HCC - Case Study

September 17, 2023

1 HCC - Case Study

In the bustling world of healthcare, efficient and effective communication between patients and healthcare providers is paramount. The Hospital System's Call Center (HCC) plays a crucial role in this regard, as it serves as the primary hub for handling inbound calls and managing telephonic interactions with patients. These interactions encompass a wide range of issues, from scheduling appointments to resolving queries related to patient care across various outpatient clinics.

In the following analysis, we will embark on a journey through this dataset to unearth insights and address crucial questions. Our goals are to conduct exploratory data analysis to summarize HCC's current state, identify key questions that the HCC manager can pose, define a model for productivity, and create a user-friendly dashboard to empower business leaders to make informed decisions based on this invaluable data resource. This multifaceted approach will not only enhance the efficiency of HCC operations but also elevate the quality of patient care provided by the Hospital System.

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1 - Data Prepocessing

- Load dataset
- Merging
- Check data info

[1]:
```
#Import necessary libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

[2]:
```
# Load the dataset
sheet1 = pd.read_excel("Case Study Data.xlsx", sheet_name="Total logged-in␣
 ↪time")
sheet2 = pd.read_excel("Case Study Data.xlsx", sheet_name="Not_Ready_Time")
sheet3 = pd.read_excel("Case Study Data.xlsx",␣
 ↪sheet_name="Handled_Calls&Handle_Time")
sheet4 = pd.read_excel("Case Study Data.xlsx", sheet_name="Agent Team Lookup")
```

[3]:
```
# Check first 5 rows to see the dataset is loaded correctly
sheet1.head()
```

[3]:

	Agent ID	Interval Start Time	Interval End Time	Total Logged In Time	Not Ready Time	Ready Time	Reserved Time	Talk Time	Next Call Prep Time
0	Agent 1	2022-08-01 08:00:00	2022-08-01 08:30:00	00:27:02	00:03:26	00:00:07	00:00:22	00:21:51	00:01:16
1	Agent 1	2022-08-01 08:30:00	2022-08-01 09:00:00	00:30:00	00:01:33	00:01:52	00:00:33	00:24:29	00:01:33
2	Agent 1	2022-08-01 09:00:00	2022-08-01 09:30:00	00:30:00	00:04:16	00:00:00	00:00:37	00:23:01	00:02:06
3	Agent 1	2022-08-01 09:30:00	2022-08-01 10:00:00	00:30:00	00:06:14	00:00:00	00:00:15	00:22:23	00:01:08
4	Agent 1	2022-08-01 10:00:00	2022-08-01 10:30:00	00:30:00	00:01:49	00:00:00	00:00:15	00:26:57	00:00:59

[4]:
```
# Check first 5 rows to see the dataset is loaded correctly
sheet2.head()
```

[4]:

	Agent ID	Interval Start Time	Interval End Time	Total Logged-in	Total Not Ready	Break	Lunch	Team Support	Meeting	After Call Work	Special Projects	Training	System Issues	Other
0	Agent 1	2022-08-01 08:00:00	2022-08-01 08:30:00	00:27:02	00:03:26	00:00:00	00:00:00	00:00:00	00:00:00	00:03:23	00:00:00	00:00:00	00:00:00	00:00:03
1	Agent 1	2022-08-01 08:30:00	2022-08-01 09:00:00	00:30:00	00:01:33	00:00:00	00:00:00	00:00:00	00:00:00	00:01:33	00:00:00	00:00:00	00:00:00	00:00:00
2	Agent 1	2022-08-01 09:00:00	2022-08-01 09:30:00	00:30:00	00:04:16	00:00:01	00:00:00	00:00:00	00:00:00	00:04:15	00:00:00	00:00:00	00:00:00	00:00:00
3	Agent 1	2022-08-01 09:30:00	2022-08-01 10:00:00	00:30:00	00:06:14	00:06:14	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00
4	Agent 1	2022-08-01 10:00:00	2022-08-01 10:30:00	00:30:00	00:01:49	00:00:00	00:00:00	00:00:00	00:00:00	00:01:49	00:00:00	00:00:00	00:00:00	00:00:00

```
4          00:00:00  00:00:00       00:00:00  00:00:00
```

[5]:
```
# Check first 5 rows to see the dataset is loaded correctly
sheet3.head()
```

[5]:
```
  Agent ID       Date  Number of Calls Handled Average Handle Time
0  Agent 1 2022-08-01                       94            00:04:40
1  Agent 1 2022-08-02                       80            00:04:42
2  Agent 1 2022-08-03                       81            00:04:34
3  Agent 1 2022-08-04                       73            00:05:12
4  Agent 1 2022-08-05                       75            00:04:51
```

[6]:
```
# Check first 5 rows to see the dataset is loaded correctly
sheet4.head()
```

[6]:
```
  Agent ID Agent Team
0  Agent 1     team_1
1  Agent 2     team_3
2  Agent 3     team_3
3  Agent 4     team_4
4  Agent 5     team_4
```

Since sheet 1 and sheet 2 and sheet 4 have the common column 'Agent ID', 'Interval Start Time', 'Interval End Time', we will merge these two sheets. Sheet 3 will be left as is for further analysis (if we merge, the information will be duplicated).

[7]:
```
# Merge sheet1 and sheet2 on 'Agent ID', 'Interval Start Time', and 'Interval␣
 ↪End Time'
hcc_df = pd.merge(sheet1, sheet2, on=['Agent ID', 'Interval Start Time',␣
 ↪'Interval End Time'])
hcc_df = pd.merge(hcc_df, sheet4, on=['Agent ID'])
```

[8]:
```
# Split the "Interval Start Time" column into "Date" column (in case we need␣
 ↪analysis in daily basis)
hcc_df['Date'] = hcc_df['Interval Start Time'].dt.date
hcc_df['Date'] = pd.to_datetime(hcc_df['Date'])

# Create a list of column names in the desired order
desired_order = ['Agent ID','Agent Team','Date'] + [col for col in hcc_df.
 ↪columns if col not in ['Agent ID','Agent Team','Date']]

# Reorder the columns based on the desired order, drop duplicated columns
hcc_df = hcc_df[desired_order]
hcc_df = hcc_df.drop(['Total Not Ready','Total Logged-in'], axis =1)

hcc_df.head()
```

[8]:
```
  Agent ID Agent Team       Date Interval Start Time   Interval End Time  \
0  Agent 1     team_1 2022-08-01 2022-08-01 08:00:00 2022-08-01 08:30:00
1  Agent 1     team_1 2022-08-01 2022-08-01 08:30:00 2022-08-01 09:00:00
2  Agent 1     team_1 2022-08-01 2022-08-01 09:00:00 2022-08-01 09:30:00
3  Agent 1     team_1 2022-08-01 2022-08-01 09:30:00 2022-08-01 10:00:00
4  Agent 1     team_1 2022-08-01 2022-08-01 10:00:00 2022-08-01 10:30:00

  Total Logged In Time Not Ready Time Ready Time Reserved Time Talk Time  \
0             00:27:02       00:03:26   00:00:07      00:00:22  00:21:51
1             00:30:00       00:01:33   00:01:52      00:00:33  00:24:29
2             00:30:00       00:04:16   00:00:00      00:00:37  00:23:01
3             00:30:00       00:06:14   00:00:00      00:00:15  00:22:23
4             00:30:00       00:01:49   00:00:00      00:00:15  00:26:57

  Next Call Prep Time     Break     Lunch Team Support   Meeting  \
0            00:01:16  00:00:00  00:00:00     00:00:00  00:00:00
1            00:01:33  00:00:00  00:00:00     00:00:00  00:00:00
2            00:02:06  00:00:01  00:00:00     00:00:00  00:00:00
3            00:01:08  00:06:14  00:00:00     00:00:00  00:00:00
4            00:00:59  00:00:00  00:00:00     00:00:00  00:00:00

  After Call Work Special Projects  Training System Issues     Other
0        00:03:23         00:00:00  00:00:00      00:00:00  00:00:03
1        00:01:33         00:00:00  00:00:00      00:00:00  00:00:00
2        00:04:15         00:00:00  00:00:00      00:00:00  00:00:00
3        00:00:00         00:00:00  00:00:00      00:00:00  00:00:00
4        00:01:49         00:00:00  00:00:00      00:00:00  00:00:00
```

[9]:
```
hcc_df.shape
```

[9]:
```
(24912, 20)
```

[10]:
```
hcc_df.isnull().sum()
```

[10]:
```
Agent ID                0
Agent Team              0
Date                    0
Interval Start Time     0
Interval End Time       0
Total Logged In Time    0
Not Ready Time          0
Ready Time              0
Reserved Time           0
Talk Time               0
Next Call Prep Time     0
Break                   0
Lunch                   0
```

```
Team Support            0
Meeting                 0
After Call Work         0
Special Projects        0
Training                0
System Issues           0
Other                   0
dtype: int64
```

[11]:
```
hcc_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 24912 entries, 0 to 24911
Data columns (total 20 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   Agent ID              24912 non-null  object
 1   Agent Team            24912 non-null  object
 2   Date                  24912 non-null  datetime64[ns]
 3   Interval Start Time   24912 non-null  datetime64[ns]
 4   Interval End Time     24912 non-null  datetime64[ns]
 5   Total Logged In Time  24912 non-null  object
 6   Not Ready Time        24912 non-null  object
 7   Ready Time            24912 non-null  object
 8   Reserved Time         24912 non-null  object
 9   Talk Time             24912 non-null  object
 10  Next Call Prep Time   24912 non-null  object
 11  Break                 24912 non-null  object
 12  Lunch                 24912 non-null  object
 13  Team Support          24912 non-null  object
 14  Meeting               24912 non-null  object
 15  After Call Work       24912 non-null  object
 16  Special Projects      24912 non-null  object
 17  Training              24912 non-null  object
 18  System Issues         24912 non-null  object
 19  Other                 24912 non-null  object
dtypes: datetime64[ns](3), object(17)
memory usage: 4.0+ MB
```

Re-format the time-related columns for more appropriate analysis. We will change from column **'Total Logged In Time'** to column **'Other'** as **timedelta64**.

[12]:
```
# Specify the columns that contain time-related data
time_related_columns = hcc_df.columns[5:20]

# Convert the time-related columns to float as Days
for col in time_related_columns:
```

```
    #hcc_df[col] = pd.to_timedelta(hcc_df[col].astype(str)).dt.total_seconds() /
↪ (3600 * 24)
    hcc_df[col] = pd.to_timedelta(hcc_df[col].astype(str))
```

[13]:
```
hcc_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 24912 entries, 0 to 24911
Data columns (total 20 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   Agent ID              24912 non-null  object
 1   Agent Team            24912 non-null  object
 2   Date                  24912 non-null  datetime64[ns]
 3   Interval Start Time   24912 non-null  datetime64[ns]
 4   Interval End Time     24912 non-null  datetime64[ns]
 5   Total Logged In Time  24912 non-null  timedelta64[ns]
 6   Not Ready Time        24912 non-null  timedelta64[ns]
 7   Ready Time            24912 non-null  timedelta64[ns]
 8   Reserved Time         24912 non-null  timedelta64[ns]
 9   Talk Time             24912 non-null  timedelta64[ns]
 10  Next Call Prep Time   24912 non-null  timedelta64[ns]
 11  Break                 24912 non-null  timedelta64[ns]
 12  Lunch                 24912 non-null  timedelta64[ns]
 13  Team Support          24912 non-null  timedelta64[ns]
 14  Meeting               24912 non-null  timedelta64[ns]
 15  After Call Work       24912 non-null  timedelta64[ns]
 16  Special Projects      24912 non-null  timedelta64[ns]
 17  Training              24912 non-null  timedelta64[ns]
 18  System Issues         24912 non-null  timedelta64[ns]
 19  Other                 24912 non-null  timedelta64[ns]
dtypes: datetime64[ns](3), object(2), timedelta64[ns](15)
memory usage: 4.0+ MB
```

[14]:
```
hcc_df.head()
```

[14]:

	Agent ID	Agent Team	Date	Interval Start Time	Interval End Time	Total Logged In Time	Not Ready Time	Ready Time	Reserved Time
0	Agent 1	team_1	2022-08-01	2022-08-01 08:00:00	2022-08-01 08:30:00	0 days 00:27:02	0 days 00:03:26	0 days 00:00:07	0 days 00:00:22
1	Agent 1	team_1	2022-08-01	2022-08-01 08:30:00	2022-08-01 09:00:00	0 days 00:30:00	0 days 00:01:33	0 days 00:01:52	0 days 00:00:33
2	Agent 1	team_1	2022-08-01	2022-08-01 09:00:00	2022-08-01 09:30:00	0 days 00:30:00	0 days 00:04:16	0 days 00:00:00	0 days 00:00:37
3	Agent 1	team_1	2022-08-01	2022-08-01 09:30:00	2022-08-01 10:00:00	0 days 00:30:00	0 days 00:06:14	0 days 00:00:00	0 days 00:00:15
4	Agent 1	team_1	2022-08-01	2022-08-01 10:00:00	2022-08-01 10:30:00				

```
4      0 days 00:30:00 0 days 00:01:49 0 days 00:00:00 0 days 00:00:15

        Talk Time Next Call Prep Time           Break  Lunch Team Support  \
0 0 days 00:21:51     0 days 00:01:16 0 days 00:00:00 0 days       0 days
1 0 days 00:24:29     0 days 00:01:33 0 days 00:00:00 0 days       0 days
2 0 days 00:23:01     0 days 00:02:06 0 days 00:00:01 0 days       0 days
3 0 days 00:22:23     0 days 00:01:08 0 days 00:06:14 0 days       0 days
4 0 days 00:26:57     0 days 00:00:59 0 days 00:00:00 0 days       0 days

  Meeting After Call Work Special Projects Training System Issues  \
0  0 days 0 days 00:03:23           0 days   0 days        0 days
1  0 days 0 days 00:01:33           0 days   0 days        0 days
2  0 days 0 days 00:04:15           0 days   0 days        0 days
3  0 days 0 days 00:00:00           0 days   0 days        0 days
4  0 days 0 days 00:01:49           0 days   0 days        0 days

            Other
0 0 days 00:00:03
1 0 days 00:00:00
2 0 days 00:00:00
3 0 days 00:00:00
4 0 days 00:00:00
```

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1.1 2 - EDA:

Conduct exploratory (descriptive) data analysis and summarize key findings pertaining to HCC's current state.

- 2a. Overall
- 2b. By team
- 2c. By Agent
- 2d. Staffing Plan

a) Overall time estimation for all the activities:

[15]:
```
hcc_df.describe()
```

[15]:
```
            Total Logged In Time             Not Ready Time  \
count                      24912                      24912
mean   0 days 00:22:47.069845857  0 days 00:03:37.874638728
std    0 days 00:12:22.696562502  0 days 00:06:40.461289026
min              0 days 00:00:00            0 days 00:00:00
25%       0 days 00:21:51.750000            0 days 00:00:00
50%              0 days 00:30:00            0 days 00:00:11
```

```
75%              0 days 00:30:00            0 days 00:04:14
max              0 days 00:30:00            0 days 00:30:00

                     Ready Time              Reserved Time  \
count                     24912                      24912
mean   0 days 00:02:14.546202633  0 days 00:00:17.288334938
std    0 days 00:04:25.724780060  0 days 00:00:19.288031934
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 00:00:00            0 days 00:00:00
50%              0 days 00:00:05            0 days 00:00:15
75%       0 days 00:02:18.250000            0 days 00:00:27
max              0 days 00:30:00            0 days 00:14:26

                      Talk Time        Next Call Prep Time  \
count                     24912                      24912
mean   0 days 00:15:30.948859987  0 days 00:01:06.411809569
std    0 days 00:10:40.340246808  0 days 00:00:58.443825965
min              0 days 00:00:00            0 days 00:00:00
25%       0 days 00:01:49.750000            0 days 00:00:05
50%              0 days 00:19:09            0 days 00:01:00
75%              0 days 00:24:59            0 days 00:01:44
max              0 days 00:30:00            0 days 00:08:38

                          Break                      Lunch  \
count                     24912                      24912
mean   0 days 00:00:39.447736030  0 days 00:01:00.675417469
std    0 days 00:02:32.250826455  0 days 00:04:46.022551244
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 00:00:00            0 days 00:00:00
50%              0 days 00:00:00            0 days 00:00:00
75%              0 days 00:00:00            0 days 00:00:00
max              0 days 00:30:00            0 days 00:30:00

                    Team Support                    Meeting  \
count                     24912                      24912
mean   0 days 00:00:00.636159280  0 days 00:00:06.517501605
std    0 days 00:00:23.855751314  0 days 00:01:12.196593646
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 00:00:00            0 days 00:00:00
50%              0 days 00:00:00            0 days 00:00:00
75%              0 days 00:00:00            0 days 00:00:00
max              0 days 00:30:00            0 days 00:30:00

                 After Call Work           Special Projects  \
count                     24912                      24912
mean   0 days 00:01:02.020110789  0 days 00:00:06.772840398
std    0 days 00:02:14.947299607  0 days 00:01:15.055259239
```

```
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 00:00:00            0 days 00:00:00
50%              0 days 00:00:00            0 days 00:00:00
75%              0 days 00:01:00            0 days 00:00:00
max              0 days 00:29:33            0 days 00:30:00

                        Training              System Issues  \
count                      24912                      24912
mean   0 days 00:00:30.285444765  0 days 00:00:02.215237636
std    0 days 00:03:23.426900289  0 days 00:00:25.820708740
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 00:00:00            0 days 00:00:00
50%              0 days 00:00:00            0 days 00:00:00
75%              0 days 00:00:00            0 days 00:00:00
max              0 days 00:30:00            0 days 00:27:48

                           Other
count                      24912
mean   0 days 00:00:09.304190751
std    0 days 00:01:00.932564703
min              0 days 00:00:00
25%              0 days 00:00:00
50%              0 days 00:00:00
75%              0 days 00:00:00
max              0 days 00:30:00
```

[16]:
```
#Daily average Talk Time trend

daily_average_talk_time = hcc_df.groupby(hcc_df['Date'].dt.date)['Talk Time'].
 ↪mean().reset_index()
daily_average_talk_time['Talk Time'] = daily_average_talk_time['Talk Time'].dt.
 ↪total_seconds() / 60
```

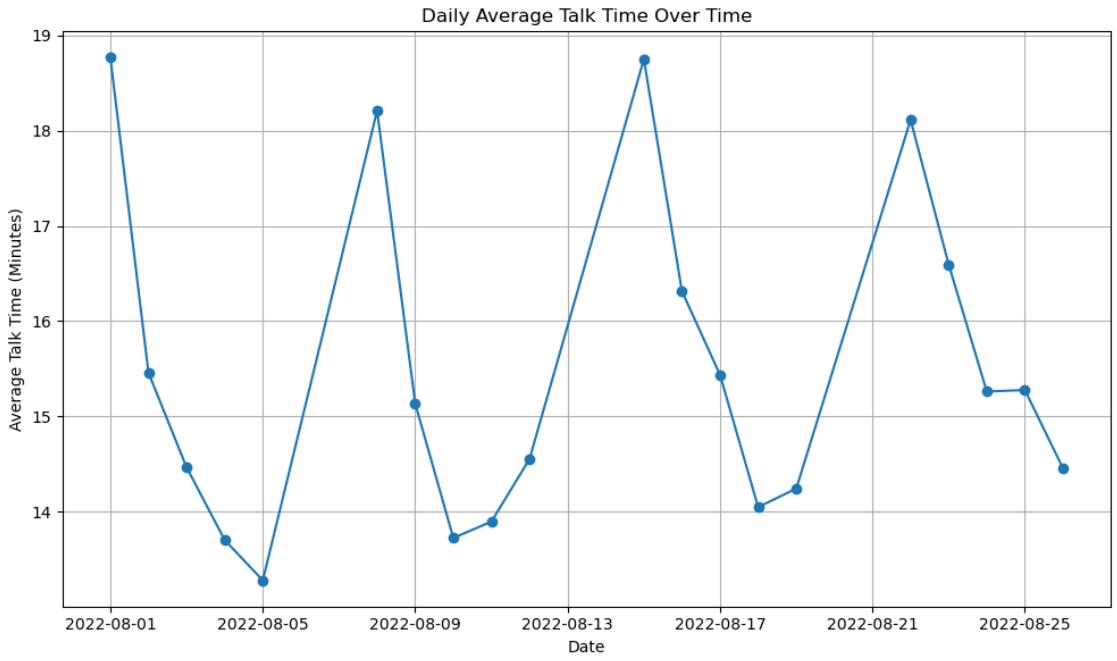
[17]:
```
# Rename the column
daily_average_talk_time.rename(columns={'Talk Time': 'Talk Time (Minutes)'},␣
 ↪inplace=True)
```

[18]:
```
# Convert the 'Date' column to datetime
daily_average_talk_time['Date'] = pd.
 ↪to_datetime(daily_average_talk_time['Date'])
daily_average_talk_time.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20 entries, 0 to 19
Data columns (total 2 columns):
 #   Column               Non-Null Count  Dtype
---  ------               --------------  -----
 0   Date                 20 non-null     datetime64[ns]
```

```
 1   Talk Time (Minutes)  20 non-null     float64
dtypes: datetime64[ns](1), float64(1)
memory usage: 448.0 bytes
```

[19]:
```
# Create a line plot
plt.figure(figsize=(10, 6))
plt.plot(daily_average_talk_time['Date'], daily_average_talk_time['Talk Time␣
 ↪(Minutes)'], marker='o', linestyle='-')
plt.xlabel('Date')
plt.ylabel('Average Talk Time (Minutes)')
plt.title('Daily Average Talk Time Over Time')
plt.grid(True)
plt.tight_layout()

# Show the plot
plt.show()
```



b) By team:

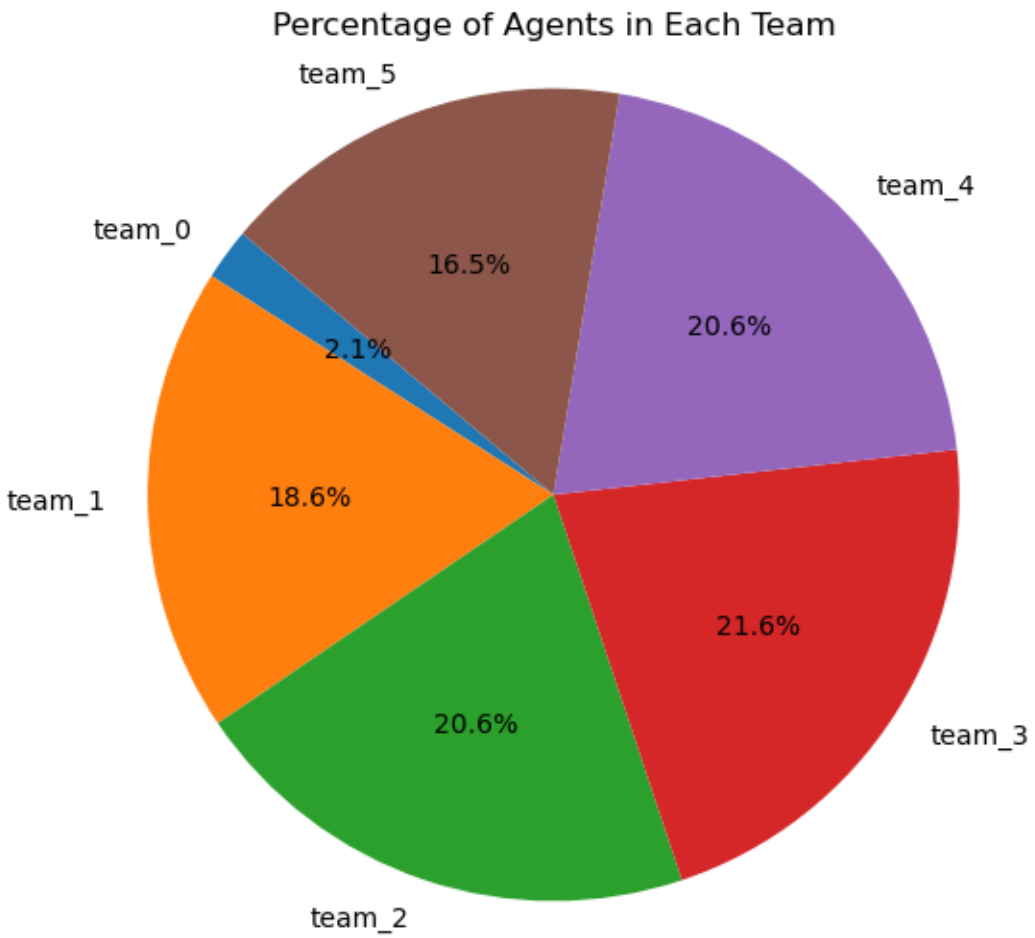
[20]:
```
team = sheet4.groupby(['Agent Team']).count().reset_index()

# Calculate the total count of agents in the dataset
total_agents = team["Agent ID"].sum()

# Calculate the percentage of each team
team["Percentage"] = (team["Agent ID"] / total_agents) * 100
```

```
team
```

[20]:

	Agent Team	Agent ID	Percentage
0	team_0	2	2.061856
1	team_1	18	18.556701
2	team_2	20	20.618557
3	team_3	21	21.649485
4	team_4	20	20.618557
5	team_5	16	16.494845

[21]:
```
# Create a pie chart
plt.figure(figsize=(6, 6))
plt.pie(team["Percentage"], labels=team["Agent Team"], autopct="%1.1f%%",␣
 ↪startangle=140)
plt.title("Percentage of Agents in Each Team")
plt.axis("equal")  # Equal aspect ratio ensures that pie is drawn as a circle.

# Show the pie chart
plt.show()
```



[22]:
```
team_sorted = hcc_df.groupby(['Agent Team'])[time_related_columns].sum().
↪reset_index()
team_sorted
```

[22]:

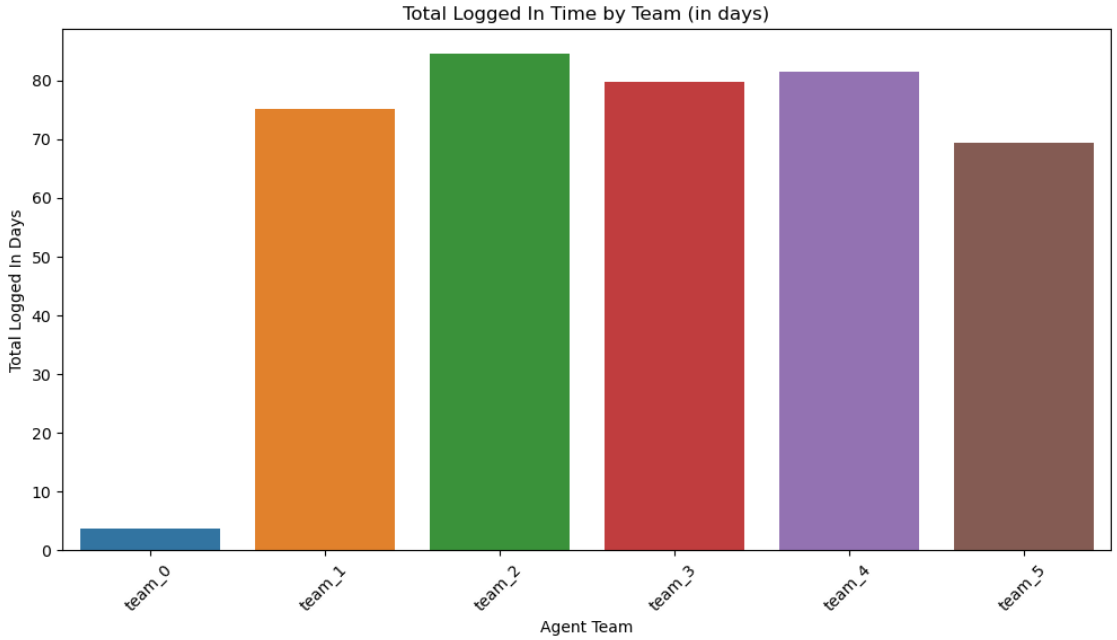
	Agent Team	Total Logged In Time	Not Ready Time	Ready Time	Reserved Time	Talk Time	Next Call Prep Time	Break	Lunch	Team Support	Meeting	After Call Work	Special Projects	Training	System Issues	Other
0	team_0	3 days 16:24:03	0 days 12:57:57	0 days 22:44:08	0 days 00:48:24	2 days 00:13:49	0 days 03:39:45	0 days 01:55:04	0 days 04:03:32	0 days 00:00:25	0 days 00:48:54	0 days 02:04:47	0 days 00:00:00	0 days 03:40:08	0 days 00:00:00	0 days 00:25:07
1	team_1	75 days 04:53:42	12 days 19:19:08	5 days 19:34:04	1 days 02:31:59	51 days 14:01:33	3 days 21:26:58	1 days 23:02:38	3 days 05:50:09	0 days 02:07:37	0 days 10:11:58	4 days 02:43:24	0 days 15:41:54	1 days 14:41:09	0 days 01:59:19	0 days 15:01:00
2	team_2	84 days 12:28:05	10 days 06:51:17	11 days 12:33:22	1 days 00:48:21	57 days 11:53:13	4 days 04:21:52	1 days 21:51:45	3 days 17:02:24	0 days 00:27:27	0 days 02:25:50	2 days 05:15:26	0 days 07:24:13	1 days 11:00:38	0 days 02:35:05	0 days 10:48:29
3	team_3	79 days 19:29:40	12 days 06:22:59	4 days 05:44:38	0 days 23:58:18	58 days 04:10:55	4 days 03:12:50	2 days 08:05:57	3 days 11:11:05	0 days 00:38:48	0 days 05:12:53	3 days 04:32:12	0 days 10:52:08	1 days 20:25:28	0 days 05:54:10	0 days 11:30:18
4	team_4	81 days 12:40:30	13 days 00:49:38	8 days 05:19:06	1 days 00:34:39	55 days 13:12:15	3 days 16:44:52	2 days 10:08:54	3 days 14:35:12	0 days 00:07:33	0 days 16:25:29	4 days 06:23:59	0 days 08:08:02	1 days 02:46:10	0 days 03:23:45	0 days 10:50:34
5	team_5	69 days 10:11:24	13 days 21:20:34	8 days 01:08:17	0 days 18:56:26	43 days 14:38:13	3 days 02:07:54	2 days 15:54:24	3 days 07:10:04	0 days 01:02:18	0 days 10:01:00	4 days 00:10:57	0 days 04:45:48	2 days 13:00:58	0 days 01:27:27	0 days 15:47:38

[23]:
```
time_columns = ['Total Logged In Time','Not Ready Time', 'Ready Time',␣
↪'Reserved Time', 'Talk Time', 'Next Call Prep Time', 'Break', 'Lunch',
                  'Team Support', 'Meeting', 'After Call Work', 'Special␣
↪Projects', 'Training', 'System Issues', 'Other']
```

[24]:
```
#By days
team_sorted2 = team_sorted.copy()
```

```
for col in time_columns:
    team_sorted2[col] = team_sorted2[col].dt.days + team_sorted2[col].dt.
 ↪seconds / (3600 * 24)
```

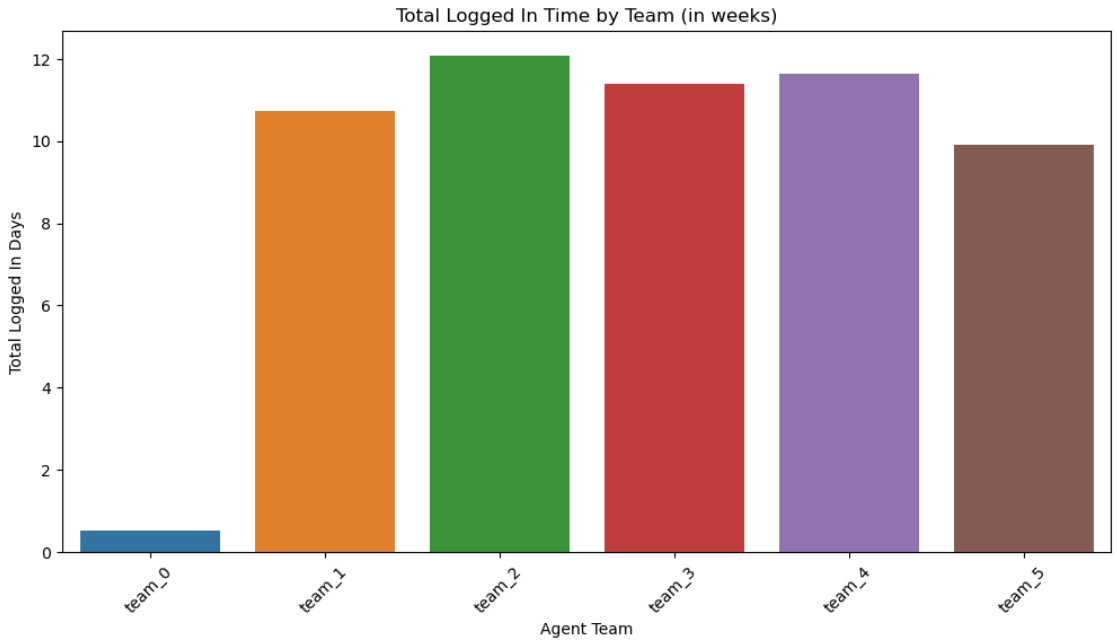
[25]:
```
# Create a bar plot of Total Logged In Time by Team in days
plt.figure(figsize=(12, 6))
sns.barplot(x='Agent Team', y='Total Logged In Time', data=team_sorted2)
plt.title('Total Logged In Time by Team (in days)')
plt.xlabel('Agent Team')
plt.ylabel('Total Logged In Days')
plt.xticks(rotation=45)
plt.show()
```



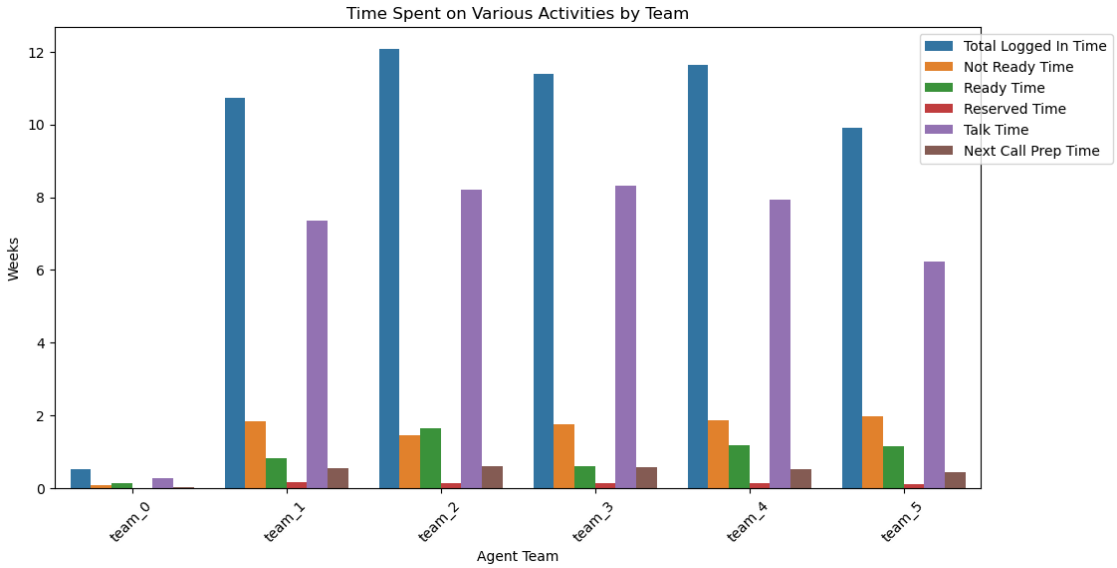
[26]:
```
#By weeks
team_sorted3 = team_sorted2.copy()

for col in time_columns:
    team_sorted3[col] = team_sorted3[col] / 7
```

[27]:
```
# Create a bar plot of Total Logged In Time by Team in weeks
plt.figure(figsize=(12, 6))
sns.barplot(x='Agent Team', y='Total Logged In Time', data=team_sorted3)
plt.title('Total Logged In Time by Team (in weeks)')
plt.xlabel('Agent Team')
plt.ylabel('Total Logged In Days')
plt.xticks(rotation=45)
```

```
plt.show()
```



[28]:
```
overall_activity = ['Total Logged In Time','Not Ready Time', 'Ready Time',␣
 ↪'Reserved Time', 'Talk Time', 'Next Call Prep Time']

# Create a stacked bar plot of various activities by Team
stacked_data = team_sorted3[['Agent Team'] + overall_activity].
 ↪melt(id_vars='Agent Team', var_name='Activity', value_name='Time (Days)')

#Plotting
plt.figure(figsize=(12, 6))
sns.barplot(x='Agent Team', y='Time (Days)', hue='Activity', data=stacked_data)
plt.title('Time Spent on Various Activities by Team')
plt.xlabel('Agent Team')
plt.ylabel('Weeks')
plt.xticks(rotation=45)
plt.legend(loc='upper right', bbox_to_anchor=(1.15, 1))
plt.show()
```



What percentage of logged-in time on average did teams spend on each task per time interval (on daily/weekly basis)?

[29]:
```
# Calculate the percentage of time spent on each task
team_sorted22 = team_sorted2.iloc[:,:7].copy()

activity_columns = team_sorted22.columns[2:]  # Exclude 'Agent Team' and 'Total␣
↪Logged In Time'
for activity in activity_columns:
    team_sorted22[activity] = (team_sorted22[activity] / team_sorted22['Total␣
↪Logged In Time']) * 100

# Rename the column
team_sorted22 = team_sorted22.drop(['Total Logged In Time'], axis = 1)

# Display the result
team_sorted22.reset_index()
```

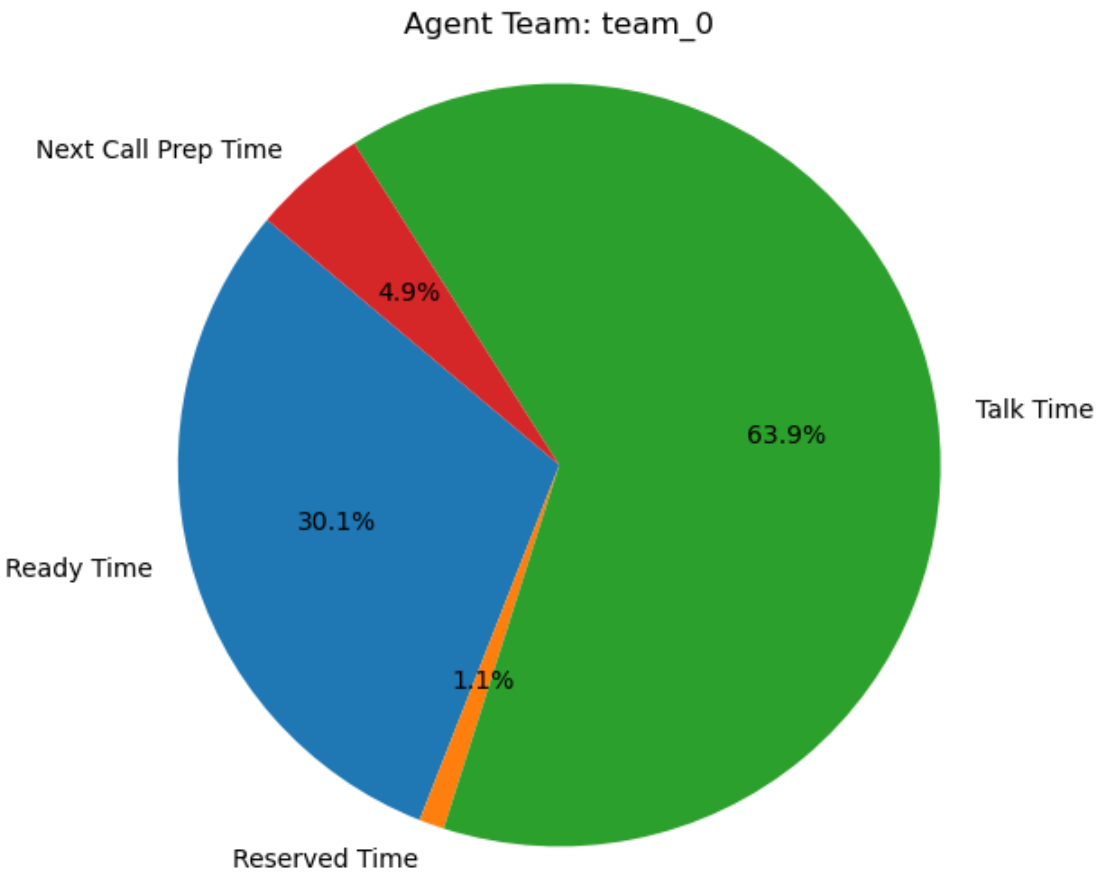
[29]:

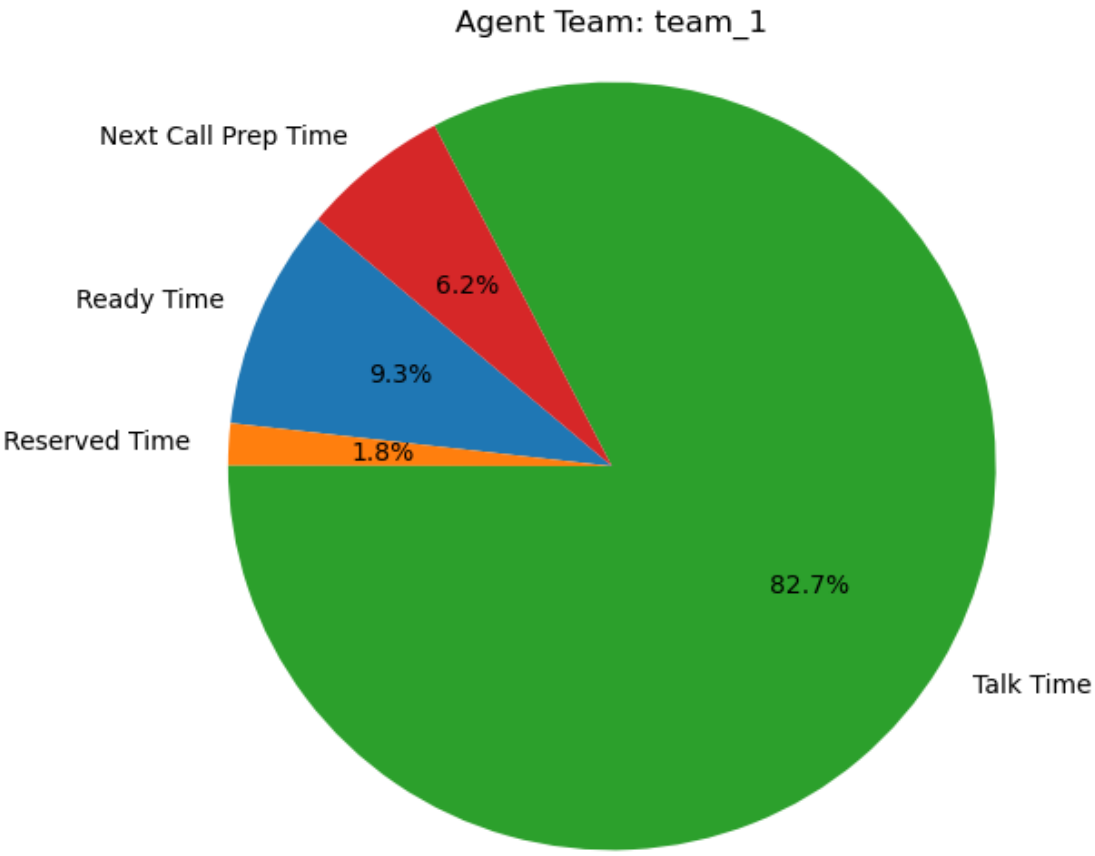
	index	Agent Team	Not Ready Time	Ready Time	Reserved Time	Talk Time	\
0	0	team_0	14.667094	25.718712	0.912510	54.558623	
1	1	team_1	17.026968	7.732737	1.470061	68.592679	
2	2	team_2	12.169515	13.633742	1.222885	68.026062	
3	3	team_3	15.368515	5.311625	1.251461	72.888854	
4	4	team_4	15.987695	10.084369	1.256085	68.136209	
5	5	team_5	20.006288	11.591599	1.136758	62.816182	

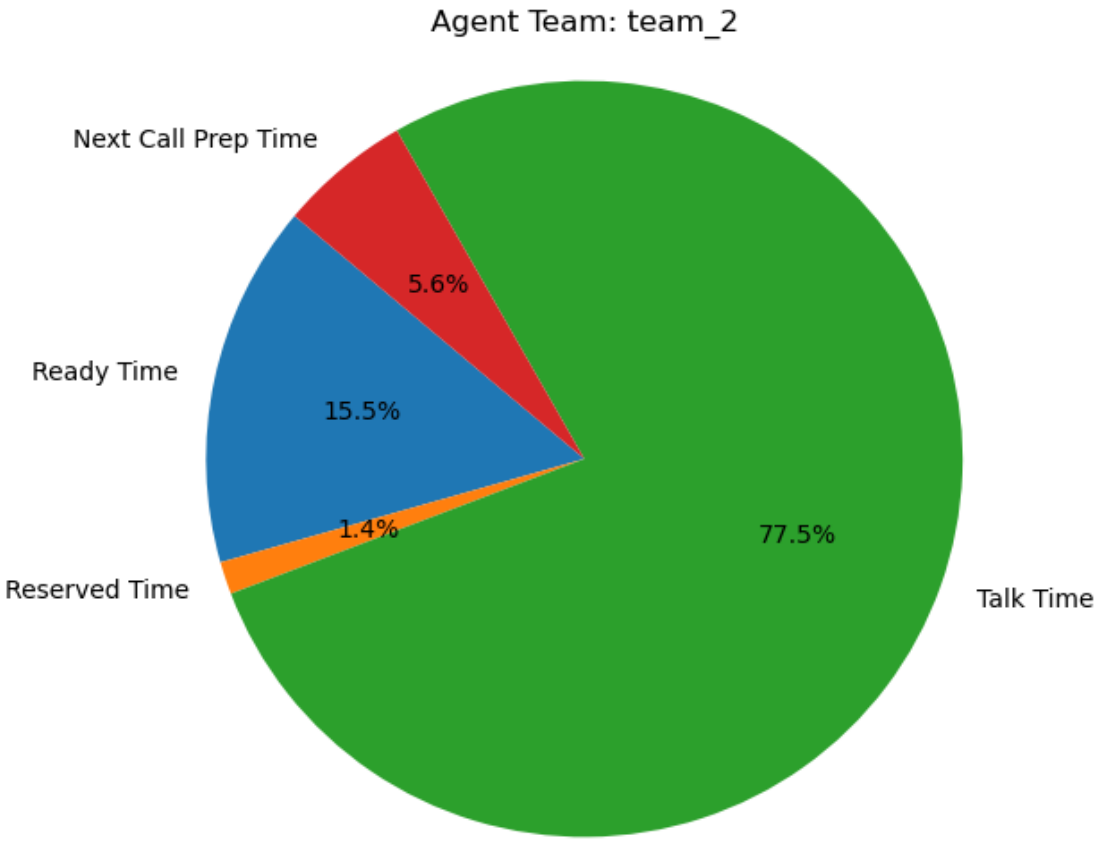
	Next Call Prep Time
0	4.143060

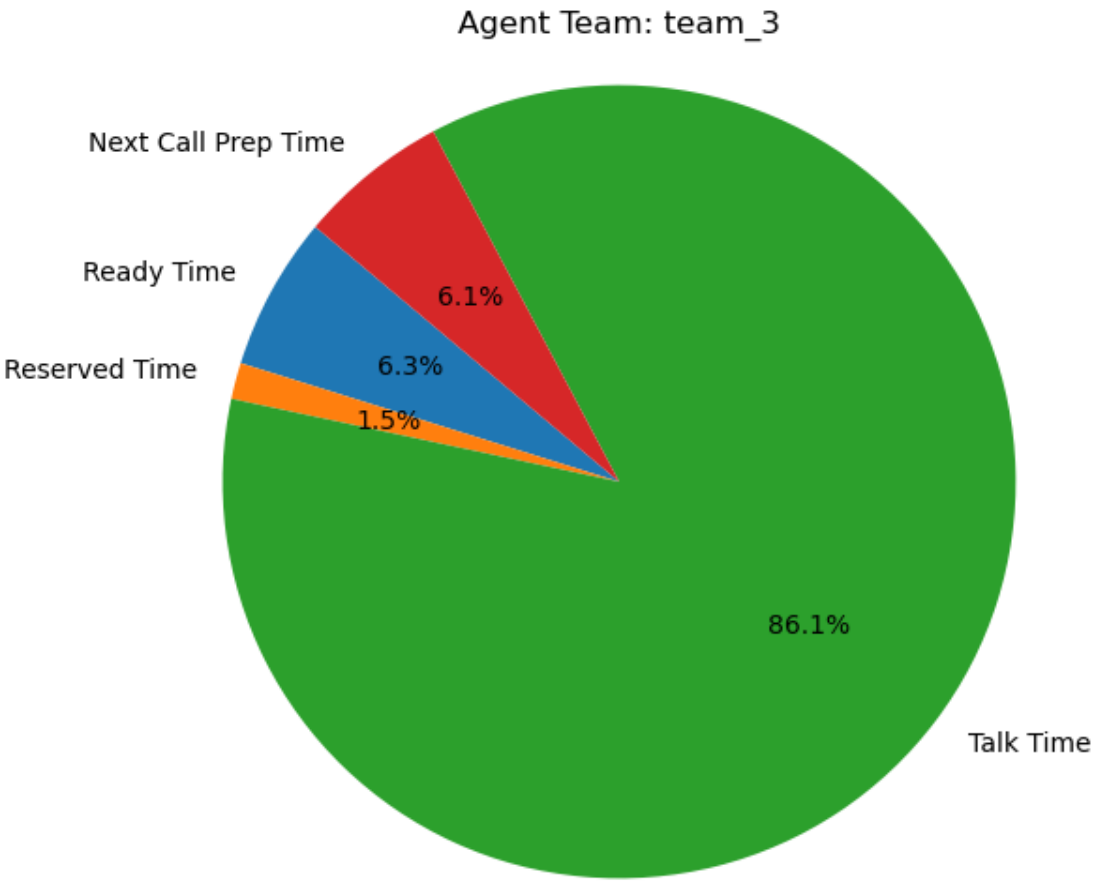
```
1              5.177556
2              4.947795
3              5.179545
4              4.535642
5              4.449172
```

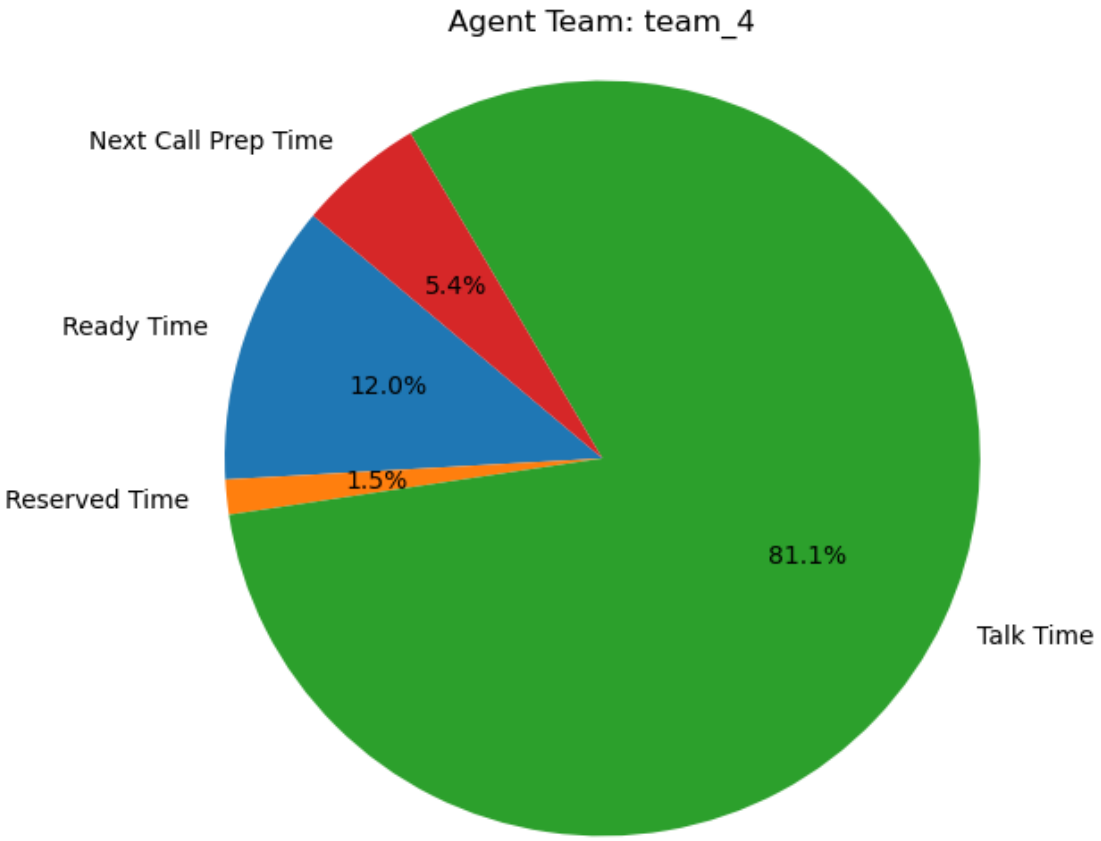
[30]:
```python
# Group the data by 'Agent Team' and sum the time spent in each activity
team_activity_totals = team_sorted22.groupby('Agent Team').sum()

# List of activities (excluding 'Agent Team' column)
activities = team_activity_totals.columns[1:]

# Create a pie chart for each agent team
for team in team_activity_totals.index:
    team_data = team_activity_totals.loc[team, activities]
    plt.figure(figsize=(6, 6))
    plt.pie(team_data, labels=activities, autopct='%1.1f%%', startangle=140)
    plt.title(f'Agent Team: {team}')
    plt.axis('equal')
    plt.show()
```

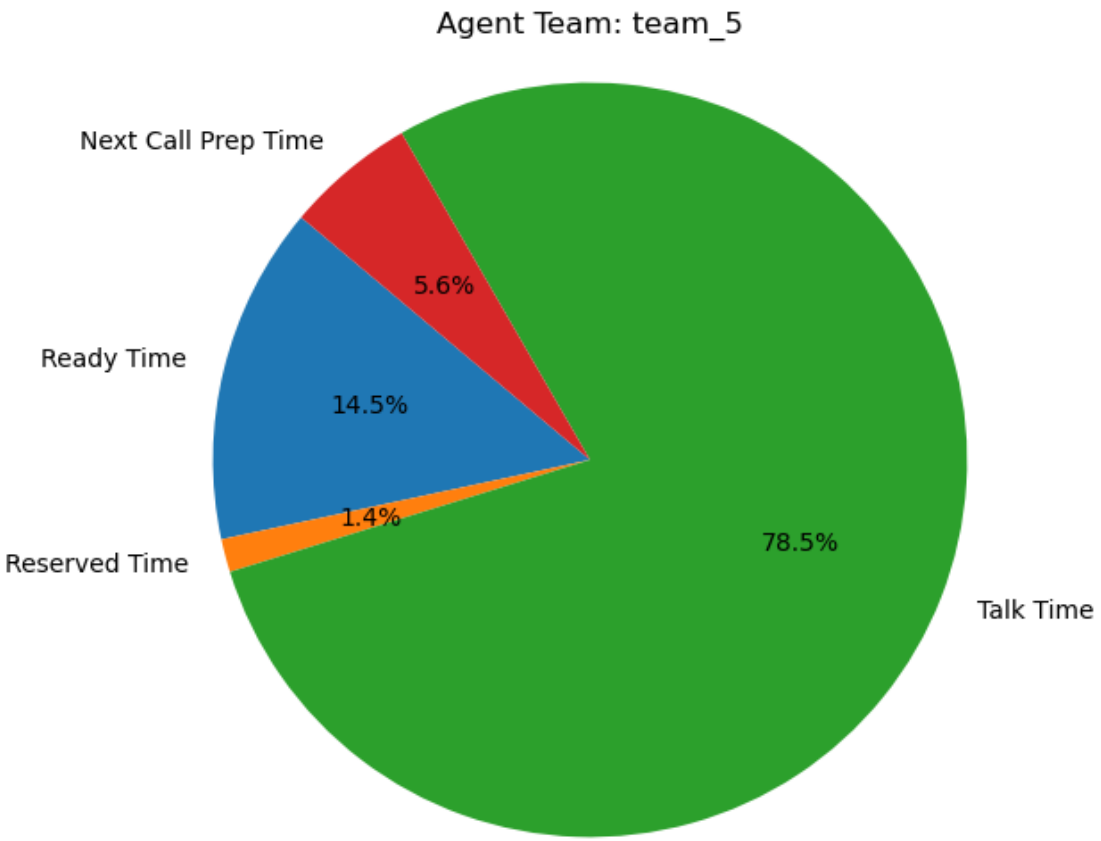



Agent Team: team_1
Next Call Prep Time
6.2%
Ready Time
9.3%
Reserved Time
1.8%
82.7%
Talk Time


Agent Team: team_2
Next Call Prep Time
5.6%
Ready Time
15.5%
Reserved Time
1.4%
77.5%
Talk Time


Agent Team: team_3
Next Call Prep Time
Ready Time
Reserved Time
6.1%
6.3%
1.5%
86.1%
Talk Time


Agent Team: team_4
Next Call Prep Time
5.4%
Ready Time
12.0%
Reserved Time
1.5%
81.1%
Talk Time



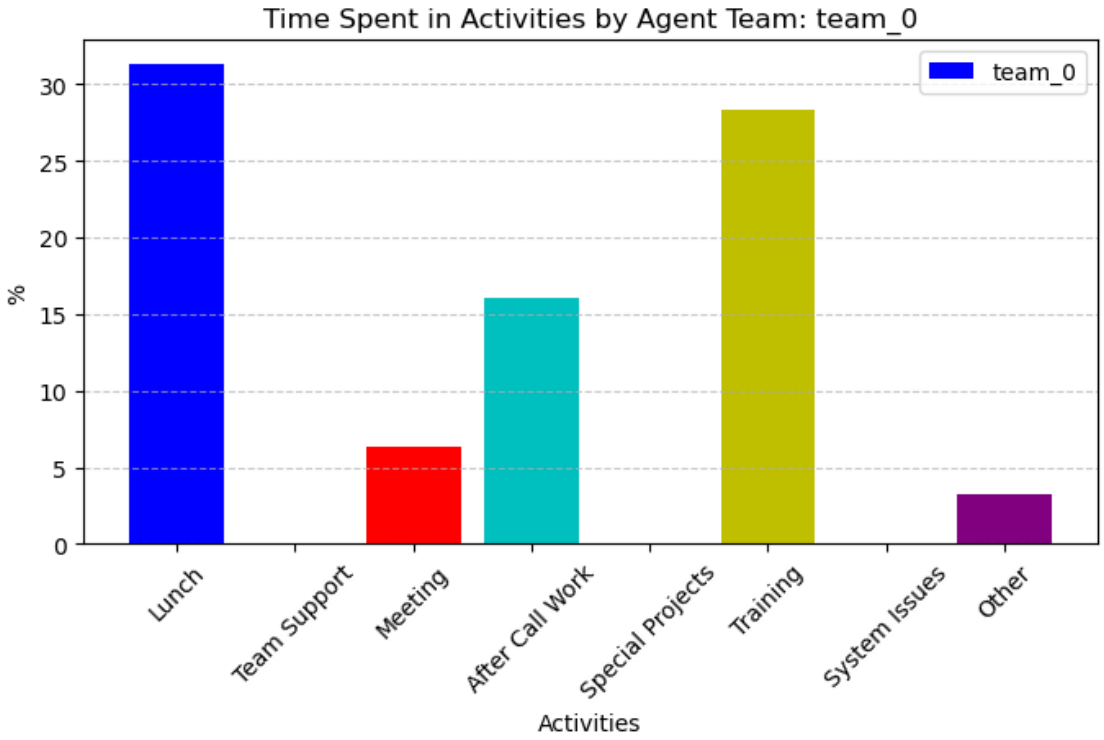
[31]:
```
# Specify the column names to copy
columns_to_copy = ["Agent Team"] + ["Not Ready Time"] + list(team_sorted2.
 ↪columns[-9:])

# Create a new DataFrame with the selected columns
team_sorted23 = team_sorted2[columns_to_copy].copy()

# Exclude 'Agent Team' and 'Not Ready Time'
activity_columns2 = team_sorted23.columns[2:]
for activity in activity_columns2:
    team_sorted23[activity] = (team_sorted23[activity] / team_sorted23['Not␣
 ↪Ready Time']) * 100

# Rename the column
team_sorted23 = team_sorted23.drop(['Not Ready Time'], axis = 1)

# Display the result
team_sorted23.reset_index()
```

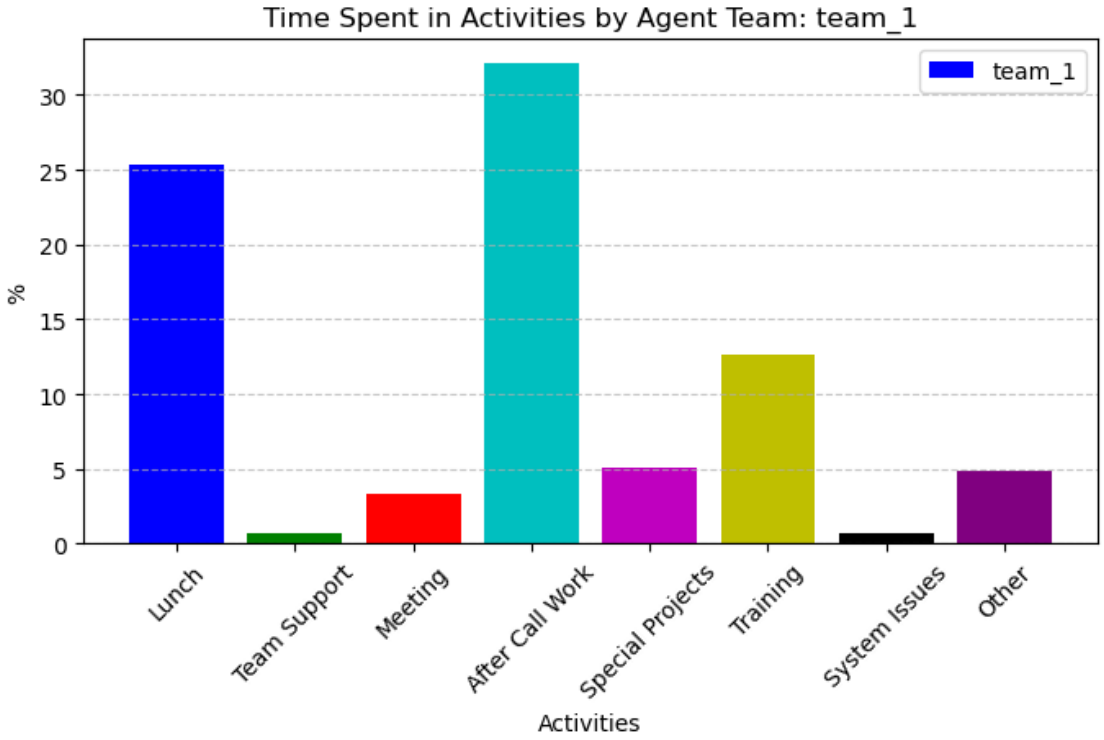
[31]:

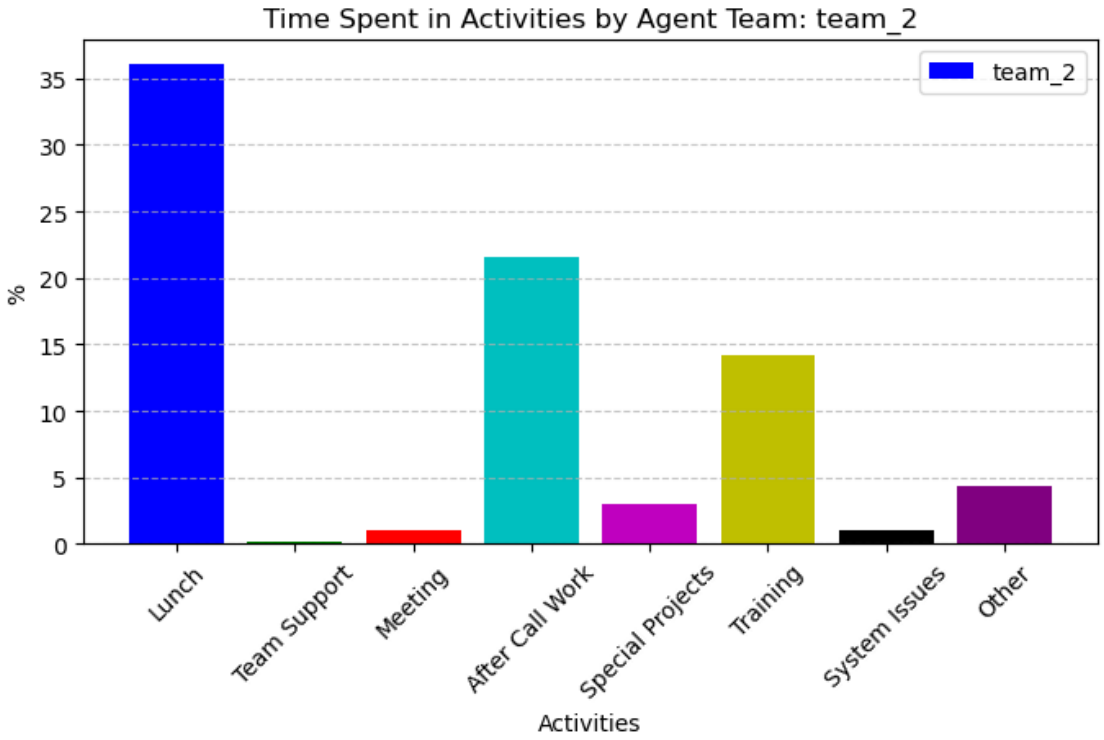
	index	Agent Team	Break	Lunch	Team Support	Meeting	\
0	0	team_0	14.791011	31.304497	0.053560	6.285751	
1	1	team_1	15.307842	25.327383	0.692097	3.318847	
2	2	team_2	18.578741	36.069798	0.185332	0.984610	
3	3	team_3	19.056520	28.257306	0.219668	1.771407	
4	4	team_4	18.588003	27.678751	0.040225	5.250413	
5	5	team_5	19.171457	23.749660	0.311491	3.004915	

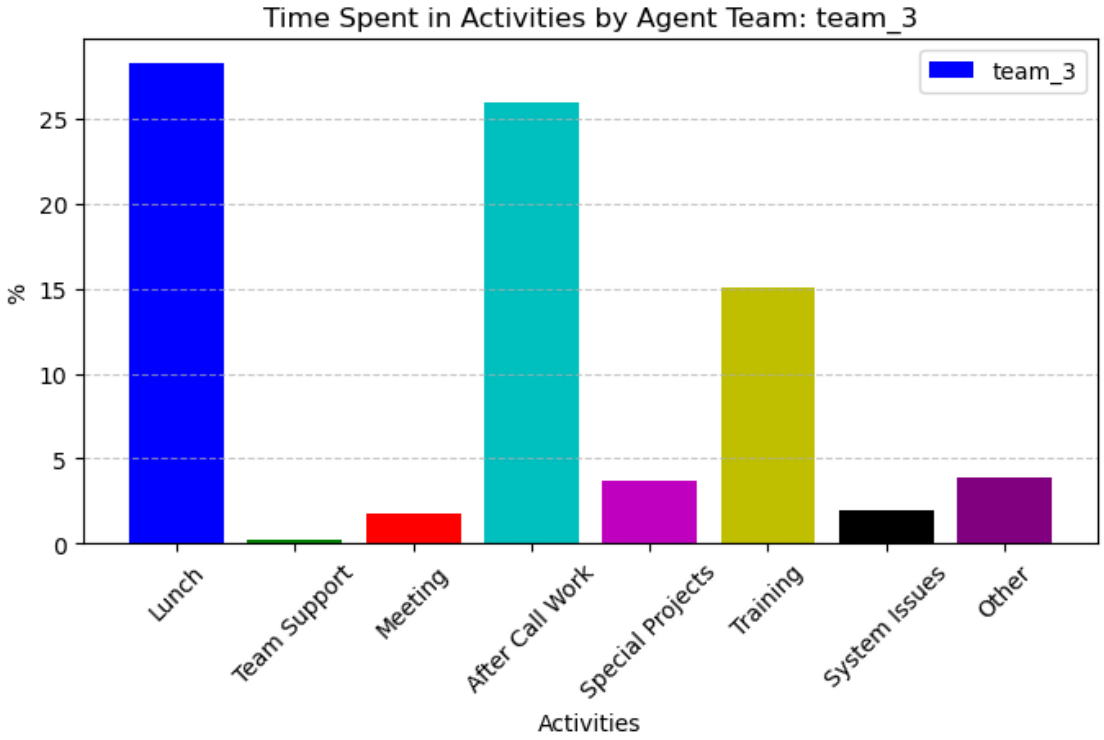
	After Call Work	Special Projects	Training	System Issues	Other
0	16.040020	0.000000	28.296591	0.000000	3.228571
1	32.124069	5.108158	12.588173	0.647084	4.886347
2	21.574318	2.999177	14.182656	1.047062	4.378306
3	25.999005	3.692091	15.090693	2.005135	3.908173
4	32.733635	2.600122	8.557262	1.085530	3.466060
5	28.853932	1.428960	18.304315	0.437238	4.738032

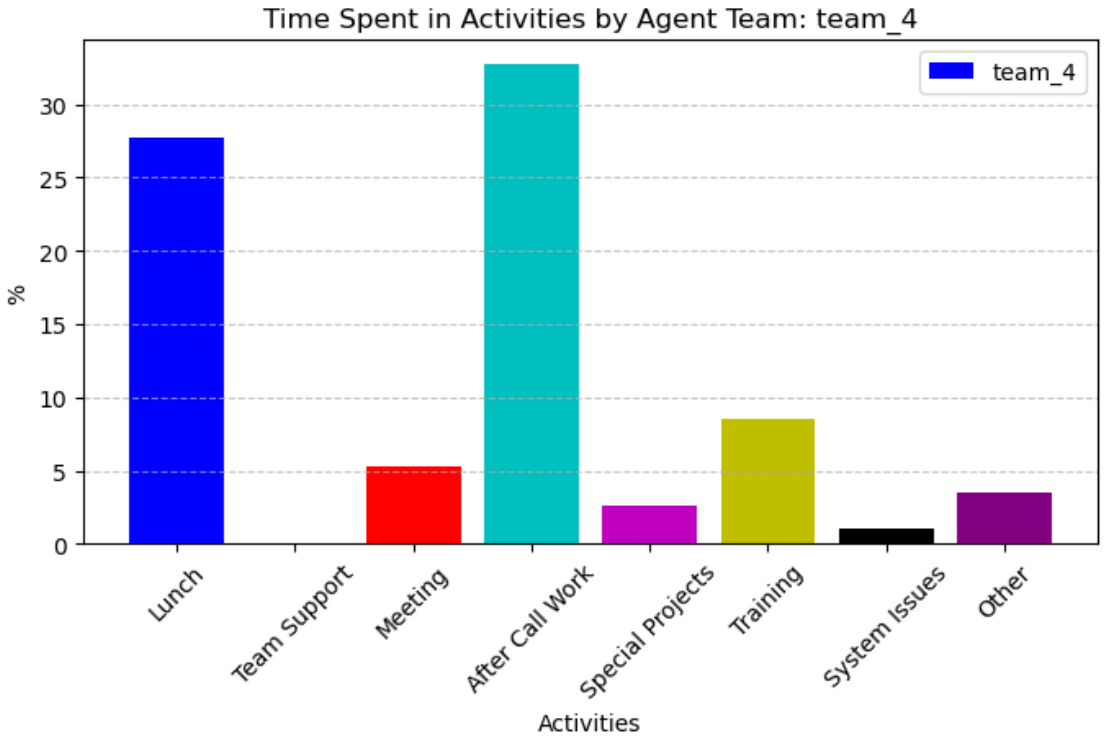
[32]:
```
# Group the data by 'Agent Team' and sum the time spent in each activity
team_activity_totals2 = team_sorted23.groupby('Agent Team').sum()

# List of activities (excluding 'Agent Team' column)
activities2 = team_activity_totals2.columns[1:]


# Create a bar chart for each agent team with customizations
for team in team_activity_totals2.index:
    team_data2 = team_activity_totals2.loc[team, activities2]
    plt.figure(figsize=(8, 4))

    # Set custom colors for bars
    colors = ['b', 'g', 'r', 'c', 'm', 'y', 'k', 'purple', 'orange']

    plt.bar(activities2, team_data2, label=team, color=colors)
    plt.title(f'Time Spent in Activities by Agent Team: {team}')
    plt.xlabel('Activities')
    plt.ylabel('%')
    plt.legend()

    # Customize gridlines
    plt.grid(axis='y', linestyle='--', alpha=0.7)

    plt.xticks(rotation=45)
    plt.show()
```

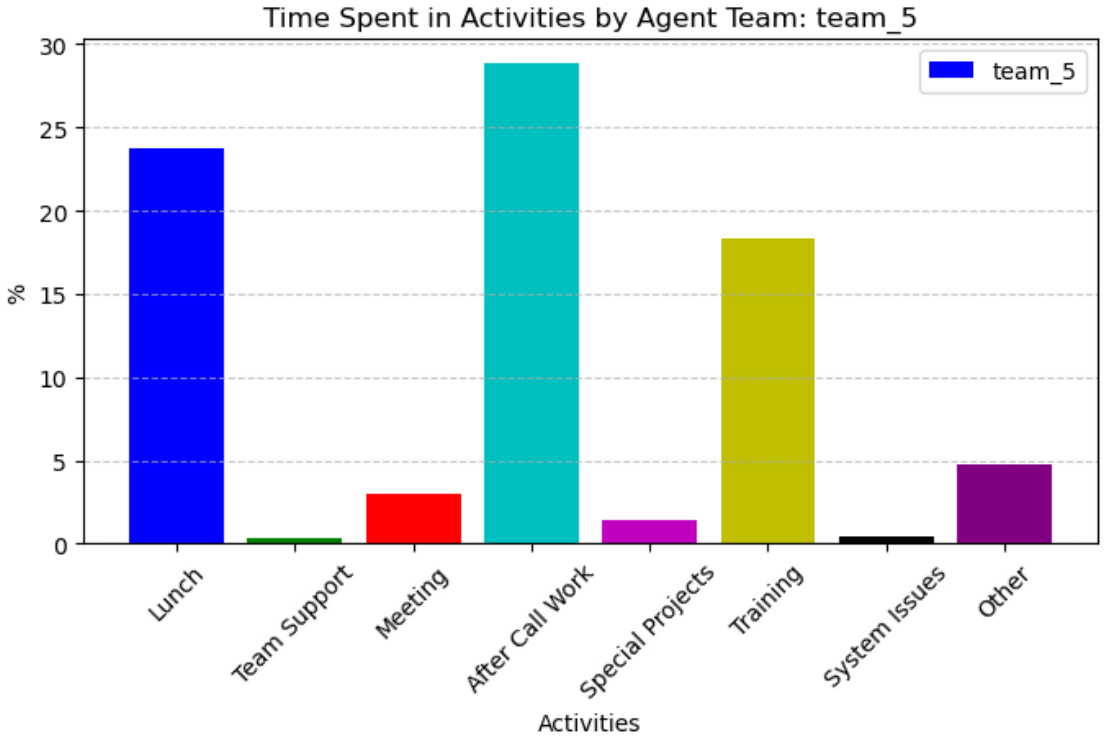

Time Spent in Activities by Agent Team: team_0
team_0
%
30
25
20
15
10
5
0
Lunch
Team Support
Meeting
After Call Work
Special Projects
Training
System Issues
Other
Activities


Time Spent in Activities by Agent Team: team_1
team_1
%
30
25
20
15
10
5
0
Lunch
Team Support
Meeting
After Call Work
Special Projects
Training
System Issues
Other
Activities


Time Spent in Activities by Agent Team: team_2
team_2
%
0
5
10
15
20
25
30
35
Lunch
Team Support
Meeting
After Call Work
Special Projects
Training
System Issues
Other
Activities


Time Spent in Activities by Agent Team: team_3
team_3
%
0
5
10
15
20
25
Lunch
Team Support
Meeting
After Call Work
Special Projects
Training
System Issues
Other
Activities


Time Spent in Activities by Agent Team: team_4
team_4
%
0
5
10
15
20
25
30
Lunch
Team Support
Meeting
After Call Work
Special Projects
Training
System Issues
Other
Activities


Time Spent in Activities by Agent Team: team_5
team_5
%
0
5
10
15
20
25
30
Lunch
Team Support
Meeting
After Call Work
Special Projects
Training
System Issues
Other
Activities

What is agents/teams utilization rate (on daily basis)? How about non-utilized time?

[33]:
```
copied_df = hcc_df.copy()

for col in time_related_columns:
    copied_df[col] = copied_df[col].dt.total_seconds() / (3600 * 24)

copied_df
```

[33]:

	Agent ID	Agent Team	Date	Interval Start Time	Interval End Time	Total Logged In Time	Not Ready Time	Ready Time	Reserved Time	Talk Time	Next Call Prep Time	Break	Lunch	Team Support	Meeting
0	Agent 1	team_1	2022-08-01	2022-08-01 08:00:00	2022-08-01 08:30:00	0.018773	0.002384	0.000081	0.000255	0.015174	0.000880	0.000000	0.0	0.0	0.0
1	Agent 1	team_1	2022-08-01	2022-08-01 08:30:00	2022-08-01 09:00:00	0.020833	0.001076	0.001296	0.000382	0.017002	0.001076	0.000000	0.0	0.0	0.0
2	Agent 1	team_1	2022-08-01	2022-08-01 09:00:00	2022-08-01 09:30:00	0.020833	0.002963	0.000000	0.000428	0.015984	0.001458	0.000012	0.0	0.0	0.0
3	Agent 1	team_1	2022-08-01	2022-08-01 09:30:00	2022-08-01 10:00:00	0.020833	0.004329	0.000000	0.000174	0.015544	0.000787	0.004329	0.0	0.0	0.0
4	Agent 1	team_1	2022-08-01	2022-08-01 10:00:00	2022-08-01 10:30:00	0.020833	0.001262	0.000000	0.000174	0.018715	0.000683	0.000000	0.0	0.0	0.0
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
24907	Agent 97	team_3	2022-08-26	2022-08-26 14:30:00	2022-08-26 15:00:00	0.020833	0.000000	0.002859	0.000255	0.016563	0.001157	0.000000	0.0	0.0	0.0
24908	Agent 97	team_3	2022-08-26	2022-08-26 15:00:00	2022-08-26 15:30:00	0.020833	0.000000	0.010127	0.000231	0.009780	0.000694	0.000000	0.0	0.0	0.0
24909	Agent 97	team_3	2022-08-26	2022-08-26 15:30:00	2022-08-26 16:00:00	0.020833	0.003113	0.013252	0.000104	0.003669	0.000694	0.003113	0.0	0.0	0.0
24910	Agent 97	team_3	2022-08-26	2022-08-26 16:00:00	2022-08-26 16:30:00	0.020833	0.000000	0.004641	0.000150	0.015579	0.000463	0.000000	0.0	0.0	0.0
24911	Agent 97	team_3	2022-08-26	2022-08-26 16:30:00	2022-08-26 17:00:00	0.001366	0.000127	0.000000	0.000000	0.001157	0.000081	0.000000	0.0	0.0	0.0

```
       After Call Work  Special Projects  Training  System Issues     Other
0             0.002350               0.0  0.000000            0.0  0.000035
1             0.001076               0.0  0.000000            0.0  0.000000
2             0.002951               0.0  0.000000            0.0  0.000000
3             0.000000               0.0  0.000000            0.0  0.000000
4             0.001262               0.0  0.000000            0.0  0.000000
…                  …                 …         …              …         …
24907         0.000000               0.0  0.000000            0.0  0.000000
24908         0.000000               0.0  0.000000            0.0  0.000000
24909         0.000000               0.0  0.000000            0.0  0.000000
24910         0.000000               0.0  0.000000            0.0  0.000000
24911         0.000000               0.0  0.000127            0.0  0.000000

[24912 rows x 20 columns]
```

[34]:
```python
# Group data by day and calculate metrics
daily_metrics = copied_df.resample('D', on='Date').agg({
    'Agent ID': 'nunique',
    'Agent Team': 'nunique',
    'Total Logged In Time': 'sum',
    'Talk Time': 'sum',
    'Reserved Time': 'sum',
    'Ready Time': 'sum',
    'Not Ready Time': 'sum'
    # Count unique agents per day
}).reset_index()
```

[35]:
```python
daily_metrics
```

[35]:
```
         Date  Agent ID  Agent Team  Total Logged In Time  Talk Time  \
0  2022-08-01        72           6             22.497778  16.891944
1  2022-08-02        70           6             18.478287  13.524988
2  2022-08-03        76           6             21.292801  13.740868
3  2022-08-04        73           6             19.299444  12.501030
4  2022-08-05        65           6             17.548275  10.786806
5  2022-08-06         0           0              0.000000   0.000000
6  2022-08-07         0           0              0.000000   0.000000
7  2022-08-08        76           6             25.178576  17.300139
8  2022-08-09        74           6             21.129942  13.998750
9  2022-08-10        74           6             20.431238  12.692361
10 2022-08-11        70           6             18.688819  12.156539
11 2022-08-12        60           5             16.096632  10.913530
12 2022-08-13         0           0              0.000000   0.000000
13 2022-08-14         0           0              0.000000   0.000000
14 2022-08-15        66           6             20.715914  15.470359
15 2022-08-16        67           6             19.318831  13.662639
```

```
16 2022-08-17        67           6              18.630799  12.926655
17 2022-08-18        71           6              19.512106  12.465220
18 2022-08-19        63           6              17.587118  11.214699
19 2022-08-20         0           0               0.000000   0.000000
20 2022-08-21         0           0               0.000000   0.000000
21 2022-08-22        77           5              25.329861  17.434664
22 2022-08-23        70           5              20.517870  14.519931
23 2022-08-24        69           5              18.978657  13.161956
24 2022-08-25        64           5              17.072141  12.220648
25 2022-08-26        60           5              15.866713  10.839861
```

	Reserved Time	Ready Time	Not Ready Time
0	0.266319	0.638623	3.631736
1	0.259549	1.044062	2.724259
2	0.276806	2.852882	3.432037
3	0.248403	2.086516	3.550139
4	0.211725	2.886794	2.861366
5	0.000000	0.000000	0.000000
6	0.000000	0.000000	0.000000
7	0.302558	2.840532	3.557419
8	0.270428	2.601551	3.217431
9	0.262870	2.879653	3.633553
10	0.224375	2.393310	3.045046
11	0.200440	1.614734	2.574722
12	0.000000	0.000000	0.000000
13	0.000000	0.000000	0.000000
14	0.254618	0.877454	3.094780
15	0.255833	1.322859	3.104005
16	0.244352	1.701910	2.826736
17	0.239815	2.568322	3.325787
18	0.218519	2.565370	2.779502
19	0.000000	0.000000	0.000000
20	0.000000	0.000000	0.000000
21	0.336597	2.388032	3.897743
22	0.263889	1.293368	3.374757
23	0.247176	1.527650	3.043877
24	0.209502	1.155058	2.637894
25	0.191030	1.555475	2.507731

[36]:
```python
# Define a function to calculate utilization rate
def calculate_utilization_rate(copied_df):
    utilization_time = copied_df['Ready Time'] + copied_df['Talk Time'] +␣
 ↪copied_df['Reserved Time']
    utilization_rate = utilization_time / copied_df['Total Logged In Time']
    return utilization_rate

# Define a function to calculate non-utilized time
```

```
def calculate_non_utilized_rate(copied_df):
    non_utilized_rate = copied_df['Not Ready Time'] / copied_df['Total Logged␣
 ↪In Time']
    return non_utilized_rate

# Calculate utilization rate and non-utilized time
daily_metrics['Utilization Rate'] = calculate_utilization_rate(daily_metrics)
daily_metrics['Non-Utilized Rate'] = calculate_non_utilized_rate(daily_metrics)

# Print the weekly metrics
daily_metrics.reset_index()
```

[36]:

	index	Date	Agent ID	Agent Team	Total Logged In Time	Talk Time	\
0	0	2022-08-01	72	6	22.497778	16.891944	
1	1	2022-08-02	70	6	18.478287	13.524988	
2	2	2022-08-03	76	6	21.292801	13.740868	
3	3	2022-08-04	73	6	19.299444	12.501030	
4	4	2022-08-05	65	6	17.548275	10.786806	
5	5	2022-08-06	0	0	0.000000	0.000000	
6	6	2022-08-07	0	0	0.000000	0.000000	
7	7	2022-08-08	76	6	25.178576	17.300139	
8	8	2022-08-09	74	6	21.129942	13.998750	
9	9	2022-08-10	74	6	20.431238	12.692361	
10	10	2022-08-11	70	6	18.688819	12.156539	
11	11	2022-08-12	60	5	16.096632	10.913530	
12	12	2022-08-13	0	0	0.000000	0.000000	
13	13	2022-08-14	0	0	0.000000	0.000000	
14	14	2022-08-15	66	6	20.715914	15.470359	
15	15	2022-08-16	67	6	19.318831	13.662639	
16	16	2022-08-17	67	6	18.630799	12.926655	
17	17	2022-08-18	71	6	19.512106	12.465220	
18	18	2022-08-19	63	6	17.587118	11.214699	
19	19	2022-08-20	0	0	0.000000	0.000000	
20	20	2022-08-21	0	0	0.000000	0.000000	
21	21	2022-08-22	77	5	25.329861	17.434664	
22	22	2022-08-23	70	5	20.517870	14.519931	
23	23	2022-08-24	69	5	18.978657	13.161956	
24	24	2022-08-25	64	5	17.072141	12.220648	
25	25	2022-08-26	60	5	15.866713	10.839861	

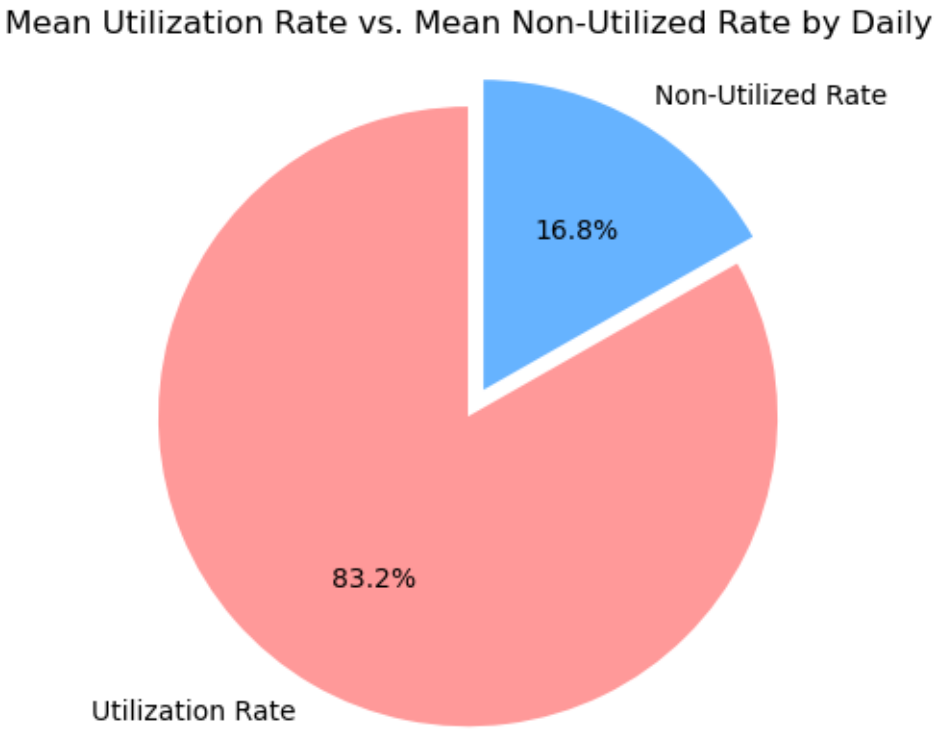
	Reserved Time	Ready Time	Not Ready Time	Utilization Rate	\
0	0.266319	0.638623	3.631736	0.791051	
1	0.259549	1.044062	2.724259	0.802488	
2	0.276806	2.852882	3.432037	0.792313	
3	0.248403	2.086516	3.550139	0.768724	
4	0.211725	2.886794	2.861366	0.791264	
5	0.000000	0.000000	0.000000	NaN	

6	0.000000	0.000000	0.000000	NaN
7	0.302558	2.840532	3.557419	0.811930
8	0.270428	2.601551	3.217431	0.798428
9	0.262870	2.879653	3.633553	0.775033
10	0.224375	2.393310	3.045046	0.790538
11	0.200440	1.614734	2.574722	0.790768
12	0.000000	0.000000	0.000000	NaN
13	0.000000	0.000000	0.000000	NaN
14	0.254618	0.877454	3.094780	0.801434
15	0.255833	1.322859	3.104005	0.788937
16	0.244352	1.701910	2.826736	0.798297
17	0.239815	2.568322	3.325787	0.782763
18	0.218519	2.565370	2.779502	0.795957
19	0.000000	0.000000	0.000000	NaN
20	0.000000	0.000000	0.000000	NaN
21	0.336597	2.388032	3.897743	0.795871
22	0.263889	1.293368	3.374757	0.783570
23	0.247176	1.527650	3.043877	0.787031
24	0.209502	1.155058	2.637894	0.795753
25	0.191030	1.555475	2.507731	0.793256

	Non-Utilized Rate
0	0.161426
1	0.147430
2	0.161183
3	0.183950
4	0.163057
5	NaN
6	NaN
7	0.141288
8	0.152269
9	0.177843
10	0.162934
11	0.159954
12	NaN
13	NaN
14	0.149391
15	0.160672
16	0.151724
17	0.170447
18	0.158042
19	NaN
20	NaN
21	0.153879
22	0.164479
23	0.160384
24	0.154515

```
25              0.158050
```

[37]:
```
# Calculate the mean utilization rate and non-utilization rate
mean_utilization_rate = daily_metrics['Utilization Rate'].mean()
mean_non_utilization_rate = daily_metrics['Non-Utilized Rate'].mean()

# Create a pie chart
labels = ['Utilization Rate', 'Non-Utilized Rate']
sizes = [mean_utilization_rate, mean_non_utilization_rate]
colors = ['#ff9999', '#66b3ff']
explode = (0.1, 0)

plt.pie(sizes, labels=labels, colors=colors, autopct='%1.1f%%', startangle=90,␣
↪explode=explode)
plt.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a circle.

# Display the pie chart
plt.title('Mean Utilization Rate vs. Mean Non-Utilized Rate by Daily')
plt.show()
```



What is agents/teams utilization rate (on weekly basis)? How about non-utilized time?

[38]:
```
# Group data by week and calculate metrics
weekly_metrics = copied_df.resample('W', on='Date').agg({
    'Agent ID': 'nunique',
    'Agent Team': 'nunique',
    'Total Logged In Time': 'sum',
    'Talk Time': 'sum',
    'Reserved Time': 'sum',
    'Ready Time': 'sum',
    'Not Ready Time': 'sum'
    # Count unique agents per week
}).reset_index()
```

[39]:
```
# Calculate utilization rate and non-utilized time
weekly_metrics['Utilization Rate'] = calculate_utilization_rate(weekly_metrics)
weekly_metrics['Non-Utilized Rate'] =␣
 ↪calculate_non_utilized_rate(weekly_metrics)

weekly_metrics.rename(columns={'Date': 'Week'}, inplace=True)

# Print the weekly metrics
weekly_metrics.reset_index()
```

[39]:

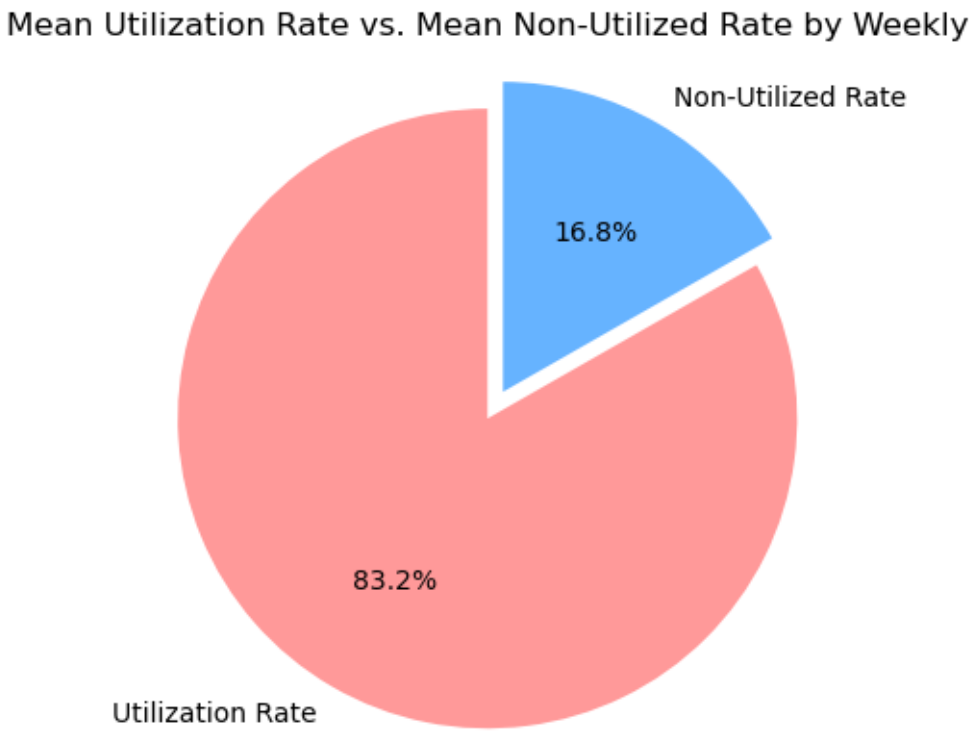
	index	Week	Agent ID	Agent Team	Total Logged In Time	Talk Time	\
0	0	2022-08-07	90	6	99.116586	67.445637	
1	1	2022-08-14	87	6	101.525208	67.061319	
2	2	2022-08-21	89	6	95.764769	65.739572	
3	3	2022-08-28	88	5	97.765243	68.177060	

	Reserved Time	Ready Time	Not Ready Time	Utilization Rate	\
0	1.262801	9.508877	16.199537	0.789145	
1	1.260671	12.329780	16.028171	0.794401	
2	1.213137	9.035914	15.130810	0.793492	
3	1.248194	7.919583	15.462002	0.791128	

	Non-Utilized Rate
0	0.163439
1	0.157874
2	0.158000
3	0.158154

[40]:
```
# Calculate the mean utilization rate and non-utilization rate
mean_utilization_rate2 = weekly_metrics['Utilization Rate'].mean()
mean_non_utilization_rate2 = weekly_metrics['Non-Utilized Rate'].mean()

# Create a pie chart
labels = ['Utilization Rate', 'Non-Utilized Rate']
sizes = [mean_utilization_rate2, mean_non_utilization_rate2]
```

```
colors = ['#ff9999', '#66b3ff']
explode = (0.1, 0)

plt.pie(sizes, labels=labels, colors=colors, autopct='%1.1f%%', startangle=90,␣
↪explode=explode)
plt.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a circle.

# Display the pie chart
plt.title('Mean Utilization Rate vs. Mean Non-Utilized Rate by Weekly')
plt.show()
```

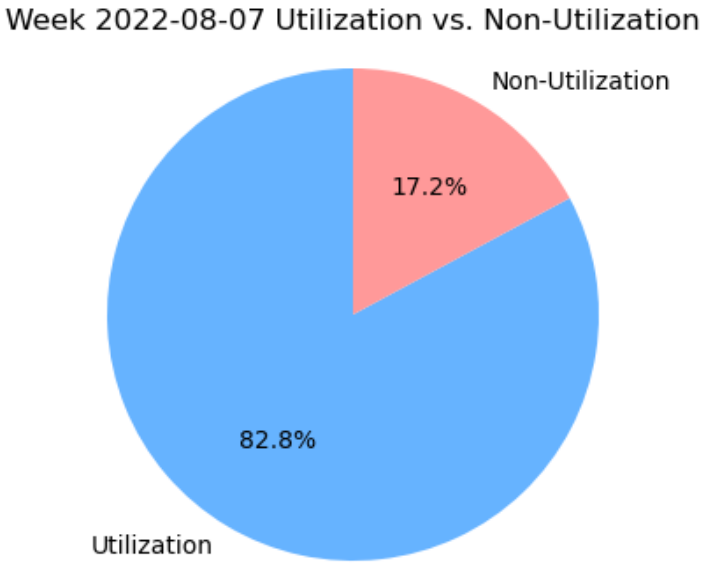


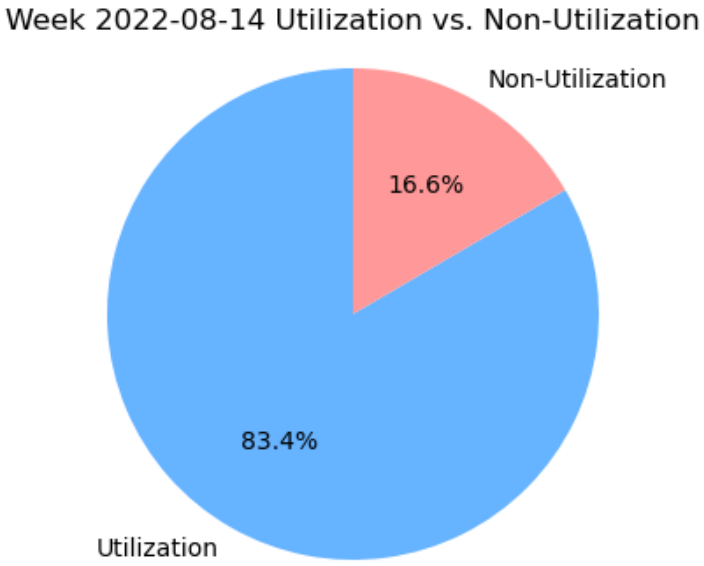
[41]:
```
weekly_metrics.info()
```

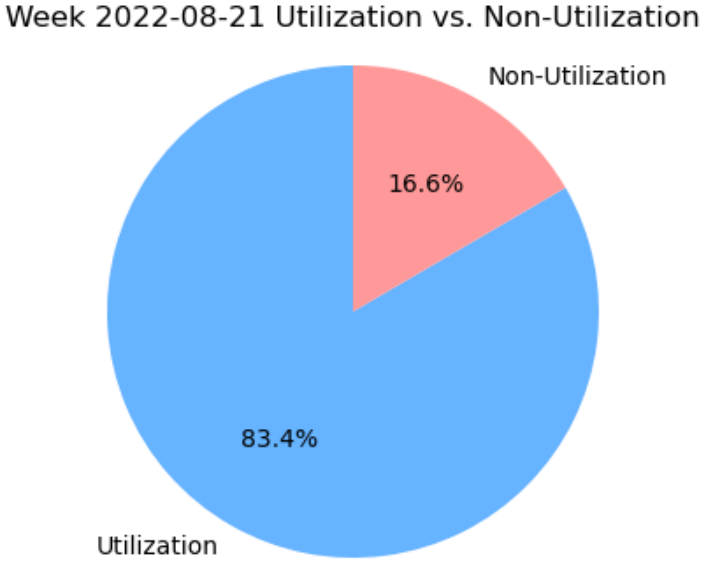
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4 entries, 0 to 3
Data columns (total 10 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   Week                  4 non-null      datetime64[ns]
 1   Agent ID              4 non-null      int64
 2   Agent Team            4 non-null      int64
 3   Total Logged In Time  4 non-null      float64
```

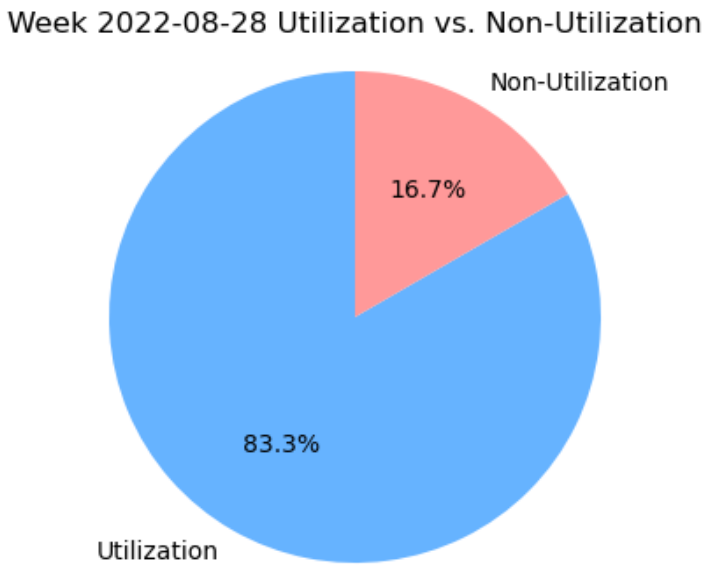
```
 4   Talk Time             4 non-null      float64
 5   Reserved Time         4 non-null      float64
 6   Ready Time            4 non-null      float64
 7   Not Ready Time        4 non-null      float64
 8   Utilization Rate      4 non-null      float64
 9   Non-Utilized Rate     4 non-null      float64
dtypes: datetime64[ns](1), float64(7), int64(2)
memory usage: 448.0 bytes
```

[42]:
```
# Extract the relevant data for visualization
weeks = weekly_metrics['Week'].tolist()
utilization_rates = weekly_metrics['Utilization Rate'].tolist()
non_utilization_rates = weekly_metrics['Non-Utilized Rate'].tolist()

# Create pie charts for each week
for week, utilization_rate, non_utilization_rate in zip(weeks,␣
↪utilization_rates, non_utilization_rates):
    plt.figure(figsize=(8, 4))
    labels = ['Utilization', 'Non-Utilization']
    sizes = [utilization_rate, non_utilization_rate]
    colors = ['#66b3ff', '#ff9999']  # Blue for utilization, red for␣
↪non-utilization
    plt.pie(sizes, labels=labels, colors=colors, autopct='%1.1f%%',␣
↪startangle=90)
    plt.title(f'Week {week.strftime("%Y-%m-%d")} Utilization vs.␣
↪Non-Utilization')
    plt.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a␣
↪circle
    plt.show()
```




Week 2022-08-14 Utilization vs. Non-Utilization
Non-Utilization
16.6%
83.4%
Utilization

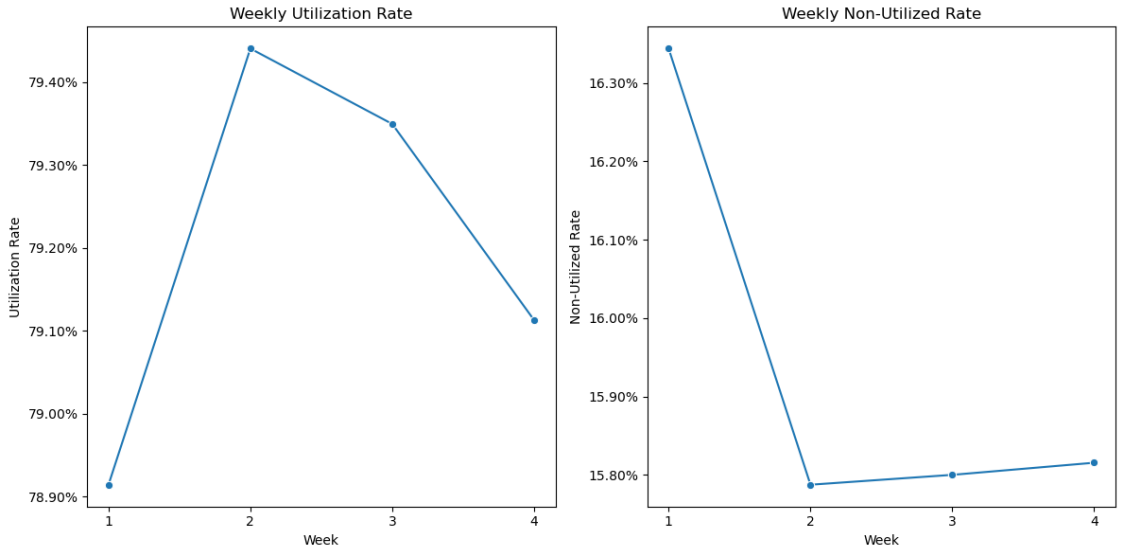

Week 2022-08-21 Utilization vs. Non-Utilization
Non-Utilization
16.6%
83.4%
Utilization



[43]:
```
weekly_metrics2 = weekly_metrics.copy()

# Initialize a counter
counter = 1

# Create a dictionary to store the mapping of old values to new values
week_mapping = {}

# Iterate through the unique values in the 'Week' column
for week in weekly_metrics2['Week'].unique():
    week_mapping[week] = str(counter)
    counter += 1

# Replace the values in the 'Week' column using the mapping
weekly_metrics2['Week'] = weekly_metrics2['Week'].map(week_mapping)
```

[44]:
```
import matplotlib.ticker as mtick  # Import the necessary module for formatting␣
 ↪y-axis as percentages

plt.figure(figsize=(12, 6))

plt.subplot(1, 2, 1)
sns.lineplot(x='Week', y='Utilization Rate', data=weekly_metrics2, marker='o')
plt.title("Weekly Utilization Rate")
plt.xlabel("Week")
plt.ylabel("Utilization Rate")
```

```
plt.gca().yaxis.set_major_formatter(mtick.PercentFormatter(1.0))  # Format␣
 ↪y-axis as percentages

plt.subplot(1, 2, 2)
sns.lineplot(x='Week', y='Non-Utilized Rate', data=weekly_metrics2, marker='o')
plt.title("Weekly Non-Utilized Rate")
plt.xlabel("Week")
plt.ylabel("Non-Utilized Rate")
plt.gca().yaxis.set_major_formatter(mtick.PercentFormatter(1.0))  # Format␣
 ↪y-axis as percentages

plt.tight_layout()
plt.show()
```



[45]:
```
# Calculate the number of FTEs (assuming a 40-hour workweek)
weekly_metrics2['FTEs'] = (weekly_metrics2['Utilization Rate'] * 40) / (60 * 5)␣
 ↪ # 60 minutes per hour, 5 workdays per week

# Print the weekly metrics
weekly_metrics2.reset_index()
```

[45]:

	index	Week	Agent ID	Agent Team	Total Logged In Time	Talk Time	\
0	0	1	90	6	99.116586	67.445637	
1	1	2	87	6	101.525208	67.061319	
2	2	3	89	6	95.764769	65.739572	
3	3	4	88	5	97.765243	68.177060	

	Reserved Time	Ready Time	Not Ready Time	Utilization Rate	\

```
0       1.262801    9.508877       16.199537          0.789145
1       1.260671   12.329780       16.028171          0.794401
2       1.213137    9.035914       15.130810          0.793492
3       1.248194    7.919583       15.462002          0.791128

   Non-Utilized Rate      FTEs
0           0.163439  0.105219
1           0.157874  0.105920
2           0.158000  0.105799
3           0.158154  0.105484
```

[46]:
```
# Group data by team and calculate average talk time per call
team_avg_talk_time = hcc_df.groupby('Agent Team')['Talk Time'].mean()
highest_avg_talk_time_team = team_avg_talk_time.idxmax()
lowest_avg_talk_time_team = team_avg_talk_time.idxmin()
```

[47]:
```
highest_avg_talk_time_team
```

[47]:
```
'team_3'
```

[48]:
```
lowest_avg_talk_time_team
```

[48]:
```
'team_0'
```

How does the number of handled calls vary by specialty (Agent Team) on a weekly basis?

[49]:
```
# Merge sheet3 with merged_df on 'Agent ID' and 'Date'
hcc_df2 = pd.merge(sheet3, sheet4, on=['Agent ID'])
hcc_df2.info()
```

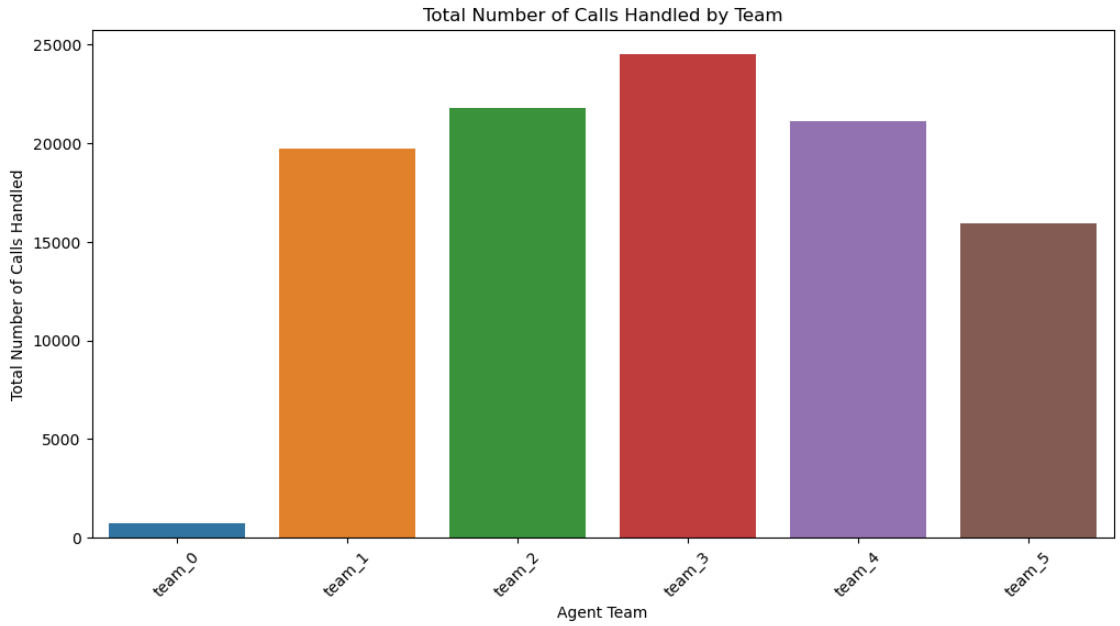
```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1919 entries, 0 to 1918
Data columns (total 5 columns):
 #   Column                   Non-Null Count  Dtype
---  ------                   --------------  -----
 0   Agent ID                 1919 non-null   object
 1   Date                     1919 non-null   datetime64[ns]
 2   Number of Calls Handled  1919 non-null   int64
 3   Average Handle Time      1919 non-null   object
 4   Agent Team               1919 non-null   object
dtypes: datetime64[ns](1), int64(1), object(3)
memory usage: 90.0+ KB
```

[50]:
```
# Group data by team and date, then calculate the number of handled calls
team_handled_calls = hcc_df2.groupby(['Agent Team'])['Number of Calls Handled'].
 ↪sum().reset_index()
team_handled_calls
```

[50]:

	Agent Team	Number of Calls Handled
0	team_0	740
1	team_1	19704
2	team_2	21788
3	team_3	24515
4	team_4	21118
5	team_5	15919

[51]:
```
# Create a bar plot of Total Logged In Time by Team in days
plt.figure(figsize=(12, 6))
sns.barplot(x='Agent Team', y='Number of Calls Handled',␣
 ↪data=team_handled_calls)
plt.title('Total Number of Calls Handled by Team')
plt.xlabel('Agent Team')
plt.ylabel('Total Number of Calls Handled')
plt.xticks(rotation=45)
plt.show()
```



[52]:
```
# Group by 'Agent Team' and the week of the 'Date'
team_weekly_handled_calls = hcc_df2.groupby(['Agent Team', hcc_df2['Date'].dt.
 ↪strftime('%U-%Y')])['Number of Calls Handled'].sum().reset_index()

# Rename the columns for clarity
team_weekly_handled_calls.columns = ['Agent Team', 'Week', 'Total Calls␣
 ↪Handled']
```

```
# Sort the data by 'Agent Team' and 'Week'
team_weekly_handled_calls = team_weekly_handled_calls.sort_values(by=['Agent␣
 ↪Team', 'Week'])

# Remove the first character from the 'Week' column
team_weekly_handled_calls['Week'] = team_weekly_handled_calls['Week'].str[1:]

team_weekly_handled_calls.reset_index()
```

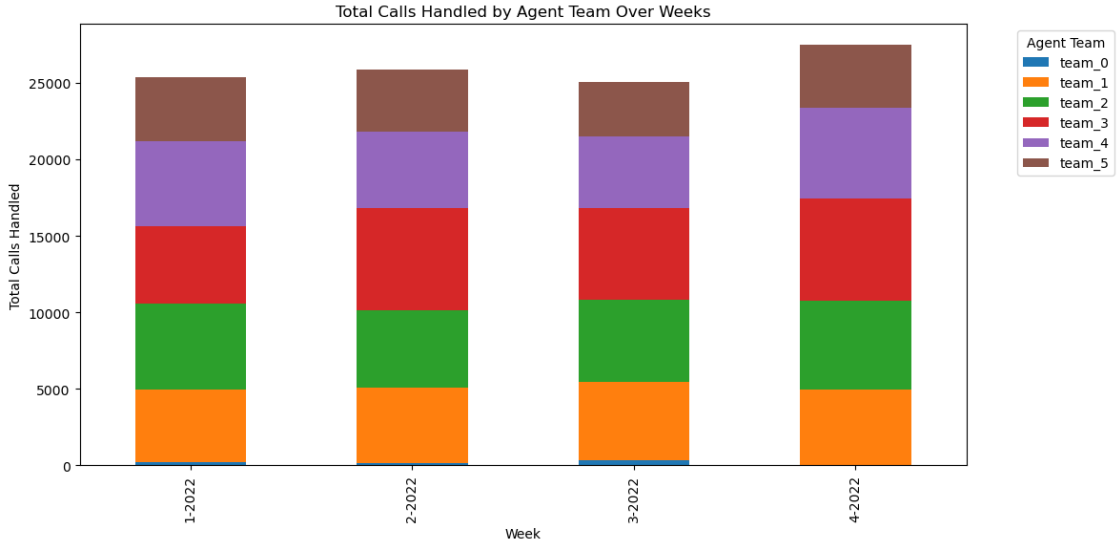
[52]:

	index	Agent Team	Week	Total Calls Handled
0	0	team_0	1-2022	217
1	1	team_0	2-2022	168
2	2	team_0	3-2022	355
3	3	team_0	4-2022	0
4	4	team_1	1-2022	4742
5	5	team_1	2-2022	4889
6	6	team_1	3-2022	5113
7	7	team_1	4-2022	4960
8	8	team_2	1-2022	5592
9	9	team_2	2-2022	5064
10	10	team_2	3-2022	5356
11	11	team_2	4-2022	5776
12	12	team_3	1-2022	5091
13	13	team_3	2-2022	6687
14	14	team_3	3-2022	6021
15	15	team_3	4-2022	6716
16	16	team_4	1-2022	5549
17	17	team_4	2-2022	4989
18	18	team_4	3-2022	4642
19	19	team_4	4-2022	5938
20	20	team_5	1-2022	4212
21	21	team_5	2-2022	4088
22	22	team_5	3-2022	3544
23	23	team_5	4-2022	4075

[53]:
```
team_weekly_handled_calls.info()
```

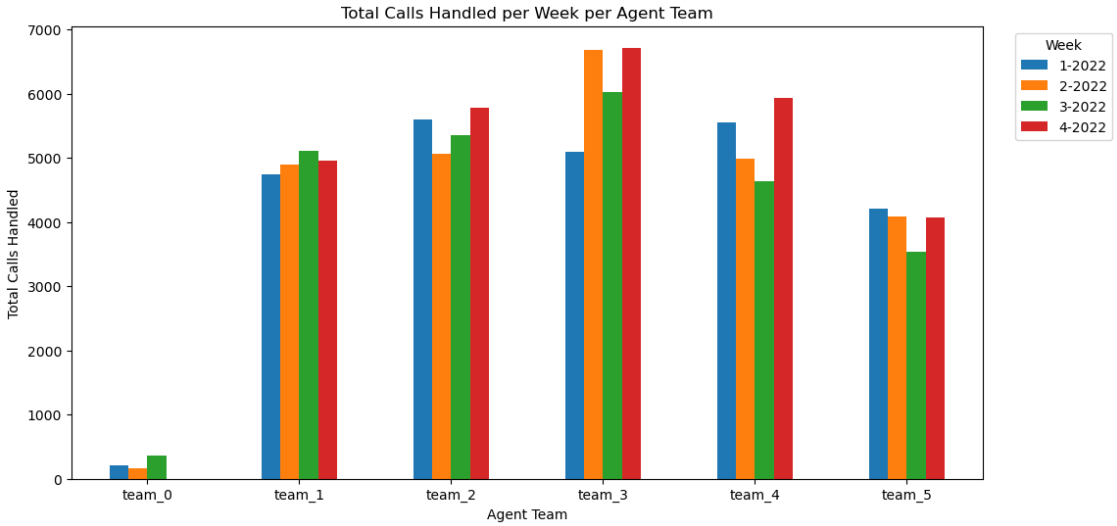
```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 24 entries, 0 to 23
Data columns (total 3 columns):
 #   Column               Non-Null Count  Dtype
---  ------               --------------  -----
 0   Agent Team           24 non-null     object
 1   Week                 24 non-null     object
 2   Total Calls Handled  24 non-null     int64
dtypes: int64(1), object(2)
memory usage: 768.0+ bytes
```

[54]:
```
# Pivot the DataFrame to prepare it for a stacked bar chart
pivot_df = team_weekly_handled_calls.pivot(index='Week', columns='Agent Team',␣
 ↪values='Total Calls Handled')

# Create a stacked bar chart
ax = pivot_df.plot(kind='bar', stacked=True, figsize=(12, 6))

# Add labels and title
plt.xlabel('Week')
plt.ylabel('Total Calls Handled')
plt.title('Total Calls Handled by Agent Team Over Weeks')

# Show the legend
plt.legend(title='Agent Team', bbox_to_anchor=(1.05, 1), loc='upper left')

# Show the chart
plt.show()
```



[55]:
```
# Create a pivot table to reshape the data for plotting
pivot_table = team_weekly_handled_calls.pivot(index='Agent Team',␣
 ↪columns='Week', values='Total Calls Handled')

# Plot the data as a bar chart
pivot_table.plot(kind='bar', figsize=(12, 6))
plt.title('Total Calls Handled per Week per Agent Team')
plt.xlabel('Agent Team')
plt.ylabel('Total Calls Handled')
plt.legend(title='Week', loc='upper right', bbox_to_anchor=(1.15, 1))
```

```
plt.xticks(rotation=0)  # Rotate x-axis labels for better readability
plt.show()
```



1.1.1 c) By Agent:

[56]:
```
agent_sorted = hcc_df.groupby(['Agent ID'])[time_related_columns].sum().
↪reset_index()
agent_sorted
```

[56]:

	Agent ID	Total Logged In Time	Not Ready Time	Ready Time	Reserved Time	Talk Time	Next Call Prep Time	Break
0	Agent 1	6 days 15:33:03	0 days 23:27:09	0 days 11:27:15	0 days 01:58:01	4 days 19:53:35	0 days 06:47:03	0 days 04:16:51
1	Agent 10	3 days 10:20:55	0 days 07:05:56	1 days 11:21:54	0 days 01:19:18	1 days 10:15:09	0 days 04:18:38	0 days 02:56:14
2	Agent 11	3 days 12:03:39	0 days 17:56:24	0 days 05:30:23	0 days 00:42:36	2 days 09:35:14	0 days 02:19:02	0 days 02:05:22
3	Agent 12	3 days 21:27:28	0 days 06:01:56	0 days 06:46:27	0 days 01:19:14	3 days 02:36:32	0 days 04:43:19	0 days 02:04:31
4	Agent 13	3 days 14:33:26	0 days 12:52:46	0 days 21:41:38	0 days 00:46:19	1 days 23:39:18	0 days 03:33:25	0 days 01:50:43
..	…	…	…	…	…	…	…	…
92	Agent 93	0 days 16:19:24	0 days 03:32:43	0 days 02:21:59				
93	Agent 94	0 days 14:20:04	0 days 01:26:29	0 days 06:17:13				
94	Agent 95	2 days 10:31:16	0 days 09:37:32	0 days 20:53:14				
95	Agent 96	1 days 04:51:38	0 days 04:05:40	0 days 13:07:34				
96	Agent 97	1 days 16:57:17	0 days 06:48:41	0 days 16:50:43				

```
92 0 days 00:07:22 0 days 09:40:56     0 days 00:36:24 0 days 00:15:16
93 0 days 00:17:45 0 days 05:45:26     0 days 00:33:11 0 days 00:21:09
94 0 days 00:37:54 1 days 01:26:33     0 days 01:56:03 0 days 01:53:09
95 0 days 00:26:25 0 days 10:20:09     0 days 00:51:50 0 days 00:43:20
96 0 days 00:41:40 0 days 14:58:08     0 days 01:38:05 0 days 02:14:12

              Lunch    Team Support         Meeting After Call Work  \
0  0 days 09:00:44 0 days 00:00:00 0 days 00:28:08 0 days 06:40:34
1  0 days 04:01:06 0 days 00:00:00 0 days 00:00:00 0 days 00:00:26
2  0 days 04:00:52 0 days 00:00:00 0 days 02:22:34 0 days 09:00:47
3  0 days 00:29:05 0 days 00:17:33 0 days 00:03:10 0 days 02:01:24
4  0 days 04:03:32 0 days 00:00:25 0 days 00:48:54 0 days 02:04:34
..             …              …              …              …
92 0 days 00:30:57 0 days 00:00:00 0 days 00:00:00 0 days 01:51:44
93 0 days 00:34:18 0 days 00:00:00 0 days 00:00:00 0 days 00:00:00
94 0 days 03:23:03 0 days 00:01:08 0 days 00:01:01 0 days 00:00:00
95 0 days 00:59:13 0 days 00:00:00 0 days 00:00:00 0 days 00:00:00
96 0 days 01:28:30 0 days 00:00:00 0 days 00:00:00 0 days 00:00:00

   Special Projects        Training   System Issues           Other
0   0 days 01:30:26 0 days 01:09:44 0 days 00:13:20 0 days 00:07:22
1   0 days 00:00:00 0 days 00:00:00 0 days 00:02:53 0 days 00:05:17
2   0 days 00:00:00 0 days 00:22:24 0 days 00:00:00 0 days 00:04:25
3   0 days 00:43:13 0 days 00:06:55 0 days 00:00:00 0 days 00:16:05
4   0 days 00:00:00 0 days 03:40:08 0 days 00:00:00 0 days 00:24:30
..             …              …              …              …
92  0 days 00:00:00 0 days 00:48:21 0 days 00:00:05 0 days 00:06:20
93  0 days 00:00:00 0 days 00:16:07 0 days 00:00:17 0 days 00:14:38
94  0 days 00:00:00 0 days 04:07:56 0 days 00:03:27 0 days 00:07:48
95  0 days 00:00:00 0 days 01:08:06 0 days 00:00:00 0 days 01:15:01
96  0 days 00:00:00 0 days 02:26:05 0 days 00:03:12 0 days 00:36:42

[97 rows x 16 columns]
```

[57]:
```
agent_sorted.describe()
```

[57]:
```
            Total Logged In Time             Not Ready Time  \
count                         97                         97
mean   4 days 01:31:37.360824742  0 days 15:32:35.597938144
std    1 days 18:10:18.923891820  0 days 09:13:50.914340245
min              0 days 01:50:37            0 days 00:05:11
25%              3 days 01:20:07            0 days 08:52:32
50%              3 days 21:27:28            0 days 14:48:45
75%              5 days 13:54:33            0 days 19:59:59
max              7 days 02:55:44            2 days 00:44:19

                      Ready Time              Reserved Time  \
```

```
count                          97                          97
mean   0 days 09:35:54.793814432  0 days 01:14:00.072164948
std    0 days 10:01:11.383552252  0 days 00:39:56.581829082
min              0 days 00:21:53            0 days 00:02:05
25%              0 days 03:08:47            0 days 00:44:23
50%              0 days 06:17:13            0 days 01:09:36
75%              0 days 12:17:01            0 days 01:37:22
max              2 days 10:07:26            0 days 02:54:20

                      Talk Time        Next Call Prep Time  \
count                          97                          97
mean   2 days 18:24:50.701030927  0 days 04:44:16.195876288
std    1 days 07:54:36.092407044  0 days 02:51:00.754656334
min              0 days 00:34:31            0 days 00:06:20
25%              1 days 22:39:40            0 days 02:46:49
50%              2 days 17:52:03            0 days 04:11:59
75%              3 days 17:22:45            0 days 06:04:05
max              5 days 10:53:50            0 days 12:35:03

                         Break                      Lunch  \
count                          97                          97
mean   0 days 02:48:51.154639175  0 days 04:19:42.948453608
std    0 days 02:05:54.771206744  0 days 03:13:09.557273657
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 01:29:00            0 days 01:28:30
50%              0 days 02:28:51            0 days 04:01:05
75%              0 days 03:50:19            0 days 07:06:24
max              0 days 14:10:11            0 days 09:54:22

                    Team Support                    Meeting  \
count                          97                          97
mean   0 days 00:02:43.381443298  0 days 00:27:53.855670103
std    0 days 00:11:19.561262312  0 days 00:42:57.453066941
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 00:00:00            0 days 00:00:00
50%              0 days 00:00:00            0 days 00:10:22
75%              0 days 00:00:03            0 days 00:35:05
max              0 days 01:43:11            0 days 03:22:35

                 After Call Work           Special Projects  \
count                          97                          97
mean   0 days 04:25:28.298969072  0 days 00:28:59.432989690
std    0 days 04:27:08.830119613  0 days 01:00:13.213648965
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 01:31:39            0 days 00:00:00
50%              0 days 03:00:45            0 days 00:00:00
75%              0 days 06:18:16            0 days 00:16:48
```

```
max              1 days 02:17:17            0 days 04:41:22

                        Training              System Issues  \
count                         97                         97
mean   0 days 02:09:38.051546391  0 days 00:09:28.927835051
std    0 days 02:46:17.749854228  0 days 00:22:02.217867254
min              0 days 00:00:00            0 days 00:00:00
25%              0 days 00:16:07            0 days 00:00:00
50%              0 days 01:09:07            0 days 00:02:49
75%              0 days 02:51:24            0 days 00:12:16
max              0 days 16:48:18            0 days 03:09:09

                           Other
count                         97
mean   0 days 00:39:49.546391752
std    0 days 00:49:37.711219140
min              0 days 00:00:37
25%              0 days 00:08:40
50%              0 days 00:22:26
75%              0 days 00:50:43
max              0 days 05:41:26
```

[58]:
```
total_performance = sheet3.groupby(['Agent ID']).sum(numeric_only=True)
total_performance
```

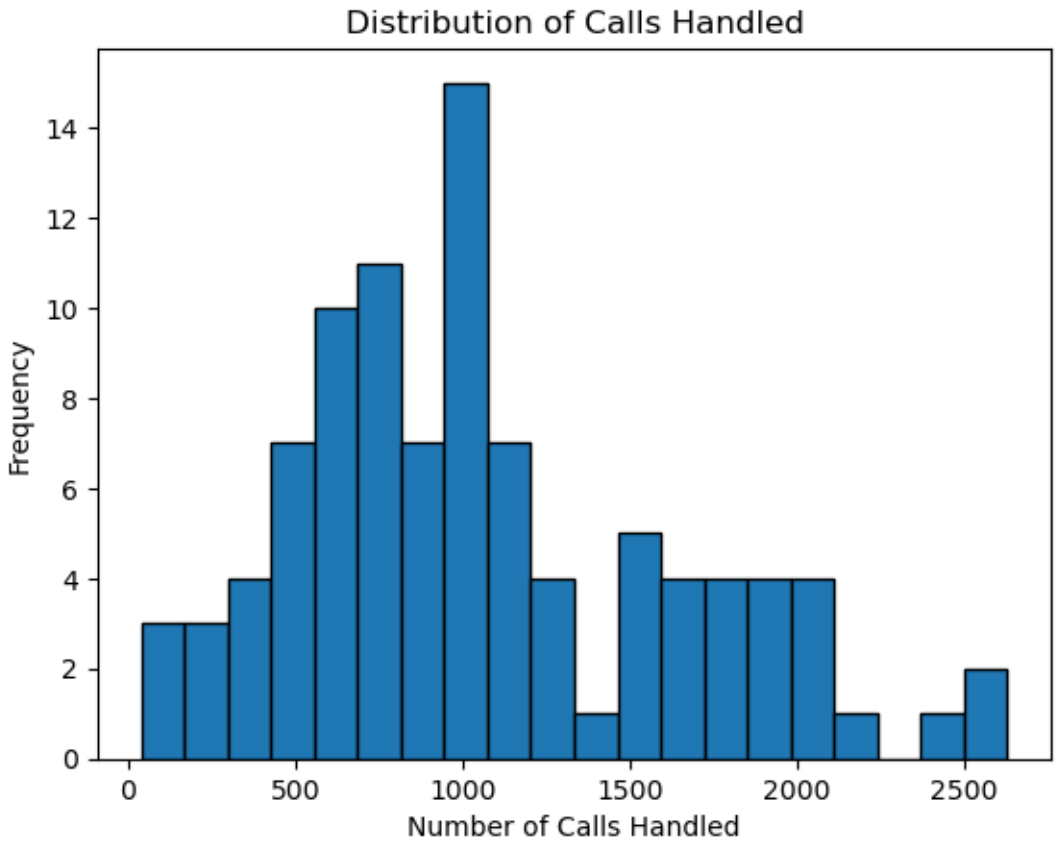
[58]:
```
          Number of Calls Handled
Agent ID
Agent 1                      1696
Agent 10                     1547
Agent 11                      608
Agent 12                     1209
Agent 13                      702
…                             …
Agent 93                      126
Agent 94                      201
Agent 95                      520
Agent 96                      284
Agent 97                      525

[97 rows x 1 columns]
```

[59]:
```
# Assuming your data is in a DataFrame called df
mean_calls = total_performance['Number of Calls Handled'].mean()
median_calls = total_performance['Number of Calls Handled'].median()
min_calls = total_performance['Number of Calls Handled'].min()
max_calls = total_performance['Number of Calls Handled'].max()
```

```
print(f"Mean Calls Handled: {mean_calls}")
print(f"Median Calls Handled: {median_calls}")
print(f"Minimum Calls Handled: {min_calls}")
print(f"Maximum Calls Handled: {max_calls}")
```

```
Mean Calls Handled: 1069.9381443298969
Median Calls Handled: 968.0
Minimum Calls Handled: 38
Maximum Calls Handled: 2632
```

[60]:
```
# Create a histogram
plt.hist(total_performance['Number of Calls Handled'], bins=20, edgecolor='k')
plt.xlabel('Number of Calls Handled')
plt.ylabel('Frequency')
plt.title('Distribution of Calls Handled')
plt.show()
```



[61]:
```
top_agents = total_performance.nlargest(5, 'Number of Calls Handled')
top_agents.reset_index()
```

[61]:

	Agent ID	Number of Calls Handled
0	Agent 31	2632
1	Agent 55	2594
2	Agent 20	2409
3	Agent 36	2167
4	Agent 2	2069

[62]:
```
bottom_agents = total_performance.nsmallest(5, 'Number of Calls Handled')
bottom_agents.reset_index()
```

[62]:

	Agent ID	Number of Calls Handled
0	Agent 81	38
1	Agent 43	102
2	Agent 93	126
3	Agent 15	189
4	Agent 94	201

1.1.2 d) Staffing Plan:

[63]:
```
daily_metrics2 = daily_metrics.copy()
daily_metrics2['Day of Week'] = daily_metrics2['Date'].dt.strftime('%A')

# Calculate the number of FTEs (assuming a 40-hour workweek)
daily_metrics2['FTEs'] = (daily_metrics2['Utilization Rate'] * 40) / 60  # 60␣
 ↪minutes per hour

# Print the weekly metrics
daily_metrics2.reset_index()
daily_metrics2
```

[63]:

	Date	Agent ID	Agent Team	Total Logged In Time	Talk Time	\
0	2022-08-01	72	6	22.497778	16.891944	
1	2022-08-02	70	6	18.478287	13.524988	
2	2022-08-03	76	6	21.292801	13.740868	
3	2022-08-04	73	6	19.299444	12.501030	
4	2022-08-05	65	6	17.548275	10.786806	
5	2022-08-06	0	0	0.000000	0.000000	
6	2022-08-07	0	0	0.000000	0.000000	
7	2022-08-08	76	6	25.178576	17.300139	
8	2022-08-09	74	6	21.129942	13.998750	
9	2022-08-10	74	6	20.431238	12.692361	
10	2022-08-11	70	6	18.688819	12.156539	
11	2022-08-12	60	5	16.096632	10.913530	
12	2022-08-13	0	0	0.000000	0.000000	
13	2022-08-14	0	0	0.000000	0.000000	
14	2022-08-15	66	6	20.715914	15.470359	
15	2022-08-16	67	6	19.318831	13.662639	

16	2022-08-17	67	6	18.630799	12.926655
17	2022-08-18	71	6	19.512106	12.465220
18	2022-08-19	63	6	17.587118	11.214699
19	2022-08-20	0	0	0.000000	0.000000
20	2022-08-21	0	0	0.000000	0.000000
21	2022-08-22	77	5	25.329861	17.434664
22	2022-08-23	70	5	20.517870	14.519931
23	2022-08-24	69	5	18.978657	13.161956
24	2022-08-25	64	5	17.072141	12.220648
25	2022-08-26	60	5	15.866713	10.839861

	Reserved Time	Ready Time	Not Ready Time	Utilization Rate	\
0	0.266319	0.638623	3.631736	0.791051	
1	0.259549	1.044062	2.724259	0.802488	
2	0.276806	2.852882	3.432037	0.792313	
3	0.248403	2.086516	3.550139	0.768724	
4	0.211725	2.886794	2.861366	0.791264	
5	0.000000	0.000000	0.000000	NaN	
6	0.000000	0.000000	0.000000	NaN	
7	0.302558	2.840532	3.557419	0.811930	
8	0.270428	2.601551	3.217431	0.798428	
9	0.262870	2.879653	3.633553	0.775033	
10	0.224375	2.393310	3.045046	0.790538	
11	0.200440	1.614734	2.574722	0.790768	
12	0.000000	0.000000	0.000000	NaN	
13	0.000000	0.000000	0.000000	NaN	
14	0.254618	0.877454	3.094780	0.801434	
15	0.255833	1.322859	3.104005	0.788937	
16	0.244352	1.701910	2.826736	0.798297	
17	0.239815	2.568322	3.325787	0.782763	
18	0.218519	2.565370	2.779502	0.795957	
19	0.000000	0.000000	0.000000	NaN	
20	0.000000	0.000000	0.000000	NaN	
21	0.336597	2.388032	3.897743	0.795871	
22	0.263889	1.293368	3.374757	0.783570	
23	0.247176	1.527650	3.043877	0.787031	
24	0.209502	1.155058	2.637894	0.795753	
25	0.191030	1.555475	2.507731	0.793256	

	Non-Utilized Rate	Day of Week	FTEs
0	0.161426	Monday	0.527367
1	0.147430	Tuesday	0.534992
2	0.161183	Wednesday	0.528208
3	0.183950	Thursday	0.512483
4	0.163057	Friday	0.527510
5	NaN	Saturday	NaN
6	NaN	Sunday	NaN

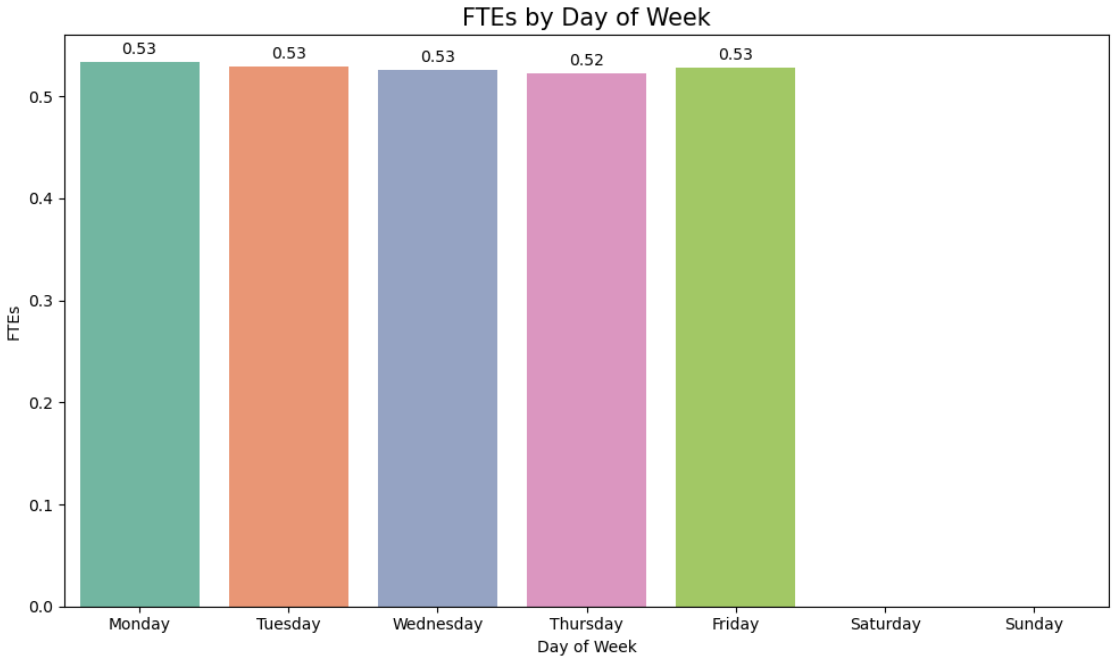
```
7            0.141288      Monday  0.541286
8            0.152269     Tuesday  0.532285
9            0.177843   Wednesday  0.516689
10           0.162934    Thursday  0.527025
11           0.159954      Friday  0.527179
12                NaN    Saturday       NaN
13                NaN      Sunday       NaN
14           0.149391      Monday  0.534289
15           0.160672     Tuesday  0.525958
16           0.151724   Wednesday  0.532198
17           0.170447    Thursday  0.521842
18           0.158042      Friday  0.530638
19                NaN    Saturday       NaN
20                NaN      Sunday       NaN
21           0.153879      Monday  0.530580
22           0.164479     Tuesday  0.522380
23           0.160384   Wednesday  0.524687
24           0.154515    Thursday  0.530502
25           0.158050      Friday  0.528837
```

[64]:
```
fte_mean_by_day = daily_metrics2.groupby('Day of Week')['FTEs'].mean().
 ↪reset_index()

# Create a custom sorting order for the days of the week
custom_order = ["Monday", "Tuesday", "Wednesday", "Thursday", "Friday",␣
 ↪"Saturday", "Sunday"]

# Convert the "Day of Week" column to a categorical data type with the custom␣
 ↪sorting order
fte_mean_by_day["Day of Week"] = pd.Categorical(fte_mean_by_day["Day of Week"],␣
 ↪categories=custom_order, ordered=True)

# Sort the DataFrame by the custom order
fte_mean_by_day = fte_mean_by_day.sort_values(by="Day of Week")

# Reset the index if needed
fte_mean_by_day.reset_index(drop=True, inplace=True)

fte_mean_by_day
```

[64]:
```
  Day of Week      FTEs
0      Monday  0.533381
1     Tuesday  0.528904
2   Wednesday  0.525446
3    Thursday  0.522963
4      Friday  0.528541
5    Saturday       NaN
```

```
6       Sunday        NaN
```

[65]:
```
# Create a bar chart
plt.figure(figsize=(10, 6))
ax = sns.barplot(x='Day of Week', y='FTEs', data=fte_mean_by_day,palette='Set2')
plt.title('FTEs by Day of Week',fontsize=15)
plt.xlabel('Day of Week')
plt.ylabel('FTEs')

# Annotate each bar with its respective productivity score
for p in ax.patches:
    ax.annotate(f'{p.get_height():.2f}', (p.get_x() + p.get_width() / 2., p.
 ↪get_height()), ha='center', va='baseline', fontsize=10, color='black',␣
 ↪xytext=(0, 5), textcoords='offset points')

plt.tight_layout()

plt.show()
```



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Jump to Section 3: Productivity Methodology

3 - Define a model for productivity using the provided variables:

Defining a model for productivity in a call center context typically involves using key performance

metrics to assess how efficiently agents and teams are handling calls. In this case, you can consider a simple model for productivity by combining metrics like utilization rate, efficiency (average handle time), and the number of handled calls.

Model for Productivity:

Utilization Rate (UR): This measures the percentage of time agents are actively engaged in productive tasks (e.g., taking calls). Higher utilization rates generally indicate better productivity.

Efficiency (EFF): Efficiency is often measured by the average handle time (AHT) per call. Lower AHT suggests more efficient call handling.

Number of Handled Calls (NHC): The total number of calls handled by an agent or team can also be an indicator of productivity.

To create a composite productivity score, we can use a weighted combination of these metrics based on their relative importance to the call center's goals. For example:

Productivity Score (PS) = w1 * UR + w2 * (1 - EFF) + w3 * NHC

Where:

w1, w2, w3 are weights assigned to each metric, reflecting their importance. These weights can be adjusted based on the call center's priorities.

[66]:
```
# Define a function to calculate efficiency
def calculate_efficiency(copied_df2):
    efficiency = copied_df2['Talk Time'] / copied_df2['Total Logged In Time']
    return efficiency
```

[67]:
```
copied_df2 = copied_df.copy()
```

[68]:
```
# Calculate utilization rate and non-utilized time
copied_df2['Utilization Rate'] = calculate_utilization_rate(copied_df2)
copied_df2['Non-Utilized Rate'] = calculate_non_utilized_rate(copied_df2)
copied_df2['Efficiency'] = calculate_efficiency(copied_df2)
```

[69]:
```
copied_df2
```

[69]:

	Agent ID	Agent Team	Date	Interval Start Time	Interval End Time	\
0	Agent 1	team_1	2022-08-01	2022-08-01 08:00:00	2022-08-01 08:30:00	
1	Agent 1	team_1	2022-08-01	2022-08-01 08:30:00	2022-08-01 09:00:00	
2	Agent 1	team_1	2022-08-01	2022-08-01 09:00:00	2022-08-01 09:30:00	
3	Agent 1	team_1	2022-08-01	2022-08-01 09:30:00	2022-08-01 10:00:00	
4	Agent 1	team_1	2022-08-01	2022-08-01 10:00:00	2022-08-01 10:30:00	
…	…	…	…	…	…	
24907	Agent 97	team_3	2022-08-26	2022-08-26 14:30:00	2022-08-26 15:00:00	
24908	Agent 97	team_3	2022-08-26	2022-08-26 15:00:00	2022-08-26 15:30:00	
24909	Agent 97	team_3	2022-08-26	2022-08-26 15:30:00	2022-08-26 16:00:00	
24910	Agent 97	team_3	2022-08-26	2022-08-26 16:00:00	2022-08-26 16:30:00	
24911	Agent 97	team_3	2022-08-26	2022-08-26 16:30:00	2022-08-26 17:00:00	

```
       Total Logged In Time  Not Ready Time  Ready Time  Reserved Time  \
0                  0.018773        0.002384    0.000081       0.000255
1                  0.020833        0.001076    0.001296       0.000382
2                  0.020833        0.002963    0.000000       0.000428
3                  0.020833        0.004329    0.000000       0.000174
4                  0.020833        0.001262    0.000000       0.000174
…                     …              …          …              …
24907              0.020833        0.000000    0.002859       0.000255
24908              0.020833        0.000000    0.010127       0.000231
24909              0.020833        0.003113    0.013252       0.000104
24910              0.020833        0.000000    0.004641       0.000150
24911              0.001366        0.000127    0.000000       0.000000

       Talk Time  …  Team Support  Meeting  After Call Work  \
0       0.015174  …           0.0      0.0         0.002350
1       0.017002  …           0.0      0.0         0.001076
2       0.015984  …           0.0      0.0         0.002951
3       0.015544  …           0.0      0.0         0.000000
4       0.018715  …           0.0      0.0         0.001262
…          …  …           …       …              …
24907   0.016563  …           0.0      0.0         0.000000
24908   0.009780  …           0.0      0.0         0.000000
24909   0.003669  …           0.0      0.0         0.000000
24910   0.015579  …           0.0      0.0         0.000000
24911   0.001157  …           0.0      0.0         0.000000

       Special Projects  Training  System Issues     Other  Utilization Rate  \
0                   0.0  0.000000            0.0  0.000035          0.826141
1                   0.0  0.000000            0.0  0.000000          0.896667
2                   0.0  0.000000            0.0  0.000000          0.787778
3                   0.0  0.000000            0.0  0.000000          0.754444
4                   0.0  0.000000            0.0  0.000000          0.906667
…                  …       …              …       …               …
24907               0.0  0.000000            0.0  0.000000          0.944444
24908               0.0  0.000000            0.0  0.000000          0.966667
24909               0.0  0.000000            0.0  0.000000          0.817222
24910               0.0  0.000000            0.0  0.000000          0.977778
24911               0.0  0.000127            0.0  0.000000          0.847458

       Non-Utilized Rate  Efficiency
0               0.127004    0.808261
1               0.051667    0.816111
2               0.142222    0.767222
3               0.207778    0.746111
4               0.060556    0.898333
…                  …          …
24907           0.000000    0.795000
```

```
24908           0.000000    0.469444
24909           0.149444    0.176111
24910           0.000000    0.747778
24911           0.093220    0.847458

[24912 rows x 23 columns]
```

a) Productivity by team:

[70]:
```
# Calculate team-level productivity
team_productivity = copied_df2.groupby('Agent Team')[['Efficiency',␣
 ↪'Utilization Rate', 'Non-Utilized Rate']].mean()

#  Display the team-level productivity metrics
team_productivity.reset_index()
```

[70]:
```
  Agent Team  Efficiency  Utilization Rate  Non-Utilized Rate
0     team_0    0.541065          0.795201           0.163201
1     team_1    0.669305          0.760131           0.188256
2     team_2    0.657391          0.804826           0.146117
3     team_3    0.714895          0.779054           0.167481
4     team_4    0.660812          0.772761           0.181879
5     team_5    0.614152          0.740468           0.215216
```

[71]:
```
# Merge team_productivity with team_handled_calls on 'Agent Team'
team_model = pd.merge(team_productivity, team_handled_calls, on=['Agent Team'])
team_model
```

[71]:
```
  Agent Team  Efficiency  Utilization Rate  Non-Utilized Rate  \
0     team_0    0.541065          0.795201           0.163201
1     team_1    0.669305          0.760131           0.188256
2     team_2    0.657391          0.804826           0.146117
3     team_3    0.714895          0.779054           0.167481
4     team_4    0.660812          0.772761           0.181879
5     team_5    0.614152          0.740468           0.215216

   Number of Calls Handled
0                      740
1                    19704
2                    21788
3                    24515
4                    21118
5                    15919
```

[72]:
```
# Define weights for each metric (you can adjust these)
w1 = 0.4
w2 = 0.3
w3 = 0.3
```

```
# Calculate the productivity score (PS)
team_model['Productivity Score'] = w1 * team_model['Utilization Rate'] + w2 *␣
 ↪(1 - team_model['Efficiency']) + w3 * team_model['Number of Calls Handled']

# Sort the data by productivity score to identify top-performing and␣
 ↪low-performing agents/teams
team_sorted_data = team_model.sort_values(by='Productivity Score',␣
 ↪ascending=False)

team_sorted_data
```

[72]:

	Agent Team	Efficiency	Utilization Rate	Non-Utilized Rate	\
3	team_3	0.714895	0.779054	0.167481	
2	team_2	0.657391	0.804826	0.146117	
4	team_4	0.660812	0.772761	0.181879	
1	team_1	0.669305	0.760131	0.188256	
5	team_5	0.614152	0.740468	0.215216	
0	team_0	0.541065	0.795201	0.163201	

	Number of Calls Handled	Productivity Score
3	24515	7354.897153
2	21788	6536.824713
4	21118	6335.810861
1	19704	5911.603261
5	15919	4776.111942
0	740	222.455761

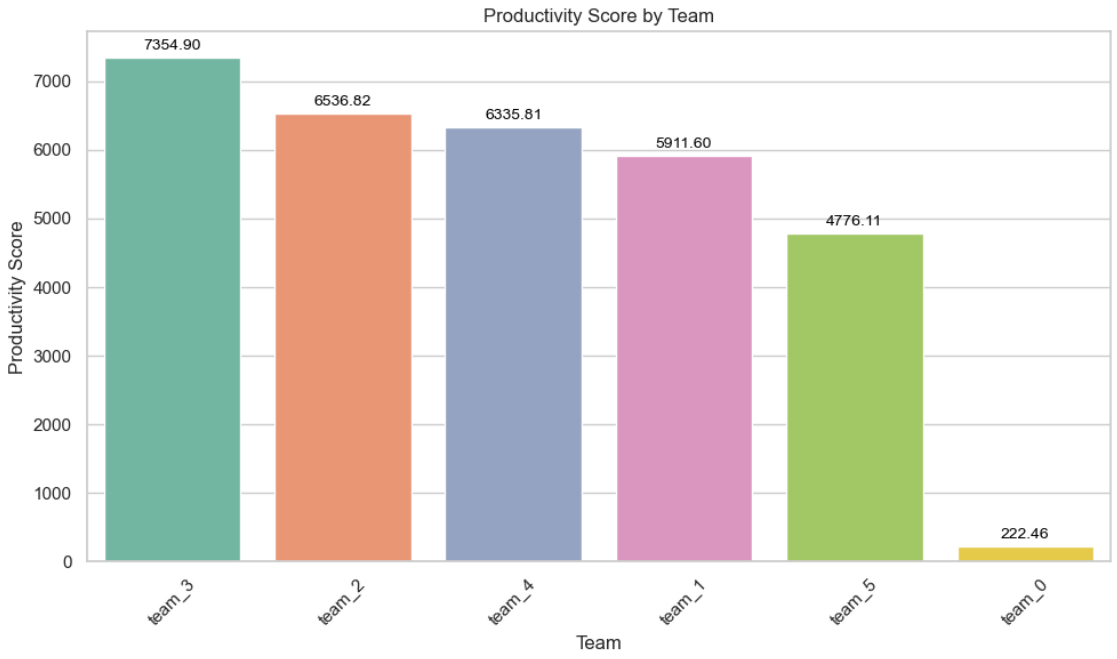
[73]:
```
# Set Seaborn style and color palette
sns.set(style="whitegrid")
sns.set_palette("pastel")

plt.figure(figsize=(10, 6))
ax = sns.barplot(x='Agent Team', y='Productivity Score', data=team_sorted_data,␣
 ↪palette="Set2")
plt.xlabel('Team')
plt.ylabel('Productivity Score')
plt.title('Productivity Score by Team')
plt.xticks(rotation=45)

# Annotate each bar with its respective productivity score
for p in ax.patches:
    ax.annotate(f'{p.get_height():.2f}', (p.get_x() + p.get_width() / 2., p.
 ↪get_height()), ha='center', va='baseline', fontsize=10, color='black',␣
 ↪xytext=(0, 5), textcoords='offset points')

plt.tight_layout()
```

```
plt.show()
```



b) Productivity by agent:

[74]:
```
# Calculate agent-level productivity
agent_productivity = copied_df2.groupby(['Agent Team', 'Agent␣
↪ID'])[['Efficiency', 'Utilization Rate', 'Non-Utilized Rate']].mean()

# Display the agent-level productivity metrics
agent_productivity.reset_index()
```

[74]:

	Agent Team	Agent ID	Efficiency	Utilization Rate	Non-Utilized Rate
0	team_0	Agent 13	0.548810	0.793844	0.164659
1	team_0	Agent 81	0.249877	0.846207	0.108362
2	team_1	Agent 1	0.723987	0.808010	0.148564
3	team_1	Agent 24	0.668878	0.787074	0.192299
4	team_1	Agent 26	0.707143	0.769979	0.190876
..	…	…	…	…	…
92	team_5	Agent 72	0.665250	0.761292	0.196366
93	team_5	Agent 77	0.682051	0.755109	0.207221
94	team_5	Agent 8	0.635942	0.774859	0.177422
95	team_5	Agent 84	0.266130	0.816374	0.141748
96	team_5	Agent 88	0.471968	0.704191	0.260199

[97 rows x 5 columns]

[75]:
```
# Merge agent_productivity with total_performance on 'Agent ID'
agent_model = pd.merge(agent_productivity, total_performance, on=['Agent ID'])
agent_model
```

[75]:

Agent ID	Efficiency	Utilization Rate	Non-Utilized Rate	Number of Calls Handled
Agent 13	0.548810	0.793844	0.164659	702
Agent 81	0.249877	0.846207	0.108362	38
Agent 1	0.723987	0.808010	0.148564	1696
Agent 24	0.668878	0.787074	0.192299	507
Agent 26	0.707143	0.769979	0.190876	946
…	…	…	…	…
Agent 72	0.665250	0.761292	0.196366	968
Agent 77	0.682051	0.755109	0.207221	908
Agent 8	0.635942	0.774859	0.177422	862
Agent 84	0.266130	0.816374	0.141748	680
Agent 88	0.471968	0.704191	0.260199	984

[97 rows x 4 columns]

[76]:
```
# Define weights for each metric (you can adjust these)
w1 = 0.4
w2 = 0.3
w3 = 0.3

# Calculate the productivity score (PS)
agent_model['Productivity Score'] = w1 * agent_model['Utilization Rate'] + w2 *␣
 ↪(1 - agent_model['Efficiency']) + w3 * agent_model['Number of Calls Handled']

# Sort the data by productivity score to identify top-performing and␣
 ↪low-performing agents/teams
agent_sorted_data = agent_model.sort_values(by='Productivity Score',␣
 ↪ascending=False)
```

```
agent_sorted_data
```

[76]:
```
          Efficiency  Utilization Rate  Non-Utilized Rate  \
Agent ID
Agent 31    0.701059          0.792421           0.145182
Agent 55    0.730204          0.750964           0.176208
Agent 20    0.673734          0.771363           0.160972
Agent 36    0.620405          0.812553           0.125120
Agent 2     0.632228          0.657759           0.287839
…                …                 …                  …
Agent 94    0.391485          0.854785           0.105329
Agent 15    0.708972          0.752618           0.181351
Agent 93    0.584128          0.736218           0.225475
Agent 43    0.587481          0.623204           0.363461
Agent 81    0.249877          0.846207           0.108362

          Number of Calls Handled  Productivity Score
Agent ID
Agent 31                     2632          790.006651
Agent 55                     2594          778.581324
Agent 20                     2409          723.106425
Agent 36                     2167          650.538900
Agent 2                      2069          621.073435
…                             …                  …
Agent 94                      201           60.824469
Agent 15                      189           57.088355
Agent 93                      126           38.219249
Agent 43                      102           30.973037
Agent 81                       38           11.963520

[97 rows x 5 columns]
```

[77]:
```
#Top 5 agents have highest PS
agent_sorted_data.nlargest(5, 'Productivity Score')
```

[77]:
```
          Efficiency  Utilization Rate  Non-Utilized Rate  \
Agent ID
Agent 31    0.701059          0.792421           0.145182
Agent 55    0.730204          0.750964           0.176208
Agent 20    0.673734          0.771363           0.160972
Agent 36    0.620405          0.812553           0.125120
Agent 2     0.632228          0.657759           0.287839

          Number of Calls Handled  Productivity Score
Agent ID
Agent 31                     2632          790.006651
```

```
Agent 55                    2594          778.581324
Agent 20                    2409          723.106425
Agent 36                    2167          650.538900
Agent 2                     2069          621.073435
```

[78]:
```
#Top 5 agents have lowest PS
agent_sorted_data.nsmallest(5, 'Productivity Score')
```

[78]:
```
          Efficiency  Utilization Rate  Non-Utilized Rate  \
Agent ID
Agent 81    0.249877          0.846207           0.108362
Agent 43    0.587481          0.623204           0.363461
Agent 93    0.584128          0.736218           0.225475
Agent 15    0.708972          0.752618           0.181351
Agent 94    0.391485          0.854785           0.105329

          Number of Calls Handled  Productivity Score
Agent ID
Agent 81                       38           11.963520
Agent 43                      102           30.973037
Agent 93                      126           38.219249
Agent 15                      189           57.088355
Agent 94                      201           60.824469
```

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