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TEM 598: Transform Info. Meaningful Communication

P6 - Final Report

Tesla Deaths: An In-depth Look into Driver, Occupant, and Pedestrian Deaths

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1. INTRODUCTION:

Data has been studied and collected by The National Transportation Safety Board, offers a thorough examination of tragic Tesla car collisions that have claimed the lives of the driver, another passenger, a biker, or a pedestrian. It includes a wealth of information on the tragic occurrences, such as the time and place of each crash, the models involved, and whether Autopilot was turned on at the time. Every case is assigned a distinct identity for quick reference and in-depth review. You now can thoroughly examine these documents to comprehend what occurred during those awful events and how we can avoid them from occurring again.

The goal of this study is to determine the positive and negative effects of Tesla's new project Autopilot on the company's development. Based on the data provided, it is possible to infer that the introduction of Autopilot helps Tesla's development, positioning it as a leader in both ADAS and the driverless car sector. In terms of pros, Autopilot distinguishes Tesla from other automakers by replacing the conventional LiDAR system with a combination of eight cameras around the car; utilizing the high working efficiency system "HydraNet" to avoid repeated computations between different tasks; and upgrading with BEV spatial transformation layer to assist transforming 2D images captured to real-world 3D space.

Thus, all the evidence shown above proves that Tesla's revolutionary Autopilot technology offers it great fortune and elevates it to the forefront of the autonomous vehicle business. While it is reasonable that the increasing number of car accidents employing Autopilot signal that it is technologically immature, Tesla should begin to take actions to prevent such problems rather than waiting for them to arise. By assessing the benefits and cons of Autopilot, it is regarded a successful Tesla innovation and one of the major factors to Tesla's future success.

2. SCOPE OF INQUIRY:

The research examined the cross-verified information from NHTSA investigations and reports (such as telemetric data from Tesla compiled in the NHTSA Standing General Order on Crash Reporting ("SGO") portal) as well as expert testimony in court cases pertaining to the particular crashes, the confirmed number of Tesla Autopilot crashes—that is, incidents where Autopilot was active within 30 seconds of the crash—is currently sixteen crashes resulting in nineteen fatalities. It's important to highlight that it is yet to cross-verify three cases with one fatality each in the SGO with media coverage.

The IIHS distributes mortality data on car types and driver deaths per million registered vehicle years on a periodic basis. Given that the overall cost of a difficult to obtain base Model 3 is still more than 35,000 USD, the closest classification to apply to Tesla's is large or midsized luxury SUVs. Numerous vehicles have zero, as the IIHS chart demonstrates. To help them better grasp the contrast, we welcome the users to compute the rates for the other models. Additionally, using on data provided by the Tesla firm, we attempt to estimate the million registered miles per fatality for the Tesla fleet; however, mileage data is no longer made available.

As of 1/31/2023, we are aware of the following non-Tesla electric vehicle deaths:

August 12, 2021: Nio - ES8 - 1 death
May 27, 2021: Nissan - Leaf - 1 death
Nov. 9, 2020: Chevrolet - Bolt - 1 death.

Feb 28, 2020: Renault - Zoe - 2 deaths
June 18, 2020: Jaguar - I Pace - 1 death
July 31, 2019: Nissan - Leaf - 1 death
May 29, 2012: BYD - e6 electric taxi - 1 death.

Additionally, I used the assumption that every Tesla ever sold was still in operation as of the period's end on December 31, 2016, which had the unintended consequence of somewhat underestimating the actual mortality rate. The figure below shows years of ownership for all Tesla car models, along with a graph showing that tesla is 6.6 times less likely to crash than a normal car. [1]

Year	Vehicles Sold	Quarters on road	Vehicle Years
2012	2,650	17.4	11,528
2013	22,477	13.4	75,298
2014	31,655	9.4	74,389
Q1 2015	10,045	7.4	18,583
Q2 2015	11,532	6.4	18,451
Q3 2015	11,603	5.4	15,664
Q4 2015	17,478	4.4	19,226
Q1 2016	14,820	3.4	12,597
Q2 2016	14,402	2.4	8,641
Q3 2016	24,821	1.4	8,687
Q4 2016	22,254	0.4	2,225
	Tesla total vehicle years		265,290

Fig 2.1 Years of ownership for all Tesla Model S and X vehicles as of December 31, 2016

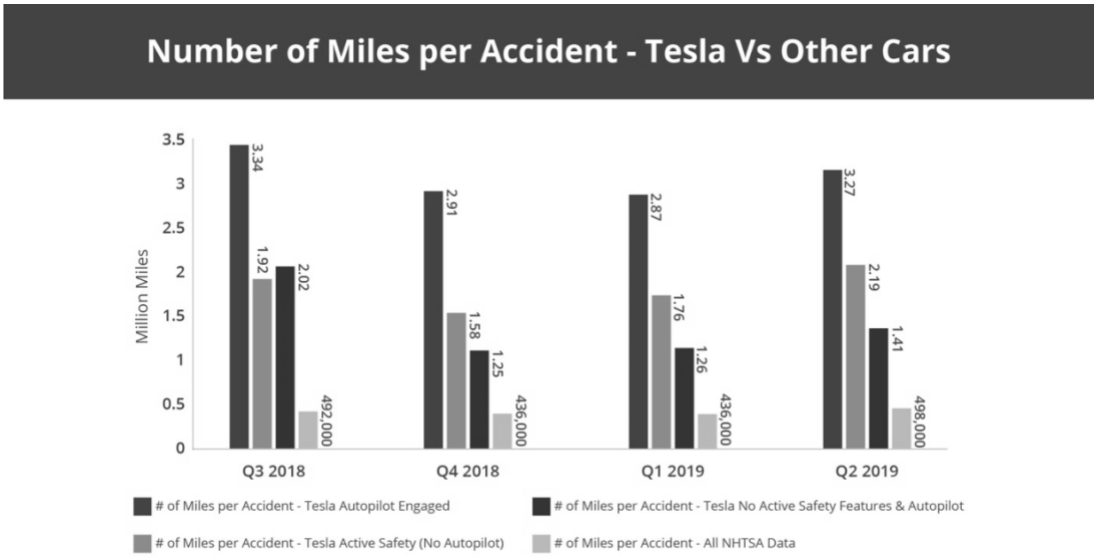

Fig 2.2 Graph showing Tesla 6.6 times less likely to crash than a normal car.

No other vehicle has a vehicle safety rating as high as the most recent Model 3's 0.38, according to the NHTSA. This is explained by Tesla automobiles' low center of gravity and evenly distributed weight.

3) METHODS:

Tesla makes improvements on Autosteer, summon (Beta), Perpendicular Auto Park, Enhanced Autopilot Visualizations, Traffic-Aware Cruise Control Improvements, Additional Autopilot Improvements, HomeLink: Auto-Open/Close, Vehicle Lock Improvements, Display Auto-Brightness, Supercharger Site Availability, Trip Planner Improvement, and Other Improvements are among the enhancements made by Tesla. Tesla released the last version of Autopilot HW1, version 8.0, at the end of 2016. It enhances the Intuitive Media Players, Voice Commands, Maps, Navigations, Cabin Overheat Protections, Trip Planners, and Autopilot Enhancements in version 8.0.

Tesla's reputation, on the other hand, is being influenced while the company is growing. Autopilot is also a two-edged blade, bringing with it a slew of issues and criticisms for Tesla. Since 2018, the safety of Tesla's autopilot has been a hot topic, causing a customer belief crisis to some extent. In the United States, automotive event data is first gathered in 2022, after the NHTSA (National Highway Traffic Safety Administration) mandated in June 2021 that all automakers record car accidents involving "Level-2" ADAS. Tesla is once again pushed to the brink of public opinion after the data is first disclosed a year later. On June 15th, 2022, the United States safety agency reports that Tesla is responsible for most driver-assist crashes. Throughout the year, Tesla has been involved in approximately 70% (273) of the 392 recorded car crashes employing ADAS. Honda (90 reported accidents), Subaru (10), and Ford Motor (5) will be the top three vehicle brands, while Toyota, BMW, and General Motors will have had fewer than four accidents in the previous year. [7]

The method and equipment used to source and acquire initial data will depend on the type of data you are looking to acquire. I used these certain methods for the collection of Tesla car crash deaths data.
Surveying: Surveying is used to collect data related to topography, elevation, and other spatial information. The equipment used in surveying includes theodolites, total stations, GPS devices, and aerial photography or LiDAR technology.

Interviews and Questionnaires: Interviews and questionnaires are a common method for gathering data from people. The equipment used for this method is typically a pen and paper or an electronic device such as a tablet or smartphone.

Focus Groups: Focus groups involve bringing a group of people together to discuss a specific topic. The equipment used for this method is typically a recording device such as a digital audio recorder.

Observations: Observations involve recording data by watching and recording events as they occur. The equipment used for this method can include a video camera or still camera, a notebook, or an electronic device.

Web Scraping: Web scraping involves extracting data from websites. The equipment used for this method can include web scraping software, programming languages like Python, and APIs.

A graphical representation of how data is collected is shown in a figure below. In some cases, data may need to be purchased from third-party sources. The methods used to acquire this data will depend on the specific vendor and may include a subscription or one-time purchase.

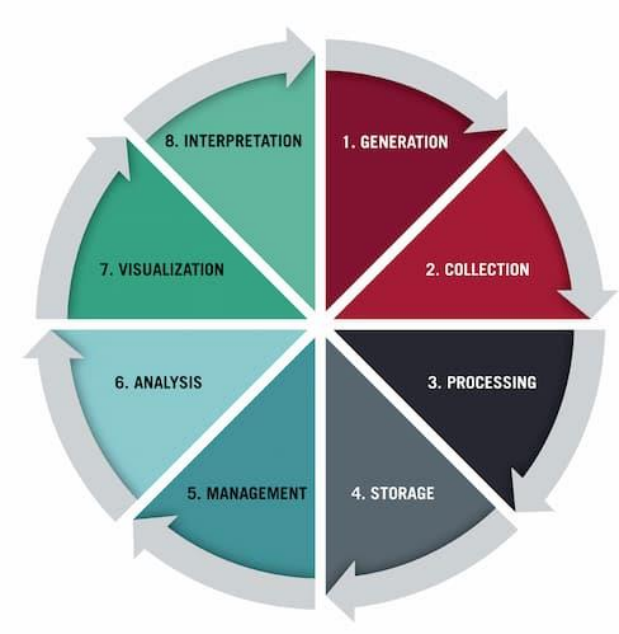

Fig 3.1 Graphical visualization of how Data is collected.

1. **What type of data preprocessing, measurements to be analyzed.**

The data/methods used to contribute to a more accurate depiction of quantitative data based on the given information, the type of data preprocessing required would likely involve collecting data related to crashes and accidents involving autonomous vehicles and comparing it with data on crashes involving human drivers. This would involve analyzing factors such as reaction times, system effectiveness, and other relevant metrics. It would also require identifying and gathering relevant data sources, such as patent filings and behavior in related situations, to better understand how automakers approach these hypothetical problems. Additionally, the data analysis would need to consider the expected improvements in technology that are likely to make autonomous vehicles safer in the future. Overall, the data analysis would require careful attention to detail and a rigorous approach to processing and analyzing complex data sets. [4]

In terms of acquisition and equipment systems, it's important to ensure that the equipment you are using is reliable and accurate. This may include using equipment that has been calibrated or tested for accuracy, maintaining equipment regularly, and ensuring that it is used properly. Additionally, data security and privacy are important considerations, particularly if the data you are collecting includes personal information. This may include encrypting data and restricting access to it. A collaborative driving style of data classification is shown below.

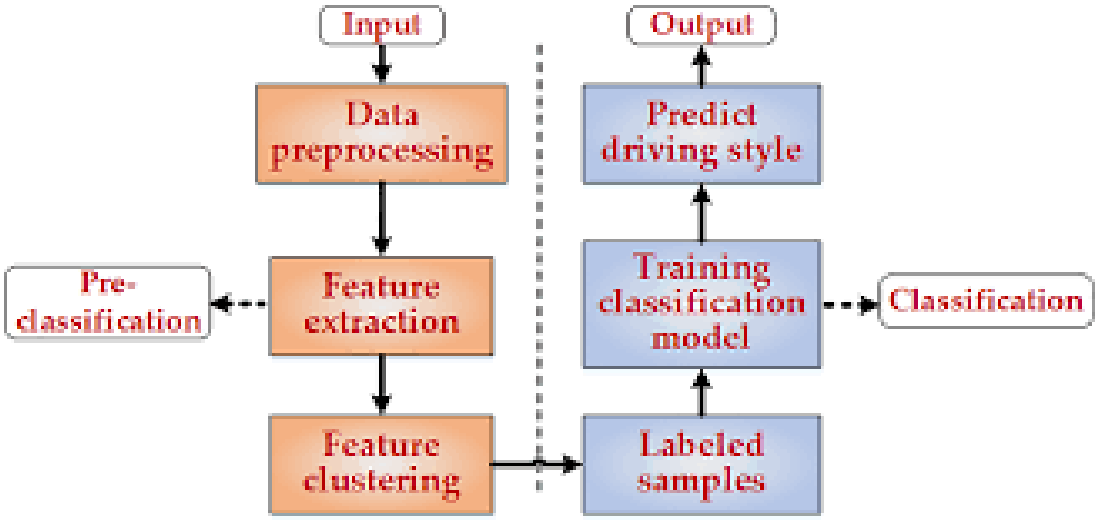

Figure 3.2 Collaborative driving style classification method enabled by majority voting ensemble.

The analysis approach to analyzing Tesla car crash deaths would involve a comprehensive examination of the available data and information related to the accidents. The following steps could be taken: [3]

1. Data collection: Collect all relevant data on the accidents, including details on the vehicles involved, the location, weather conditions, and other relevant factors. This data can be obtained from various sources, including police reports, eyewitness accounts, and news articles.
2. Categorization: Categorize the accidents based on factors such as the type of accident, the severity of the crash, the location, and the time of day. This will help to identify patterns and trends in the data.
3. Comparative analysis: Compare the accidents involving Tesla's autopilot mode with accidents involving other cars, both electric and traditional, to determine whether there are any significant differences in the frequency or severity of accidents.

4. Identify contributing factors: Analyze the data to identify the contributing factors to the accidents, including driver behavior, road conditions, and the performance of the autopilot system.
5. Statistical analysis: Perform statistical analysis to identify patterns and trends in the data, including correlations between different factors and the frequency and severity of accidents.
6. Recommendations: Based on the analysis, make recommendations for improvements to the autopilot system and other factors that can help to reduce the risk of accidents involving electric vehicles.

Overall, the analysis approach should be data-driven and objective, with a focus on identifying the root causes of accidents and developing strategies to prevent them in the future.

4. ANALYSIS:

1.2 Analysis of data and how prevalent it is.

Since August of last year, the NHTSA has been looking into Autopilot following several accidents between Tesla's and emergency vehicles that were stopped alongside roads and flashing their lights. When the probe was advanced to what is known as an engineering analysis in June, it took a step toward a recall. In documents, the agency expressed concerns about the system after discovering that many drivers were failing to take precautions to avoid collisions despite the vehicle's warnings and that the technology was being used in situations where it had limited functionality.

As of only the year 2022, Germany reports to have the maximum number of Tesla car crash cases amounting to 254 cases. Followed by the USA claiming 253 cases. USA amounts to 73%, China = 5% and others = 22% as the country where accidents occurred.

The NHTSA also reported 16 collisions in which vehicles equipped with automated systems collided with emergency vehicles and trucks flashing warning lights, resulting in 15 injuries and one death. The National Transportation Safety Board, which has also studied some of the Tesla crashes dating back to 2016, has advised that the NHTSA and Tesla limit the use of Autopilot to regions where it can work safely. The NTSB also suggested that the NHTSA order Tesla to upgrade its systems to guarantee that drivers pay attention. The NHTSA has yet to act on the suggestions. [2] The graph below shows crash car rates before and after autosteer installation.

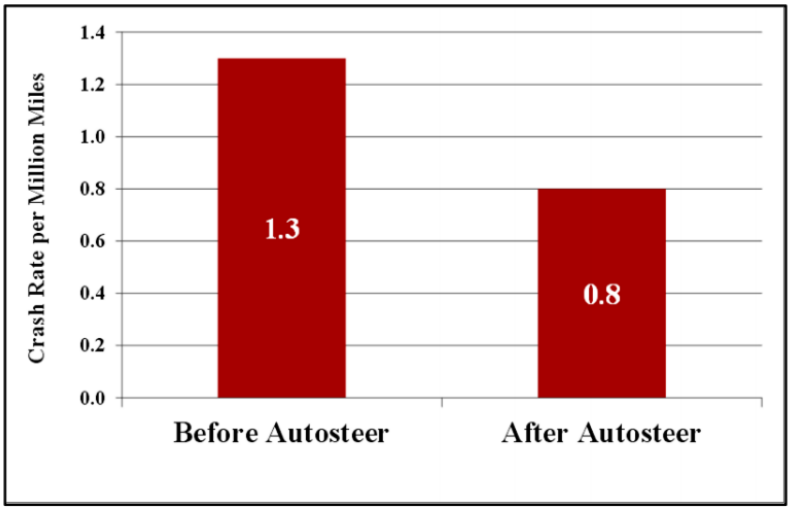

Fig 4.1 Crash Rates in MY 2014-16 Tesla Model S and 2016 Model X vehicles Before and After Autosteer Installation.

ANALYSIS I:

The National Transportation Safety Board's data, which has been reviewed and collected, provides a thorough study of devastating Tesla car incidents that have claimed the life of the driver, another passenger, a biker, or a pedestrian. It contains a multitude of information about the sad events, such as the time and location of each crash, the models involved, and whether Autopilot was turned on at the time. Each case is given a unique identifier for easy reference and in-depth review. You can now thoroughly analyze these records to understand what happened during those heinous events and how we can prevent them from happening again. I'm undertaking an analysis of Tesla-related deaths and categorizing them.

Tesla Deaths is a database of Tesla incidents that resulted in the death of a driver, occupant, cyclist, motorcyclist, or pedestrian, regardless of whether the Tesla or its driver was at fault.

An up-to-date list of Tesla fatalities and Tesla accident deaths, as well as much crash data as possible (e.g., location of crash, names of deceased, etc.). This sheet also tracks claimed and proven Tesla autopilot crashes, that is, incidents in which Autopilot was enabled during a Tesla crash that resulted in death.

Consider using descriptive statistics such as means and medians to identify if some models are. more prone to accidents than others when compared to one another, as well as investigating whether Autopilot feature usage has any association to greater rates/numbers of deaths.

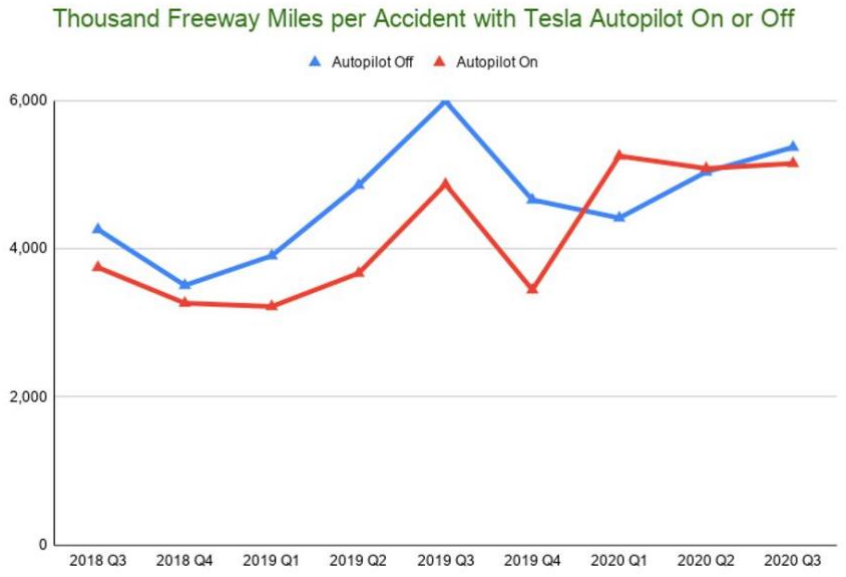

Figure 4.2 Chart of miles per "accident" with and without Tesla Autopilot, corrected for freeway vs. city driving.

ANALYSIS II:

Tesla is known for its innovative electric vehicles that are equipped with advanced autonomous driving features. To provide transparency about the safety of its vehicles, the company releases quarterly statistics on the number of accidents per mile driven by its fleet. These statistics are broken down by driving mode, including Autopilot engaged, active safety features but no Autopilot, and neither.

According to the most recent statistics, in the third quarter, the rate of accidents per 4.59 million miles driven with Autopilot engaged was one, compared to one accident per 2.42 million miles driven without Autopilot but with active safety features, and one accident per 1.79 million miles driven without either. While these numbers may appear to suggest that Autopilot significantly reduces the risk of accidents, it is important to consider the contexts in which Autopilot is typically used.

Research conducted by the Massachusetts Institute of Technology (MIT) has found that 94% of Autopilot use occurs on limited access highways, which are typically easier to navigate and have lower accident rates compared to city streets. In fact, Tesla officially approves the use of Autopilot only on highways. By contrast, non-Autopilot driving includes a mix of 40% highway and 60% city street driving. This is significant because accident rates are around three times higher on city streets compared to highways.

Furthermore, Tesla is currently beta testing its Full Self-Driving (FSD) product with a small group of users. Unlike Autopilot, which is intended for use only on highways, FSD is designed to perform the same functions on city streets as well. It remains to be seen how the accident rates for FSD-equipped vehicles will compare to those of Autopilot and non-Autopilot driving. Overall, while Tesla's accident rate statistics are informative, it is important to consider the context in which these accidents occur, including the driving mode and the type of road.

Another graph on Tesla accidents with the Autopilot every 7.5 million kilometers distance since October 2018 is below

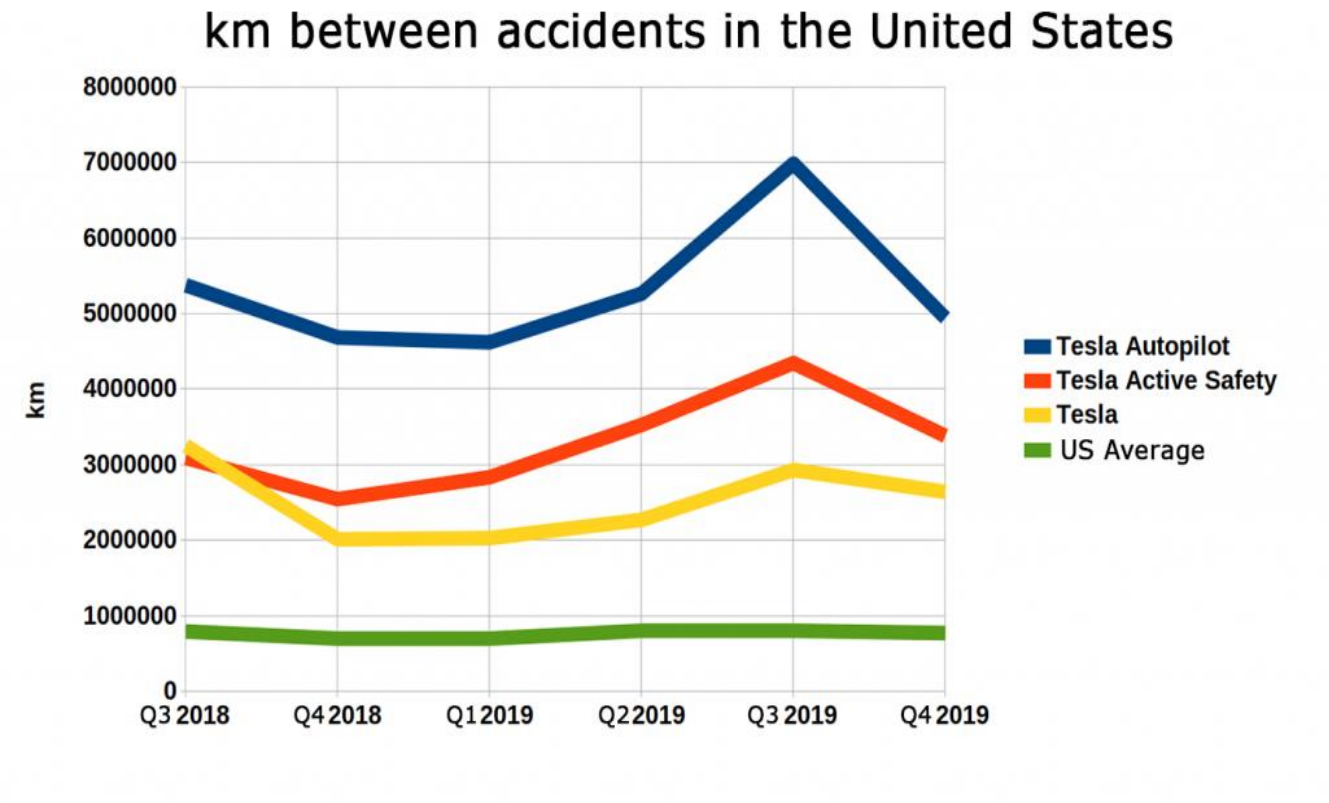

Figure 4.3 Distance in KM in between the accidents

Over here, I will talk about the accidents reported in the 1st quarter, we registered one accident for every 4.68 million miles driven in which drivers had Autopilot engaged. We recorded one collision for every 1.99 million miles traveled by individuals driving without Autopilot but with our active safety measures. We recorded one collision for every 1.42 million miles traveled by drivers who did not use Autopilot or other active safety measures. In comparison, according to the most recent NHTSA data, there is an automotive crash every 479,000 miles in the United States.

According to the results of the investigation, the Autopilot appears to be quite effective in preventing accidents. The data, however, may only be compared in absolute terms, from one quarter to the next. Moreover, drivers frequently use Autopilot only on highways, where accidents are less likely.

Yet, when comparing these data to the previous quarter, we observe a 50% improvement, demonstrating the constant work done by developers such as lately the detection of traffic lights and stop signs, always decreasing hazards even further. When Elon Musk decides to make Autopilot available as a subscription service, its popularity could skyrocket.

The conclusion being, everything has its pros and cons, Tesla here cannot be solely judged on the crashes that happen because of the Autopilot, because the pros of Autopilot weighs more: Listing some of them here:

1. Navigate on autopilot.
2. Autosteer
3. Auto Lane change
4. Auto Park
5. Automatic Emergency Braking: Applies brakes based on detecting cars and other obstacles.
6. Forward Collision Warning: Warns the driver of any potential collisions with any slower-moving or stationary cars.
7. Side Collision Warning: Warns of potential collisions with any obstacles alongside the car.
8. Obstacle Aware Acceleration: Detects any obstacle in front of your car while driving at low speeds and automatically reduces acceleration.
9. Blind Spot Monitoring: Warns the driver if any car or obstacle changes lanes.
10. Lane Departure Avoidance: Corrective steering is applied to keep your car in the intended lane.
11. Emergency Lane Departure Avoidance: Detects if your car is deflecting from its lane and steers it back into the driving lane to prevent collisions.

ANALYSIS III:

Another analysis is done on the Tesla auto pilot crash system, the data has been collected from various new articles published and interviews, along with National Transportation Safety Board's data.

Figure 4.4 Tableau visualization which shows death by any season or time recorded.

- Accidents in Tesla vs the deaths that happened.
- Deaths based on hour and day of the week.
- Accidents and deaths by the actual damage that happened to the passenger medically.
- Accidents and deaths because of any street light fluctuations.

Consequently, all the evidence shown above proves that Tesla's revolutionary Autopilot technology offers it great fortune and elevates it to the forefront of the autonomous vehicle business. While it is reasonable that the increasing number of car accidents employing Autopilot signal that it is technologically immature, Tesla should begin to take actions to prevent such problems rather than waiting for them to arise. By assessing the benefits and cons of Autopilot, it is regarded a successful Tesla innovation and one of the major factors to Tesla's future success.

5. RESULTS:

In August of last year, the NHTSA began investigating Tesla's Autopilot system following several accidents involving Tesla vehicles and emergency vehicles that were stopped alongside roads and flashing their lights. The probe advanced to an engineering analysis in June, which took a step towards a recall. The NHTSA expressed concerns about the system after discovering that many drivers were failing to take precautions to avoid collisions despite the vehicle's warnings and that the technology was being used in situations where it had limited functionality. The NHTSA also reported 16 collisions in which vehicles equipped with automated systems collided with emergency vehicles and trucks flashing warning lights, resulting in 15 injuries and one death. The National Transportation Safety Board (NTSB) has studied some of the Tesla crashes dating back to 2016 and has advised that the NHTSA and Tesla limit the use of Autopilot to regions where it can work safely. The NTSB also suggested that the NHTSA order Tesla to upgrade its systems to guarantee that drivers pay attention. The NHTSA has yet to act on the suggestions.

In the first analysis, I have created a database of Tesla incidents that resulted in the death of a driver, occupant, cyclist, motorcyclist, or pedestrian, and categorized them. I have also suggested using descriptive statistics such as means and medians to identify if some models are more prone to accidents than others when compared to one another, as well as investigating whether Autopilot feature usage has any association to greater rates/numbers of deaths.

In the second analysis, I have discussed Tesla's accident rate statistics and how Autopilot affects accident rates. I have also mentioned that Tesla is currently beta testing its Full Self-Driving (FSD) product, which is designed to perform the same functions on city streets as well.

I have also listed the pros of Autopilot and concluded that while there are some incidents where Autopilot has been involved, the benefits of Autopilot outweigh the cons.

Overall, I have provided a comprehensive analysis of Tesla accidents, including statistics, potential causes, and benefits of Autopilot.

6. CONCLUSIONS & RECOMMENDATIONS

The results presented highlight the potential benefits and drawbacks of Tesla's Autopilot technology. On the positive side, Autopilot has enabled Tesla to position itself as a leader in both ADAS and the driverless car sector, distinguishing it from other automakers. The technology has been continuously improved, with a range of features added to make driving safer and more convenient for Tesla owners.
However, the data also indicates that Autopilot has contributed to a growing number of car accidents, which has had a negative impact on Tesla's reputation. While Autopilot is still considered technologically immature, it has great potential for future success, if Tesla takes actions to address the safety concerns and prevent accidents from occurring.
Overall, the results suggest that Tesla has a significant opportunity to continue developing its Autopilot technology and position itself as a leader in the autonomous vehicle market. However, it will need to address the safety concerns and ensure that the technology is ready for widespread use to achieve this goal.

Based on the information provided by the datasets and NHTSA, several conclusions and recommendations can be made regarding the safety of Tesla vehicles and their autonomous driving features:

1. The confirmed number of Tesla Autopilot crashes resulting in fatalities is currently sixteen, with three cases yet to be cross verified. It is important for Tesla to continue to prioritize safety and implement measures to reduce the risk of accidents.
2. While Tesla's accident rate statistics appear to suggest that Autopilot reduces the risk of accidents, it is important to consider the contexts in which Autopilot is typically used. Most of the Autopilot use occurs on limited access highways, which have lower accident rates compared to city streets.
3. Tesla is currently beta testing its Full Self-Driving (FSD) product with a small group of users, which is designed to perform the same functions on city streets as well. It is important for Tesla to thoroughly test and evaluate the safety of FSD before making it available to the wider public.
4. The IIHS mortality data on car types and driver deaths per million registered vehicle years shows that numerous vehicles have zero fatalities, and Tesla's classification as large or mid-sized luxury SUVs makes it difficult to directly compare to other vehicles. It would be helpful for Tesla to provide additional information on how their safety ratings compare to other similar vehicles.
5. The graph on Tesla accidents with Autopilot every 7.5 million kilometers distance since October 2018 shows a decreasing trend, indicating that Tesla is taking steps to improve the safety of its vehicles and autonomous driving features.

Based on these conclusions, the following recommendations can be made:

1. Tesla should continue to prioritize safety and implement measures to reduce the risk of accidents, including improving the safety features of Autopilot and FSD.
2. Tesla should provide more detailed information on how their safety ratings compare to other similar vehicles to give consumers a better understanding of the safety of Tesla vehicles.
3. Tesla should thoroughly test and evaluate the safety of FSD before making it available to the wider public.
4. Consumers should be aware of the contexts in which Autopilot and FSD are typically used, and the risks associated with driving in different environments. They should also be aware that Autopilot and FSD are not substitutes for attentive driving and that drivers should always remain alert and ready to take control of the vehicle at any time.

Based on the information provided, the following future steps should be carried out.

1. Continued prioritization of safety: Tesla should continue to prioritize safety in all aspects of its vehicles and autonomous driving features. This could include further improvements to Autopilot and FSD, as well as other safety features such as advanced driver assistance systems.
2. Thorough testing and evaluation of FSD: Tesla should conduct thorough testing and evaluation of its FSD product before making it available to the wider public. This could include additional testing on city streets and in various driving conditions to ensure the safety and reliability of the product.
3. More detailed safety information: Tesla should provide more detailed information on how their safety ratings compare to other similar vehicles. This could give consumers a better understanding of the safety of Tesla vehicles and help them make informed decisions when purchasing a vehicle.

Overall, the future steps for Tesla should focus on ensuring the safety and reliability of its vehicles and autonomous driving features, while also providing consumers with transparent and detailed information on the safety of their vehicles.

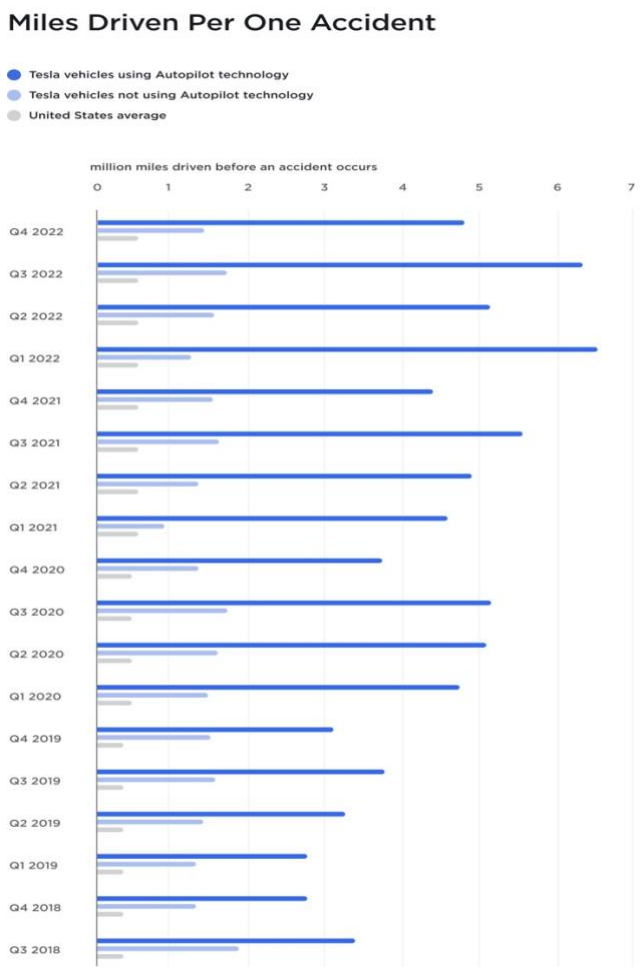

Fig 6.1 Graph showing comparison of the Tesla using autopilot or not.

The above statistic shows that Tesla vehicles manufactured after September 2014 are equipped with active safety features that provide an additional layer of protection beyond the physical structure of the vehicle. Leveraging the connectivity of Tesla's global fleet, which has accumulated over 9 billion miles driven with Autopilot engaged, they analyze real-world data to gain insights into the diverse ways accidents occur. Based on these findings, they develop safety features that empower Tesla drivers to mitigate or avoid accidents. Moreover, over-the-air software updates enable the introduction of safety features and enhancements long after a car has been delivered, as well as updated versions of existing safety features that incorporate the latest real-world data collected by the fleet.

To provide critical safety information to the public, they have voluntarily released quarterly safety data since October 2018. In July 2019, and started issuing annual updates on vehicle fires. It is worth noting that accident rates for all vehicles on the road can vary from quarter to quarter and can be influenced by seasonal factors, such as reduced daylight and inclement weather conditions.

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