A Study on the People's Perspective of Crash of Boeing 737 MAX-8

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Abstract

Air travel is one of the safest (0.18 fatal accidents per million flights) and fastest mode of transportation out of all the other modes of transportation. The aviation industry has generated over 838 billion USD in revenue globally (2019, Statistica). Despite its huge contribution to the global economy, the aviation industry is majorly dominated by two key aircraft manufacturers, Boeing (American) with its 7-series of jets and Airbus (European) with its A-series of jets. To compete in the market, Boeing launched 737 MAX series in 2011, which promises to be more fuel-efficient compared to its previous model (737 NG) and competitors (A320). However, within a few years of its operation, two 737 MAX fatal crashes occurred in October, 2018 and March, 2019, respectively, killing all passengers and crew onboard (Total = 346). This raised a serious question as to how safe 737 MAX is for further operation. This research paper aims to review the facts, analyze critical decisions, study their impact on the public minds and to discuss if they want to fly on a Boeing 737 Max using logistic regression and twitter API.

Introduction

On the evening of March 9, 2019, Paul Njoroge was up late, tracking a flight from Toronto, Canada to Addis Ababa, Ethiopia.

It was the first leg of his family's journey to visit relatives in Kenya for what was to be the trip of their lifetimes. After his family arrived safely at their layover in Addis Ababa, Mr. Njoroge went to

bed, expecting to check in again the next day.
As he slept, his wife Carolyne, their three children—6-year-old Ryan, 4-year-old Kelli, and 9- month-old Rubi—and his mother-in-law, Ann, continued their journey by boarding Ethiopian Airlines flight 302 from Addis Ababa, Ethiopia, to Nairobi, Kenya. It was a crystal-clear day, but within minutes of take-off the unthinkable happened: the Boeing 737 MAX, a brand new aircraft with 157 passengers and crew members on board, began to dive back towards the ground as the pilots fought to force the plane's nose back up toward the sky. The battle did not last long. Six minutes after take-off, Ethiopian Airlines flight 302 crashed. The jet's impact left a massive crater in a field just a few miles from the airport. Not a single soul survived.

Over one year later, Mr. Njoroge testified before the U.S. House Committee on Transportation and Infrastructure that he is still haunted by the image of his young children's final moments. "I have nightmares about how they must have clung to their mother, crying, seeing the fright in her eyes as they sat there helplessly. And there was nothing I could do to save them," he said. "I miss their laughter, their playfulness, their touch."

Mr. Njoroge would soon learn that his family members were the victims of not the first, but the second Boeing 737 MAX aircraft that was involved in a catastrophic, fatal crash killing everyone on board—an extraordinary fact given the significant advances in aviation safety over the last two decades, and the fact that the 737 MAX was a newly certified aircraft.
The story of the Boeing 737 MAX was never expected to be associated with catastrophe. It was supposed to be a story of American ingenuity and technological success—a modern, more fuel efficient airplane that had already become the manufacturing giant's best-selling jet in its storied history prior to the first MAX crash of Lion Air flight 610 in Indonesia on October 28, 2018. Ethiopian Airlines flight 302 crashed on March 10, 2019, just two years and two days after the Federal Aviation Administration (FAA) had certified the new 737 derivative aircraft as safe to fly. Clearly it was not.

The Boeing 737 MAX is now the subject of multiple investigations and lawsuits around the world and will be forever associated with the tragic deaths of 346 people killed in two separate crashes within five months of each other, as well as

one rescue diver who died attempting to recover bodies from the Lion Air crash in the Java Sea.

This report concludes the U.S. House Committee on Transportation and Infrastructure's 18- month long investigation of the design, development, and certification of the 737 MAX aircraft, and related matters. The Committee's investigation has revealed multiple missed opportunities that could have turned the trajectory of the MAX's design and development toward a safer course due to flawed technical design criteria, faulty assumptions about pilot response times, and production pressures. The FAA also missed its own opportunities to change the direction of the 737 MAX based on its aviation safety mission. Boeing failed in its design and development of the MAX, and the FAA failed in its oversight of Boeing and its certification of the aircraft.

At the direction of Committee Chair Peter DeFazio and Subcommittee on Aviation Chair Rick Larsen, this report is being released to help inform the public's understanding of what went so horrifically wrong and why. Despite the sweeping and substantive problems that have been identified by this Committee's investigation as well as various other investigations, both Boeing and the FAA have suggested that the certification of the 737 MAX was compliant with FAA regulations. The fact that a compliant airplane suffered from two deadly crashes in less than five months is clear evidence that the current regulatory system is fundamentally flawed and needs to be repaired.

In this paper we examine how the crash of the Boeing 737 affected the public sentiment and if the public will ever fly with the Boeing 737 again. For this we have collected the data from twitter and divided it into three parts neutral, positive and negative . We have used logistic regression for our prediction.

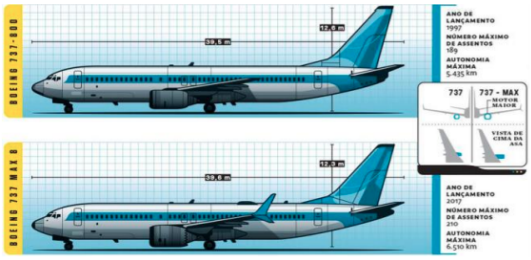


Figure 2: Altitude and speed of Lion Air Flight 610
Source: Boeing, 2020

Flight Analysis

Lion Air Flight 610

On 29 October, 2018, Lion Air Flight 610 was preparing for its departure from Soekarno-Hatta International Airport in Jakarta heading to

Depati Amir Airport in Pangkal, Pinang. It was noticed by the pilots during “before take-off checklist” that the ADI (Automatic Direction Finder) of the plane was not working properly. It is clear from the recorder that the captain was the Pilot-In-Command and the Co-Pilot was the one monitoring the flight. At 11:15 UTC, pilots attempted to set the pitch trim of the plane, which is a standard operating procedure before take-off. Pitch trim helps the pilots from exerting a constant pressure on the control column. For example, the pilot may trim the nose up before take-off, so when airborne, the pilots won‟t have to exert a constant pressure on the control column. After the flight received a green signal from the tower for take-off, one of the pilots engaged TOGA (Take-off/Go Around) and the engines were at their maximum power. A few seconds after take-off, the left stick shaker got activated, which is a warning to the pilots that their plane is about to stall. After a few seconds in the air, “Take-off Configuration” warning was given to the pilots by the system, which indicated that the plane was not properly configured for take-off. At 11:22 UTC, the co-pilot noticed that the primary flight display (PFD) displayed different airspeeds to the co-pilot and captain. The PFD displayed 173 knots to the co-pilot and 164 knots to the captain. Both the pilots in the cockpit were in speed disagreement. After some time, another problem popped up. Both of them were now in altitude disagreement by 230 feet. The tower asked the pilots to climb to 27000 feet, which was the scheduled cruising altitude for the flight. As the pilots were trying to figure out a solution, they asked the tower to hold on to 5000 feet. At 5000 feet, the pilots retracted the flaps and at this point, the MCAS (Maneuvering Characteristics Augmentation System) system came out alive. MCAS is a Paper ID: SR20805210709 DOI: 10.21275/SR20805210709 411 International Journal of Science and Research (IJSR) ISSN: 2319-7064 ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583 Volume 9 Issue 8, August 2020 www.ijsr.net Licensed Under Creative Commons Attribution CC BY flight control software that adjusts the horizontal stabilizer trim to push the nose downwards, when the aircraft is operating in manual flight, with flaps up (Boeing Statement on Lion Air Flight 610 Preliminary Report, Nov, 2018). MCAS takes input from one of the two angle of attack (AOA) sensors, making it susceptible to single point of failure. The MCAS was automatically activated for 10 seconds ON and 5 seconds OFF, which made it difficult for pilots to figure out as to why the plane‟s nose was pitching downwards automatically. The plane was losing 600 feet of altitude within seconds. The captain asked the ATC (Air Traffic Controller) to return back to the airport as they could not figure out a solution to the problem and were

struggling to maintain a stable cruising altitude. While returning to the airport, the pilot asked for 3000 feet altitude to be locked, as they lost control of the actual altitude and wanted to refrain from causing trouble to other aircrafts in the airspace. While returning, pilots mentioned that most of the systems and equipment were not working properly. MCAS got activated every 10 seconds and switched OFF for 5 seconds which resulted in loss of altitude with nose pitched downwards for 10 seconds and pilots tried to regain the altitude in the remaining 5 seconds. This cycle kept on repeating itself and as it was happening rapidly, without prior information to pilots about MCAS, pilots were not able to understand the reason behind sudden loss of altitude of the plane. The plane was experiencing a steep descent for 10 seconds (when MCAS is ON). A sudden shift in altitude and airspeed can be observed from the graph given below. Pilots had to adjust the pitch trim every few seconds. It was a nightmare in the cockpit as the pilots did not even have sufficient time to consult the Boeing checklist. At 11:32 UTC, the Lion Air Flight 610 crashed in the Jawa Ocean with a 40-degree steep nose downwards with the system repeatedly announcing “PULL UP TERRAIN PULL UP TERRAIN” killing all 189 crew and passengers onboard. (Indonesian National Transport Safety Committee) Figure 1: Altitude and speed of Lion Air Flight 610 Source: Flightradar24

Ethiopian Airlines Flight 302

On 10 March, 2019, Ethiopian Airlines Flight 302 was all set to depart from Addis Ababa, Bole International Airport in Ethiopia to Jomo Kenyatta International Airport in Nairobi, Kenya. The Pilot-In-Command for the flight was the captain with 8,122 hours of flying experience on 737 series along with first officer with 361 hours of flying experience on 737 series. The plane took-off at 8:38 without any difficulties. Shortly after the lift-off, the first officer noticed that the captain"s angle of attack (AOA) sensor was displaying erroneous readings. Within a few seconds of the plane being airborne, the left stick shaker got activated and the values shown by PFD (Primary flight display) of the captain was different from that of the first officer. The airspeed, altitude and flight director pitch bar values were different on both the sides. The captain attempted to engage the auto-pilot twice, but this resulted in two auto-pilot warnings. At about 1000 feet, the left auto-pilot was engaged, pitch trim position was reduced to 4.6 units. At 8:39:45, the flaps were completely retracted by the first officer. At 8:39:57, the captain asked the first officer to inform ATC that they were facing flight control issues. As the captain was not able to have control over the systems of the aircraft, hence to gain control over the situation, the captain

disengaged the auto-pilot. Shortly after the auto-pilot disengagement, the pitch trim moved from 4.6 to 2.1 units and an automatic Aircraft Nose Down (AND) got activated for 9 seconds, which caused the plane to tilt downwards. To counteract the tilt, the flight crew moved the control column manually, to re-establish a positive climb. Approximately 5 seconds after the end of the stabilizer motion, a second instance of automatic AND stabilizer trim occurred, pushing the trim down further to 0.4 units. The ground proximity sensors warned the pilots as the altitude of the plane dropped suddenly. Both pilots used trim buttons on their controls to counteract the automatic change. The pilots decided to disable the “Stab Trim”. This means that the stabilizer can no longer automatically lower the pitch and the crew will no longer be able to adjust the stabilizer manually. The only option left is to rotate the trim wheel to adjust the pitch trim. At 8:40:41, a third instance of AND automatic trim command occurred without any corresponding motion of the stabilizer. As the pilots were busy understanding the altitude issue, the pilots forgot to retract the throttle. The engines were running on maximum power. The airspeed of the plane was more than 340 knots, which indicated an overspeed warning. In an attempt to stabilize the plane‟s altitude, the first officer tried to adjust the pitch by rotating the trim wheel manually. The captain asked the first officer to request the vectors to return back to the airport, as they were completely losing control over the plane. With sudden ups and downs in the altitude of the plane, even landing the aircraft safely to the airport would have been a challenge. At 8:43:20, a fourth instance of AND automatic trim command occurred, which pulled the plane‟s nose further down. With the plane‟s nose down, engines running on full power, the plane crashed with a speed of more than 700 miles per hour, killing all 157 crew and passengers onboard. The aircraft disappeared from the radar screens at 8:44, 6 minutes after the take-off.

Similarities between Ethiopian Airlines and Lion Air Crashes

Both the planes crashed shortly after take-off (Within 15 minutes of take-off).

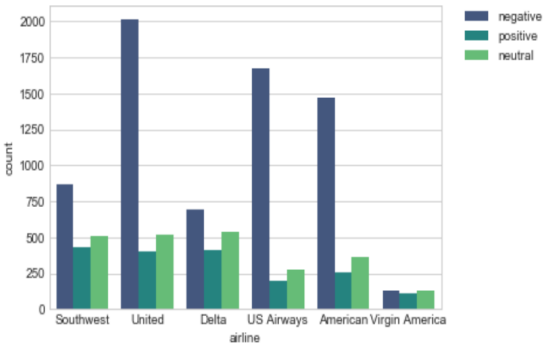
Both the planes experienced a sudden loss of altitude, with the nose of the plane pitching downwards automatically.

The readings shown by Primary Flight Displays were different in both the cases. Both the captain and first officer had a disagreement on the values of airspeed and altitude.

The MCAS got automatically activated after the retraction of flaps, in both the cases. Both the planes had to experience a bumpy

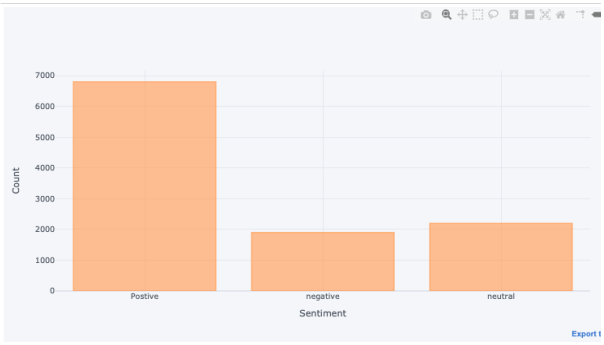
ride, as the altitude of the plane was changing very frequently (in time intervals of 10 seconds).

Pilots in both the planes struggled to understand the MCAS software. In both the cases, the left stick shaker got activated, which implies a stall position of the aircraft.



DATA SET

We have collected the data from twitter using Twitter API. Tweets ids were hydrated using a hydrator. Moreover all the Tweets are in English only.
To collect the relevant Twitter data hashtags like Boeing 737 , crash ,Lion Air Flight 610,Ethiopian Air Flight 302 etc were used.
This data is used to get the general sentiment of the people.
(The grape below shows the count of positive ,negative and neural tweets in our training set)



Pre-processing Of Data

The tweets were pre-processed before being fed to our model. Each tweet underwent following changes.

1. Removal of non-alphanumeric characters: Many tweets consisted of emojis that were unused by the models. Non alpha-numeric characters cannot be evaluated by the model and therefore thre existence in the sentence gives an inaccurate analysis of the weightage of different categories that the tweet belongs to.
2. Punctuation: All the tweets were converted to lowercase. Apart from this all the punctuation marks were removed from all the tweets to make them shorter and faster to evaluate.
3. Lemmatization: Lemmatization of nltk library was used rather than porter stemmer as the former reduces words to

meaningful words. The models used can only evaluate meaningful words.

4. Stop words. Few words are selected from the nltk stopwords corpus and are removed from every tweet to give accurate analysis of empath analysis.

Data Prediction

After the pre-processing is completed, we have used a count vectorization method to identify key words in a dataset.

For making viable predictions to use for the report we need to build a model and most importantly we need to train our model and that can only be done if we already have a similar type of database in hand. For this we extracted an airline database from kaggle.

This database is kind of similar to the one we made using the tweets. This database we first use to extract keywords and train the model and then we basically feed the tweets database to it. The classifier that we used is passive aggressive classifier. Before that we also used the Tfidf Transformer. After we got the final results we have used matplotlib for giving our findings a more robust and presentable view, for this we have used a pie chart.

Conclusion

As seen above, we have plotted different graphs to identify the mental emotions and mental pictures of the people all around the globe with respect to Boeing's aircraft 737 MAX-8.
All of them depict that the maximum number of the people are still terrified to set foot in this particular line of aircraft, even after the parent company and the Federal Aviation Agency (FAA) gives it a clean chit to once again keep its wings in the free air.