AIML Capstone Project - Autonomous Driving - Lee Thornquist

Part 2

2.1 Preliminary data inspection and cleaning

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:
```
# load the data
df = pd.read_csv('/Users/leethornquist/Desktop/AI:ML Caltech Bootcamp/Foundations/07 - Capstone/Autonomous Driving/Capstone 1 - Autonomous Driving/Part 2/Tesla - Deaths.csv')
df
```

Out[2]:

	Case #	Year	Date	Country	State	Description	Deaths	Tesla driver	Tesla occupant	Other vehicle	...	Verified Tesla Autopilot Deaths	Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO	Unnamed: 16	Unnamed: 17	
0	294	2022	1/17/2023	USA	CA	Tesla crashes into back of semi	1	1	-	-	...	-	-	https://web.archive.org/web/20221222203930/htt...	https://web.archive.org/web/20221222203930/htt...	https://web.ar
1	293	2022	1/7/2023	Canada	-	Tesla crashes	1	1	-	-	...	-	-	https://web.archive.org/web/20221222203930/htt...	https://web.archive.org/web/20221222203930/htt...	https://web.arc
2	292	2022	1/7/2023	USA	WA	Tesla hits pole, catches on fire	1	-	1	-	...	-	-	https://web.archive.org/web/20221222203930/htt...	https://web.archive.org/web/20221222203930/htt...	https://web.ar
3	291	2022	12/22/2022	USA	GA	Tesla crashes and burns	1	1	-	-	...	-	-	https://web.archive.org/web/20221222203930/htt...	https://web.archive.org/web/20221222203930/htt...	https://web.arc
4	290	2022	12/19/2022	Canada	-	Tesla crashes into storefront	1	-	-	-	...	-	-	https://web.archive.org/web/20221223203725/htt...	https://web.archive.org/web/20221223203725/htt...	https://web.arc
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
289	5	2014	7/14/2014	USA	CA	Tesla kills motorcyclist	1	-	-	1	...	-	-	https://web.archive.org/web/20220817120807/htt...	https://web.archive.org/web/20220817120807/htt...	https://web.ar
290	4	2014	7/4/2014	USA	CA	Thief crashes stolen Tesla	1	1	-	-	...	-	-	https://web.archive.org/web/20220817120839/htt...	https://web.archive.org/web/20220817120839/htt...	https://web.ar
291	3	2014	7/4/2014	USA	CA	Tesla rear ends stopped car	3	-	-	3	...	-	-	https://web.archive.org/web/20220412004559/htt...	https://web.archive.org/web/20220412004559/htt...	https://web.arc
292	2	2013	11/2/2013	USA	CA	Tesla kills cyclist	1	-	-	-	...	-	-	https://web.archive.org/web/20220817121049/htt...	https://web.archive.org/web/20220817121049/htt...	https://web.ar
293	1	2013	4/2/2013	USA	CA	Tesla veers into opposite lane	2	-	-	2	...	-	-	https://web.archive.org/web/20150425055520/htt...	https://web.archive.org/web/20150425055520/htt...	https://web.arc

294 rows × 24 columns

In [3]:
```
# Check data types
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 294 entries, 0 to 293
Data columns (total 24 columns):
 #   Column                                                  Non-Null Count  Dtype  
---  ------                                                  --------------  -----  
 0   Case #                                                  294 non-null    int64  
 1   Year                                                    294 non-null    int64  
 2   Date                                                    294 non-null    object 
 3    Country                                                294 non-null    object 
 4    State                                                  294 non-null    object 
 5    Description                                            294 non-null    object 
 6    Deaths                                                 294 non-null    int64  
 7    Tesla driver                                           289 non-null    object 
 8    Tesla occupant                                         285 non-null    object 
 9    Other vehicle                                          290 non-null    object 
 10   Cyclists/ Peds                                         291 non-null    object 
 11   TSLA+cycl / peds                                       292 non-null    object 
 12   Model                                                  294 non-null    object 
 13   Autopilot claimed                                      276 non-null    object 
 14   Verified Tesla Autopilot Deaths                        290 non-null    object 
 15   Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO  293 non-null    object 
 16  Unnamed: 16                                             289 non-null    object 
 17  Unnamed: 17                                             289 non-null    object 
 18   Source                                                 294 non-null    object 
 19   Note                                                   9 non-null      object 
 20  Deceased 1                                              87 non-null     object 
 21  Deceased 2                                              17 non-null     object 
 22  Deceased 3                                              4 non-null      object 
 23  Deceased 4                                              0 non-null      float64
dtypes: float64(1), int64(3), object(20)
memory usage: 55.3+ KB
```

In [4]:
```
# Check for missing values
missing_values = df.isnull().sum()
print(missing_values)
```

```
Case #                                                    0
Year                                                      0
Date                                                      0
 Country                                                  0
 State                                                    0
 Description                                              0
 Deaths                                                   0
 Tesla driver                                             5
 Tesla occupant                                           9
 Other vehicle                                            4
 Cyclists/ Peds                                           3
 TSLA+cycl / peds                                         2
 Model                                                    0
 Autopilot claimed                                       18
 Verified Tesla Autopilot Deaths                          4
 Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO       1
Unnamed: 16                                               5
Unnamed: 17                                               5
 Source                                                   0
 Note                                                   285
Deceased 1                                              207
Deceased 2                                              277
Deceased 3                                              290
Deceased 4                                              294
dtype: int64
```

In [5]:
```
# Clean column names by stripping leading/trailing spaces
df.columns = df.columns.str.strip()
```

In [6]:
```
# Remove columns with excessive missing values and irrelevant columns
df = df.drop(columns=['Source', 'Unnamed: 16', 'Unnamed: 17', 'Note', 'Deceased 1', 'Deceased 2', 'Deceased 3', 'Deceased 4'])
```

In [7]:
```
#checking ot make sure they were removed
df.head()
```

Out[7]:

	Case #	Year	Date	Country	State	Description	Deaths	Tesla driver	Tesla occupant	Other vehicle	Cyclists/ Peds	TSLA+cycl / peds	Model	Autopilot claimed	Verified Tesla Autopilot Deaths	Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO
0	294	2022	1/17/2023	USA	CA	Tesla crashes into back of semi	1	1	-	-	-	1	-	-	-	-
1	293	2022	1/7/2023	Canada	-	Tesla crashes	1	1	-	-	-	1	-	-	-	-
2	292	2022	1/7/2023	USA	WA	Tesla hits pole, catches on fire	1	-	1	-	-	1	-	-	-	-
3	291	2022	12/22/2022	USA	GA	Tesla crashes and burns	1	1	-	-	-	1	-	-	-	-
4	290	2022	12/19/2022	Canada	-	Tesla crashes into storefront	1	-	-	-	1	1	-	-	-	-

In [8]:
```
# Check for duplicates
duplicate_rows = df.duplicated().sum()
print(f'Duplicate rows: {duplicate_rows}')
```

```
Duplicate rows: 0
```

In [9]:
```
# Remove duplicate rows
df = df.drop_duplicates()
```

In [10]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 294 entries, 0 to 293
Data columns (total 16 columns):
 #   Column                                                  Non-Null Count  Dtype 
---  ------                                                  --------------  ----- 
 0   Case #                                                  294 non-null    int64 
 1   Year                                                    294 non-null    int64 
 2   Date                                                    294 non-null    object
 3   Country                                                 294 non-null    object
 4   State                                                   294 non-null    object
 5   Description                                             294 non-null    object
 6   Deaths                                                  294 non-null    int64 
 7   Tesla driver                                            289 non-null    object
 8   Tesla occupant                                          285 non-null    object
 9   Other vehicle                                           290 non-null    object
 10  Cyclists/ Peds                                          291 non-null    object
 11  TSLA+cycl / peds                                        292 non-null    object
 12  Model                                                   294 non-null    object
 13  Autopilot claimed                                       276 non-null    object
 14  Verified Tesla Autopilot Deaths                         290 non-null    object
 15  Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO  293 non-null    object
dtypes: int64(3), object(13)
memory usage: 36.9+ KB
```

In [11]:
```
# Convert Date column to datetime
df['Date'] = pd.to_datetime(df['Date'], errors='coerce')
```

In [12]:
```
# List of columns to convert to Int64
columns_to_convert = [
    'Tesla occupant',
    'Other vehicle',
    'Cyclists/ Peds',
```

```
    'TSLA+cycl / peds',
    'Verified Tesla Autopilot Deaths',
    'Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO'
]

# Convert columns to float64
for column in columns_to_convert:
    df[column] = pd.to_numeric(df[column], errors='coerce')

# Convert the columns from float64 to Int64 and fill NaN with 0
for column in columns_to_convert:
    df[column] = df[column].astype('Int64').fillna(0)

# Verify the changes
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 294 entries, 0 to 293
Data columns (total 16 columns):
 #   Column                                                  Non-Null Count  Dtype
---  ------                                                  --------------  -----
 0   Case #                                                  294 non-null    int64
 1   Year                                                    294 non-null    int64
 2   Date                                                    294 non-null    datetime64[ns]
 3   Country                                                 294 non-null    object
 4   State                                                   294 non-null    object
 5   Description                                             294 non-null    object
 6   Deaths                                                  294 non-null    int64
 7   Tesla driver                                            289 non-null    object
 8   Tesla occupant                                          294 non-null    Int64
 9   Other vehicle                                           294 non-null    Int64
 10  Cyclists/ Peds                                          294 non-null    Int64
 11  TSLA+cycl / peds                                        294 non-null    Int64
 12  Model                                                   294 non-null    object
 13  Autopilot claimed                                       276 non-null    object
 14  Verified Tesla Autopilot Deaths                         294 non-null    Int64
 15  Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO  294 non-null    Int64
dtypes: Int64(6), datetime64[ns](1), int64(3), object(6)
memory usage: 38.6+ KB
```

In [13]:
```
# Convert Tesla driver column to integer (1 if driver died, 0 if driver lived)
df['Tesla driver'] = df['Tesla driver'].apply(lambda x: 1 if x == '1' else 0)
df['Autopilot claimed'] = df['Autopilot claimed'].apply(lambda x: 1 if x == '1' else 0)
```

In [14]:
```
# checking to make sure everything converted correctly
df
```

Out[14]:

	Case #	Year	Date	Country	State	Description	Deaths	Tesla driver	Tesla occupant	Other vehicle	Cyclists/ Peds	TSLA+cycl / peds	Model	Autopilot claimed	Verified Tesla Autopilot Deaths	Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO
0	294	2022	2023-01-17	USA	CA	Tesla crashes into back of semi	1	1	0	0	0	1	-	0	0	0
1	293	2022	2023-01-07	Canada	-	Tesla crashes	1	1	0	0	0	1	-	0	0	0
2	292	2022	2023-01-07	USA	WA	Tesla hits pole, catches on fire	1	0	1	0	0	1	-	0	0	0
3	291	2022	2022-12-22	USA	GA	Tesla crashes and burns	1	1	0	0	0	1	-	0	0	0
4	290	2022	2022-12-19	Canada	-	Tesla crashes into storefront	1	0	0	0	1	1	-	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
289	5	2014	2014-07-14	USA	CA	Tesla kills motorcyclist	1	0	0	1	0	0	-	0	0	0
290	4	2014	2014-07-04	USA	CA	Thief crashes stolen Tesla	1	1	0	0	0	1	-	0	0	0
291	3	2014	2014-07-04	USA	CA	Tesla rear ends stopped car	3	0	0	3	0	0	-	0	0	0
292	2	2013	2013-11-02	USA	CA	Tesla kills cyclist	1	0	0	0	1	1	-	0	0	0
293	1	2013	2013-04-02	USA	CA	Tesla veers into opposite lane	2	0	0	2	0	0	S	0	0	0

294 rows × 16 columns

In [15]:
```python
# Find unique values in the 'Model' column
unique_models = df['Model'].unique()

# Display the unique values
print(unique_models)
```

```
[' – ' ' Y ' '1' '2' '3' ' S ' ' X ']
```

In [16]:
```python
# Convert Model column to category
df['Model'] = df['Model'].astype('category')

# Replace ' – ' with NaN
df['Model'] = df['Model'].replace(' – ', np.nan)

# Verify the change
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 294 entries, 0 to 293
Data columns (total 16 columns):
 #   Column                                                  Non-Null Count  Dtype
---  ------                                                  --------------  -----
 0   Case #                                                  294 non-null    int64
 1   Year                                                    294 non-null    int64
 2   Date                                                    294 non-null    datetime64[ns]
 3   Country                                                 294 non-null    object
 4   State                                                   294 non-null    object
 5   Description                                             294 non-null    object
 6   Deaths                                                  294 non-null    int64
 7   Tesla driver                                            294 non-null    int64
 8   Tesla occupant                                          294 non-null    Int64
 9   Other vehicle                                           294 non-null    Int64
 10  Cyclists/ Peds                                          294 non-null    Int64
 11  TSLA+cycl / peds                                        294 non-null    Int64
 12  Model                                                   113 non-null    category
 13  Autopilot claimed                                       294 non-null    int64
 14  Verified Tesla Autopilot Deaths                         294 non-null    Int64
 15  Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO  294 non-null    Int64
dtypes: Int64(6), category(1), datetime64[ns](1), int64(5), object(3)
memory usage: 36.8+ KB
```

In [17]:

```python
# Get the count of each unique value in the 'Model' column, including NaN
model_counts = df['Model'].value_counts(dropna=False)

# Display the counts of each unique value, including NaN
print(model_counts)

# Sum the occurrences of all unique values, including NaN
total_model_count = model_counts.sum()
print(f'Total count of all unique values in the Model column, including NaN: {total_model_count}')
```

```
Model
NaN    181
 S      45
3       39
 X      17
 Y      10
1        1
2        1
Name: count, dtype: int64
Total count of all unique values in the Model column, including NaN: 294
```

In [18]:

```python
# Convert State and Country columns to category
df['State'] = df['State'].astype('category')
df['Country'] = df['Country'].astype('category')
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 294 entries, 0 to 293
Data columns (total 16 columns):
 #   Column                                                  Non-Null Count  Dtype
---  ------                                                  --------------  -----
 0   Case #                                                  294 non-null    int64
 1   Year                                                    294 non-null    int64
 2   Date                                                    294 non-null    datetime64[ns]
 3   Country                                                 294 non-null    category
 4   State                                                   294 non-null    category
 5   Description                                             294 non-null    object
 6   Deaths                                                  294 non-null    int64
 7   Tesla driver                                            294 non-null    int64
 8   Tesla occupant                                          294 non-null    Int64
 9   Other vehicle                                           294 non-null    Int64
 10  Cyclists/ Peds                                          294 non-null    Int64
 11  TSLA+cycl / peds                                        294 non-null    Int64
 12  Model                                                   113 non-null    category
 13  Autopilot claimed                                       294 non-null    int64
 14  Verified Tesla Autopilot Deaths                         294 non-null    Int64
 15  Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO  294 non-null    Int64
dtypes: Int64(6), category(3), datetime64[ns](1), int64(5), object(1)
memory usage: 34.9+ KB
```

In [19]:
```
print(df['Country'].unique())
```

```
[' USA ', ' Canada ', ' China ', ' Mexico ', ' UK ', ..., ' Austria ', ' Ukraine ', ' Spain ', ' Holland ', ' Japan ']
Length: 23
Categories (23, object): [' Australia ', ' Austria ', ' Belgium ', ' Canada ', ..., ' Taiwan ', ' UK ', ' USA ', ' Ukraine ']
```

In [20]:
```
print(df['State'].unique())
```

```
['CA', '-', 'WA', 'GA', 'MO', ..., ' IN ', ' DE ', ' NH ', ' TN ', ' HI ']
Length: 43
Categories (43, object): [' AZ ', ' CA ', ' CO ', ' DE ', ..., 'PA', 'SC', 'UT', 'WA']
```

In [21]:
```
# Save the cleaned data to a new CSV file
cleaned_file_path = '/Users/leethornquist/Desktop/AI:ML Caltech Bootcamp/Foundations/07 - Capstone/Autonomous Driving/Capstone 1 - Autonomous Driving/Part 2/Tesla_Deaths_Cleaned.csv'
df.to_csv(cleaned_file_path, index=False)
```

2.2 Exploratory Data Analysis

a. Perform an in-depth exploratory data analysis on the number of events by date, per year, and per day for each state and country

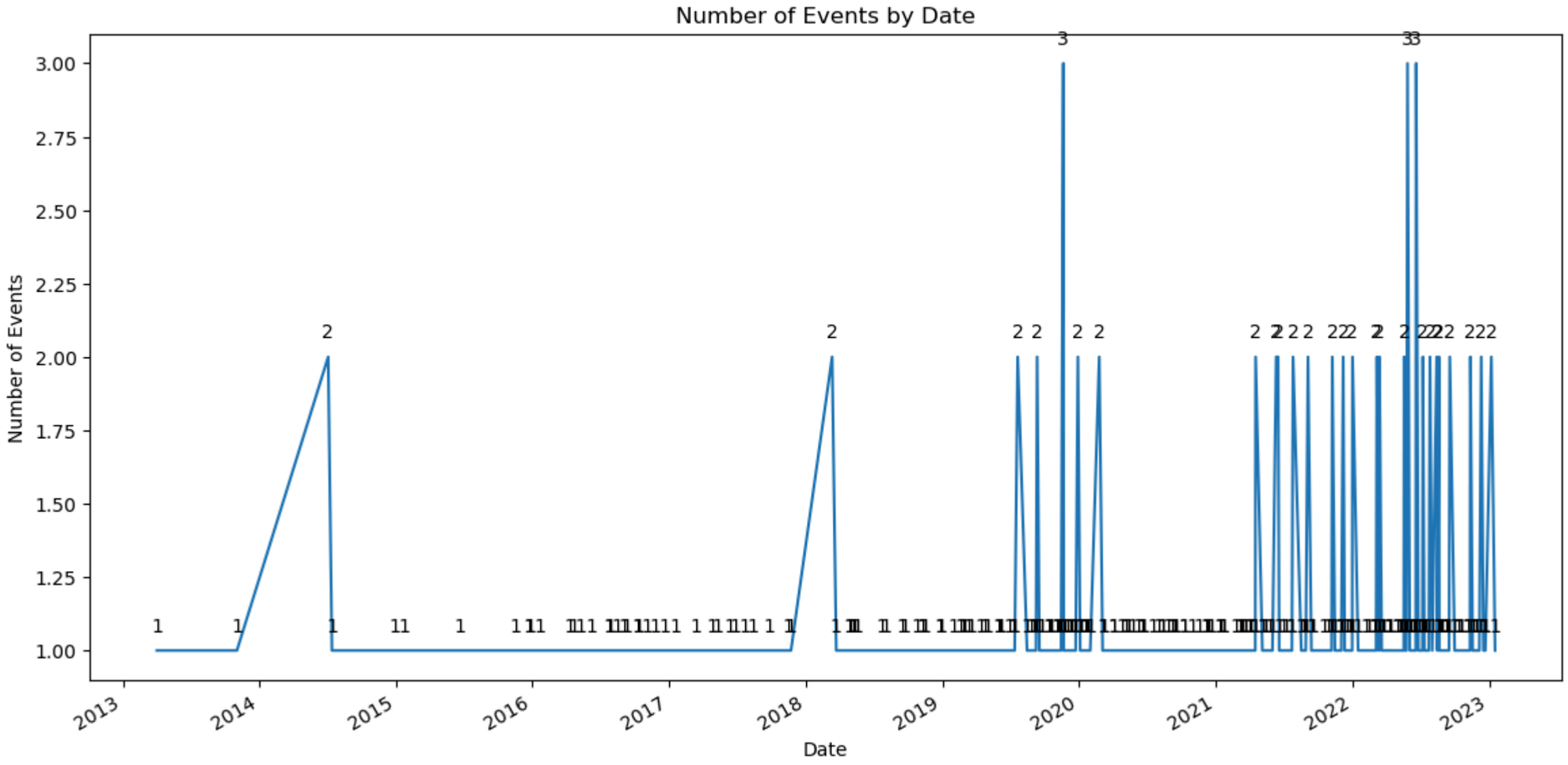
In [22]:
```
df = pd.read_csv('/Users/leethornquist/Desktop/AI:ML Caltech Bootcamp/Foundations/07 - Capstone/Autonomous Driving/Capstone 1 - Autonomous Driving/Part 2/Tesla_Deaths_Cleaned.csv')
```

In [23]:
```
df['Date'] = pd.to_datetime(df['Date'], errors='coerce')

# Convert State and Country columns to category
df['State'] = df['State'].astype('category')
df['Country'] = df['Country'].astype('category')

# Convert Model column to category
df['Model'] = df['Model'].astype('category')

# Replace ' - ' with NaN
df['Model'] = df['Model'].replace(' - ', np.nan)

df.info()
```

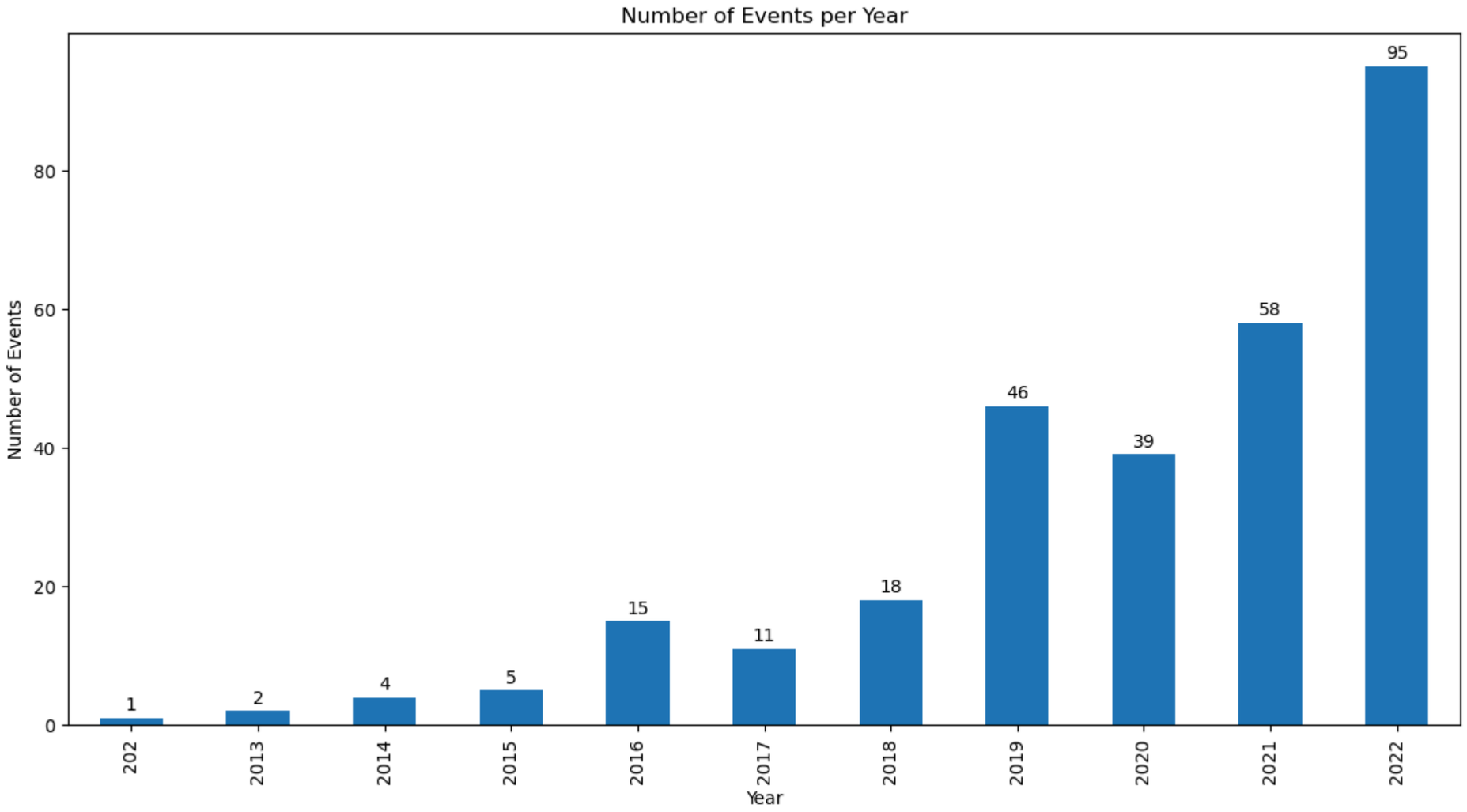
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 294 entries, 0 to 293
Data columns (total 16 columns):
 #   Column                                                  Non-Null Count  Dtype
---  ------                                                  --------------  -----
 0   Case #                                                  294 non-null    int64
 1   Year                                                    294 non-null    int64
 2   Date                                                    294 non-null    datetime64[ns]
 3   Country                                                 294 non-null    category
 4   State                                                   294 non-null    category
 5   Description                                             294 non-null    object
 6   Deaths                                                  294 non-null    int64
 7   Tesla driver                                            294 non-null    int64
 8   Tesla occupant                                          294 non-null    int64
 9   Other vehicle                                           294 non-null    int64
 10  Cyclists/ Peds                                          294 non-null    int64
 11  TSLA+cycl / peds                                        294 non-null    int64
 12  Model                                                   113 non-null    category
 13  Autopilot claimed                                       294 non-null    int64
 14  Verified Tesla Autopilot Deaths                         294 non-null    int64
 15  Verified Tesla Autopilot Deaths + All Deaths Reported to NHTSA SGO  294 non-null    int64
dtypes: category(3), datetime64[ns](1), int64(11), object(1)
memory usage: 33.2+ KB
```

In [24]:

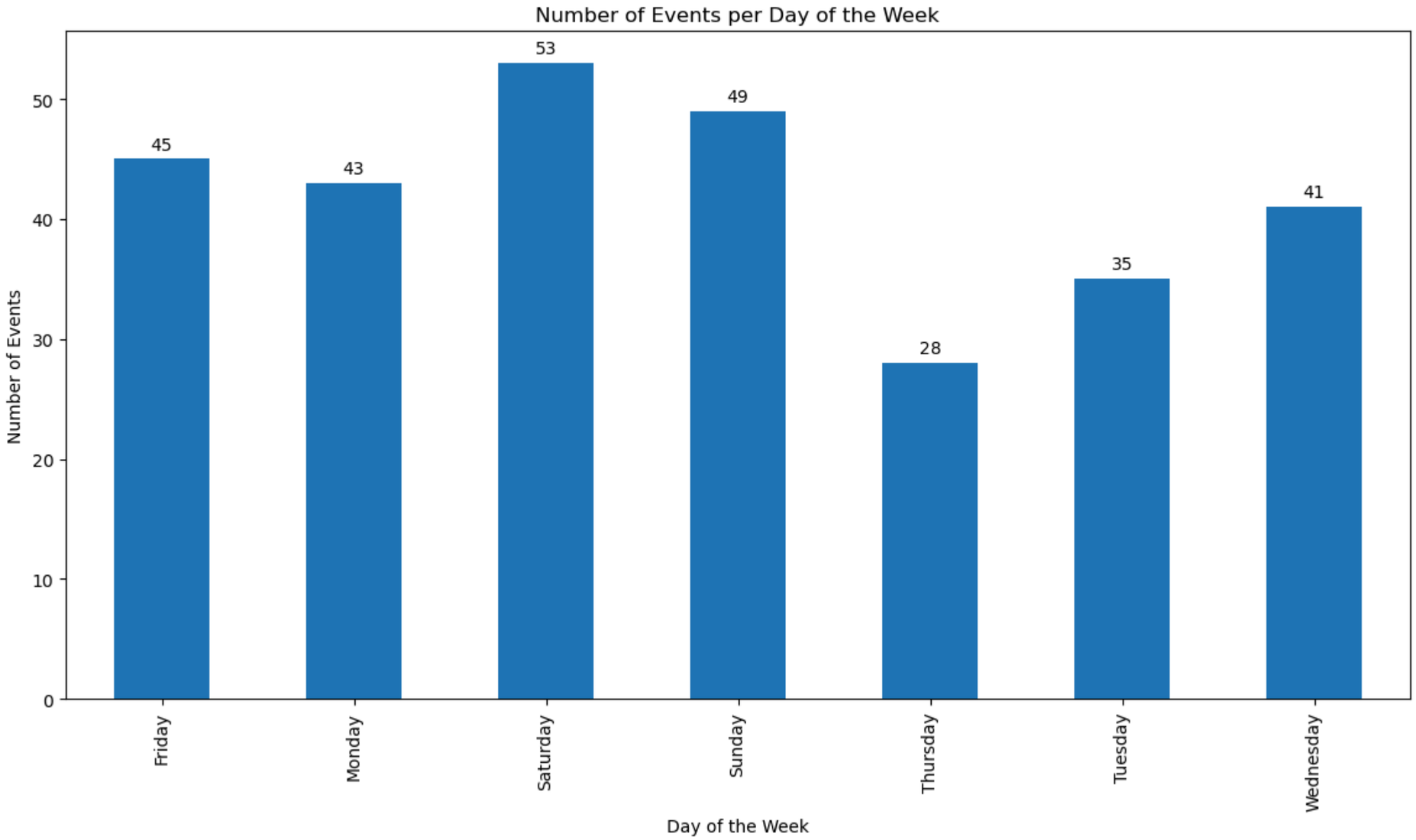
```python
# Plot number of events by date
plt.figure(figsize=(14, 7))
events_by_date = df['Date'].value_counts().sort_index()
events_by_date.plot(kind='line')
plt.title('Number of Events by Date')
plt.xlabel('Date')
plt.ylabel('Number of Events')

# Annotate the plot
for i, value in enumerate(events_by_date):
    plt.annotate(value, (events_by_date.index[i], value), textcoords="offset points", xytext=(0,10), ha='center')

plt.show()
```



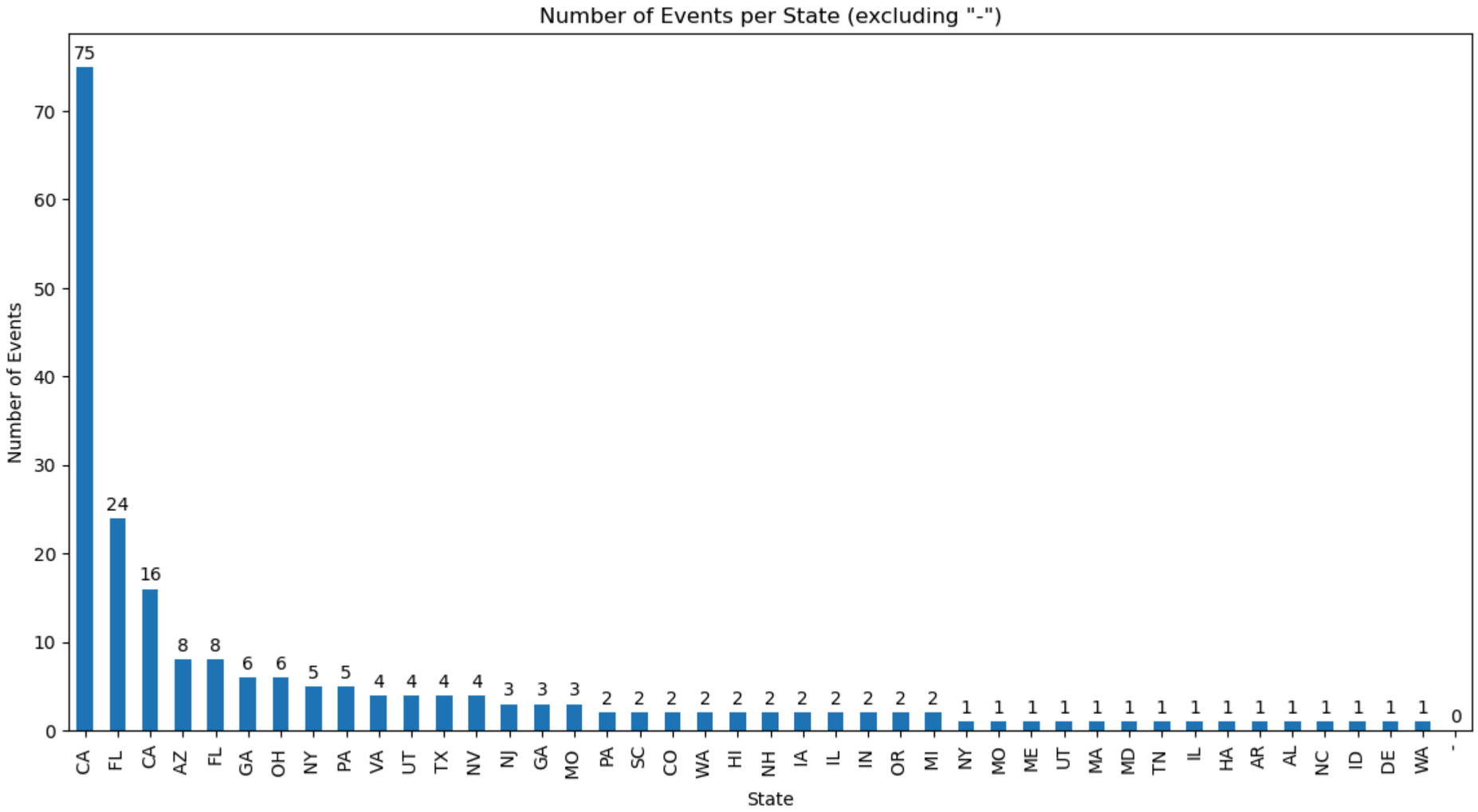
In [25]:
```python
# Plot number of events per year
plt.figure(figsize=(14, 7))
events_per_year = df['Year'].value_counts().sort_index()
events_per_year.plot(kind='bar')
plt.title('Number of Events per Year')
plt.xlabel('Year')
plt.ylabel('Number of Events')

# Annotate the plot
for i, value in enumerate(events_per_year):
    plt.text(i, value + 0.5, str(value), ha='center', va='bottom')

plt.show()
```



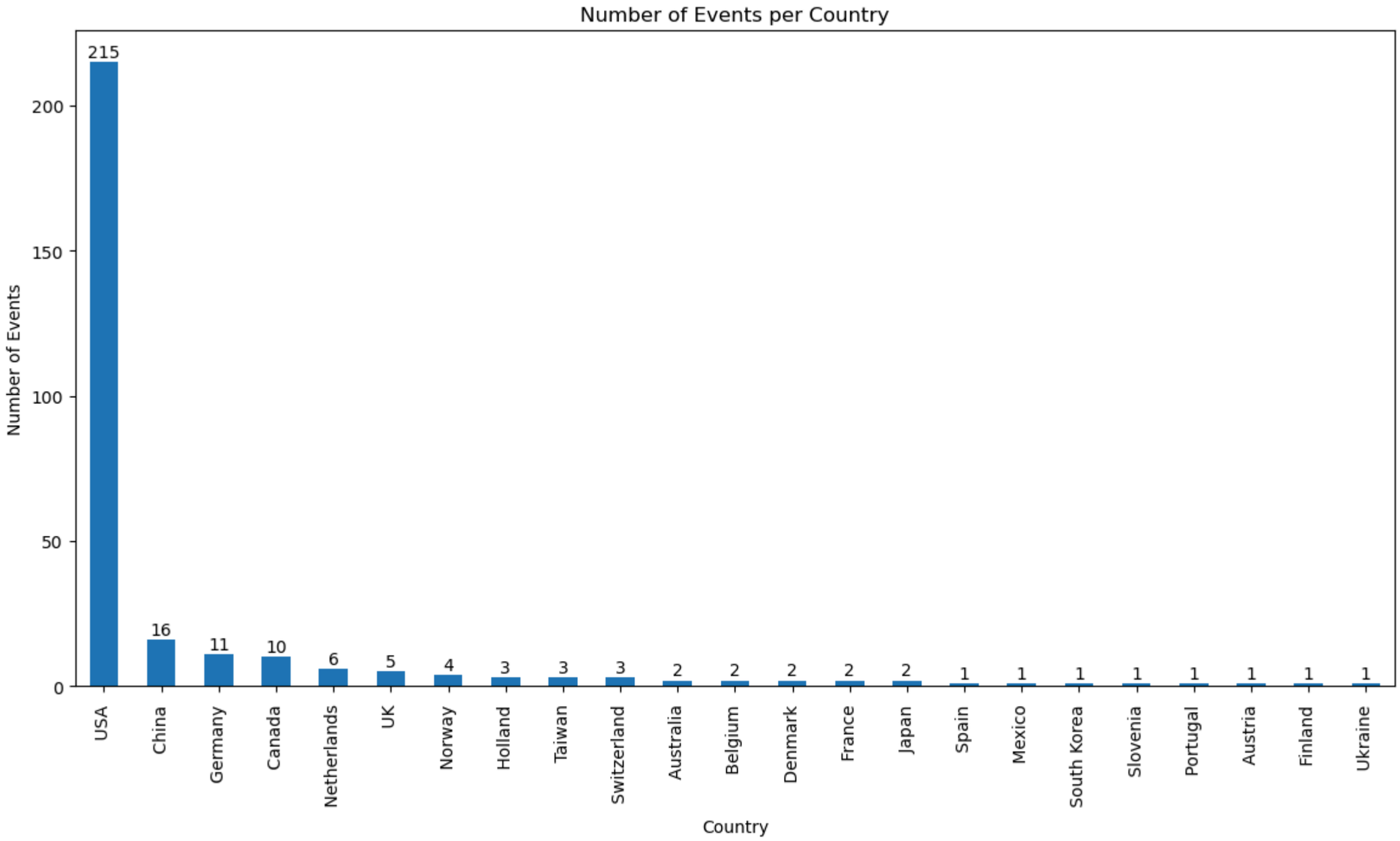
In [27]:
```python
# Extract day of the week from Date and create DayOfWeek column
df['DayOfWeek'] = df['Date'].dt.day_name()

# Plot number of events per day of the week
plt.figure(figsize=(14, 7))
events_per_dayofweek = df['DayOfWeek'].value_counts().sort_index()
events_per_dayofweek.plot(kind='bar')
plt.title('Number of Events per Day of the Week')
plt.xlabel('Day of the Week')
plt.ylabel('Number of Events')

# Annotate the plot
for i, value in enumerate(events_per_dayofweek):
    plt.text(i, value + 0.5, str(value), ha='center', va='bottom')

plt.show()
```



In [28]:
```
# Filter out rows where State is '-'
df_filtered = df[df['State'] != '-']

# Plot number of events per state excluding '-'
plt.figure(figsize=(14, 7))
events_per_state_filtered = df_filtered['State'].value_counts()
events_per_state_filtered.plot(kind='bar')
plt.title('Number of Events per State (excluding "-")')
plt.xlabel('State')
plt.ylabel('Number of Events')

# Annotate the plot
for i, value in enumerate(events_per_state_filtered):
    plt.text(i, value + 0.5, str(value), ha='center', va='bottom')

plt.show()
```



In [29]:
```
# Plot number of events per country
plt.figure(figsize=(14, 7))
events_per_country = df['Country'].value_counts()
events_per_country.plot(kind='bar')
plt.title('Number of Events per Country')
plt.xlabel('Country')
plt.ylabel('Number of Events')

# Annotate the plot
for i, value in enumerate(events_per_country):
    plt.text(i, value + 0.5, str(value), ha='center', va='bottom')

plt.show()
```



b. Analyze the different aspects of the death events

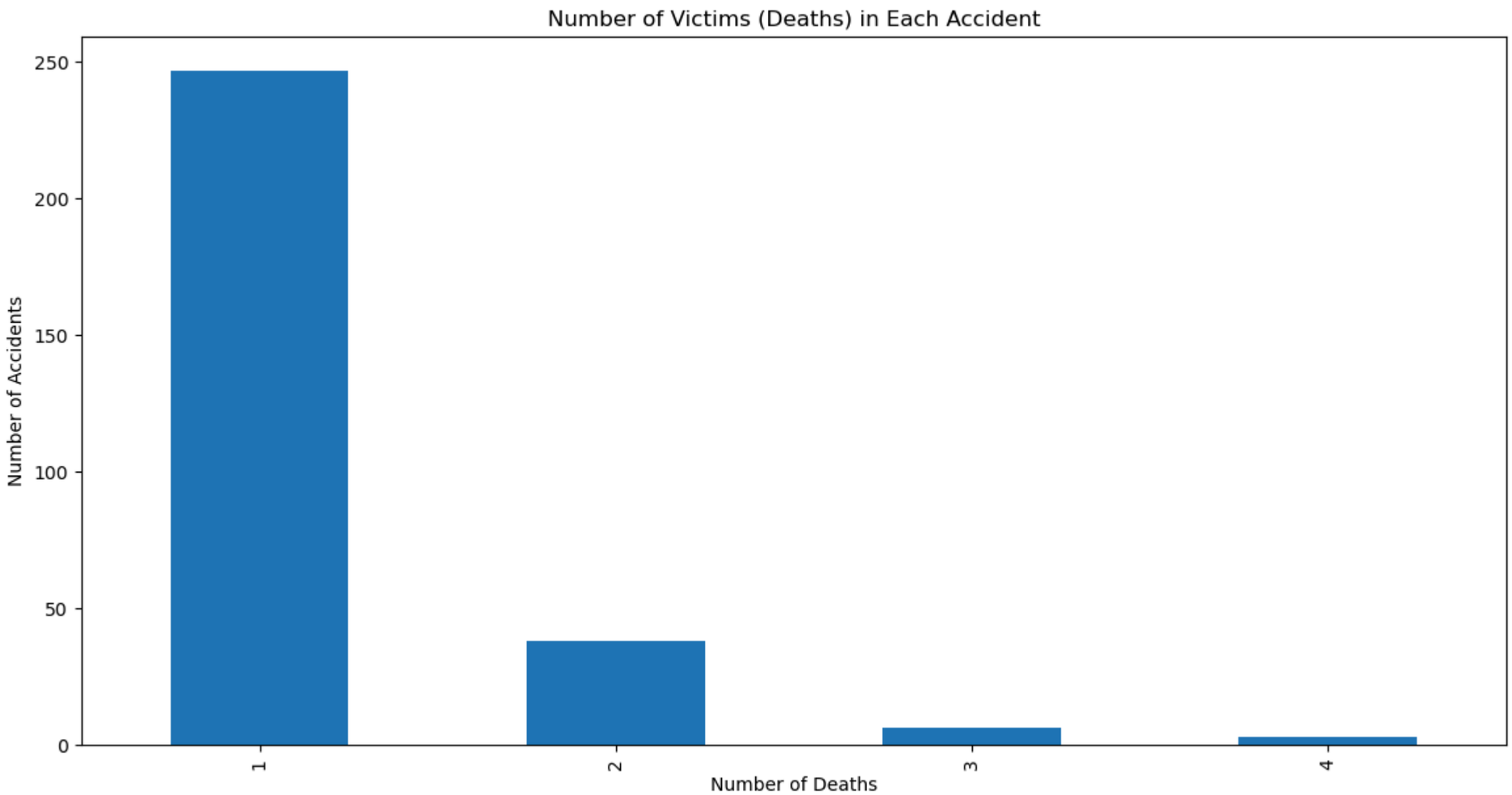
What is the number of victims (deaths) in each accident?

In [30]:
```
# Distribution of number of deaths in each accident
deaths_distribution = df['Deaths'].value_counts().sort_index()
print(deaths_distribution)
```

```
Deaths
1    247
2     38
3      6
4      3
Name: count, dtype: int64
```

In [31]:
```
# Plot the distribution
plt.figure(figsize=(14, 7))
deaths_distribution.plot(kind='bar')
plt.title('Number of Victims (Deaths) in Each Accident')
plt.xlabel('Number of Deaths')
```

```
plt.ylabel('Number of Accidents')
plt.show()
```



How many times did tesla drivers die?

In [32]:
```
# Number of times Tesla drivers died
tesla_driver_deaths = df['Tesla driver'].sum()
print(f'Tesla drivers died in {tesla_driver_deaths} accidents.')
```

```
Tesla drivers died in 117 accidents.
```

What is the proportion of events in which one or more occupants died?

In [33]:
```
# Proportion of events with one or more Tesla occupants dying
occupant_death_events = (df['Tesla occupant'] > 0).sum()
total_events = len(df)
occupant_death_proportion = occupant_death_events / total_events
print(f'Proportion of events with one or more occupants dying: {occupant_death_proportion:.2%}')
```

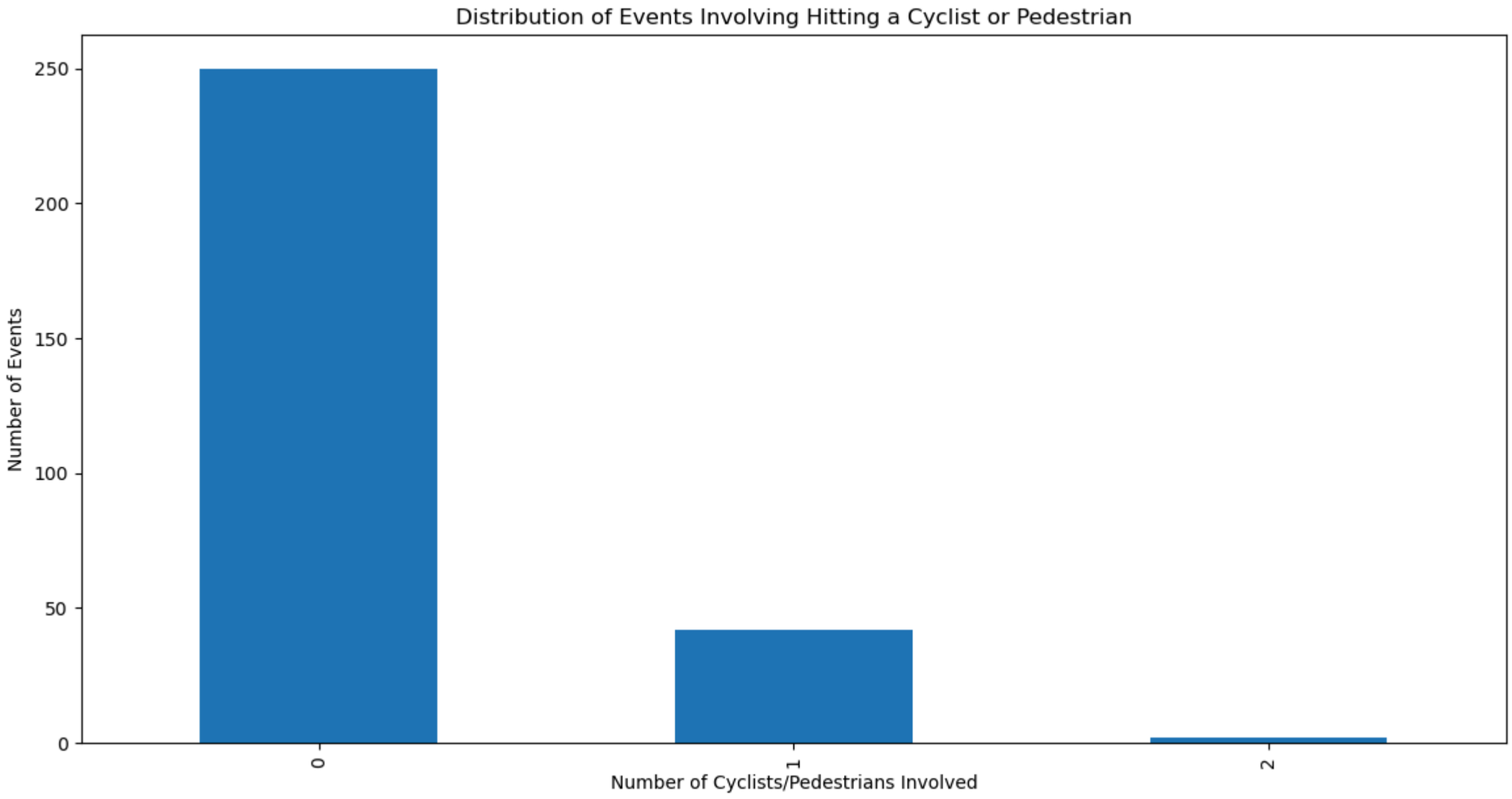
```
Proportion of events with one or more occupants dying: 14.63%
```

What is the distribution of events in which the vehicle hit a cyclist or a pedestrian?

In [34]:
```
# Distribution of events involving hitting a cyclist or pedestrian
cyclist_ped_events = df['Cyclists/ Peds'].value_counts().sort_index()
print(cyclist_ped_events)
```

```
Cyclists/ Peds
0    250
1     42
2      2
Name: count, dtype: int64
```

In [35]:
```
# Plot the distribution
plt.figure(figsize=(14, 7))
cyclist_ped_events.plot(kind='bar')
plt.title('Distribution of Events Involving Hitting a Cyclist or Pedestrian')
plt.xlabel('Number of Cyclists/Pedestrians Involved')
plt.ylabel('Number of Events')
plt.show()
```



How many times did the accident involve the death of an occupant or driver of a Tesla along with a cyclist or pedestrian?

In [36]:
```
# Number of events with Tesla driver or occupant deaths along with cyclist/pedestrian deaths
joint_death_events = df[(df['Tesla driver'] > 0) | (df['Tesla occupant'] > 0) & (df['Cyclists/ Peds'] > 0)].shape[0]
print(f'Number of accidents involving deaths of Tesla occupants/drivers and cyclists/pedestrians: {joint_death_events}')
```

```
Number of accidents involving deaths of Tesla occupants/drivers and cyclists/pedestrians: 118
```

What is the frequency of Tesla colliding with other vehicles?

In [37]:
```
# Frequency of Tesla colliding with other vehicles
collision_with_other_vehicles = (df['Other vehicle'] > 0).sum()
```

```
print(f'Number of accidents involving collision with other vehicles: {collision_with_other_vehicles}')
```

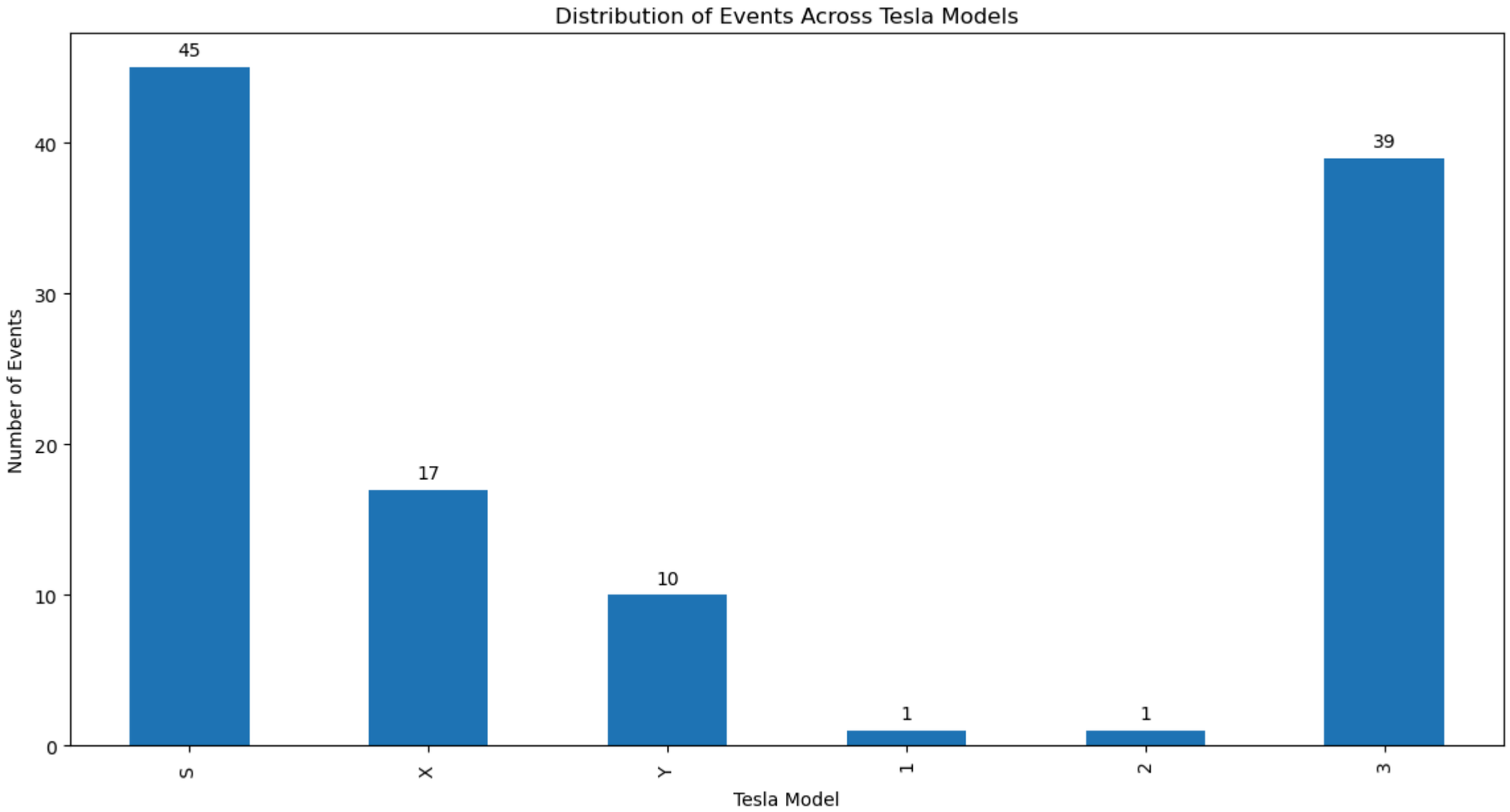
```
Number of accidents involving collision with other vehicles: 110
```

C. Study the event distribution across models

In [38]:
```
# Count the number of events for each model
events_per_model = df['Model'].value_counts().sort_index()
print(events_per_model)

# important note that there are 181 missing values in the model column, so I am choosing not to show them in this distribution
```

```
Model
 S     45
 X     17
 Y     10
1       1
2       1
3      39
Name: count, dtype: int64
```

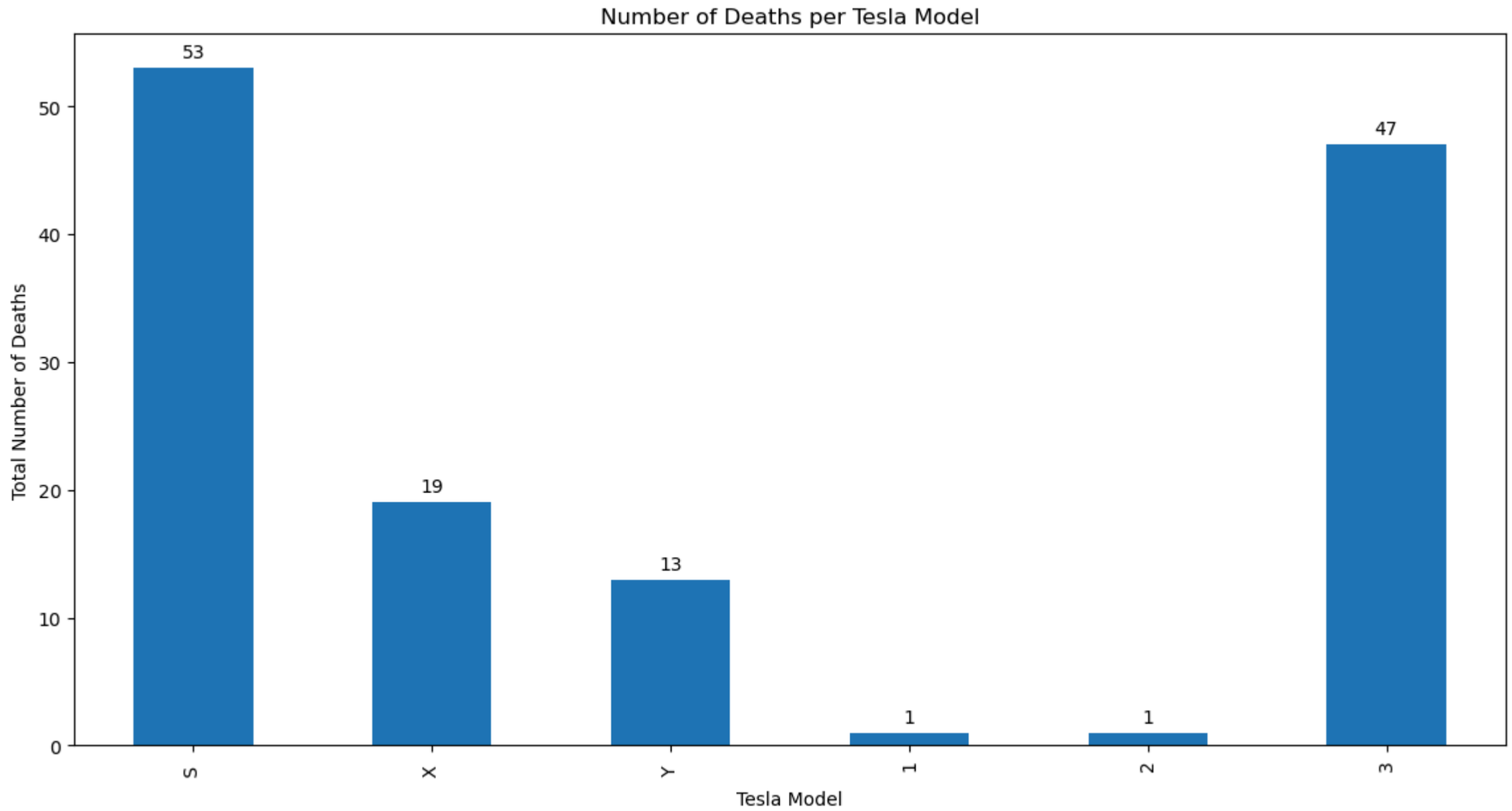
In [39]:
```
# Plot the distribution of accidents across models
plt.figure(figsize=(14, 7))
events_per_model.plot(kind='bar')
plt.title('Distribution of Events Across Tesla Models')
plt.xlabel('Tesla Model')
plt.ylabel('Number of Events')

# Annotate the plot
for i, value in enumerate(events_per_model):
    plt.text(i, value + 0.5, str(value), ha='center', va='bottom')

plt.show()
```



Showing the number of deaths per model

In [40]:
```python
# Aggregate the number of deaths per model
deaths_per_model = df.groupby('Model')['Deaths'].sum().sort_index()
print(deaths_per_model)

# Plot the number of deaths per model
plt.figure(figsize=(14, 7))
deaths_per_model.plot(kind='bar')
plt.title('Number of Deaths per Tesla Model')
plt.xlabel('Tesla Model')
plt.ylabel('Total Number of Deaths')

# Annotate the plot
for i, value in enumerate(deaths_per_model):
    plt.text(i, value + 0.5, str(value), ha='center', va='bottom')

plt.show()
```

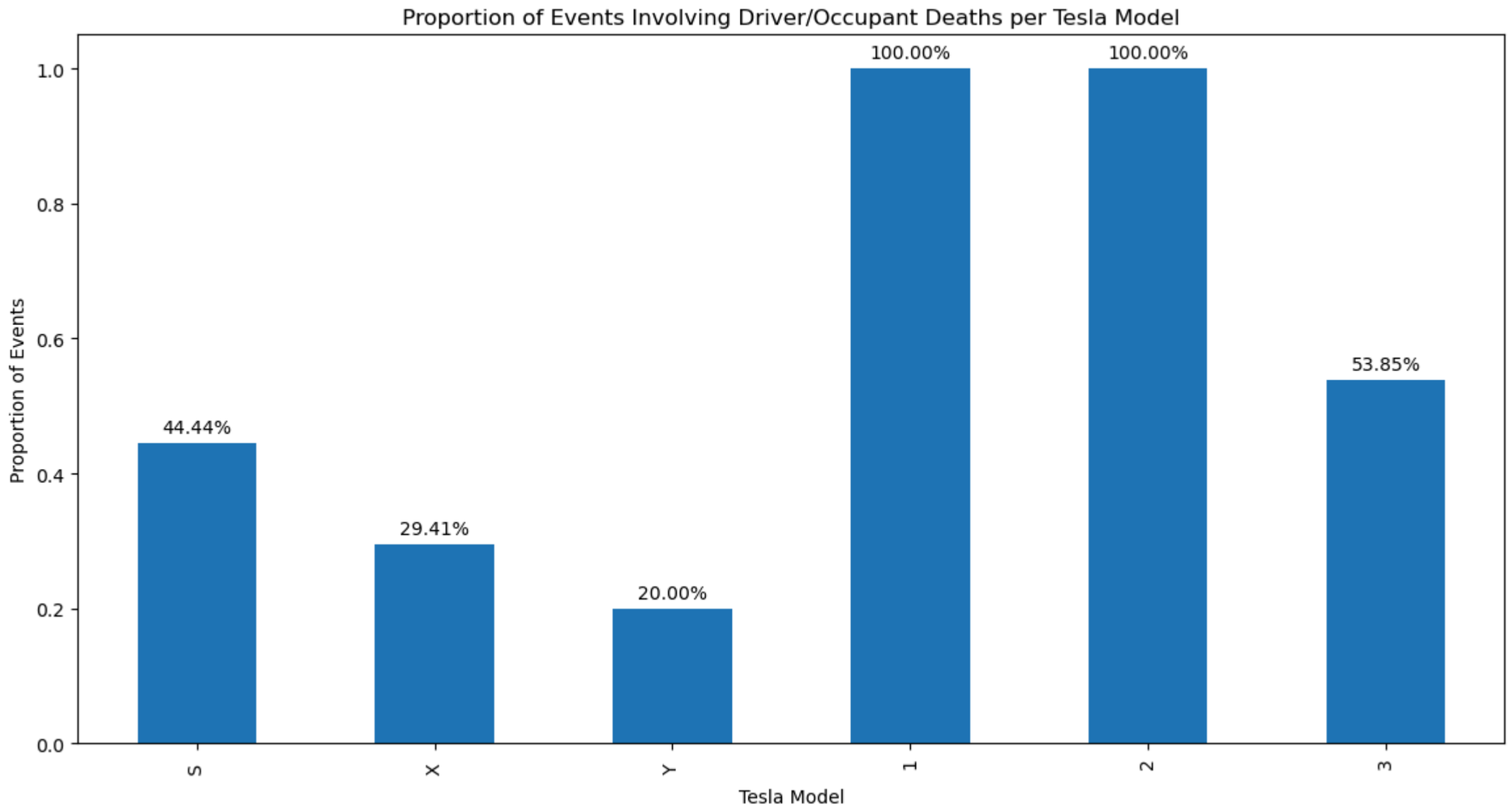
```
Model
 S     53
 X     19
 Y     13
1       1
2       1
3      47
Name: Deaths, dtype: int64
```



Showing the Proportion of Events Involving Driver/Occupant Deaths per Model

In [41]:
```python
# Calculate the proportion of events involving driver/occupant deaths per model
death_events_per_model = df.groupby('Model').apply(lambda x: ((x['Tesla driver'] > 0) | (x['Tesla occupant'] > 0)).mean()).sort_index()
print(death_events_per_model)

# Plot the proportion of events involving driver/occupant deaths per model
plt.figure(figsize=(14, 7))
death_events_per_model.plot(kind='bar')
plt.title('Proportion of Events Involving Driver/Occupant Deaths per Tesla Model')
plt.xlabel('Tesla Model')
plt.ylabel('Proportion of Events')

# Annotate the plot
for i, value in enumerate(death_events_per_model):
    plt.text(i, value + 0.01, f'{value:.2%}', ha='center', va='bottom')

plt.show()
```

```
Model
 S     0.444444
 X     0.294118
 Y     0.200000
1      1.000000
2      1.000000
3      0.538462
dtype: float64
```



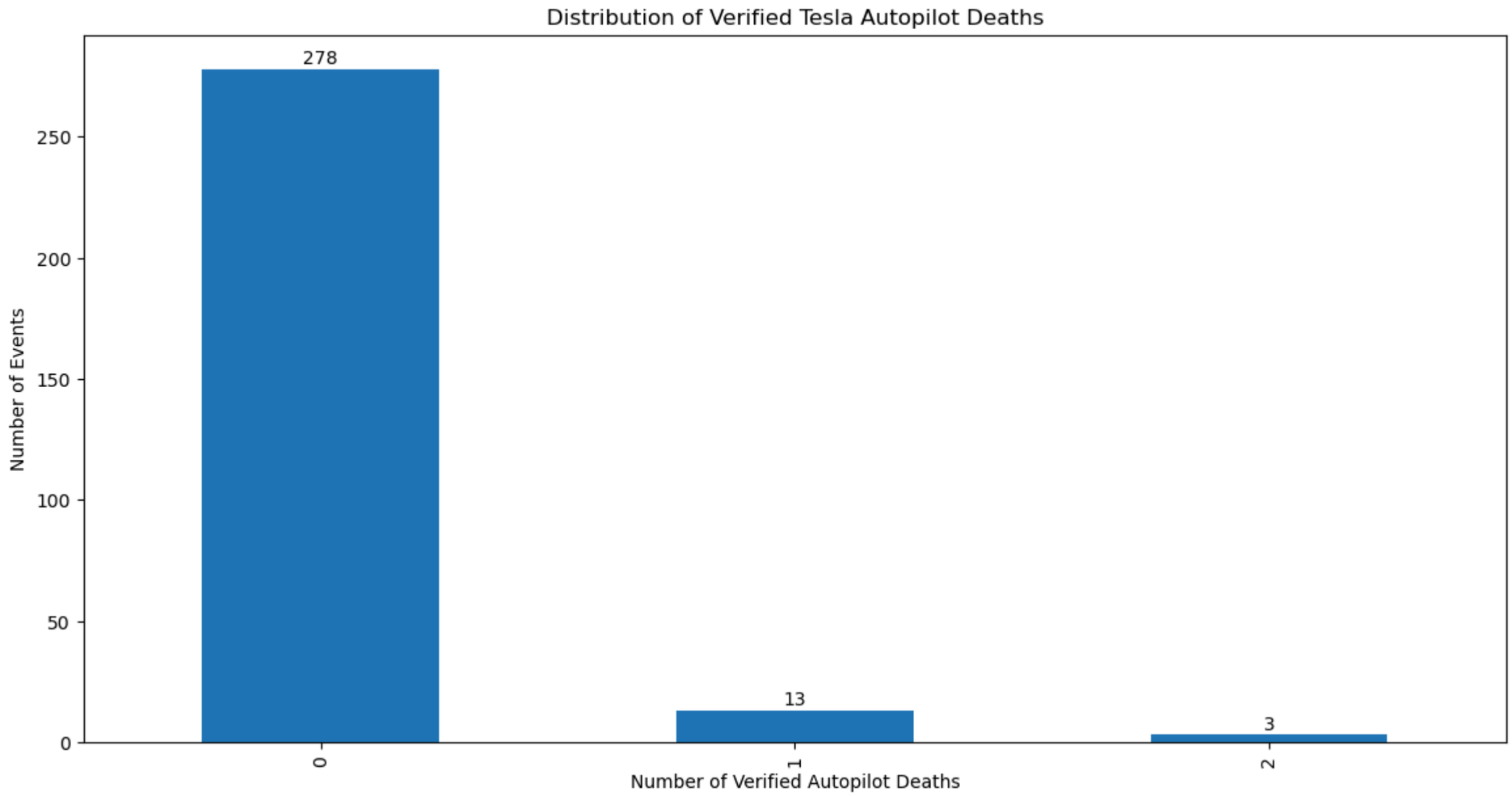
D. Check the distribution of verified Tesla autopilot deaths

In [42]:
```
# Count the number of verified Tesla autopilot deaths
autopilot_deaths_count = df['Verified Tesla Autopilot Deaths'].value_counts(dropna=False).sort_index()
print(autopilot_deaths_count)
```

```
Verified Tesla Autopilot Deaths
0    278
1     13
2      3
Name: count, dtype: int64
```

In [43]:
```
# Plot the distribution of verified Tesla autopilot deaths
plt.figure(figsize=(14, 7))
autopilot_deaths_count.plot(kind='bar')
plt.title('Distribution of Verified Tesla Autopilot Deaths')
plt.xlabel('Number of Verified Autopilot Deaths')
plt.ylabel('Number of Events')
```

```
# Annotate the plot
for i, value in enumerate(autopilot_deaths_count):
    plt.text(i, value + 0.5, str(value), ha='center', va='bottom')

plt.show()
```



The above shows us that there are only a few verified autopilot deaths. Most of them were not verified (0).

In [ ]: