                0.0519
2                650        1000     26224000                0.0564
```



In [8]:
```
print("-----------------------------------------------------------------------------
```

```
-------------------------------------------------------------------------------
-------------------------------------------------------
```

Finding the most optimal Aircraft Type for each City-Pair by Range, Passenger Demand and Cost

Modifying the lowest_cost table to keep relevant columns

In [9]:
```
cost = lowest_cost.drop(['Hours Flown', 'Costs per flight hour', 'Total Costs',"Ave.
print(cost)
```

	index	Aircraft Type	Number of Seats	Range (Km)	Cost per seat per km
0	1	A330	250	8000	0.0333
1	4	B747	350	10000	0.0381
2	0	A320	150	5000	0.0417
3	3	B737	150	5000	0.0425
4	5	Q400	90	1500	0.0519
5	2	ATR72	75	1000	0.0564

Iterating over city pairs table and generating the cost for each aircraft type for each city pair.

lowest cost = (cost per seat per km number of seats *distance* number of trips)*

number of trips = passengers/number of seats

In [10]:
```
for source,destination,passengers,distance in city_pairs.itertuples(index=False):
    cost[source + "-" + destination + ' cost'] = np.where(cost["Range (Km)"] >= dist
print(cost)
```

	index	Aircraft Type	Number of Seats	Range (Km)	Cost per seat per km	\
0	1	A330	250	8000	0.0333	
1	4	B747	350	10000	0.0381	
2	0	A320	150	5000	0.0417	
3	3	B737	150	5000	0.0425	
4	5	Q400	90	1500	0.0519	
5	2	ATR72	75	1000	0.0564	

	AA-BB cost	BB-CC cost	CC-AA cost	AA-DD cost
0	49950	108225	6660	16650
1	80010	173355	5334	13335
2	56295	NaN	5004	12510
3	57375	NaN	5100	12750
4	NaN	NaN	7473	18684
5	NaN	NaN	6767	16919

Finding the most optimal aircraft type for each city pair

In [11]:
```
AA_BB = cost.sort_values("AA-BB cost", ascending=True).iloc[0,0]
BB_CC = cost.sort_values("BB-CC cost", ascending=True).iloc[0,0]
CC_AA = cost.sort_values("CC-AA cost", ascending=True).iloc[0,0]
AA_DD = cost.sort_values("AA-DD cost", ascending=True).iloc[0,0]

optimal = pd.DataFrame(columns=["Optimal Flight","No. of Trips"])
optimal["Optimal Flight"] =[AA_BB,BB_CC,CC_AA,AA_DD]
optimal["No. of Trips"] = np.ceil(city_pairs["Passengers"]/cost["Number of Seats"])

print(optimal)

print(f"The most optimal flights for city-pairs AA-BB, BB-CC, CC-DD, AA-DD are {AA_B
```

	Optimal Flight	No. of Trips
0	1	2.0
1	1	2.0
2	0	2.0
3	0	2.0

```
The most optimal flights for city-pairs AA-BB, BB-CC, CC-DD, AA-DD are 1, 1, 0, 0 re
spectively
```

The most optimal flights for city-pairs AA-BB, BB-CC, CC-DD, AA-DD are A330, A330, A320, A320 respectively