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The paper reviews the 26 “landing on the taxiway” cases happened between 1982 and 2016 recorded by the National Transportation Safety Board (NTSB) aviation accident/incident database, it evaluates causal and contributing factors such as visibility, navigation, preparation, fatigue, experiences, age and more affecting pilots’ operations. Also, personnel injury/fatality and severity of the aircraft damage are extracted from the NTSB’s accident/incident databases to conduct the inductive research. Some interesting findings in the paper includes the experienced pilots landing on the taxiway, and different trends of mistakes between general aviation (GA) and commercial operation. Based on these findings, the authors have given several recommendations to mitigate the possibility of landing on the taxiway.

On February 17, 2017, Harrison Ford told the Federal Aviation Administration (FAA) tower controller, “I’m the schmuck landed on the taxiway (BBC, 2017).” The word appeared when Harrison Ford was making a post-incident report to the tower after Mr. Ford landed his Aviat Husky—N89HU on Taxiway C at John Wayne airport instead of the Runway 20L as cleared by the tower controller (Thurber, 2017). “Landing on the taxiway” is rare and peculiar in aviation industry; however, the consequence could be catastrophic due to causality and economic loss, which needs to be studied for the possible prevention programs. This paper will review the 26 “landing on the taxiway” cases happened between 1982 and 2016 recorded by the National Transportation Safety Board (NTSB) aviation accident/incident database, it evaluates causal and contributing factors such as visibility, navigation, preparation, fatigue, experiences, age and more affecting pilots’ operations. Also, personnel injury/fatality and severity of the aircraft damage will be extracted from the NTSB’s accident/incident databases to conduct the inductive research.

Literature Review

In the 21st Century, air transportation is the safest way to travel; in 2004, the absolute number of 430 fatalities with the respect to1.8 billion passenger-kilometers (Stoop & Kahan, 2005). And in 2013, the World Health Organization (WHO) listed the European region as the lowest fatality rate on road, at 9.3 per 100,000 population (World Health Organization, 2018). In the sky, aviation is safer. According to the Federal Aviation Administration (FAA), the number of life loss in general aviation (GA) has dropped from 471 to 347from fiscal year 2010 to 2016, respectively the GA fatal accidents per 100,000 Hours has dropped from 1.10 to 0.89 per 100,000 hours (FAA, 2018).

There are few research projects concerning landing on the wrong runway or taxiway. In a recent study of landing on the wrong runway, it showed that most of pilots were low time pilots and wrong runway landings often took place in good visibility conditions (Jin & Lo, 2017). It has been shown that way-finding and situation and the sensation of being lost in aviation are the common reasons behind landings on the wrong runways, a comparison of airports in the vicinity of a destination airport and the use of Global Positioning System (GPS) to assist in an identification procedure as a navigation strategies are recommended for the prevention of wrong runway landings (De Voogt & Van Doorn, 2007).

In the aviation history, we have seen several major innovations to avoid aviation accidents, prevent aviation accidents from happening, and improve aviation safety in return. The Swiss Cheese model proposed by Dr. James Reason (1997) attributed aviation accidents into four levels: organizational influences, unsafe supervision, preconditions for unsafe acts, and the unsafe acts themselves, and there are defenses for these four levels, when the defenses were broken up, and the accidents will appear (Reason, 1997). Drawing on the Reason's concepts of active and latent failures, Dr. Shappell and Dr. Wiegmann developed the Human Factors Analysis and Classification System (HFACS) to investigate and analyze human aspects of aviation, and later it was used in training and accident prevention, the HFACS describes four levels of failure: 1. Unsafe Acts, 2. Preconditions for Unsafe Acts, 3. Unsafe Supervision, and 4. Organizational Influences. Under the four levels, there are more finite detailed reasons (Shappell & Wiegmann, 2000).

In this research, the authors chose the SHELL model as the fundamental theory to conduct a case study of taxiway landing accidents, because it does not only look at the human elements (liveware) of accidents, but also other contributory categories like hardware, software, environment and their iterative relationship in a holistic way (Hawkins & Orlady, 1993).

Methodology and Data Analysis

To illustrate the methodology and find answers for research questions, the authors reviewed 26 events and generated a list of contributory factors. Case study was chosen to conduct the inductive study. By definition, a case study is "a method used to study an individual or an institution in a unique setting or situation in as intense and as detailed a manner as possible. (Salkind, 2012) (Leenders & Erskine, 1978)" The unique situation in all the cases are "landing on the taxiway." All the cases were recorded in the NTSB Aviation Accident Database & Synopses by the NTSB investigation professionals. And the events were investigated, and reports were written in a generally standardized way, which guaranteed the inter-rater reliability of the research data including not only factual data like pilot flight hours, local airport weather information etc., but also the probable causes and findings (Salkind, 2012). The authors also read the reports and made the conclusions of probable causes and findings which matched the NTSB ones. The subjects investigated entailed most civil aviation operations in the United States, so the result shall be predictively valid for civil aviation cases (Salkind, 2012).

NTSB Aviation Accident Database & Synopses Searching

The authors searched the key word of "landing on the taxiway" in the NTSB aviation database, it returns totally 47 event records dated between 04/01/1965 and 03/10/2016 involving landing on the taxiway. After the careful reading of each report several times, the authors concluded there are only 26 reports of the events dated between 7/4/1982 and 3/10/2016. From the report, the authors extracted the following variables: event data, number of injuries, degrees of injury (none, minor, serious), death toll, aircraft damage (none, substantial, destroyed), pilot/copilot flight hour, pilot/copilot rating, pilot/copilot age, visibility, light, wind speed, aircraft make, aircraft model, landing gear configuration, runway heading, taxiway heading, operation in terms of aviation regulation, and event factors provided by the NTSB accident investigation personnel in the probable causes and findings. By the interpretation of each report, the authors also came up with additional factors contributed to these events, and divided them into these categories: pilot factors, aircraft factors, and software. Using all the data gathered above, the authors are able to answer the following questions under the framework of SHELL model.

Findings

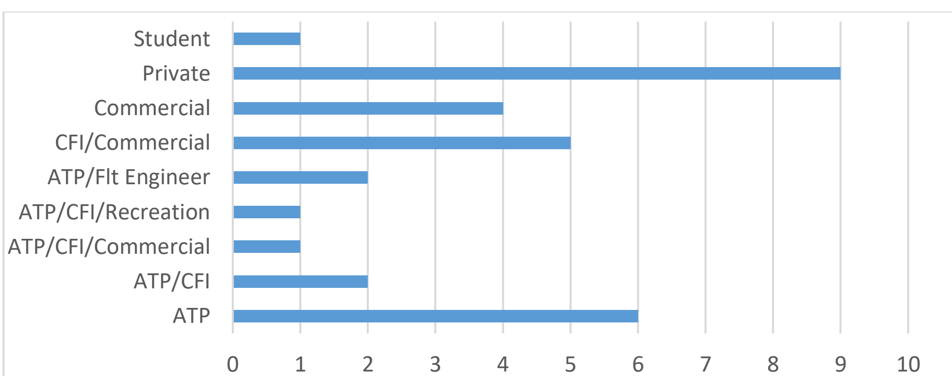
Using the SHELL model (Hawkins & Orlady, 1993), the authors would like to answer the following questions:

Consequence: What were the aircraft damages, human injuries or fatalities associated with the events?

In terms of aircraft damage, the authors see about 73% (19/26) of aircraft involved with "landing on the taxiway" have experienced the substantial damage, 8% (5/26) of them have experienced no damage, and 7% (2/26) of them have been destroyed. And it is noteworthy that the ones with no damage are all aircraft operated under commercial operations including two Part 121, one part 135, and one foreign air carrier. There were 21 events with no injury or death occurred, three events with one minor injury, one event with one serious injury and one minor injury, and one event with one serious injury and one death.

Liveware: What was the pilots' background related to the events? (Pilot flight hours and ratings etc.)

Table 1.
Count of Pilot Ratings



As we can see, there were totally 31 pilots involved with the 26 events of landing on the taxiway. And it is a surprising fact that two thirds of the pilots (21/31) hold ratings commercial or higher, which means they are professional pilot by the FAA standards (FAA, 2019). The average and median flight hour of the pilots are 4917.52 and 2207, and the average age of them is 46.25 years old.

Environment: What were the weather like during the events? (Visibility, Wind Speed, Light Condition)

The average visibility of the events is seventeen statute miles, and there're a couple of recordings of high visibilities, so the authors also counted the mode of the visibility of them: 10 statute miles. And all the five aircraft operated under the commercial operation rules, the airport authority were responsible for not providing clear runway indications for the pilots to land: taxiway lights and runway lights mixing, runways covered by the snow, and water. The average wind speed of the events is eight knots per hour. The light condition distribution was the following: 21 days, one dusk, one night, and one night/bright.

Liveware: What are the pilots' factors in the events?

18 out of 26 events could be identified with the piloting factors involved, and five of them are operated under the commercial operation categories: Part 121, Part 135, and foreign air carrier operation. Surprisingly, all the pilots in the five events had committed the same mistake: selected the wrong runway and landed on the parallel taxiway. The rest of the pilots were operating aircraft under Part 91 and one unknown condition. The authors used the HFACS model to analyze the pilots' factors and divided them into these five categories: skill-based errors, decision-errors, perceptual errors, routine violations, and exceptional violations. The authors found that the primary culprits (16 counts) are skill-based errors which were mainly controlling errors: failing to keep the speed, direction, and attitude. The secondary culprits (7 counts) were perceptual errors which were similar to the transport pilots' mistakes: wrong identification of runway. There were three decision-errors, one routine violation, and no exceptional violation.

Hardware: What were the aircraft conditions in the events? (Aircraft make/model, landing gear types, w/ or w/o mechanic problems)

By their respective aircraft manufacturers and models, there were five transport category aircraft, one helicopter, and twenty GA airplanes. In terms of landing gear configuration, there were one helicopter, two tailwheels and twenty-three tricycles. There were eleven aircraft with mechanic problems that could contributed to the taxiway landing events. And seven of them were related to the aircraft engines; causing the partial or full power loss.

Software: What were the software issue in these events?

There were fifteen events could be identified with the software issues: the operators did not have the knowledge and did not follow the procedure. For the Part 135 or Part 121 or the foreign carrier, the pilots were unfamiliar with the landing procedures and landed good aircraft on the taxiways could be counted as the Controlled Flight into Terrain (CFIT). And we also see one case from the Delta Air Lines that two tired crew landed on the taxiway by mistake after a long international flight due to the lack of fatigue management and one crew incapacitated due to food poison (NTSB, 2010). On the other hand, the GA group in these cases have a variety of software problems: misreading of the Exhaust Gas Temperature (EGT) gauge, poor fuel management, negligence of fuel-sampling in the pre-flight check, misunderstanding of trim controls, lack of situational awareness for the cold weather operation, ignorance of airport landing restriction, lack of situational awareness for the high density/high temperature takeoff, and deviation of landing gear extension procedure. There was also a case that the wrong installation of mixture cable by the mechanic caused the emergency landing on the taxiway after takeoff.

What were other causes of the events?

There was one event of illegal transportation of 250 kilograms of cocaine by air, and the suspect landed aircraft on the taxiway, and the person ran away with the injuries.

Conclusion

From this study, we found that two thirds of taxiway landing pilots had commercial pilot rating or above, and the average and median flight hour of the pilots are 4917.52 and 2207which were different from the previous similar study result that low-time/inexperienced pilots made most of the landings on the wrong runway (Jin & Lo, 2017). And the visibilities were generally good during the events, and eleven GA aircraft with mechanic problem were contributing to the taxiway landings. Finally, we recommend that the commercial pilots should be familiar with the landing procedures like a good memory of key reference points on the destination airports, added simulator training of landing on the new airports, and the application of fatigue risk management to the pilots in the airlines. For GA community, we recommend that the mechanics should take care of aircraft mechanic condition before each flight, and the pilots should maintain situational awareness in the extreme weather environments like hot, humid, cold weathers, and geographic locations like long cross-country flight, plateau operations.

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