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Reducing Runway Incursions: The Role of Collaboration, Education, and Training

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Abstract

Runway incursions are a major threat to aviation safety and can cause major delays and collisions that have significant human and financial implications for airlines. This study investigated how training, education, and collaboration may be improved to reduce the occurrence of runway incursions at airports. Data collection involved interviews, a focus group, and document analysis to explore the participants' perceptions. The interviews and focus group involved a purposive sample of 12 pilots, air traffic controllers, airport administrators, and ground personnel. The interviews and focus group transcripts were chunked, coded, and patterns sought to form five key themes addressing the research question: exercising key safety practices, effective communication, a greater focus on scenario-based training, need for greater standardization, and more collaboration and partnership among stakeholders. The findings have the potential to influence Federal Aviation Administration's (FAA) decision-making through resource allocation for improving runway safety, as well as to inform the prevention of runway incursions through improvements to education, training, and collaboration.

Keywords: Runway incursion, education, collaboration, training

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Chapter 1: Introduction

Runway incursions present a major risk to aviation safety, especially during takeoff and landing, and cause major delays and unsafe situations that cost human lives and airlines millions of dollars annually. Statistics indicate that over 1,264 runway incursions occurred in the U.S. in 2014 alone (Federal Aviation Administration [FAA], 2014a). Runway incursions represent a group of Airport Surface Deviations (ASDs) that involve potential collisions or erroneous movements that are associated with at least one runway at airports (Stroeve, van Doorn, Bakker, & Som, 2015).

Over the years, airports have become busier and more complex due to technological advancement and globalization (Stroeve et al., 2015). The growing air traffic in the U.S. increases the likelihood of fatal runway incursions by aircraft. Compared to past periods, takeoffs and landings are currently performed at a faster pace, while only considering the separation between aircraft and the ability to clear active runways by staying in the taxiway exit before crossing the departure runway to access the terminal gate (Johnson, Zhao, Faulkner, & Young, 2016). The FAA and Congress have raised many concerns regarding the high rate of interruptions during takeoff and landings to allow crossing of active runways by all types of aircraft and other airport vehicles attempting to get to the terminal area. Educating and training aviation personnel about the effective use of airport infrastructure to prevent the occurrence of fatal incidents and accidents is an ongoing challenge (Cardosi, 2010).

Education appears to be important for improving the awareness of runway incursions among pilots and administrators (International Civil Aviation Organization [ICAO], 2007). The ICAO is tasked with developing an efficient and safe global air transport and ensuring all countries have the opportunity to own international airlines. However, the education

requirements for becoming a pilot have not been updated since 2013 (George, 2015). Currently, the educational requirement to become a commercial pilot is a bachelor's degree including associated education and training as stipulated by the FAA. However, due to the increasing complexity of the airport environment, it is important to ensure continuous education and training of pilots, administrators, ATC staff, and ground operators (Ary, Jacobs, Sorensen, & Walker, 2014).

Collaboration between ATC personnel, pilots, and ground vehicle personnel is also critical to avoid mishaps that could increase the risk of runway incursions. Baker and McClusky (2005) stated that collaboration involves the sharing of information by aviation staff to achieve common goals, objectives, or solutions to specific problems. Collaboration facilitates effective flow of ground operations and communication between staff, thus, minimizing the likelihood of runway incursions at airports (FAA, 2015a).

Past investigations on runway incursions at U.S. airports over the past decade have found that these events are caused by lack of situational awareness, failure to comply with ATC instructions, and nonadherence to standard operating procedures (Skybrary, 2017). To ensure safe airport operations, pilots, ATC personnel, and ground vehicle operators need to be trained and provided with adequate education to improve situational awareness and minimize the occurrence of runway incursions (Johnson et al., 2016).

Background, Context, and History

Background

Runway incursions, historically, have been the cause of property damage, injuries, and loss of life. They occur whenever an aircraft is in the process of an ATC approved landing or takeoff and is then interfered with by obstacles on the ground (Johnson et al., 2016). These

obstacles may include people, objects, vehicles, or even other aircraft (FAA, 2015a). Runway incursions can be categorized into three groups: pilot deviations, operational incidents, and pedestrian/vehicle deviations. Pilot, operational, and vehicle deviations account for approximately 57%, 23%, and 20% of the total runway incursions in the U.S. (Rankin, 2012). Runway incursions can also be stratified from categories A to D based on severity (FAA, 2017a). Incursions in Category A are the most severe, with those in Category D being the least severe (FAA, 2017a). The severity of the runway incursions are determined based on the level of avoidance and immediate safety consequences (FAA, 2017a).

Context

This multiple-case study involved runway incursions at three high traffic airports in the mid-Atlantic area involving commercial and general aviation operations. These airports are among the busiest airports in the world (Zupan, 2013). Data collection involved a focus group, secondary documents, and interviews involving pilots, air traffic controllers, airport managers, vehicle drivers, mechanics, and ground personnel, all performing key operations at the given airports.

History

Runway incursions at U.S. airports have been documented since the 1920s (Thomas, 2002). Various historical events can be classified as runway incursions under the FAA definition. The most prominent runway incursion in the aviation history is the collision between KLM Boeing 747 and a PanAm 747 in 1977, which caused 583 fatalities (McCreary & Pollard, 1998). Based on the National Transportation Safety Board (NTSB) report, the major cause of the crash was dense fog which significantly limited the visibility of the runway from the tower. Also, the captain of KLM 747 started to take off before receiving clearance from the tower. Investigations

on runway incursions have identified specific errors by airport vehicle drivers, pilots, mechanics, ground personnel, and air traffic controllers that can be addressed by improving collaboration, training, and education (Baker & McClusky, 2005; Cardosi, 2010).

Conceptual Framework for the Problem

A conceptual framework refers to a theoretical structure of rules, assumptions, and principles that represent ideas of a broad concept (Awé & Bauman, 2010). The function of a conceptual framework in this study was to attempt to connect all the aspects of the research including the purpose, problem, literature review, methodology, data collection, and evaluation (Grant & Osanloo, 2016). The conceptual framework was beneficial for this study because it provides coherence and guided the researcher throughout the implementation and evaluation of the project. The theoretical foundation of this study was based on Bandura's Social Cognitive Theory (SCT), which stipulates that learning is influenced by behavioral, cognitive, and environmental factors (Bandura, 1999). Unlike conventional psychological theories that associate learning with direct experience, SCT suggests that learning can occur through observation of other people's behaviors (Bandura, 1989). Based on SCT, observational learning is guided by four main features: attention, retention, reproduction, and motivation (Bandura, 1999). Attention refers to the process of selectively observing and gathering information from ongoing activities, while retention involves restructuring and transforming the information in form of conceptions and rules and keeping the information into memory (Bandura, 1989). Reproduction refers to the act of performing the actual behavior, while motivation involves the process of motivating learners to attention, practice, and retention (Bandura, 1999). The SCT is based on three primary concepts: human agency, self-regulation, and self-efficacy (Bandura, 1989).

Human Agency

This concept suggests that learners make intentional decisions to invest in learning and adopting behavior change (Bandura, 1999). The core aspect of human agency is the ability to initiate action for given purposes. The three modes of human agency based on the SCT are personal, proxy, and collective (Bandura, 2001).

Self-Regulation

This concept involves self-created actions, thoughts, and feelings that are designed and adapted cyclically to achieve personal goals (Bandura, 1999). Bandura posited that self-regulation functions through psychological sub-functions including self-monitoring, judgmental, and self-reactive influences (Bandura, 2001). Thus, individuals can use reactive and proactive strategies to regulate their behaviors.

Self-Efficacy

Bandura reported that self-efficacy involves people's beliefs in their ability to effectively control their actions and events in their lives (Bandura, 1999). People's reactions to particular situations are partially based on their cognition about their ability to assume certain behaviors (Bandura, 1999). The four sources of self-efficacy based on the SCT include enactive mastery experiences, social persuasions, observational involvements, and psychological and physiological states (Bandura, 2001).

The integration of SCT in this study could facilitate the assessment of the contribution of pilots, air traffic controllers, airport vehicle operators, ground crews, and airport administrators may minimize the rate of runway incursions through education, training, and collaboration. The SCT's predominant concept that individuals can change their surroundings to achieve desired goals was critical in evaluating the role of pilots, air traffic controllers, and other stakeholders in

the aviation sector whom may influence the occurrence of runway incursions (Bandura, 1999). Through human agency, action was initiated through education and training of pilots, air traffic controllers, and ground personnel on runway incursions and methods of preventing these occurrences. Through self-regulation, pilots, air traffic controllers, and aviation stakeholders are able to engage in actions that minimize the risk of runway incursions at U.S. airports (Bandura, 1989). By learning how to prevent runway incursions, stakeholders in the aviation industry can improve their self-efficacy, thus, reducing the likelihood of future occurrences.

Statement of the Problem

Runway incursions continue to pose significant threats to safety at U.S. airports and are likely to increase further in the coming decades as the demand for air transport grows (FAA, 2015b). According to the FAA, runway incursions are precursors to aviation accidents and have constantly increased since 2007 (FAA, 2009). Therefore, training of aviation personnel on how to effectively utilize simulators, the cockpit, collaboration and control tower can significantly enhance situational awareness, thereby, reducing the risk of runway incursions (Baker & McClusky, 2005). The main problem addressed in this study is that, despite collaboration, and training, runway incursions still occur approximately thrice a month at U.S. airports (FAA, 2012).

Purpose of the Study

The purpose of this study was to understand how training, education, and collaboration may be improved in order to minimize the occurrence of runway incursions at U.S. airports. As such, the study was aimed at analyzing the knowledge, attitudes, and practices of aviation stakeholders regarding how their collaboration, training, and education may be improved to reduce runway incursions. Because complete eradication of runway incursions is impossible, it is

necessary to ensure continuous education and training of aircrew to reduce the risk of future occurrence (FAA, 2011). In addition, improved collaboration is important to ensure effective communication and coordination during airport operations. Improved collaboration, training, and education can significantly enhance airport safety and promote customer satisfaction (FAA, 2012).

Research Question

One research question was addressed by this study regarding the pilots, air traffic controllers, airport administrator, and ground personnel who frequent the busy New York and New Jersey airports that accept general aviation and commercial traffic. The question involved investigating the knowledge, attitudes, and practices of licensed pilots and airport administrators who manage aircraft in and out of regional airports in relation to:

RQ1: How might collaboration, education, and training be improved in order to help prevent runway incursions?

Rationale, Relevance, and Significance of the Study

Rationale

The rationale for conducting this study was to understand the role of collaboration, education, and training in reducing runway incursions and improving aviation safety, and identify the improvements needed. The FAA has set a number of goals directed at minimizing the frequency, severity, and rate of runway incursions at U.S. airports (FAA, 2012). To achieve these goals, the FAA has considered different strategies including training, procedural interventions, and infrastructural and technological improvements. In collaboration with various companies, the FAA continues to research and develop more feasible and cost-effective technologies to minimize the occurrence of runway incursions at U.S. airports (U.S. Government

Accountability Office [GAO], 2007). Some of the interventions that have been implemented in most airports include installation of improved lighting systems, signage, and markings, publication of guidance materials, and provision of new monitoring and tracking software. This study was aimed at improving the understanding of the effectiveness of training, education, and collaboration in reducing the occurrence of runway incursions.

Relevance

Runway incursions continue to be a major safety concern at U.S. airports (Galle et al., 2010). Though many studies about airport safety have been conducted, only a few have evaluated runway incursions (Szuchman & Thomlison, 2011). In addition, there is a lack of literature on surveys involving stakeholders in the aviation sector and the role of collaboration, training, and education in reducing runway incursions at U.S. airports (ICAO, 2007). Therefore, this study provided important information for developing effective strategies to curb the occurrence of runway incursions at U.S. airports.

Significance

The significance of this study is that it would enhance education, training, and collaboration among aircrew members and facilitate efficient allocation of resources in the aviation sector. Understanding how education, training, and collaboration influence runway incursions is critical because the FAA and other stakeholders have to allocate resources to developing technologies and procedures to reduce these events (Galle et al., 2010). Runway incursions still pose major problems at U.S. airports and have significant local and global implications (FAA, 2012). Though the FAA strives to minimize the occurrence of runway incursions through the Runway Safety Program (RSP), the effectiveness of this strategy is still unclear (GAO, 2007). Evaluating the effectiveness of education, training, and collaboration in

reducing runway incursions would help the FAA and airlines in allocating the limited resources to improve runway safety. In addition, this study helped in addressing the gap in literature regarding the effectiveness of training, education, and collaboration in preventing runway incursions. The findings may increase policymakers' understanding of the effectiveness of strategies used by the FAA in reducing the rate of runway incursions at U.S. airports. The study results also helped in identifying the required improvements in the existing strategies for minimizing runway incursions. Also, the FAA can utilize the knowledge gained from the study to further enhance the Runway Safety Programs, thus, enhancing the overall safety of air travel systems worldwide.

Definition of Key Terms

Airdrome. An airdrome or airport refers to a landing field for aircraft that has extensive equipment, buildings, and shelters (Alomar & Tolujevs, 2017).

Collaboration. Collaboration refers to the act of jointly working with others to achieve common goals and objectives (Goytia et al., 2013).

Education. Education is the process of imparting or acquiring skills, knowledge, habits, and beliefs (Slavich & Zimbardo, 2012).

Runway incursion. A runway incursion is an event involving incorrect presence of people, aircraft, or vehicle in designated areas in an airdrome (Rodriguez & Cusick, 2012).

Training. Training refers to an organized activity that is aimed at providing instructions and information to improve the performance and knowledge of the recipient (van der Heiden, Pohl, Mansor, & van Genderen, 2015).

Assumptions, Delimitations, and Limitations

Assumptions

Assumptions include the aspects that are out of the researcher's control, but are relevant to a study (Creswell, 2014), like honesty of participants and the appropriateness of the survey to address the research problem and research question. This study was based on the assumption that pilots, mechanics, and other participants would provide honest responses during the interviews. It was also assumed that the survey was reliable, valid, and could effectively discover the experiences of participants it is intended to evaluate.

Delimitations

Delimitations are features that define the boundaries and limit the scope of a study (Wiens, 2007), and include the choice of research question, objectives, theoretical perspectives, themes, and the population. The first delimitation is that the participants would only be asked questions involving general aviation accidents. The data involved in this study was also based on the pilots' past ten years' experience and others' past one year experience. The setting of this study was also limited to airports within New York and New Jersey.

Limitations

Limitations refer to potential weaknesses in a study that are out of the researcher's control (Creswell, 2014), which typically include the use of small sample size, lack of reliable data, inadequate prior research on topic, and the possibility of researcher bias. Though this study has numerous strengths, it is also limited by various aspects. The first limitation involves the qualitative nature of the case study. Qualitative research designs have negative implications on the generalizability and reliability of the findings of the study. The major limitations of qualitative research designs are that they are time-consuming, there is no verification of findings, and they cannot be used to determine causality (Anderson, 2010).

The small sample size also limited the scope and increased the likelihood of bias in the study. Creswell (2014) highlighted that small sample sizes increase variability in data, which may cause uncoverage and voluntary response bias. Other limitations of this study included time-intensiveness, lack of representativeness, and susceptibility to researcher bias. According to Anderson (2010), case studies may be time-intensive due to the thick description and extensive analysis needed to analyze the phenomenon of interest. Usually, qualitative case studies take longer and the findings may be detailed or lengthy (Anderson, 2010). To mitigate this limitation, the sample size and number of questions posed to the participants during the interviews and focus group was kept low. The use of a qualitative case study design in this study significantly inhibited the generalizability of the findings to all U.S. airports (Yin, 2014). In addition, the qualitative nature of the case study increased the likelihood of researcher bias as the findings were based on the investigator's judgment (Yin, 2014). In this study, researcher bias was minimized by coding the data from the interviews and the focus group, and using secondary documents to verify and support findings.

Summary

Reducing the occurrence of runway incursions in major airports in the U.S. and around the world is a difficult task. The purpose of this study was to assess stakeholder knowledge, attitudes, and practices in relation to how training, education, and collaboration may be improved to reduce the occurrence of runway incursions at U.S. airports. The study was expected to address the gap in literature about the efficacy of education, training, and collaboration in reducing runway incursions at airports. The findings of this study may assist the FAA and other stakeholders in developing programs to minimize the occurrence of runway incursions at airports (Baker & McClusky, 2005; George, 2015). Chapter 2 presents an in-depth review of literature

related to stakeholder collaboration, training, education, regarding the occurrence and avoidance of runway incursions. Chapter 3 presents the methodological procedures that were employed during the study, while Chapter 4 provides detailed findings based on data analysis. Chapter 5 provides a discussion of the findings, limitations, and implications of the study.

Chapter 2: Literature Review

The purpose of this study was to understand how training, education, and collaboration may be improved in order to minimize the occurrence of runway incursions at U.S. airports. This chapter provides a comprehensive discussion of previous literature on runway incursions and how education, training, and collaboration can be used to reduce their occurrences. Specifically, the chapter presents the conceptual framework, synthesis of literature, and a review of potential methodological issues.

Runway incursion occurs when a plane is taxiing or moving from one spot to another on the airport surface during taxi, takeoff, or landing (Cardosi, Chase, & Eom, 2010). Runway incursion could also occur at an airdrome that involves incorrect presence of people or vehicles in an area reserved for landing and takeoff of aircraft. Some major causes of runway incursions include crossing hold short lines, taking off or landing on the wrong runway, or wildlife, typically birds or geese interfering with takeoff or landing. Runway incursions can happen at any airport to any aircraft at any time. Property damage and even death can be the result of runway incursions (Rodriguez & Cusick, 2012).

In 1977 at the Canary Islands Tenerife airport, airport controllers parked a number of aircraft that had been diverted to the airport on the main runway (Kilroy, 2011). The fog was so thick pilots could not see planes parked next to them. The pilot of a KLM Boeing 747, thinking he had been cleared for takeoff when he misheard the control tower, started his takeoff run. His KLM plane ploughed into a parked Pan Am 747. Forty-nine tons of fuel were ignited, and 583 people lost their lives. Airport controllers did not know a crash had occurred for 20 minutes; this crash is currently cited as the worst runway incursion in aviation history (Ebert, 2012).

Many variables impact proficiency in mitigating runway incursions (Baron, 2011). Although some incursions like wildlife interference are sometimes unavoidable, vigilance in learning how to react to events is intended to either avoid runway incursions or react appropriately (Hooey, 2006) when they happen. Runway incursions tend to occur at the rate of about three a day in the U.S. National Air Space System (FAA, 2012). The objective of the qualitative multiple-case study was to explore the perceptions, attitudes, and lived experiences of a range of stakeholders, including licensed pilots and airport administrators. Human errors such as a deviation from accuracy, lack of focus, carelessness, inadequate knowledge, poor decision making, and wandering from norms are human factors that can lead to an incursion and may be a result of a lack of collaboration, education, and training of some or all stakeholders, which in turn, may be leading to the continuing problem with incursions (Cardosi et al., 2010).

The problem related to runway incursions is that after careful consideration of human factors, and the collaboration, education, and training of key stakeholders in the aviation environment, runway incursions continue to occur at the rate of about three cases per month (FAA, 2012). This might mean that there is not enough collaboration, education, and training, or perhaps there is an incongruity in the collaboration, education, and training that is causing the continuation of the runway incursions.

Runway incursions are grouped into category A, category B, category C, and Category D (FAA, 2015b). Category A involves a severe incident in which collision was slightly evaded. On the contrary, Category B involves an incident whereby there is a reduction in separation, therefore presenting a significant likelihood for collision. For collision to be avoided in case of such occurrence, a real time corrective evasive measure should be rapidly applied (FAA, 2012). Category C entails an incident in which there is enough time and distance to evade a collision,

while category D is composed by an incident that satisfies all elements of a runway incursion including the presence of aircrafts, people, or vehicles on the area reserved for aircraft landing and takeoff. Incidences that occur under Category D are not followed by immediate effects.

Categories for severity are generally comprised of three sections: pilot deviations, operational deviations, and vehicle/pedestrian deviations (Cardosi et al., 2010). Because all of the severity categories include human interaction, it is important to ensure that proper training and education occurs while collaboration among all stakeholders allows for the flow of updated education and training materials as well as assisting in collaborative communication methods, and models like the models utilized in many medical fields to enhance teamwork and accuracy.

Most studies in aviation are of a quantitative nature, but a qualitative study may assist in determining the current conditions that pilots are experiencing through interview questions and focus groups (Cardosi et al., 2010; FAA 2012; International Civil Aviation Organization [ICAO], 2007). Recently there has been a growing interest in studying how collaboration, education, and training can increase safety in the aviation industry. Over the past five decades there have been studies investigating different causes of runway incursions, but few attempts have been made to study qualitative data regarding the importance of collaboration, education, and training in reducing runway incursions. More qualitative studies can help highlight the importance of collaboration, education, and training in the aviation industry.

The main research question for this study was to explore how collaboration, education, and training might be improved in relation to runway incursions. The aim was to determine whether better collaboration, education, and training among the stakeholders involved in aviation such as the pilots, air traffic controllers, and others can make the safety record better regarding runway incursions. There are many studies that show runway incursions are a consistent

phenomenon among the aviation industry, however, there is no qualitative study that utilizes focus groups and interviews to determine how collaboration, education, and training may help to mitigate runway incursions, requiring the need for this study. The purpose of current study arose from the need to determine how collaboration, education, and training can help mitigate runway incursions, and establish whether new data can lead to better collaboration, education, and training through new perspectives.

Conceptual Framework

Leading causes of runway incursions are categorized into three groups by the Federal Aviation Administration (FAA): pilot deviations, operational errors/deviations, and vehicle/pedestrian deviations (ICAO, 2007). Pilot deviations are actions that could go against federal aviation rules such as disobeying an instruction from Air Traffic Control (ATC) by taking off, landing, and traversing a runway hold marking without clearance. Operational errors/deviations include actions by air traffic controllers that lead to a reduction in spacing between several aircrafts, an aircraft and an obstacle, clearance by an aircraft to land or takeoff on a closed runway (FAA, 2015b). In addition, operational deviations may occur when an aircraft is cleared into runway while another aircraft is landing at the same time, and when a takeoff clearance is issued (ICAO, 2007). Vehicle/pedestrian deviations include persons and vehicles traversing the airport environment without authorizations from air traffic control. Runway incursion severity is influenced by environmental factors, the distance between an aircraft and vehicle, speed of an aircraft and vehicle, nonconformity to corrective actions, and available time for reaction (ICAO, 2007; FAA, 2012). The three causal factors of aircraft incursion are interrelated because they result due to lack of conformity to standard operating

procedures, unfamiliarity with the airport, and failure to adhere to stipulated ATC instructions. Consequently, a conceptual framework must be applicable to the way these three factors interact.

A conceptual framework in empirical research is an abstract construction related to the connectedness of the integral parts of the study and upon which their connectedness can be analyzed and significance assigned (Cairney & St Denny, 2015; Creswell, 2014). In this study, the connectedness of pilot deviations, operational errors/deviations, and vehicle/pedestrian deviations represent the key factors that lead to runway inclusions. Because each of these factors is in some way related to human operations, the conceptual framework must be related to the way the operations are related. Figure 1, Conceptual Framework on the following page is a representation of the connectedness among the various factors affecting runway incursions.

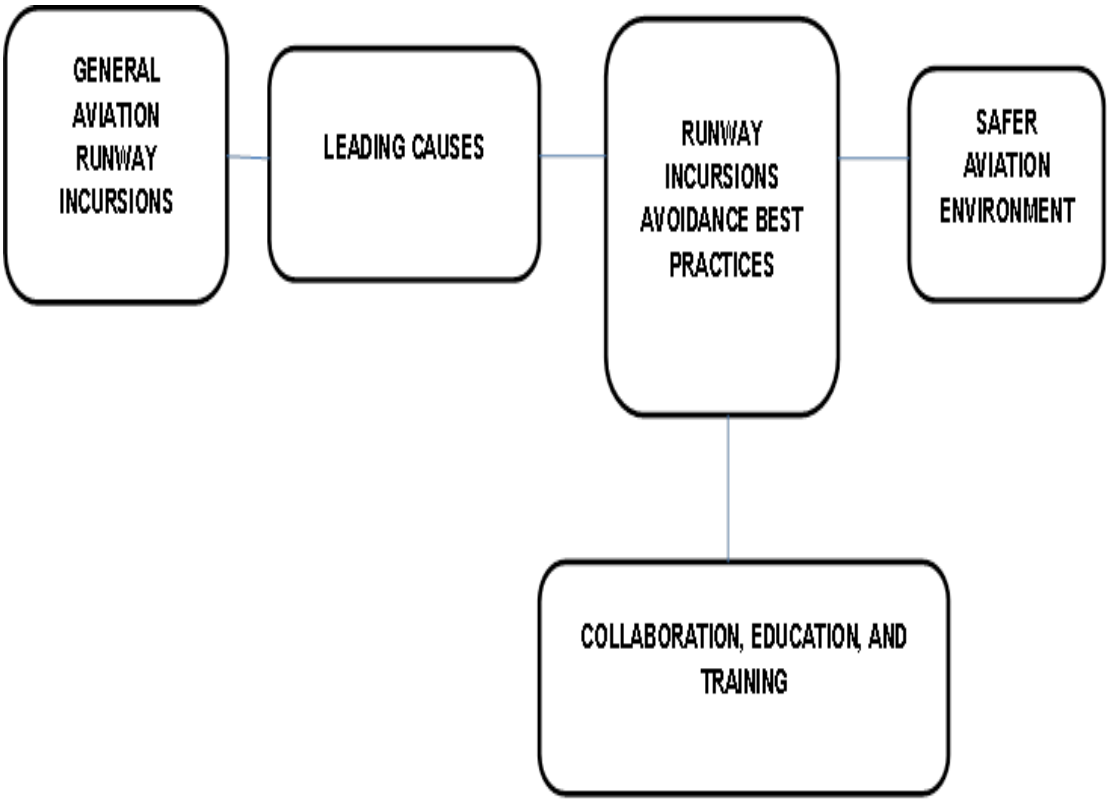

Figure 1. Conceptual framework.

The bidirectional interaction and reciprocal causation of stakeholders in airport safety can be appropriately characterized by the social cognitive theory of Wood and Bandura (1989). Bidirectional interaction, which includes every person on the ground, in the control tower, and in an aircraft and their interactive behaviors in an environment that is challenging, constantly changing, and complicated, comprises a framework for understanding why people behave as they do in aviation, as illustrated in figure 2.

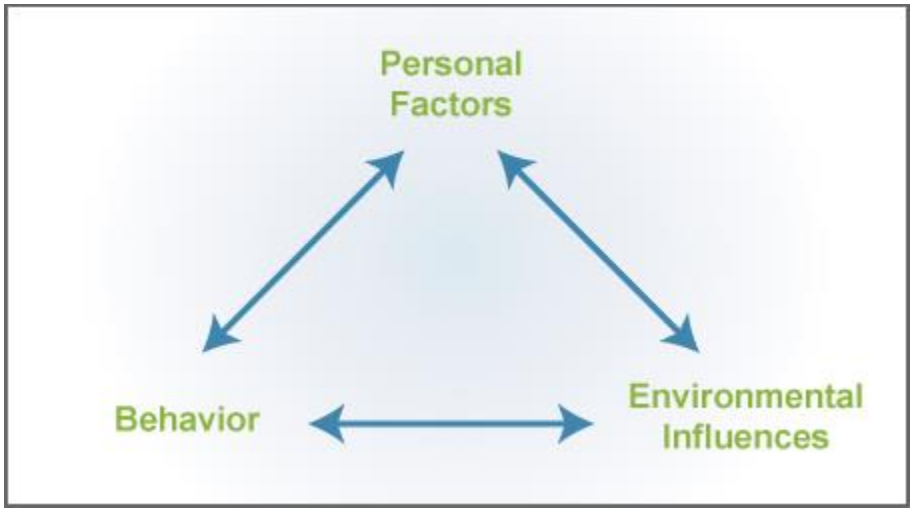

Figure 2. Adapted from: Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Cognition refers to "the way people perceive stimuli and how they use this information to guide their behavior*"* (Cools & Van den Broeck, 2006, p. 360). Cognition involves observational learning that influences an individual's behavior, just as constant observation of the environment of an airport is a moment-to-moment need of all stakeholders if safety was assured. Observational learning involves four component processes: (a) what individuals selectively observe and what information they store about what they observe, (b) retention of information about events in the form of rules and concepts, (c) behavioral reactions that take symbolic perceptions and translates them into courses of behavior; and (d) motivation that provides an

incentive to act, which are more likely to happen if the outcomes are valued and positive rather than unrewarding or punishing (Wood & Bandura, 1989). The social cognitive theory defines various concepts of learning. Examples of concepts essential for learning as identified by Bandura include self-regulation, self-efficacy, and human agency. Self-regulation refers to self-generated thoughts and actions applied in order to achieve personal goals, while self-efficacy entails people's beliefs to effectively coordinate their actions throughout their lives. Self-efficacy is drawn from physiological and psychological states, social persuasion, enactive mastery experiences, and observational experiences. The human agency concept is characterized by power to originate actions for given purposes. Therefore, the concept regards the intention of deciding to invest in learning and endorse behavioral change.

Bandura (2001) asserted that, "to be an agent is to intentionally make things happen by one's action" (p1). The author concluded that human behavior is explained through everyone's cognition, which is the ability to process, represent, retrieve, and use coded information to manage tasks. Bandura (2001) and Wood (2003) theorized that social cognition is what it means to be human. In terms of learning disabilities, the subject of this study, the human, may be the disability, becoming faulty, and executing tasks that lead to a runway incursions or unsafe aviation acts. Better collaboration, with the models above or others as maps and guides, can teach the aviation community to use its resources and collaborate with ATC, for example to help mitigate and in many cases, eliminate the human factor errors that may occur, thanks to redundancy in checks and balances through ATC, ground control, others in the cockpit, electronic gadgets and other alerting systems. This case study investigated the reasons why runway incursions continue to occur given the level of preparation all stakeholders receive.

According to the SCT, the intensity of people's behavior is associated with their beliefs (Ng & Lucianetti, 2016). As earlier mentioned, the self-efficacy concept is how likely somebody is to achieve a goal or task that they have set out to accomplish. How people feel and their beliefs about themselves can affect the way one approaches themselves ultimately effecting the decision-making process. Being afraid and trepidation about deciding in aviation, can be unsafe, and detrimental to not causing destruction to property and lives due to runway incursion occurrences; therefore, social cognition posits that avoiding feelings of fear and trepidation by continually utilizing collaboration, education, and training to overcome these factors.

Review of Research Literature and Methodological Literature

The purpose of the review of the research and methodological literature was to establish a ground from the evidence base within the study field. This evidence base is often created utilizing a search matrix that lists multiple sources that can then be analyzed to find trends and create a more accurate picture of the current research's depth of knowledge. Szuchman and Thomlison (2011) noted three types of reviews of research literature: empirical, theoretical, and systematic. Empirical reviews take all the research and summarize it together to gain current knowledge in the field; theoretical reviews provide a more in depth and meticulous analyses of the present theoretical viewpoints in the literature; and systematic reviews are utilized in quantitative studies to explain how certain interventions may create different outcomes. The methodological part of the literature review also provides a base of evidence for the methodological choice used in this study. Determining logical rationales for choices of methodology, tools and instruments that are justified for the study, and detailed descriptions of the procedures used to analyze the data help determine the validity of the choice of qualitative multiple-case study research in this study (Concordia University, 2018).

Following is a discussion of four aspects of aviation safety, each representing factors that affect runway incursions. In this discussion we define human factors, collaboration, education, and training to discuss what would be more effective in helping to reduce runway incursions. Human factors deal with the nature of humans and how they react to the environment in which they find themselves (FAA, 2015c). Collaboration refers to the cooperation and interaction among all stakeholders who are responsible for maintaining a safe environment in the aviation industry. On the contrary, education refers to the classroom and technical classes stakeholders in aviation safety are exposed to as they prepare to enter the world of airports, aircraft, and flying (ICAO, 2007). Training refers to hands-on experience pilots, air traffic controllers, and all other stakeholders in the environment of safety in aviation must undergo before performing their assigned roles.

Human Factors Leading to Incursions

Humans come in all shapes and sizes, and with that individuality comes the chance of making an error or doing something different from others (Baron, 2011). Human factors are the abilities that each person is capable of and what limitations they have and how that effects their abilities to utilize tools, perform tasks and assure safety (Cooper, Forrest, & Cramp, 2006). On February 14, 2017, actor Harrison Ford landed at the John Wayne airport in California narrowly missing a Boeing 747 with 110 passengers and a crew of six (Harrison, 2017). Human error nearly cost the lives of 116 people because of the landing on the incorrect runway – a taxiway in this case. In aviation, the human factor directly affects how the persons in the cockpit, and others engaged in the movement of aircraft, and all the other moving parts of an active airfield on how reliable people are to perform their tasks correctly (Gibbons, von Thaden, & Wiegmann, 2006).

The situation may have been triggered due to high workload of the 747-flight crew shortly before landing and departure. The crew may have been engaged in tasks such as organizing the aircrafts ready for takeoff, receiving departure clearance instructions from ATC, being on the lookout for inappropriate departure procedures, and addressing crew and passengers that just landed or are ready for takeoff (CBS News, 2017). With the increased workload, there is a possibility that miscommunication or loss of situational awareness led to Harrison Ford's aircraft narrowly missing a Boeing 747 with 110 passengers and several flight crew members (Harrison, 2017). In this incident, the collaboration may have been better in the form of communication on the part of the flight crew. The situation could have been avoided by conducting an orientation among the crew shortly before landing so as to determine the responsibility of each person regarding their position with respect to taxiways and airport layout so as to ensure proper landing of aircrafts (FAA, 2012). In addition, the crew has to reconfigure aircraft systems according to the instructions provided by ATC.

Collaborating with others may help mitigate or resolve issues like designating which runway to land, and thereby enhance safety via better communication. An empirical study revealed that the flight crew had a much greater workload (FAA, 2015c). More collaboration should therefore be encouraged to help share the workload and minimize chances for human errors (Weiner & Nagel, 1988).

Communication among stakeholders also plays an important role in helping to mitigate runway incursions and provide a safe environment. Communication in the cockpit mainly comes in an audio form, but can also come in a visual form or even a tactile method such as a hand signal from a person marshaling the aircraft in or out of a gate. Clear, standardized communication is the most effective way to ensure that instructions are relayed in a manner that

all stakeholders can decode; thus, the aviation industry uses English globally as the primary language of communication so that confusion is minimized regardless of where in world it is taking place (Kovalchik, 2014). However, despite the introduction of a system that validates competence in Aviation English by ICAO, there are still several instances where pilots together with their crew use their native languages during communication, thereby leading to misunderstandings in regard to airplane flight clearances. Technology and the balance between automation in the cockpit and the human interface has become a center of controversy. Ensuring that automation is utilized as an augmentation tool and not as a substitute for piloting an aircraft are issues that plague the industry (Weiner & Nagel, 1988).

Other factors such as lack of sleep, malnutrition, being on medication, having a cold or flu, or other human ailment are part of the safety picture in the aviation industry, which are especially critical for pilots because these ailments can cause human errors (Millward, 2010). Flying takes a great deal of concentration and when the human interface is comprised in some way, it cannot perform at its peak and should be negated or avoided because it may lead to a runway incursion.

Collaboration Among Stakeholders

Collaboration is when more than one person comes together whether they know each other or not, to share information in a collaborative effort towards a common objective or solution to a problem (Baker & McClusky, 2005). Collaboration in aviation is an integral part of a smooth flow of operations on all levels including flight operations, ground operations, communications among air traffic control, airport and aircraft operations, and pilot and crew members. All stakeholders in aviation have some form of communication that involves more than one person, making it a collaboration.

Collaboration is integral and beneficial in maintaining a safe environment, one where actions can be challenged and opposing or clarifying an others position could lead to new information being presented that was not considered previously. For example, At Chiang Kai-Shek International Airport in Taipei on October 31, 2000, the pilot of a Singapore Airline 747 airliner bound for Los Angeles International Airport attempted to take off from a closed runway. The flight crew had information that the runway was closed; however, the pilot thought differently, and no crew member challenged his authority. They trusted the decision-making capabilities of the captain (Daffyd, 2009). Collaboration in the cockpit could have been better, which might have helped avoid this accident. At nearly full takeoff speed, the airliner impacted a concrete barrier, then a construction site and burst into flames. Of the 179 people on board, 83 were killed. Collaboration among the cockpit crew could have negated this runway incursion.

If collaboration among all stakeholders is succinct and flowing smoothly, there will be a flow between the aircraft, air traffic controllers, and gate operators (Baker & McClusky, 2005). For instance, gate operators should inform the crew on board that all passengers are accounted for. The pilot or co-pilot contacts the tower, where an air traffic controller clears them to take off and assigns a taxiway and runway. This process happens back and forth continuously with varying issues that need attention; for instance, if there are active thunderstorms in the area, a control tower may delay the departure time. If one part of the collaboration does not flow freely then the other parts in the process can fail. Collaboration in the cockpit includes crew resource management where everyone on board, pilots, copilots, navigators, flight attendants, and others, even passengers at times need to collaborate and work together (Collaborative Decision Making, 2017). Although there are several quantitative studies investigating different causes of runway

incursions, a search of the literature failed to reveal any empirical, qualitative study to explore the causes and effects of runway incursions.

Education of Pilots and Administrators

Educational requirements to become a pilot have not been updated in decades (George, 2015). The education requirement to become a commercial pilot for an airline or regional airline is normally a Bachelor's degree and associated education and training as required by the Federal Aviation Administration. The non-commercial general aviation section of the aviation world does not have similar education requirements; in fact, there are no educational requirements to become a general aviation pilot. To become a pilot, the requirement is 40 hours of flight training; however, almost no one completes training in the 40 hours, generally taking about double or more to earn a private pilot certificate depending on the student.

Collaboration requires that a person is able to think about more than just themselves. Every move that is made could positively or negatively affect the rest of the people in the collaborative effort. For example, In Milan, Italy, a runway incursion occurred on October 8, 2001. A Scandinavian MD 80 aircraft airliner departing for Copenhagen, Denmark was nearly at takeoff speed when a Cessna private jet tried to scurry across from one side of the runway to the other. The pilot of the airliner appeared to try to avoid the collision and ploughed into a baggage handling area of Kubate Airport. The small jet had violated a communication from air traffic to hold short. The crash resulted in 118 people losing their lives, 104 on the airliner and 14 others between the small jet and in the baggage handling area (Willan, 2001). This is an example of how the human factor is an imperative aspect of collaboration. No matter how many times the collaboration occurs such as the instructions being given to the pilot by air traffic control, it is still the responsibility of the human pilot to take appropriate actions to ensure that the

instructions were recorded and executed correctly. In this case, they were not, leading to catastrophe.

The role played by education in the choice of the small jet to ignore control tower directions is unknown; however, no pilot with adequate education would ever move a plane into the path of a jetliner in an effort to beat it (George, 2015). In addition, FAA has launched several educational initiatives to educate pilots and administrators on the ways of improving airport surface operations safety. The initiative to sensitize pilots on the significance of using advanced flight deck display systems is an example of a measure that could help reduce accidents. The cockpit display systems could reduce aircraft inversions by enhancing communication between the aircraft crew controllers and pilots, ensuring an increase in number of aircrafts landing safely, and alerting pilots regarding any challenges experienced along the air runways (FAA, 2011). To date, no empirical study as discovered during the literature search that was inclusive of all stakeholders in aviation safety, and none that probed a breadth of data about the needs of education to improve runway safety. However, a number of quantitative studies have been conducted to justify the need of educating pilots and administrators on ways of improving aviation safety and efficacy. An example includes educating pilots on the use of runway incursion prevention system (RIPS), the synthetic vision system, and the hold short advisory landing technology, all developed by the National Aeronautics and Space Administration (NASA).

Training in the Simulator, Cockpit, or Control Tower

There is a need for continual education and training for persons in the aviation industry especially pilots, because, skills may get dilapidated if not asserted frequently, which could lead to unsafe acts causing runway incursions and possibly death. This training also must be a

collaborative effort between the aviation industry and the aviation professionals so that the information is standardized (Baker &McClusky, 2005). For months, a Malaysian Airline pilot trained on his home flight simulator for a flight on March 8, 2014. The flight was from Kuala Lumpur International Airport to Beijing, China. He calculated the exact point in the South China Sea where he would turn his Boeing 777 left and cross the Malay Peninsula without being detected by civilian radar. Once in the Andaman Sea, he turned left again and disappeared into the Indian Ocean. The plane carried 12 crew members and 227 passengers from 15 nations. The aircraft was never found again after the crash. Better collaboration on the part of the pilot and crew as well as the controllers tracking the plane could have given the plane an opportunity to rectify their position and increase their situational awareness. Additional training and education on the part of the pilot and flight crew in an approved training device with authorized flight instructors may have mitigated errors that lead to the demise of this aircraft and the related deaths.

Simulator training is precise *(*Sparko, Bürki-Cohen, & Go, 2010). The pilot knew at exactly what point and with what controls he needed to turn the plane to avoid radar, probably without passengers noticing. Only military radar followed the flight, but lost it once the plane reached the Andaman Sea. Only a trained pilot or frequent flight passenger might have noticed the change of direction. Planes turn without wing dips because the vertical stabilizer on the tail does the turning. In a tragic way, this illustrates the reason why every person who is involved with aviation safety needs training. It is precise. It eliminates error and saves lives.

Training is what pilots and others in aviation do to gain knowledge or a set of skills to manage operations on the ground and in the air. Training can come in many platforms in aviation including simulations, face-to-face classroom, online, or book training, practical training, apps

for training using a phone or tablet or other medium (ICAO, 2007). The aviation community is held to a high education standard. Every aircraft has its own intricacies even if they are the same model and type; thus, training to fly an aircraft can help to mitigate runway incursions and other aviation related accident. It takes more than just simulator training to be a proficient pilot, although simulator training is invaluable in the aviation industry.

Even though most pilots already go through considerable training, the majority continue to enroll in aviation safety classes during their flying careers and other training that helps to sharpen their skills and keep them updated on the latest improvements in air traffic control or the planes they are flying. Aeronautical giants such as Bombardier and others spend millions of dollars a year on training budgets to have events such as safety down days that are solely dedicated to training their people on how to become safer pilots (Bombardier Customer Services, 2015). There is no requirement for these pilots to continue their training however they chose to because they know that being proficient in knowing the factors leading to runway incursions and understanding other aviation safety concerns can help them be aware of possible precursors leading to safety concerns in order to help mitigate and or avoid them (ICAO, 2007). The literature search failed to reveal a comprehensive survey of all stakeholders in aviation safety regarding human factors, collaboration, education, and training, to determine if any causes and effects of continuing runway incursions can be reduced or eliminated.

Social Cognitive Theory

People's perceptions about themselves may affect their ability to be successful or not through change and adaptation and that perception also depicts the casual structure of the social cognition theory (Bandura, 2001). A person's ability to feel that they complete a task may go a long way to assuring success. These beliefs may either yield an optimistic or pessimistic result

which, will ultimately prove to be self-enhancing or self-hindering. People are more likely to take up something that they feel they are capable of achieving. Therefore, stakeholder's attitudes in the aviation industry may have a direct implication on the role of collaboration, education, and training in reducing runway incursions. Choice behaviors can be influenced by many factors including social influences and different environments sometimes making it difficult to maintain a standard among the collaboration, education, and training in aviation.

The perception of group cohesion and teamwork can also help build collaboration and help people become more self-confident in achieving a desired task (Bandura, 2001). Interaction between groups of people needs to be simple so that that everybody can have a standardized understanding throughout the social system. Becoming more resilient in overcoming challenges and increasing performance can all be ameliorated with a perceived collective efficacy or knowing that you are a part of a bigger team and picture set to accomplish something greater than the sum of just one's actions. The SCT demonstrates that social rules and structures come in variations in interpretations, enforcements, opposition, and circumvention and because of this more data should be collected on how collaboration, education, and training can help bring new knowledge on Social cognition and safety.

Synthesis of Research Findings

In the synthesis portion, it is necessary to go over the research material to find details that are mentioned more than once, that form a pattern, to generalize, form theories, and to help bring resolution to any conflicts found in the literature as well as to uncover any issues that might need research in the future (Concordia University, 2018). This section integrates the major parts of the literature to form a model of the bigger picture as well as a compare and contrast of runway incursion mitigation methods. The synthesis section tells the reader the bigger picture by

analyzing the relevant studies and noting key points that need scrutiny. The synthesis provides insight into the patterns of findings within the literature that inform my study about the reasons for runway incursions, best leading practices for avoidance, as well as my key focus regarding collaboration, education, and training.

Runway incursions continue to haunt the aviation world as a major safety concern. A runway incursion can be as simple as a plane crossing a line prematurely, or as severe as two planes crossing the same line and crashing. Even with technological augmentation to assist with mitigating runway incursions, general aviation runway incursions continue to occur at about three a day nationwide (FAA, 2012).

A search of the literature failed to reveal any comprehensive empirical study that included all stakeholders in an exploration of the perceptions, attitudes, and lived experiences of about human factors that can lead to runway incursions and possible lacks in collaboration, education, and training that may be leading to the continuing problem with incursions. However, most of the studies found revealed a trend in the need for more knowledge on the effects of collaboration, education, and training as a tool to mitigate runway incursions and increase safety (Baker & McClusky, 2005; George, 2015; Harrison, 2017; Weiner & Nagel, 1988). Thus, a comparative discourse about methods in empirical literature is nearly impossible because of the dearth of empirical studies about runway incursions. The bulk of the literature about runway incursions is represented by article in popular magazines and newspaper reports and not in scientific research studies. The problem related to runway incursions is that after careful observation of the needs to consider human factors, and the collaboration, education, and training of all stakeholders in the aviation environment, runway incursions continue to occur at the rate of about three per month (FAA, 2012). A search of the literature revealed an incomplete and

unbalanced body of empirical studies about how to decrease the frequency of runway incursions. No studies were found that were systematic studies of the perceptions, attitudes, and lived experiences of pilots, air traffic controllers, vehicle drivers, mechanics, and all other involved in operations at commercial and general aviation airports in the New York and New Jersey system of airports. While a great deal of collaboration, education, and training are involved in earning a position in the field of aviation, specific recommendations related improving collaboration, education, and training are not in evidence in the literature. The leading causes of runway incursions continue to be the same according to safety statistics, noting miscommunications between flight crew and air traffic control or other personnel, a vehicle/pedestrian or other ground interference, and wildlife.

FAA categorizes runway incursions into three categories: pilot error, vehicle/pedestrian error, and operational errors (Cardosi et al., 2010). The human component to aviation is always a factor in runway safety until planes can fly themselves with minimal human support. Because of the human interaction, aircraft accidents continue to be attributed to some form of human error (Wiegmann & Shappell, 2006). Knowing the pre-cursors that have led to runway incursions in the past may help others to learn from those mistakes, thus helping to mitigate future incursions (Hooey, 2006).

A multi-faceted approach with many mitigation procedures is the best method to ensure safety (Darr, 2008). The addition of electronic maps, radio frequency identification tags for aircraft tracking, moving maps, and other technological augmentation has been implemented to help alleviate runway incursions, yet they continue to occur frequently, leading me to believe that the human factor needs to be addressed more. Much of the literature points to a need to address the human aspect involved in causing runway incursions by increasing collaboration

among persons and organizations involved in the critical phases an aircraft traverses, as well as adding extra education and training (Runway Safety Plan, 2011).

Categories for severity are generally comprised of three sections: pilot error and deviations, operational error and deviations, and vehicular/pedestrian errors and deviations (Cardosi, 2010). Because all the severity categories include human interaction, it is important to ensure the proper training and education occurs while collaboration among all stakeholders allows for the flow of updated education and training materials as well as assisting in collaborative communication to mitigate runway incursions.

Critique of Previous Research

The purpose of critiquing previous research is necessary to ensure validation of the evidence, concepts, and claims found in the previous research as well establishing their logical coherence, assessing their merit in the scientific community, and their specificity in modeling, explaining, or describing how the previous research is relevant in the real world (Concordia University, 2018). Pursuing a methodical evaluation and tools based on science and logic are appropriate ways to assess the works of the past. Properly analyzing the previous research without making unfounded assumptions is the best way to present the critique.

A search of the literature revealed an incomplete and unbalanced body of empirical studies about how to decrease the frequency of runway incursions. No studies were found that were systematic studies of the perceptions, attitudes, and lived experiences of pilots, air traffic controllers, vehicle drivers, mechanics, or others involved in key operations at commercial and general aviation airports in the New York and New Jersey system of airports. While a great deal of collaboration, education is involved in earning a position in the field of aviation, specific recommendations related to improving collaboration, education, and training are not in evidence

in the literature. Previous research is plentiful in the areas of collaboration, education, and training separately in the aviation and related fields.

Previous research points to runway incursions being caused by three primary factors: (a), not adhering to the instructions of air traffic controllers, (b) not being familiar with the current airport ground schematic, and (c) not conforming to the current standard operating procedures (FAA, 2012). Normally, pilots depend on visual devices like signs, painted centerlines, and lighting together with a paper chart to traverse the airfield when taxiing. Ground communication occur on a separate radio frequency called the ground frequency used solely for taxiing and other aircraft movements while on the ground. The controller on the ground typically tells the pilot which taxi route to follow while moving around the airfield whereas, on uncontrolled airfields, the sole responsibility of traversing the airfield and self-identifying your plane and position over the radio, is the job of the pilot in command and crew if any.

Language the air traffic controller uses to issue the instructions is a specific protocol of verbiage to avoid miscommunications that can lead to runway incursions. It is the duty of the pilot in command to take note and read back the specific taxi instructions. The pilot then proceeds to taxi the aircraft to the designated area while navigating through any surface obstacles including traffic and wildlife. Air traffic control keeps track of all taxi clearances issued to ensure that no incursions occur (Airstrike Hazards, 2005).

It is the primary job of the pilot and flight crew to utilize the “See and Avoid” theory to maintain safe operations. While more advanced commercial aircraft like Boeing and Airbus employ upgraded technological traffic alerting devices like The Airport Surface Detection Equipment and Traffic Alerting Collision Avoidance System, general aviation aircraft might not have such advances, making air traffic control instructions invaluable in avoiding runway

incursions (Schönefeld & Möller, 2012). These traditional avoidance efforts have been successful in the past and are still utilized; however, with the consistent increase in air traffic volume, airport surface conditions have gotten increasingly congested. Complexity increases with the addition of various airport obstacles such as hangars, additional taxi lanes, lights, signs, and markings. To add to the congestion is the recent increase in wildlife strikes during takeoff and landing. Certain actions can mitigate runway incursion by wildlife by assessing the threat over a full year because wildlife exhibits seasonal behavior. A runway assessment for wildlife should be included in any runway incursion mitigation evaluation (Airstrike Hazards, 2005).

There are many variables involved in runway incursions. Pilots, drivers, and air traffic controllers are the main persons involved, but at times wildlife can also become a factor. Runway incursions are divided into recurring events such as vehicle or aircraft crossing in front of a landing aircraft, or a vehicle or aircraft crossing in front of an aircraft during takeoff. A vehicle or aircraft crossing the runway-holding position markings, a vehicle or aircraft unsure of its position on the airport and accidentally entering an active runway, a miscommunication that leads to the failure to follow an air traffic control assignment, and an aircraft that passes behind another vehicle or other aircraft that has not exited the runway are also causes. Most runway incursions develop during visual meteorological conditions during daylight hours; and most incursions at night occur in low visibility (ICAO, 2007). The causes above are the most common factors that lead to runway incursions. It is the duty of the pilot and flight crew to ensure adherence to this list, and be vigilant for other factors that could add to runway incursions, not yet been anticipated. There are many findings when it comes to causes of trends in runway incursions, but the literature is lacking a study that focuses on collaboration, education, and training and how those three factors together could help mitigate runway incursions.

This critique points out that there are many factors involved in aviation such as language, how people perceive things, self-confidence and others that may all effect how a person's decision-making ability is executed, which, is like the definition of social cognitive theory. Because people are involved in the major functions at airports and on airplanes, the interaction of the social construct on a dynamic level can help explore what precursors to runway incursions to look out for as well as gaining a better understanding of human factors involved in social cognition. There is a lot of social interaction while an airplane is taxiing between the cockpit the ground, the tower, and others such as the "Company," these interactions may be a part of the problem or the solution to alleviating runway incursions, but are unclear unless a study such as this one is conducted.

Review of Methodological Issues

In the planning stages of a study, a researcher needs to become informed about methodological design issues that may impact the given study. Methodological issues include the analysis of the relationships between the issues or research question being investigated, and a systematic understanding of the problem, or research question (Concordia University, 2018). Deciding upon a reliable and valid research methodology involves many choices, including design, sampling, data collection, and data analysis (Boote, 2005). The methodological aspect of this study was necessary to ensure that a rigorous, systematic approach is utilized to gather and analyze data. An understanding of how researchers have collected their data was explained in this section, as well as what tools were most effective in collecting data such as interviews, focus groups, and previous case studies (Creswell, 2014). Analyzing methods that have been used in studies relevant to the research question may help to lead to a more suitable methodology and methods for investigating how collaborative practices may reduce runway incursions. This

section presents a suitable method for data collection and analysis to effectively answer the research question.

Qualitative Research

Qualitative research has three major purposes: to explore, explain, or describe a phenomenon (Cairney & St Denny, 2015). Cairney and St Denny asserted that an assumption in qualitative research is that participants create their own reality. Research questions should be open-ended and encourage subjectivity and emotions to explore such questions as how and why (Irvine, Drew, & Sainsbury, 2013).

Creswell (2014) described qualitative research as human realities envisioned by people who experience life differently. A qualitative method with a multiple-case study design was deemed appropriate to accomplish the objectives of this study because case studies may provide a platform for wide-raging exploration of problems and possible solutions. Qualitative research was deemed appropriate over mixed or quantitative methods research because the study was aimed at understanding the pilots' perceptions regarding collaboration, education, and training and their effects on preventing runway incursions. The multiple-case study design was specifically selected because it can provide more details compared to other research designs. There is a greater depth of data obtained with qualitative case study experimental designs than others as well. Yin (2014) described a case study as research that allows for an investigation into a holistic and meaningful assessment of real-life events. Yin believed case study research is the preferred research design for examining contemporary events, such as runway incursion. Based on Stake (1995), Boblin, Ireland, Kirkpatrick, and Robertson (2013) suggested case studies are characterized by generalization as opposed to particularization.

A search of the literature revealed several empirical studies about airport safety or related topics, but nothing that encompassed the dynamic of collaboration, education, and training all in one. All literature found was from newspaper articles, journals or books that did not employ any form of empirical analysis similar to this study. However, there were some similar studies only cited here, such as Enoma, Allen, and Enoma (2009), Cong, Hu, Dong, Wang, and Feng (2016), and Landry (2012) which provided insight on the need for further research into collaboration, education, and training and their effects on mitigating runway incursions. Gibbons, von Thaden, and Wiegmann (2006), which has been cited in this proposal, did not conduct an empirical study, but instead developed and a 5-factor model comprised of management involvement, organizational commitment, pilot empowerment, accountability and reporting systems pertaining to airline safety. A number of pilots and airline managers received and completed the commercial aviation safety survey. Findings from the survey indicated that there was need of revision of the 5-factor model due to establishment of various areas that required alignment as revealed by the results. After revision, 4 main factors and 11 sub-factors were included in the new model. The main issue addressed in the new model was the need of accounting for the management-employee relations in airline operations. Lack of an empirical study supports the justification for and significance of the present study.

Focus groups. A focus group is like interviews that are less structured, but a focus group consists of more than just collecting data all at once from participants (Gill, Stewart, Treasure, & Chadwick, 2008). The focus group establishes a discussion relevant to a subject organized for research purposes. Focus groups are often monitored by a person called a facilitator or a mediator. A focus group can help generate information depicting the collective views of the

participants and the meanings that those views represent. Focus groups can also help the researcher gain a deeper understanding of participant's beliefs and experiences.

Establishing a group of people for the focus group entails finding a group that is able to communicate amongst each other with some ease, not having to worry about repercussions and to be able to speak freely (Gill et al., 2008). Successful groups are groups that can interact well amongst each other. Considering the size of the focus group is also a significant consideration because smaller groups might limit the discussion whereas larger groups might become cumbersome not allowing for enough interaction and data collection. It is possible to have a focus group that consists of as little as 3 persons and as many as 14, however, it is suggested that somewhere between 6 and 8 participants is optimum for a thorough conversation and discussion where all participants have time to voice opinions and thoughts.

Case studies. A case study is a form of research that investigates and analyzes a problem through the research of one case hence a case study (University of Southern California, 2017). A case study investigates a place, a person, an event, something that is misunderstood, or any other subject that requires analysis to extract the main themes and outcomes that might help plot a future trend that needs investigating, provide a clearer understanding of a research problem, or shed light on an unexplored area. A case study normally involves one case however, when doing a comparative case study, you may need to investigate more than one case study. A multiple-case study design involves the use of multiple data collection strategies and many instrumental cases (Gustafsson, 2017). From Yin's (2014) viewpoint, case study research should be based on multiple sources of data converging in a triangulation method. In addition, case study research should benefit from previous theoretical developments to guide data collection and analysis. Yin recommended that researchers should use evidence from six major sources including archival

records, documentation, direct observations, interviews, physical artefacts, and participant observation.

For the phenomenon of runway incursions mitigation and for a more reliable analysis, this study utilized multiple case studies. Researching case studies is perfect for exploring the available studies about collaboration, education, and training, however, this study may help to see how the perceptions and attitudes of stakeholders in the aviation industry can help shed new light on the continuing occurrences of runway incursions.

An interview, as a data collection tool for research, is a way to get answers from people participating in a study (Robert Wood Johnson Foundation [RWJF], 2008). Interviews can be conducted in many ways including, face-to-face individual and group interviews. The medium utilized to conduct the interview can be via a landline, an electronic device such as a computer, smart phone, iPad, or other means as needed for the research. Interviews can be structured, semi-structured, unstructured, an informal interview, and or a focus group.

For this study, a semi-structured interview gives the interviewer and the respondent, a chance to discuss in a formal setting, a pre-calculated set of questions, normally asked, in a specific order. The semi-structured interview format follows an outline however, there are opportunities for the interviewer to pursue conversation relating to the outline or research question. A semi structured interview is good for a study where the researcher might not get a chance to re interview the participants like this one. The interview outline can provide a clear path for the interviewer to follow to attempt to collect comparable, reliable, qualitative data (RWJF, 2008). The semi-structured interview normally comes after a period of observation where a non-formal, non-structured conversation with the participants takes place so that the researcher can gain a better understanding of the environment and variables related to the

research question to be able to create suitable interview questions for the actual interview. Including open ended questions gives the interviewer and the participants the ability to stray from the main topic to pursue alternate theories that might help better understand the research question in abstract thought.

With the permission of the participants, interviews can be recorded for review later, but note taking is also suitable. The benefit of a semi structures interview is that the questions regarding runway incursion mitigation can be prepared before the interview allowing time for a rapport to be created with the interviewee which is important so that the participant can feel free to express their views without hindrances.

Issues pertaining to the ethical protection of participants. When conducting a research study that involves gathering data from human participants, certain ethical guidelines must be adhered to for the protection of the participant. When dealing with human subjects, it is mandatory to solicit consent before involving them. Throughout the research, ensuring the safety of the subjects is of paramount importance and emotional, physical, or any kind of harm to the participants was not be tolerated (Purdue, 2012).

Excluding personal biases is the one way to ensure objectivity. Whether the data collected were kept anonymous needs to be decided by the researcher and relayed to the participants. When choosing the subjects for the research, choosing individuals based on the needs of the study yielded more reliable and valid results than choosing the subjects based on ease of access or randomly. Some institutions require approval from a board before proceeding with human subject research to ensure that ethics requirements are not violated. When the results get reported, it is necessary to depict the results accurately as they were observed or recorded and not out of context (Purdue, 2012).

Summary

In summary, this chapter shows that the major issues that can lead to runway incursions such as collaboration, education, and training need to be explored more thoroughly to see of social cognition or a person's understanding of the material plays an important role in helping to mitigate runway incursions (FAA, 2015b). Because personal beliefs and other social and environmental events can affect everybody differently because of our individuality, it is important to conduct a study on the perspectives of aviation stakeholders on the effects of collaboration, education, and training on reducing runway incursions (FAA, 2012). More emphasis needs to be put on the human factors associated with runway incursions and deviations from collaboration, education, and training. Redundant systems continue to play an important role in attempts to eliminate runway incursions.

Upgrading all technologies and making the technologies as uniform and interchangeable as possible ensures that there is a global cohesion, which can make runway safety more efficient (FAA, 2015b). With so many variables involved in taxi and operation of an aircraft, the continued vigilance of the flight crew, specifically the pilot, co-pilot, crew, and the air traffic controllers, is of the upmost importance. Wildlife has played an important role in many runway incursions, and has become a top concern for aviation. Allowing persons in the aviation industry to enter with bad communication skills such as inefficient or negligible English-speaking capabilities may be a major contributor to runway incursions and other safety hazards. A search of the literature failed to reveal any empirical study about collaboration, education, and training, which included all stakeholders in an assessment of these factors to help prevent runway incursions (ICAO, 2007).

Security of runways is of major importance. New systems allow for audible alarms in the aircraft, text messages to the plane, and many other redundant systems to alert flight crews of impending danger; however, ultimately it is the pilot and co-pilot with the responsibility to ensure that they are familiar with all diagrams related to that airport (FAA, 2012; Schönefeld, & Möller, 2012). Proficiency in the execution and instructions given by air traffic control relies on the flight crew to thoroughly and methodically follow all procedures, and to check and recheck to ensure that a runway incursion does not occur.

Air travel will only continue to increase, with so many aircraft operating on Earth, it is more important now than ever that safe runway practices and those that are unsafe and have continually lead to disaster are identified and remediated (ICAO, 2007). Eliminating unsafe acts play an important role in the prevention of runway incursions as the human being, the common denominator in every runway incursion, must be constantly vigilant and aware and not be sightseeing, texting on a cell phone, or holding a conversation with the co-pilot, which is an unsafe act (Schönefeld, & Möller, 2012).

It is also the responsibility of air traffic control to uphold personal professionalism and ensure that transmissions are clear and understandable. Even with all the advances that commercial aircraft have, general aviation is not always as advanced. Time demands and increased workloads may be causing people to skip safety items like reading back instructions completely, or checking an airport diagram thoroughly before taxiing, or using a checklist (FAA, 2015b). The over reliance on technology and automation may be a major part in runway incursions. The main points of exploring social cognition and the effects of collaboration, education, and training are justified by the lack of research found on the subjects. Chapter 3 provides a discussion of the methodology used in the study. Chapter 4 presents the findings of

the study, while Chapter 5 provides a comprehensive discussion of the findings, limitations, and implications of the study.

Chapter 3: Methodology

Reducing runway incursions has been a major priority for the NTSB for decades (Schönefeld & Möller, 2012). The literature review revealed a lack of adequate empirical evidence regarding the causes of runway incursions at U.S. airports despite collaboration and training of pilots, ground crews, controllers, and airport administrators (Asteliin, 2013). Federal agencies such as the FAA, NTSB, and organizations such as ICAO have published observations, experiences, and other forms of empirical evidence in form of papers, studies, reports, and different forms of qualitative and quantitative data. Although there is previous research on airport incidents, no studies have focused on the experiences of collaboration, education, and training as tools for mitigating runway incursions. The focus of this study was to discover how participants in the aviation industry may utilize collaboration, education, and training to minimize the occurrence of runway incursions at U.S. airports.

When gathering information to understand human behavior, for example, in social science, a qualitative design is often preferred (Creswell, 2016; Miles, Huberman, & Saldana, 2014; Rubin & Babbie, 2014). The methodology selected for any study should be dependent on the research objectives and gaps identified in literature, and for how it helps to answer the research question (Asteliin, 2013). This study employed a multiple-case study approach to explore how collaboration, education, and training may be improved in order to reduce the frequency of runway incursions at U.S. airports.

Research Question

When constructing qualitiative research questions, it is important to ensure that they are measurable, appropriately defined, focused, and refined (Creswell, 2014). Qualitative research questions are aimed at interpreting or improving the understanding of phenomena as opposed to

proving anythi\ng (Cairney & St Denny, 2015). An appropriate research question identifies important aspects such as a problem or issue that is relevant to a broad community of scholars and normally start with “why” or “how” (Creswell, 2014). Based on the gaps that were identifed in the literature review, my purpose was to uncover the causes of runway incursions, and provide recommendations to stakeholders regarding remediation practices to reduce the occurrence of these events. The main research question in this study is aimed at understanding how education, collaboration, and training may be enhanced in order to reduce the rate of runway incursions.

RQ1: How might collaboration, education, and training be improved in order to help prevent runway incursions?

Purpose of the Study

Prevention of runway incursions is necessary to prevent potential loss of life, damage to infrastructure and aircraft, and financial losses for airlines (ICAO, 2007). Researching the perceptions, attitudes, behaviors, and lived experiences of aviation industry participants is the focus of this study. The purpose of this study was to determine how collaboration, education, and training can be improved to promote aviation safety, especially in reducing the occurrence of runway incursions. Participants in the aviation industry should understand the importance of collaboration, education, and training to enhance safety through proficiency in execution of their duties and responsibilities (FAA, 2011).

Design of the Study

The design of this study is based on a non-positivistic philosophy, which means a person’s perception of truth is dependent on observers and how they understand a given “truth” (Gergen, 1999, p.2). Non-positivists believe that reality is complex and multifaceted, and that a single phenomenon can have many interpretations (Gergen, 1999). Based on the non-positivistic

concept of constructivism, reality is a construction of collective thoughts that are interpreted by observers through interactions and communication.

Qualitative case studies that involve the use of interviews, secondary data, and focus groups provide a three-dimensional inquiry (Creswell, 2014), which was the intent of this study. The primary focus of qualitative research design is to understand humans and their behaviors (VanderStoep & Johnston, 2009). In qualitative studies, different attitudes, conflicting opinions, and the importance of temperament and actions are key focal areas for data collection and analysis. These factors improve the understanding of people's actions, especially in fields such as such as aviation. Additionally, qualitative research entails logical discussions of ideas, opinions, and opposing forces systemically utilizing the theory of knowledge or philosophy of science to represent the "dialectical model," an understanding that knowledge is the result of dialectic actions such as the use of multiple data sources, and constant testing of agreements and developing interpretations (Creswell, 2014). Increased collaboration among stakeholders in the aviation industry may allow for education and training in areas of interest through logical, in-depth discussions, consideration of opposing viewpoints and other knowledge in order to develop effective operating procedures for maintaining safety. Collaboration and discussion among the various aviation governmental agencies, aviators, and other participants in the aviation industry is a representation of the dialectical model and how learning through exchanging information in a collaborative manner may increase knowledge in areas of the aviation industry where safety is a major concern as with runway incursions.

To gain a better understanding of the perceptions and attitudes of the stakeholders such as pilots and airport administrators in the aviation industry, qualitative research is preferable to analyzing the numerical values in quantitative research. Qualitative researchers gather data from

participants while in their own setting and encourage them to explore their own perceptions, attitudes, and lived experiences of the study topic (Polit & Beck, 2010). A qualitative multiple-case study design explores a group of individuals to understand a social or human problem the group is experiencing (Yin, 2014).

As shown in the literature review, the prevailing and continuing incidence of runway incursions that can lead to damage and/or death are resulting mostly from human errors. An improved understanding of the association between runway incursions and collaboration, education, and training among participants in the aviation industry may help with mitigation and increased safety. A multiple-case study design was suitable for this study because the findings are based on credible and dependable research methods. The multiple-case study approach also allows for the duplication of the research and evaluation of data for validity and reliability in order to assess credibility and objectivity.

Research Population and Sampling Method

Identification of the site, setting, and participants is necessary to ensure that the selection strategy is appropriate to answer the research question (Creswell, 2014; Cronin, 2014). It is desirable to involve all stakeholders engaged in moving aircraft operations for the safety of all concerned. Pilots, air traffic controllers, mechanics, and other grounds personnel may have different knowledge, attitudes, and practices regarding the role of training, education, and collaboration as strategies to minimize runway incursion incidents. Their inclusion in the study would therefore foster understandings from their perceptions about required improvements and missing parts for improving the effectiveness of the training, education, and collaboration that reduce runway incursions.

Due to limited resources, only a purposive sample of 12 pilots, air traffic controllers, airport administrators, and ground personnel were used for this study. Forcino, Leighton, Twerdy, and Cahill (2015) demonstrated that one of the instances when a small sample size would be beneficial is when the researcher has limited resources or funds. Though saturation normally occurs at 12 participants, some researchers suggest that the appropriate sample size for qualitative research studies should be 6 to 20 subjects with the possibility of adding more depending on the study objectives and available resources (Fusch & Ness, 2015; Latham, 2014). Though sample sizes are common in aviation literature, only a few have used it in the study of runway incursions. For example, Rogerson and Lambert (2012) evaluated opinions regarding the Prioritization of risks in runway safety from seven experts. In case of any difficulty in recruiting participants, I requested assistance from the airport authorities to convince their employees to participate in the case study. In case of a limited sample, I would be conducting a qualitative review of previous literature on runway incursions.

The participants were selected using purposive sampling technique from airports in New York and New Jersey. A purposive sample is a non-probability sample, where participants are selected based on their characteristics, objective of the study, and convenience (Creswell, 2014). The primary benefits of using purposive sampling is because it is cost-effective and can be used to collect data that would otherwise be impossible using probability sampling techniques such as those requiring formal access to lists of populations.

The selection criteria included only those who are licensed pilots with at least 10 years of experience. Grounds personnel, airport administrators, and air traffic controllers were required to have more than one-year experience working in the busy airports. These personnel were involved with the everyday activities relevant to airport safety. The sample of participants was drawn from

airports in the congested New York and New Jersey area. The choice of this setting for the case study was due to proximity and the congested airports that are major sources of runway incursions in commercial and general aviation.

Data Collection and Procedures

Data Collection

Case studies must be conducted carefully and with rigor in order to benefit from multiple sources of evidence (Creswell, 2014). In case study designs, triangulation is important to ensure findings are comprehensive and reflect the participants' perceptions and ideas as accurately as possible (Yin, 2014). In addition, triangulation promotes the reliability of case studies (Creswell, 2014). The multiple sources of data in case studies allow investigators to develop comprehensive, meaningful stories based on the participants' understanding of the topic. Data collection was conducted using interviews and a focus group designed to explore the experiences of pilots, air traffic controllers, airport administrators, and ground personnel regarding collaboration, education, and training, focusing on their role in reducing runway incursions. Interviews and focus groups were recorded to ensure that all the information provided is captured. Audio tapes were transcribed by the principal investigator soon after data collection and destroyed once crosschecked with the transcripts. The interviews and focus group were used to evaluate the participants' behaviors and perceptions regarding runway incursions and the importance of collaboration, education, and training in the aviation industry.

Interviews. A semi-structured interview protocol (Appendix A) was used for data collection. Different versions of the protocol have previously been administered successfully in many fields including education, the armed forces, and business (Jamshed, 2014). The semi-structured interview protocol, containing questions on participants' thoughts, is appropriate for a

case study design and was implemented consistently across all interviews. The interview protocol was focused on understanding the knowledge, attitudes, and behaviors of each participant, rather than a random application of unstructured wide-ranging questions. In so doing, the researchers allow questions, answers, and discussion to emerge or enlarge during the interviews (Cairney & St. Denny, 2015). The protocol was intended as a tool for presenting questions that require a narrative response or descriptive commentary (Roulston, 2010; Turner, 2010), which circumvents yes or no answers, would or should remarks, or conjecture. The researcher can ask follow-up questions as needed to clarify responses or confirm a clear understanding of participant perceptions. The resulting data is specific to the research question, detailed, and specific to the participant's knowledge attitudes, and behaviors which they may perceive as negative or positive. The interviews were administered to 12 people.

Upon IRB approval, phone calls were made to the interviewees regarding their participation in this study. The contact information and list of potential interviewees was provided by the respective airport authorities after approving the study. A follow-up letter with consent form was sent to potential respondents inviting them to participate in the study (Appendix B). A snowball sampling method may be used to ensure that 12 people are included, in case the correct number of participants needed for the study do not volunteer (Breslin & Buchanan, 2011; Creswell, 2014). A 45–60 minutes appointment was booked for an interview with each participant at a convenient time and place. An in-person interview format was used to collect data from the participants. Before the interview, the purpose and objectives of the study was reviewed and permission for documenting the interview sought. The participants also signed consent forms before the interviews and focus group.

Based on the recommended procedures for qualitative case studies by Ketokivi and Choi (2014) and Singh (2014), a Demographic Survey (see Appendix C) was administered orally to provide an overview of the respondent's characteristics. Next, the semi-structured Interview Protocol, (see Appendix A) based on the research question and containing open-ended questions, was implemented to collect data needed to answer the research question.

Focus groups and documents. Focus groups mainly involve the administration of interviews to many participants at a given time (Gill et al., 2008). Focus groups are mainly composed of 8–12 participants who do not know each other, but share similar experiences that can be evaluated to understand a given phenomenon (Giles, Sniehotta, McColl, & Adams, 2015). The primary objective of conducting a focus group was to facilitate self-disclosure among respondents regarding their experiences, values, opinions, and issues (Gill et al., 2008). In this study, a focus group was used to understand the participants' perceptions, experiences, and attitudes towards the use of training and collaboration to minimize the occurrence of runway incursions.

The focus group involved seven pilots with experience in the aviation industry. Participants were grouped into one focus group, which was conducted after the interviews to better understand baseline perceptions regarding the role of training, education, and collaboration in reducing runway incursions (Giles et al., 2015). The focus group was guided by the researcher where participants discussed their experiences, attitudes, and perspectives on runway incursions, use of training, education, and collaboration as strategies to enhance runway safety, and ways to improve the strategies (Gill et al., 2008). The researcher took field notes during the focus groups to capture behaviors, gestures, and facial expressions that may not have been inherent in recordings.

Documents were used to compare the participants' responses with previous data on the use of training, education, and collaboration to address runway incursions. Data were retrieved mainly from documents and reliable websites such as the FAA and NTSB. Documents relating to runway incursions and their causes were analyzed to understand the role of training, education, and collaboration in reducing runway incursions. I used the ICAO document 9870, *Manual on the Prevention of Runway Incursions* (ICAO, 2007), *Advisory Circular 150/5300-13A* (FAA, 2016a), *European Action Plan for the Prevention of Runway Incursions* (Eurocontrol, 2011). The documents were properly cited in APA format, as required by copyright rules.

Identification of Attributes

Various attributes that correlate directly to this study were identified to assist in understanding the risk factors that are associated with runway incursions. Attributes such as collaboration and training were identified in past research (Baker & McClusky, 2005; George, 2015; ICAO, 2007). The interview questions involved the investigation of knowledge, attitudes, and behaviors, or the lived experiences of licensed pilots and airport administrators who manage small fixed wing aircraft in and out of regional airports in relation to how collaboration and training could be improved to prevent runway incursions.

Data Analysis Methods and Procedures

Creswell (2015) and Turner (2010) suggested that results from interviews support the use of thematic analysis as a way to uncover recurrent themes and find linkages with which to develop insights that respond to the identified gaps in knowledge. Exploring the knowledge, attitudes, and practices of pilots and administrators regarding runway incursions was critical in addressing the research question. The use of a multiple-case study design facilitated appropriate

documentation of knowledge, attitudes, and practices of pilots and administrators based on their experiences in the aviation industry.

Astalin (2013), and Hazzan and Nutov (2014) indicated that qualitative research is exploratory, while the role of the researcher is mainly investigative. Creswell (2014) and Yin (2014) agreed that inductive reasoning, a process for developing conclusions and generalizations, appropriately follows and emerges in conjunction with qualitative data collection. Hazzan and Nutov (2014) recommend methods of organizing qualitative data into categories and interpreted in a manner that facilitates the development of a holistic perspective of lived experiences by grouping their responses into themes, patterns, and concepts.

Theme identification is a fundamental task that helps to explicitly relate everything back to the research question. Theme identification is performed before, during, and after data collection, by analyzing the text and finding word repetitions, key terms, and key words in context (Yin, 2014). Accessing the frequency in which words are used within texts is another method of generating unique themes (Ryan & Bernard, n.d.).

After identification, I organized themes to facilitate productive data analysis. The documented text responses were coded for themes using Microsoft Excel and Microsoft Word software, which allows the investigator to upload various file formats such as audio, video, text, or websites, into a program for coding the words and phrases, and for creating lists of themes and patterns. This software aided the researcher in applying inductive reasoning, the final step in qualitative case study data analysis (Yin, 2014). Themes and patterns established about participants' knowledge, attitudes, and practices as well as proposed improvements, were used for decision making in regard to improving collaboration education, and training in order to minimize runway incursions and enhance aviation safety.

Data quality is an important factor in qualitative and quantitative research because it affects the credibility and validity of findings (Creswell, 2014). The quality of data can be negatively affected by aspects such as human errors, violations of integrity constraints, heterogeneous data, duplicate records, syntactic errors, missing entries, noisy sensors, and outliers (Rao & Nageswara, 2012). Therefore, researchers should ensure effective data cleaning is conducted before analyzing data (Creswell, 2014). In this study, I reviewed all collected data by eliminating duplicates, filling missing information, removing errors, and fixing integrity constraint violations. After data cleaning, I reviewed the qualitative data by identifying interesting responses based on the research question. I then summarized the responses and coded the data based on existing themes.

Limitations, Assumptions, and Delimitations of the Research Design

Limitations to the research design refer to the conditions that are beyond the researcher's control (Concordia University, 2018). Various limitations, such as time constraints and small sample size may influence the findings of this study (Creswell, 2014). The first limitation of this study involves the sample, which consists of pilots, air traffic controllers, and ground personnel who are involved in the daily operations of moving aircraft on runways and other areas of the airport. The sample size was a limitation because the scope and course of the study did not allow the inclusion of additional participants in the research study. The second limitation involved the selection criteria, which included selecting only licensed pilots with at least 10 years of experience, air traffic controllers, airport administrators and grounds personnel with at least one year of experience. The scope of the research study was only limited to the New York and New Jersey area of the East coast and enlarging the study would consume more time and effort.

Assumptions involve factors that are relevant to the study, but out of the researcher's control (Creswell, 2014). The responses provided by the participants during the focus group and interviews were assumed to be honest. In addition, the interview and focus group questions were assumed to be reliable and valid.

Delimitations refer to the boundaries that researcher sets and describes the choices made by the researcher that are within their control (Creswell, 2014). Delimiting factors included the selection of the population and research question for this study. The first delimitation involved only asking participants about general aviation accidents. Second, the data involved in this study was limited to the participants' past ten years experience and others' past one year experience.

Validation

Validation involves determining the soundness of researcher's claims (Seliger & Shohamy, 1989) and applies to the design and methods utilized in a study which contribute to the credibility and dependability of the study. Particularly during data collection, validity refers to the realization that the findings truly represent the phenomenon that is being measured. Validity is influenced by various factors, which may affect research findings. The use of interviews to collect data was carefully considered and the protocol specifically designed to focus on interview questions that addressed the research question.

Credibility

Credibility in qualitative research is established by considering the complexities of the study and providing a thorough explanation of those that may be hard to understand (Ary, Jacobs, Sorenson, & Walker, 2014). The credibility of data can be confirmed using methods such as triangulation, which involves the use of two or more forms of data collected and comparing them for inconsistencies (Anderson, 2010). Triangulation, which involves the use of multiple

data sources, methods, theories, or observers to gain comprehensive understanding of given phenomena (Creswell, 2014). Triangulation enhances the robustness, completeness, and richness of research findings. Prolonged engagement ensures that an extended time is spent with participants to gain a more understanding of their values, social relationships, and behaviors in a social context (Given, 2008). Reflexivity refers to the relationship between cause and effect and the methods employed by the researcher (Corbin & Strauss, 2015). Researcher reflection ensures that the investigator is constantly evaluating themselves to assess thoughts, perceptions, values, and attitudes, which may help the researcher to avoid unnecessary biases (O'Hanlon, 1994), and are all utilized in this study to strengthen the credibility and reliability of the data.

To ensure optimal validity, the questions were designed to uncover in-depth information about the overarching research question driving the need for the study. Credibility is used to determine the reliability of the data that is used for analysis (Creswell, 2014). Microsoft Excel and Microsoft Word software interactively assess qualitative data in the form of codes and trends, and similarities and differences all of which can be presented graphically. Yin (2014) suggested that content validity increases the logic of the answers as they reflect the research objectives. Creswell (2014) suggested various approaches for ensuring credibility. These strategies allow the researcher to determine the generalizability of the study. However, these studies require long-term data collection and multiple sources to have meaning beyond the study. In this study, I used multiple sources of data to ensure rigorous analysis. First, documents relating to runway incursions were thoroughly analyzed as part of the literature review to provide adequate information for use during analysis.

Member checking is another technique that was employed to establish credibility in this study. Member checking involves sharing conclusions and interpretations with participants, to

allow correction of errors, providing additional information, and clarification of their intentions (Anney, 2014). Member checking was performed after the interviews to collect additional information and allow the respondents to correct errors and confirm their feedback. The findings of the study were returned to the participants for validation and to check the accuracy of their responses.

Dependability

Dependability refers to the extent to which collected data is reliable. Dependability occurs when the researcher can show that the data is stable and consistent. While various techniques can be used to confirm the dependability of data, one of the most effective method is through external auditing, where outsider researchers are approached to evaluate the research study (Zohrabi, 2013). In this study, I utilized a researcher who was not involved in the data collection process to audit the interview questions and examine the procedures for data collection, analysis, and research findings. External auditing confirmed whether the data is accurate or supported by the collected data. The researcher also determined whether the conclusions and interpretations were supported by the collected data.

Expected Findings

Expected findings are those that may be uncovered after completing data collection and making inferences in relation to collaboration, education, and training improvements. For this study, I expected to witness increased collaboration and knowledge regarding runway incursions and the maintenance of a culture of safety in the aviation industry. I also anticipated that the participants would demonstrate understanding of the vital role aviation professionals play in maintaining a safe environment with the utilization of collaboration and training in their own experiences. After implementation of this study, I expected the participants to be aware of

educational and training programs such as the Runway Incursions Avoidance in Pilot Handbook of Aeronautical Knowledge (FAA, 2016b), Federal Aviation Administration (FAA) Runway Safety Program Website (FAA, 2014b), and Runway Status Lights Program among other materials (FAA, 2017b).

Ethical Issues

To ensure research ethics are adhered to, this study was submitted to the Concordia University Institutional Review Board (IRB) for approval before beginning data collection. Throughout the data collection and analysis process, committee members were consulted to ensure ethical adherence. Each participant was required to sign an informed consent form synonymous with Concordia University's IRB regulations before individual interviews commence. The informed consent form was provided to the participants with information regarding the expected duration of the interviews, foreseeable risks, and other conditions that may occur in the duration of participation in this study. The only risk identified for this study was that some participants would require confidentiality and anonymity. Confidentiality was maintained by ensuring recordings, transcripts, code lists, notes, journals, informed consents, and other personal information are stored in a password-protected computer where the researcher has sole access. Finally, the participants were informed that participation in the project was voluntary and they would face no repercussions or penalties if they withdrew from the study (Concordia University IRB, 2018).

Researcher's Position

The researcher has been involved with aircraft since 1996 as part of the Civil Air Patrol and earned his pilot's license in 2013. The researcher is currently a single engine land pilot with close to 300 hours total time and 200 pilot in command hours with a high performance and

complex rating. Currently, the researcher volunteers with the Civil Air Patrol, flying the United States Air Force Auxiliary funded aircraft for various missions. The researcher also volunteers for other aviation organizations such as Pilots to the Rescue who rescue dogs that are up for euthanization by flying them to friendly states. The researcher has a Bachelor's degree in Aviation Management from York College in the City University of New York, and a Master's Degree in Aeronautical Science and Space Studies from Embry-Riddle Aeronautical University Worldwide. The researcher has vast experience in the aviation industry through schooling and firsthand job positions at JFK, LGA, and TEB airports in various capacities including customer service and line service, which all entailed full time positions involving some sort of aircraft movement operations. The researcher hopes to fly jet aircraft in the commercial aviation industry and graduate to space travel when the commercialization of space travel begins.

Ethical Issues

The Belmont Report (1978) outlined the ethical standards that define how to conduct a research involving human subjects. Cozby (2014) stated that "Ethical concerns are paramount when planning, conducting, and evaluating research" (p. 35). Ethical procedures were followed throughout the duration of the project. Anonymity of the participants was maintained by assigning the participants with new names only for the purposes of the study. Responses were stored confidentially in a password-protected computer to prevent access by employers or others during the study or in perpetuity. These procedures are in compliance with Concordia University's ethical guidelines and pose minimal risk to participants. This is because they do not contain either experimental treatment or exposure to physical or psychological harm as stipulated by the U.S. Federal Government Department of Health and Human Services (2009) regulation 45 CFR.

In order to reassure and ensure that the participants understand the reasons for conducting the study, the researcher carefully explained the procedures to be followed. The participants were also assured that their involvement is voluntary, and if one chooses to withdraw from the study, no sanctions were applied. In addition, no information regarding the participation of any respondent was sent to employers. All data, including text and demographic information, were stored in a secure location for three years after the study is published before being destroyed.

Summary

Chapter 3 has provided a brief explanation of the research methodology and how this study was conducted. This study procedure is designed to focus on the research question that are based on gaps that were found during the review of literature (Asteliin, 2013; Cardosi, 2010). The appropriateness of the qualitative method with a multiple-case study design is also detailed. A qualitative approach was selected because it facilitates the understanding of participants' perceptions regarding collaboration, education, and training and their potential influence on the occurrence of runway incursions. Data collection was conducted using interviews and focus groups. Documents were also reviewed to support the findings of this study. Thematic analysis was used to evaluate the interview responses and address the research question. The Microsoft Excel and Microsoft Word software were used to analyze the coded qualitative responses. Chapter 4 provides a comprehensive discussion of the findings from data analysis. The chapter also presents the potential improvements in collaboration, education, and training as they may apply to reducing runway incursions. Chapter 5 contains a detailed discussion of the results, limitations, and implications of the study.

Chapter 4: Data Analysis and Results

The purpose of this study was to investigate how training, education, and collaboration may be improved to prevent the occurrence of runway incursions at U.S. airports. This chapter provides a comprehensive presentation of the results of the study based on qualitative interviews, a focus group, and key documents. This chapter is divided into four major sections: (a) description of the sample, (b) discussion of research methodology and analysis, (c) summary of findings, and (d) presentation of data analysis and results. This study addressed the research question: How might collaboration, education, and training be improved in order to help prevent runway incursions? This research question was aimed at evaluating the participants' attitudes, knowledge, and practices in relation to how education, training, and collaboration might be improved in order to prevent runway incursions among the busy New York and New Jersey airports that accept general aviation and commercial air traffic.

Description of the Sample

The participants who were interviewed comprised a purposive sample of 12 participants including pilots, airport administrators, air traffic controllers, and ground personnel from airports in New York and New Jersey. These participants also had jobs in general aviation, commercial Part 121 operations, air traffic control, airport operations managers, airport ground personnel, and law enforcement. The participants had a relatively high level of experience, with the majority having at least 20 years' experience. Based on the interviews, 83.3% of the participants had over 20 years' experience as pilots in the aviation industry. Based on their fields of experience, the participants stated that they had experience in category 121 commercial operations, general aviation, and aircraft marshaling. The focus group included seven

participants all of whom worked in the aviation industry, mainly in general aviation, for over 25 years.

Research Methodology and Analysis

A multiple-case study design was used to investigate how training, collaboration, and education might be improved to prevent the occurrence of runway incursions at U.S. airports. Explorative in nature, the study involved three phases including interviews, a focus group, and qualitative analysis of key documents relating to the prevention of runway incursions. The interviews were conducted with 12 participants using an open-ended, semi-structured protocol to understand participant knowledge, attitudes, and practices on how education, training, and collaboration might be improved to prevent runway incursions. The interviews were conducted personally by the investigator in a designated room at the airports. The interviews lasted between 45 and 60 minutes each. The focus group included seven pilots who responded to questions relating to how education, training, and collaboration might be improved to prevent runway incursions. The focus group and interviews were then transcribed verbatim into word documents for thematic analysis. The focus group was administered in an empty room in one airport for 60 minutes. The investigator moderated the focus group while recording the participants' responses.

The responses from the focus group and interviews were chunked and coded, analyzed for patterns, then grouped into categories in order to develop key themes surrounding the improvement of education, training, and collaboration to prevent runway incursions. The analysis was conducted through constant comparison of the chunks and codes from the interviews and focus group, and the documents in order to inductively identify common themes. As stated by Boeije (2002), the constant comparative method involves the collection of data from participants which are then analyzed through open coding. The first step in the coding process

for this study involved the extraction of chunks based on the research question. To select chunks and delineate codes from the interview and focus group responses, I focused on how each related to answering the research question (see Appendix D).

The four documents that were used were the *European Action Plan for the Prevention of Runway Incursions* (Eurocontrol, 2017), ICAO document 9870, *Manual on the Prevention of Runway Incursions* (ICAO, 2007), and *Advisory Circular 150/5300-13A* (FAA, 2016a). The key documents were also evaluated to confirm, disconfirm, and extend the findings from the interviews and focus group. For example, the AC 150/5300-13A supported the findings of this study involving the need for airport runway redesign. The FAA (2016a) reported that airports should be designed with the intent of minimizing the likelihood of runway incursions. The various factors that should be considered when designing the taxiway include taxi method, steering angle, intersection angles, and three node concepts.

Summary of Findings

The findings of this study yielded five themes. The first theme was exercising key safety practices to improve education, training, and collaboration, and prevent runway incursions. The safety practices include sterile cockpit, crew resource management (CRM), improved situational awareness, mandating annual training and education, familiarization with airports, and balancing between automation and human interaction. The second theme was greater standardization of phraseology, communication, and airport procedures to enhance education, training, and collaboration to prevent runway incursions. The third theme was using effective communication to improve collaboration at airports. The fourth theme involved the need for pilots to adopt scenario-based training. The fifth theme included the need for more collaboration and partnership with stakeholders to minimize the rate of runway incursions.

Presentation of Data and Results

The primary aim of this study was to explore the ways of improving education, training, and collaboration to prevent the frequency of runway incursions in New York and New Jersey airports receiving commercial and general aviation traffic. In this study, data were collected through interviews, a focus group, and key documents. The first data collection instrument was the semi-structured interview questions (Appendix A), which were used to collect the pilots' perspectives regarding how education, training, and collaboration might be improved to prevent runway incursions in New York and New Jersey airports. The second data collection instrument included a focus group (Appendix C). Five key themes were identified after chunking, coding, and analysis of the interviews and focus group: Exercise of key safety practices, need for greater standardization, effective communication, greater focus on scenario-based training, and more collaboration and partnership among stakeholders.

Exercise of Key Safety Practices

Based on the findings, education, training, and collaboration to prevent runway incursions may be enhanced by exercising key safety practices. Regarding the sterile cockpit, pilots and aviation crews should avoid distractions and non-essential communication. When asked to identify strategies that can prevent runway incursions, Pilot 1 suggested: "One [strategy] is a sterile cockpit, and the other one is the observer is required to be attentive." Pilot 2 stated that, "I think the primary things are probably sterile cockpit and looking at a chart before you move." In addition, the pilots encouraged observers to be attentive and know their radio and transponder frequencies ahead of time. Also, pilots should program the computer before leaving the taxi area. Pilot 3 also highlighted the importance of the sterile cockpit in preventing runway incursions, "Sterile cockpit that is the word I think that is awfully important. Especially because

it is important that the sterile cockpit is maintained at all times." Most of the participants acknowledged the introduction of sterile cockpits, while one recommended the use of a checklist in addition to using sterile cockpit procedures. Pilot 1 stated that;

> Particularly in-flight safety, you use what we call sterile cockpit, where we are not talking about anything that we saw last night. Movies or, you are pretty much focusing on the task at hand. What you are doing you are taxiing; you are looking at where you are going, and most of the time it is really just your task saturated with doing certain things before you are getting ready to take off.

Regarding crew resource management (CRM), aviation crews should utilize available educational and training resources including the AOPA courses, the FAA website, and ATC when necessary. Pilot 4 stated that "Even in a single pilot operation, we can make use of crew resource management. Use all available resources, and that certainly includes ATC when necessary." In addition, pilots and ground personnel should follow instructions from ATC in all operations and seek clarification when in doubt. Based on the findings, collaboration may be improved to minimize runway incursions by improving the crew's situational awareness. Based on the manual for preventing runway incursions, runway incursions involve any occurrences at airdromes resulting from the incorrect presence of aircraft, people, or vehicles in protected areas of airports designated for landing and take-off (ICAO, 2007). Thus, pilots and vehicle operators should always know their location and those of their counterparts at the airport. Additionally, pilots can use electronic flight bags and charts to monitor their location in the airport. For instance, Pilot 5 argued that:

> Especially with the new electronic flight bags, people will trace out the taxi so that the taxi clearance matches on the GPS and or aircraft movement screen. This is beneficial

because you have a constant awareness of where you are and where you are going, so you can always keep an eye.

Pilots are also encouraged to review the procedures for taxi routes before moving into the area. Familiarization with the airport is also an essential approach to improving collaboration. Based on the findings, pilots and vehicle operators should use airport diagrams and runway hot spot charts to improve their awareness of airports. In addition, the pilots should follow normal operating procedures and all instructions while taxiing. As stated pilot 1:

> Confirmation, read back confirmation, and then the other one, if you are not sure, stop and ask, which is huge. On some airport diagrams, you have HS1, HS2, what we call hotspots and they are depicted on the airport diagram. We encourage both pilots to have the airport diagram before pushing out, before taxing to an active runway. We encourage pilots to go over the procedure with the taxi routes.

Two participants identified the need for more automation and technologies to enhance situational awareness and prevent the occurrence of runway incursions. The participants indicated that automation is beneficial in identifying threats to runway incursions. Pilot 5 highlighted that:

> Automation is very helpful, that is also a threat because there is so much automation now it is about managing it, but realistically when it comes to taxiing an airplane around an airport, there is not a lot of automation involved.

However, Pilot 3 claimed that the presence of many technologies can be a source of distraction, which can cause runway incursions; *"*but I think there are too many distractions in the airplane. Everybody has to have a 2 GPS's, a handheld GPS, and iPad and a phone."

Therefore, there is a need for a balance between the use of technology and automation by pilots and the human interface.

Though automation can be used to improve education, training, and collaboration in airplanes and other areas, the participants indicated that balancing its integration with human interaction is essential to minimize the rate of runway incursions. Based on the findings, pilots and airport personnel should avoid excessive head downtime and stop relying solely on automation. Pilot 6 suggested that:

> Where you do not have to put your head down, you actually can see ahead, and you can actually see what is in front of you. That is augmented by some of the electronics and technology that I think has promise.

The *European Action Plan for the Prevention of Runway Incursions* also indicated that pilots should also avoid "head-down" operations, and instead allow for external visual awareness while taxiing (Eurocontrol, 2017). Thus, airlines should ensure crew have adequate awareness of the importance of red lights that are used in alert systems to promote situational awareness and avoid wrongful entry onto runways.

Mandating education, training, and collaboration can also minimize the rate of runway incursions at airports. The results indicated that airline managers should adopt annual pilot proficiency in practical tests, in place of the current biannual test requirements. In addition, the airlines should update training regularly based on technological changes. When asked about methods of improving education, Pilot 7 suggested that "Every year organizations such as AOPA give a 5% discount to insurance holders among other incentives for completing annual education and recurrence training."

The ICAO (2007) indicated that pilots can cause runway incursions even during the day. The situation is worsened when pilots unknowingly believe that they have adequate awareness of their position but end up in other locations. Therefore, in low visibility, more care is needed to ensure accurate navigation of the runway and ensure optimal situational awareness among all aviation crew. The presence of adequate situational awareness was also identified as a key strategy for preventing runway incursions. The participants indicated that situational awareness is prime while taxiing, therefore, pilots should know to request for readback and progressive when needed. Pilot 8 said that, "Well, the main thing is situational awareness, you have to listen up, and if there is any question, then you have to ask for readback."

Because runway incursions are always bound to occur, it is important for pilots and aviation staff to improve their situational awareness. Based on the results, maintaining adequate situational awareness during runway operations is important to avoid possible damage to aircraft which could have significant financial implications. Pilot 9 claimed that:

> It happened it is going to keep happening. My attitude, "Hey, you better straighten up." Look outside. Know where you are at all times. Situational awareness, limited distraction because you are only a second away from having a right to the FAA or buying an airplane because you balled up and you hit a wall, or you hit a fence, or you hit another airplane.

To improve situational awareness while taxiing, pilots are advised to focus on a single operation and then stop when performing checklists before proceeding with taxiing. The pilots should know everyone's location on the runway and at the airport. Pilot 9 also stated that:

> Situational awareness while you are taxiing. Maybe on a single pile operation, you should stop, perform your checklist and then move and then look out and taxi. You should

always be taxiing. Know where everyone is, know where you at on the runway or the airport. Use your lights, use your external lights, and use your airport diagram.

Familiarization with the airport and conducting a pre-study before flying into a field is also essential in promoting situational awareness. A pre-flight assessment allows the pilot to identify the correct runway in advance. Pilot 9 stated that:

> Doing your homework, i.e., your preflight. Let us say you are going to a field that you have not been before. Probably be nice to have an idea of which runway you are going to land and how you are going to taxi to your destination. To your fixed-base operator (FBO).

Where applicable, all aviation personnel should aim to improve situational awareness by communicating any information involving runway operations using standard aviation English (Eurocontrol, 2017). Another participant recommended the introduction of a scale that shows what every staff is doing at a particular moment to enhance situational awareness. Pilot 9 responded that:

> Oh! Yeah, that goes without saying. Situational awareness is prime. That should be a scale that would not even have to be talking about. That should be given that you should. Know what everyone else around is doing. Not only where you are at because you are not the only person on that airport right.

Need for Greater Standardization

Education and training may be improved by updating the current content and time requirements for earning an airman's certificate. The majority of the participants perceived that education was essential in preventing runway incursions and suggested more educational programs for pilots are needed. Pilot 6 stated that "More education. More education in aviation is

always good. It is like anything the more you learn about something the least something will happen. In this case, like runway incursion." Five pilots in the focus group identified education as a key strategy in the prevention of runway incursions. Pilot 10 stated that aviation education provides an opportunity for pilots to learn everything about flying, **"**Education yes, I think it is a great resource, a great opportunity and should be utilized for everything in flying." Pilot 11 stated that:

> The education that we receive is definitely an important item that we need when we start flying. The actual experience you get from flying to me is the icing on the cake. That sets in real life situations that you are going to be faced with at different airports. Like I flew at out of republic airport and came here at Islip and flew a bit at Brookhaven and every one of them was different.

Based on such perceptions, the pilots indicated the need for mandatory education. When asked whether education should be mandated, pilot 12 stated that "I do, there should be some sort of." Using an example, the participant highlighted why mandatory education would be important in preventing runway incursions. Pilot 12 reported that:

> I had a gentleman who was 80 somewhat years old. Joined civil air patrol and could not pass a form 5 yet he had his license for well over 50 years. He was a fantastic pilot, he flew during World War II. What they call night fighter. He went up at night with the compass and a flashlight. He was an excellent, excellent pilot but because he never had dealt with communications through airspace like Long Island things like that for the last 20 years and because his friend kept signing him for every two years they can still fly. When he came to our program, he could not pass. He did not understand communications, he did not understand procedures. He did not understand upholding

procedures or runway incursions, but this was a gentleman that had a pilot's license for well over 50 years, but he was not required to come back and test anymore.

As indicated in the example, pilots can cause runway incursions if they have ineffective communication skills, irrespective of their competence or experience. The pilot highlighted that the accident resulted from the pilot's failure to understand communications; thus, could not execute procedure effectively. In addition, the pilot could not understand runway incursions and prevention procedures despite having a license for 50 years.

Three pilots indicated that mandatory training and education is missing in the current aviation environment. One pilot argued that making education and training mandatory and biennial would facilitate continuous improvement in knowledge and awareness of runway incursions; thereby, enhancing airport safety. Pilot 10 stated that: "The same thing. I think if we to make mandatory training and mandatory education and get these agencies together to do this."

Based on the responses, the majority of the pilots mentioned the provision of additional training on runway incursions. Pilot 13 stated that the training should be conducted annually in order to enhance knowledge of runway incursions among aircrew and pilots, "Every year they get additional training on it." Pilot 10 said that training in addition to continuing education of airport personnel, the FAA safety seminars, AOPA seminars, and word of mouth could prevent the occurrence of runway incursions, "Training, continuing pilot education, things like AOPA seminars or online training." One respondent indicated that training on runway incursions can be enhanced by transforming the current programs online, simulations, using scenarios, making training mandatory, and introducing more effective programs. Based on Pilot 14, making training available online in downloadable format might significantly reduce related expenses:

> Maybe have, having different options such as the FAA doing all this training and material maybe having their department administer training to pilots and aircrew, I do not know because it all comes down to funding. Maybe put it online, so it does not have to be a book format. It could be downloaded on to a tablet or an iPad.

The ICAO (2007) emphasized that airlines should adopt educational and awareness materials including stickers, posters, newsletters, and other important tools to prevent runway incursions. An example of a material with important educational and awareness information is the ICAO runway safety toolkit. The ICAO also supported thorough education of pilots and other aviation personnel on airport signage, lighting, and markings.

Regarding phraseology, all airport personnel should speak properly, clearly, articulately, and concisely on the radio. Pilot 15 claimed that, "Phraseology is there for a purpose, and everybody should be speaking properly on the radio whether you are in the tower, TRACON center or in an aircraft. So, there should be standardization in that respect."

The standardization of communication would involve updating readbacks, inflection, and the tone of voice. Pilot 10 claimed that "Whatever kind of radio you are using but standardization of communication has to be what we use." In addition, airport procedures can be standardized by tracking the time spent during taxiing.

The ICAO (2007) also stipulated that all pilots should always listen to communications on the given frequency and attempt to visualize other aircraft or vehicles in the vicinity. In addition, pilots should be aware of the runways that will be encountered between the current location and required destination. Specifically, the pilots should focus on instructions and clearances issued to traffic involving the runways.

Irrespective of the radio being used, the participants suggested that standardization of communication was essential. The participants also highlighted the importance of updating the training and educational content in a more standardized way. Pilot 11 responded that:

> Of course, it is going to be outdated. Yeah, the FAA needs to update these tests, and I think they are updating it with the help of AOPA. AOPA is a good organization to push the government to acquire these improvements.

This study indicated the need for standardization of flight review on some topics that should be completed by pilots. The participants also reiterated the importance of standardizing communication from the towers to the pilots. Pilot 7 said that, "I mean standardization from the towers, standardization from the pilots. That is what you need. You know that CB (Citizens Band,) slang that comes in you cannot really use that kind of stuff."

The respondents highlighted the need to follow standardization for Part 91 operators who are tasked with small non-commercial aircraft within the U.S. Another pilot stated that following the rules would enhance communication in towered airports. Pilot 12 stated that:

> There is a part 91 standardization for non-towered airports if they follow through with it that is good nobody is really there to watch them most of the time. So again it could be a wild west as they say in some of these airports. The towered airports though generally have, you have a ground control and now at some of the major airports like Kennedy, LaGuardia and you know, Dulles and Denver International, all those.

The participants highlighted the need for additional standardization of aviation education because runway incursions occur in different ways. Currently, there is no tracking of how much time pilots spend taxiing and how many signs they need to know. Pilot 14 emphasized that:

> I think the education maybe should be a little bit more standardized because any other way you learn might not be the same way in another place where you are getting a license and where you are getting a check ride. You can have totally different runway situations. You could get your check ride here at Islip or Farmingdale, or you can get a check ride for Brookhaven. Totally different runway experiences and yet there is no tracking of how much time you actually spend taxiing, how many different kinds of signs you need to be able to identify? So there does not seem to be a whole lot of uniformity, standardization.

However, one participant from the focus group believed that education is already standardized as pilots have always been educated in accordance with current airman certification standards (ACS) and new risk mitigation and standards. Pilot 15 highlighted that the designated pilot examiners' (DPE) initiative that ensures pilots can mitigate every situation that may lead to runway incursions, "It is up to the DPE again to make sure that you can mitigate each and every type of situation that can be thought of at that particular time. Cannot do everything."

Effective Communication

Based on the findings, an increased clarity in communications at towered and non-towered airports should be monitored and modified as necessary. Effective communication allows pilots, ATC, and ground personnel to work seamlessly together to prevent runway incursions. To mitigate the risk of runway incursions, airlines should adopt safety management systems with audio and verbal communication. Pilot 10 claimed that, "safety management systems are not only proactive as they should be. Well, it is definitely not reactive, we got out of, hopefully out of that, we are supposed to be proactive, but we want to go to the next step and anticipate what would happen." Additionally, airlines should ensure communication of safety

briefings to the entire aviation community to improve the awareness that runway incursions can happen at any time, and also emphasize the importance of safety. For instance, Pilot 9 stated that:

> In Civil Air Patrol, we are mandated to have a checklist and a safety briefing every time we have an activity including a flight. There is not a lot of latitude or interpretation in reading back the checklist and using the standardized method of reading from top to bottom left to right in an appropriate English tone, so that correct understanding is ensured between the pilot, crew, tower, and others.

Another strategy to enhance communication among aviation personnel is implementing and monitoring readback procedures by ground vehicle drivers and other personnel (Eurocontrol, 2017). The requirements for readback were created to enhance flight safety. The ICAO (2007) highlighted that the strictness of the requirements is directly associated with the potential severity of misunderstandings in communications and exchange of ATC instructions and clearances. Following the readback procedures strictly ensures that aviation personnel receives and effectively understand instructions and clearances. Therefore, aviation staff should read back to the ATC the safety-sensitive sections of the instructions and clearances. The ATC is also tasked with verifying the accuracy and completeness of the readback instructions and clearances.

Where applicable, airports should also focus to enhance situational awareness by ensuring all communication involving runway incursions are performed using clear English. In relation to coordination, airports should implement full vehicle or aircraft signs for communicating all information involving runway operations. In addition, airports should avoid using confusing call signs and implement discrete RTF call signs for use by ground vehicles. It is also important to monitor and ensure that pilots and other aviation personnel use standard phraseology to avoid possible confusion, which may cause runway incursions. In relation to

communication, Eurocontrol (2017) indicated the need for airlines to implement, monitor, and ensure aviation personnel uses standard phraseology based on ICAO's guideline.

Based on the interviews, effective communication involves relaying the correct information and having someone to provide assistance regardless of rank. It is also important to avoid performing other tasks while communicating. Pilot 15 reported that staff could stop the aircraft and communicate with the ATC in case they need clarification:

> Stop the airplane, tell ATC you need a minute or two. It is all about communicating your intentions and at the same time you have a pilot next to you who is there to assist you, help you regardless of rank. Whether he is a captain or colonel in the military or captain for United. There are two pilots in the cockpit both of them have to work together for one prime objective. Safety, safety, safety.

Another aspect of communication that arose from this study was language and phraseology, which is a major problem, especially among foreign pilots entering U.S. airports. Given that English is the common aviation language in the country, airlines coming into the country may have difficulty in communication when the pilots cannot speak English well. Pilot 1 claimed that it is the responsibility of the pilot and ATC to ensure effective communication by speaking slowly when relaying information to such pilots:

> Well, English is the aviation language, but of course, you have airlines coming into this country. Some of the pilots they do not speak as good English. It is the responsibility of both ATC and the pilot. If the pilot does not understand something there is that phraseology, speak slowly. I have never heard, I do not think I have ever heard that used before and that is a tool for the pilot.

However, slowing down communication can significantly reduce the efficiency of aviation personnel at airports. Thus airlines should ensure pilots from foreign countries is by ensuring they understand English before being given licenses in their respective countries. Pilot 1 that:

> If you do not understand what they are saying, you understand English enough to get a license in your country, and you come here in the United States, and you are let us say operating out of JFK and you speak slowly. There is nothing that says, we all have to slow down. ATC, pilots we all have to effect a safe outcome. Right even with the foreign language we are talking about before, I mean there is a set, unlimited of words that you need to know. It should not be that difficult to, maybe there should be some training about that, that hey if you have an accent, no offense, we will work on standardizing your transmissions, the object here is communication and in communication would be served by standardizing. There could even have a program for that, it is like I am studying Spanish, and part of it you have to speak in Spanish. And it knows when you are not saying it right so, they can develop a program where foreign language could be, you have to read this, and if it is read correctly yes and if it is not then you have to repeat it.

Data also demonstrated the importance of ATC maintaining calm and using appropriate language when communicating with pilots. More relaxed directions would allow pilots to ask questions and reduce their fear of making mistakes. Pilot 5 stated that:

> I do not know, there is a balance that has to be reached, but whenever possible I think controller should try and relax, soften up a little bit so that the pilot will ask question if he has a question, rather than be afraid asking a guy because he is going to get his head beaten off. Say for example if a guy misses the call, may have missed the call, he is not

> sure if he missed the call, if he feels comfortable to say, "So, and so I missed a call." If he knows the guy is going to embarrass him or chew his head off things, he is not going to ask, and then he missed the call, and then he really missed a call.

Sometimes, airlines should verify whether pilots, ATC and ground vehicle operators use standard ICAO phraseologies during their communications involving runway operations (ICAO, 2007). To ensure effective transmission of information, all communications involving runway operations should be executed using the same frequency used for landing and take-off of aircraft. The ICAO (2007) emphasized that aviation staff should use full vehicle and aircraft signs for all communications involving runway operations. The ICAO also recommended the use of standardized phraseologies in all communications involving runway operations. In addition, the readback procedures should involve communications with vehicle operators in the maneuvering area. The ICAO stipulated the importance of including a requirement for obtaining explicit clearance to use the runway in cockpit procedures. Though the English language used in the ground stations is usually accepted, airlines should foster the use of standard aviation English in international airports to improve situational awareness of all staff on the frequency.

To improve communication at airports, controllers and pilots also have to maintain the appropriate behavior and temperament. While controllers are known to be more receptive, pilots may be less friendly, thus, causing miscommunication. Pilot 5 stated that some controllers fail to make their reports due to fear of being reprimanded.

> Controllers are said to be more receptive, but pilots, its two separate things, and controllers will be more receptive, friendlier, less pervading or whatever. The pilots could be less friendly, and sub-track up, usually on a common traffic frequency I do not see too much on the Tower frequency, but sometimes [inaudible] [00:20:39] guys talk about

"Hey Jim, how are you doing? Bla bla bla." Meanwhile, somebody else cannot make their report.

To improve airport operations and prevent runway incursions, all stakeholders should also be involved in the communication process. Pilot 4 stated that "I think we have good communications if we wanted to improve our operations. I think we have to get our partners more involved."

In addition, airlines should implement and ensure constant monitoring of the application of readback procedures by ground vehicle drivers and other aviation staff who work in the maneuvering area (Eurocontrol, 2017). Airlines should also consider performing a regular evaluation of radio telephony operations to assess components such as the ICAO compliant phraseology and frequency loading. In cases when conditional clearances are applied according to the ICAO provisions, airlines should ensure robust, and policy procedures are created and implemented effectively. Eurocontrol suggested that Air Navigation Services Providers and airport operators need to implement procedures that facilitate important airport information is shared with pilots and drivers using the maneuvering area in real-time through radio communication.

Based on ICAO, ineffective communication between ATC, vehicle drivers, and pilots is a major cause of runway incursions and often involves various violations. These violations include the use of unstandardized phrases, incorrect readback of instructions by pilots or vehicle drivers, and ATC's failure to ensure readback from pilots or drivers is consistent with clearance. In addition, the violations can result from failure of vehicle drivers and pilots to understand controller's instructions, accepting clearances meant for other vehicles or aircraft, complex or overlong transmissions, and blocked transmissions. The pilot-related factors that increase the

likelihood of runway incursions include non-compliance with ATC clearances, which result from ineffective communication, inadequate markings and signage, and vehicle drivers and pilots working head-down. The implementation of procedures involving runway operations using a common frequency when applicable enhances situational awareness (Eurocontrol, 2017). The ICAO (2007) recommended the use of short and precise messages during ATC communications to avoid confusion.

Greater Focus on Scenario-Based Training

The participants stated that training can be enhanced by adopting scenario-based techniques and increasing the use of simulation. One participant stated that finding a way to utilize simulation techniques effectively can enhance the quality of education, "Find a way to make greater use of simulation techniques." Pilot 1 claimed that:

> Currently, I think in general aviation you do not have that luxury of going to a simulator most of your training is done in real time actual airplane conditions. So, it is a little difficult to simulate that awareness, to peak that awareness.

Based on the respondents, scenario-based training facilitates the identification of threats, which allows pilots and vehicle operators to learn from other people's mistakes. Scenario-based training allows the evaluation of pilots' skills, by purposefully providing incorrect taxi instructions to test how they would handle threats. Pilot 3 suggested that:

> At this point like I said, I think it is mostly a scenario-based type training that needs to happen. We need to understand where the threats are; we need to put pilots in those scenarios where they have to handle those threats in a safe area, not out on actual runways.

Training may also be improved by putting pilots in simulated operating environments where they can practice handling threats away from actual runways. Using simulators or simulated environments allows airline trainers to introduce threats on aviation crew and evaluate their reactions. The pilot stated that:

> But in a simulator or some sort of simulated operating environment where put the threats on him and see how people react. People need to be exposed to, "Okay I did this I thought I was safe and I still screwed it up so how do I not do that."

The respondents also highlighted the importance and necessity of developing a comprehensive syllabus and addressing every possible outcome to improve training in the aviation community. Eurocontrol (2017) highlighted that training and assessment of pilots and other aviation personnel is important to ensure they have adequate knowledge and awareness of airdrome signage, lighting, and markings. The majority of the participants indicated that training could be improved through the adoption of scenario-based techniques. Pilot 7 stated that "It is really more just of scenario-based seems to be the best way. Learn from where the threats are, learn from what other people's mistakes were." The study also suggested that scenario-based training, using simulators can enhance training thereby preventing the occurrence of runway incursions at airports. Based on one respondent, scenario-based training can be administered using simulators where the instructors intentionally include incorrect taxi instructions to gauge the pilots' knowledge and awareness. Pilot 1 said that:

> We have employed scenarios, scenario-based training wherein the simulator we will give a taxi instruction to a pilot, and we will purposely include something incorrect in the taxiing instructions to see if the pilot is aware. So, do not just take it for granted what ATC is telling you there are some awareness and responsibility left to the pilot as well.

When receiving information, it is also important to ensure that the communication is within the safe parameter to operate. Thus, instructors can integrate scenarios help pilots understand how to communicate when faced with dramatic events. Pilot 2 reported that:

> So, we do incorporate some scenarios that help the pilot say, and it's dramatic where we have another airplane we can actually in the simulator put an airplane and taxi it across another airplane and then say, "Okay well stop and freeze the simulator."

One participant indicated that it is difficult to simulate optimal situational awareness because training is currently done in real time actual airplane conditions. However, the participant stated that training can be enhanced by introducing and encouraging the use of simulators. Pilot 1 stated that:

> I think what we can start doing, and I really hope the FAA gets on board with this is encourage them, I mean we have these red bird simulators now that are pretty, they are fantastic for training environments and they are great. I think some of that experience in that simulator needs to be reflected into or actually looked at as far as actual conditions.

An advantage of employing scenario-based training using simulators is that the sessions can be recorded for future use. Performing the training in a controlled environment means that pilots can also log it towards their experience. Pilot 3 stated that:

> It is a simulator, but we can log this towards our license because of the experience that we are receiving here. So, just putting emphasis in the simulation scenario-based training and actually having these controlled environments where they are recordable. They are loggable towards the experience of pilots. They might be, you might require more hours, but at least we are doing it in a controlled environment.

Another advantage of using simulation is that the pilots can repeatedly practice without any human casualties and no damage of property. The pilot emphasized that increasing the number of flight hours and using the simulator for the majority of the time can reduce the frequency of runway incursions and accidents. Pilot 1 highlighted that:

> We are not putting people, property other lives at risk. At least let us say instead of 40 hours for your private, let us make it 80 hours for your privacy but most of that time or more than half of that time could be done in the simulator. If you encourage that I think you will see a better outcome in terms of either runway incursions, accidents the frequency being reduced.

This study demonstrated the importance of scenario-based training and how the FAA can develop a comprehensive syllabus to improve pilots' and aviation personnel's awareness of runway incursions. The majority of the pilots in this study found the scenario-based training to be important and supported the FAA's efforts in encouraging the approach. Pilot 1 stated that:

> Yeah, scenario-based training is very important and really developing a syllabus where we are trying to touch on every possible outcome that we can see out there in the real world. So, that whole scenario based training is fantastic. I think the FA is on the right step and they are moving in the right direction to encourage this.

More Collaboration and Partnership with Stakeholders

The final theme included the need for more collaboration and partnership with stakeholders to minimize the rate of runway incursions. The participants in the focus group also perceived that improving collaboration is essential in preventing runway incursions; therefore, aviation personnel should not be afraid to engage the ATC. In addition, it is important to avoid rash decisions and always be ready to repeat instructions. Pilot 15 stated, "Do not be afraid of

asking the controller. Over here a guy said to repeat yourself. Do not let them rush you. Do not make any decisions, take your time you are PIC. Not a guy up there in that tower." Another pilot claimed that, in addition to being aware, aviation personnel should not be afraid to admit when they make mistakes or are unfamiliar with some parts of the airport. Pilot 12 said that:

> So, of course, you have to be aware at all times. Where you are, where you are going and if you are not sure where you want to where you have to go. You ask the tower for book lessons. Do not be afraid just tell them that. I am unfamiliar, but I have book lessons.

This study also highlighted the importance of effective collaboration despite unavoidable disagreements between the pilots and ATC staff. The findings indicated that all aviation personnel should communicate effectively and understand each other's jobs to enhance runway safety. Pilot 11 indicated that:

> I think both sides have to understand that there are two sides of the radio when you do not know what is going on with the other person's life. The controller has a job to do. The pilot may have a job to do, whatever it is whether its recreational flying or what have you but they both have something that they want to do. Controller's job, I think it is important that pilots understand that a controllers job is to keep them safe. I think they need to work with the controllers and personally, I have never really had a problem with a controller. They are there to help.

Phraseology was also identified by some pilots as a key component of aviation collaboration. Therefore, to prevent runway incursions, airlines should ensure aviation staffs use standard phraseology to improve collaboration and avoid confusion. In addition, the respondents reiterated the importance of avoiding shortcuts when interacting with other personnel. Pilot 14 responded that:

> Everything phraseology is very important. On the ATC side and the pilot's side. They have all these shortcuts that they use. A lot of people do not say things especially ATC will not say back I had like 3.5. What is 3.5? 3.5 What degrees?

The pilots indicated that some of the ATC personnel have never flown aircraft before, increasing the likelihood of errors that can result in runway incursions. The majority of the pilots perceived that collaboration between aviation staff was essential in improving familiarization with airports and preventing runway incursions. Pilot 4 claimed that:

> I think we have to get our partners more involved. For example, they are people that are in ATC that have never flown a plane before. They are people in the cockpit who have never gone to a tower. So, they do not understand some of the issues that the other people have.

Therefore, it is essential for ATC staff to undertake familiarization flights together with pilots to improve their situational awareness and collaboration with pilots when giving instructions. The advantage of this approach is that pilots would not need to understand the ATC personnel's roles, but would significantly enhance collaboration. Regarding the familiarization flights, Pilot 1 stated that:

> Years ago, they used to have ATC controllers actually do familiarization flights with pilots, and I do not know at what point it stopped or maybe it was being taken advantage of the fact that there is a trip going to Hawaii I want to do a fan flight. But I think that having controllers and pilots work together. Pilots interestingly do not have to understand the role of ATC in their responsibilities.

The majority of the pilots perceived that collaboration between pilots and aircrew personnel can be further enhanced. Pilot 6 reported that collaboration is a major problem at airports and improvement strategies are available:

> Yes, collaboration it is a problem. It is a problem, and there are no problems when we can find the solutions. So, the solution is out there collaborating together will either eliminate the problem completely or will reduce the frequency of this occurrence. There is a study out there somewhere I can remember but the fact that we have been addressing these issues, the frequency of these runway incursions has reduced.

Pilot 10 stated that collaboration can be enhanced by improving communication between pilots and other aviation crew, *"*Yes, as discussed before in terms of better communications at non-towered fields and at towered fields." Pilot 4 supported coordination between airports to prevent runway incursions:

> Yes and I think that there is a way to do this kind of unique. If they coordinated and confirmed let us say Kennedy and LaGuardia specifically. I said before, hours and operations are sometimes a busy notice.

Allowing aviation staff to interact and organizing bonding sessions can also enhance collaboration; thereby, improving efficiency. One participant stated that airlines should organize open sessions where pilots, ATC, and other aviation staff can meet and have conversations. Pilot 3 stated that:

> It would certainly be helpful especially with these complex airports to sort of have like an open session where pilots talk but getting pilots, controllers all together in their free time is very difficult that does not usually happen. So, I do not know, I really do not know.

As stated by Pilot 1, the era of one captain being the sole person in charge of the flight operations has passed, "no longer exists. You guys are there equal in terms of decision making and collaborating and making sure that the airplane arrives safely. That is important."

Based on the respondents, increased partnerships with the FAA and AOPA are needed to create a safer system. In addition, pilots and crew members should talk with passengers, ATC, and all stakeholders and encourage them to report any potential causes of runway incursions on the runway. Airlines should also introduce passenger briefing involving job factors and maintaining vigilance. Also, the airlines should partner with the FAA and other unions to enhance safety. Additionally, airlines should engage the FAA and AOPA constantly, and provide them with contacts such as phone number and email address to promote effective collaboration. The FAA and AOPA should partner with airlines to develop programs for all pilots and stakeholders involved in aircraft operations. For instance, pilot 2 stated that:

> If different companies, AOPA or flight safety or the FAA got together and said, "We are going to come up with a program that every year every pilot takes a 2-hour program or a 3-hour program that devotes part of that time to incidents that have happened and what caused the problems. That knowledge would be invaluable.

In addition, airports should coordinate with AOPA and other key stakeholders such as the FAA, NTSB, IATA, and others to develop standardized safety systems on airports, aircraft, and for operators. The FAA should partner with airlines to make safer runways and go around the country providing seminars promoting ways to prevent runway incursions. The finding is supported by the FAA, though AC 150/5300-13A, which recommends the redesign of airports to prevent runway incursions (FAA, 2016a). As indicated in the AC150/5300-13A, airlines should

in collaboration with the FAA consider various factors when designing the taxiway: taxi method, the three nodes concept, steering angle, and intersection angles.

Through the AC150/5300-13A, the FAA provides non-mandatory recommendations involving the designs of civil airports (FAA, 2016a). Based on the AC, various changes that have been proposed by the FAA to enhance runway safety include the introduction of a new Runway Design Code (RDC), runway geometry intersections, declared distances, Runway Protection Zone (RPZ) standards, New Taxiway Design Group (TDG), and Runway Incursion Prevention geometry.

Summary

Despite being a significant problem in the U.S. aviation industry, the results indicate that most runway incursions may be prevented through effective training, education, and collaboration. This study was aimed at exploring how training, education, and collaboration can be improved to prevent runway incursions in New Jersey and New York airports. Using various keywords and codes, I established five themes from the interviews, focus group, and documentation. The findings indicate that airlines should adopt key safety practices, collaborate with the AOPA, FAA, and other key stakeholders to increase focus on scenario-based training, ensure effective communication, and increase standardization.

The key safety practices included the adoption of the sterile cockpit, CRM, improved situational awareness, mandated education and training, and ensuring an effective balance between automation and human interactions. The focus group results indicated that sterile cockpit procedures and checklists should be used at all times to enhance flight safety. The implementation of CRM with aviation personnel and the use of essential educational materials from the AOPA and FAA were recommended in this study. Through CRM, pilots and flight

crew would improve their competence and ability to identify and mitigate threats. Situational awareness while taxiing is essential because it ensures the identification and mitigation of threats. Because of the high likelihood of runway incursions in high-traffic airports, pilots should always maintain situational awareness to avoid the financial implications associated with the events. Pilots should focus on one task at a time and stop when using checklists. The findings also suggested the need for familiarization with airports and runways before the flight. Aviation personnel should also communicate effectively using standardized aviation English to enhance collaboration and prevent runway incursions. The introduction of more effective technologies may also enhance situational awareness and prevent runway incursions. However, many technologies can cause distractions that may result in runway incursions; thus, indicating the need to balance between automation and human interactions.

Increased standardization involves updating the current time and content requirements for earning flight certification. The findings indicated the need to mandate education and training to ensure continuous and recurrent improvement in knowledge and awareness of runway incursions among the aviation personnel.

Effective communication facilitates increased clarity when sharing information in towered and non-towered airports and promotes collaboration. Airlines are advised to address the threats of runway incursions by adopting SMSs through verbal and audio means. To improve training, airlines should adopt scenario-based techniques using simulators. Scenario-based training improves pilots' ability to identify threats and facilitates continuous learning with minimal risk of aircraft damage or accidents. An increased partnership and collaboration between airlines and stakeholders including the FAA and AOPA is also essential in preventing

runway incursions. The collaboration between pilots and flight crew could be further enhanced by improving communication and organizing open sessions.

Perhaps the most important theme was the need for standardization of phraseology and more training in regard to clearly and efficiently communicating on the radios. The majority of the participants also suggested a closer partnership with the FAA and AOPA to develop better collaborative programs for all pilots and stakeholders in an effort to prevent runway incursions and enhance safety. To enhance training, the participants suggested the adoption of scenario-based training to allow pilots to practice handling threats to runway incursions continuously in an environment where there are no lives or property at risk. Chapter 5 presents an in-depth discussion of the findings, as well as relevant implications and conclusions.

Chapter 5: Discussion and Conclusions

The purpose of this study was to investigate how training, education, and collaboration might be improved to prevent the occurrence of runway incursions at U.S. airports. The findings of the case study revealed five key themes: exercise of key safety practices, effective communication, need for greater standardization, a greater focus on scenario-based training, and more collaboration and partnership among stakeholders. This chapter presents the summary of the findings, discussion of the results in relation to the literature, limitations, implication of the results for practice, policy, and theory, recommendations for further research, and a summary conclusion. This chapter also provides an in-depth interpretation of the findings with implications of the given case study.

Summary of the Results

The study addressed the research question: How might collaboration, education, and training be improved in order to help prevent runway incursions? The theoretical foundation of this study was based on Bandura's SCT (1989), which postulates that learning is dependent on various behavioral, cognitive, and environmental factors. The findings of this study suggest that education, training, and collaboration may be enhanced by exercising key safety practices, effective communication, greater standardization, and an increased focus on scenario-based training and partnership with stakeholders. The SCT addressed the unique way people gain and maintain knowledge and behaviors, while accounting for the immediate environment in which the individuals operate. Using the SCT, the investigator was able to understand how pilots' and other aviation personnel's perceptions regarding the methods of enhancing education, training, and collaboration with the goal of preventing runway incursions.

The findings of this study could be used by airline managers and stakeholders to improve training, education, and collaboration among aviation personnel. Agencies such as the FAA, NTSB, and AOPA could also use the current findings to guide their decisions regarding resource allocation in terms of airport redesign and funding runway safety projects. Given that airlines currently employ various strategies to prevent runway incursions, the findings of this study may be used to strengthen and improve the effectiveness of these initiatives.

The FAA (2012) stated that runway incursions can be avoided by conducting orientation sessions for the crew shortly before landing, distributing tasks and responsibilities in relation to positioning on taxiways, and through airport layouts to ensure effective landing and prevent avoidable collisions. Despite careful consideration of education, collaboration, and training in the aviation industry, U.S. airports still experience about three cases per month. Effective collaboration, education, and training enhance a constant flow of updated knowledge and promote teamwork among the staff (Cardosi et al., 2010). A recent report by the National Business Aviation Association (NBAA) (2018) documented how collaborative safety initiatives have been used to reduce the frequency of runway incursions at Honolulu Airport. A recent study by Zhang and Luo (2017) also found educational training as a key factor influencing the occurrence of runway incursions, where such incursions may be effectively prevented and controlled by addressing root factors, including a lack of adequate education and situational awareness.

The three primary methods for data collection included interviews, a focus group, and document analysis. Based on inductive analysis, the findings indicate that education, training, and collaboration may be enhanced in various ways to prevent runway incursions. For example, reflecting study themes, both commercial and general aviation should exercise key safety

practices such as the sterile cockpit, CRM, familiarization with airports, improved situational awareness, mandated annual education and training, and balancing between automation and human interaction. In addition, training, education, and collaboration may be enhanced to prevent runway incursions by standardizing communication, airport procedures, and phraseology. The results also indicated that more effective communication can be employed to enhance education, training, and collaboration with the aim of preventing runway incursions. This study also demonstrated that education, training, and collaboration might be improved by adopting scenario-based training, as well as increased collaboration and partnership with stakeholders.

Discussion of the Results in Relation to the Literature

The problem that led to this study was that human processes, including the education, training, and collaboration among key stakeholders in the aviation industry, are still involved with or related to approximately three runway incursions per month nationwide (FAA, 2012). The findings revealed that training, education, and collaboration have been, and continue to play a major role in the prevention of runway incursions at U.S. airports. This section explores and interprets the relevant implications of the findings from Chapter 4 in relation to my research objectives, including practical and theoretical implications. In addition, I will highlight those results that did not fully support my research purpose, including negative cases, methodological errors, design limitations, and other flaws that had an impact on the findings.

This study focused on evaluating how education, training, and collaboration could be enhanced to prevent runway incursions at airports. I interviewed pilots with an adequate response rate, yielding qualitative data that showed the various strategies for improving education, training, and collaboration in order to prevent runway incursions. I followed up the interviews

with a focus group to better understand participant perceptions regarding how training, education, and collaboration may be enhanced to prevent runway incursions. I was closely involved in the focus group and interviews, periodically engaging the participants to provide more detail and insights. As a result, the findings included the adoption of key safety practices, need for greater standardization, effective communication, a greater focus on scenario-based training, and more collaboration and partnership among stakeholders.

Various studies from the literature review were consistent with the findings. One finding indicated that airports should adopt key safety practices to prevent runway incursions, specifically the sterile cockpit, improved situational awareness, familiarization with airports, CRM, mandated annual education and training, and balancing between automation and human interaction. These practices are consistent with previous evidence from Schönefeld and Möller (2012) who argued that airlines are responsible for upholding safe runway practices and for eliminating unsafe acts that may increase the likelihood of collisions. This finding on CRM is congruent with evidence from Baron (2011) who argued that CRM can be used to improve collaboration among pilots, flight attendants, copilots, navigators, other aviation personnel, and even passengers. The finding on situational awareness is supported by Johnson et al. (2016) who claimed that pilots, ground vehicle operators, and ATC personnel need to be educated and trained effectively to improve their situational awareness and prevent runway incursions. The finding on the balance between automation and human interaction is consistent with previous evidence from Weiner and Nagel (1988) that highlighted the importance of using automation and technologies as augmentation tools as opposed to being substitutes for pilots.

The findings also indicate the need for integration of new technologies, automation, and simulation to enhance training, education, and collaboration among pilots and other aviation

personnel. The respondents, for example, suggested that balancing automation and human interaction at airports can contribute to runway incursion prevention. Specifically, this means that pilots, ground vehicle operators, and ATC personnel should use beneficial automations and technologies such as EFBs to improve situational awareness, and avoid excessive use of electronics to minimize distractions. The findings indicated that, though beneficial to airlines, automation can cause distractions that could cause runway incursions. Similar findings were also established by FAA (2015) who discouraged overreliance on technology and automation as they are among the primary causes of runway incursions.

The findings highlight the need for scenario-based training through simulators to help prevent runway incursions. This finding is consistent with Sparko et al. (2010) who demonstrated the preciseness and benefits of using simulator training. The use of simulator training ensures that pilots know which controls and at which point they need to detect or avoid radar. Integrating simulator training in the aviation and military is needed to enhance safety through the minimization of errors by improving pilots' knowledge of controls and increasing their situational awareness. As a result, pilots may avoid collisions and prevent fatal incursions.

The findings of this study indicated the need for greater standardization of education and training in order to prevent runway incursions. Education and training may be improved by updating the current content and time requirements for earning an airman's certificate. This finding is consistent with Baker and McClusky (2005) who indicated the need for continuous and recurrent training and education of aviation personnel to increase their skills, which usually deteriorate with time. Baker and McClusky highlighted that deterioration of skills among aviation staff can have significant consequences including runway incursions and even death. Thus, continuous training must be introduced to ensure aviation personnel are conversant with

updated training materials, minimizing the likelihood of runway incursions. Baker and McClusky stated that stakeholders in the aviation industry, especially pilots should receive continual training because their skills are gradually lost when not utilized frequently. However, Baker and McClusky argued that this recurrent training must involve a collaborative effort between aviation professionals and all the stakeholders in the aviation industry to ensure the information is standardized.

The findings of this study indicated that an increased clarity in communications would promote the prevention of runway incursions. Effective communication promotes collaboration among pilots, ATC, and ground personnel to prevent runway incursions. Communication in the cockpit mainly comes in an audio form, but can also come in a visual form or even a tactile method such as a hand signal from a person marshaling the aircraft in or out of a gate. Clear, standardized communication is the most effective way to ensure that instructions are relayed in a manner that all stakeholders can decode; thus, the aviation industry uses English globally as the primary language of communication so that confusion is minimized regardless of where in the world it is taking place (Kovalchik, 2014). This finding is corroborated by Kovalchik who stated that effective communication among stakeholders is essential in preventing runway incursions and providing a safe environment for airport operations.

This study identified the need for increased partnership and collaboration with stakeholders to prevent runway incursions. This finding is consistent with Weiner and Nagel (1988) who found that collaboration among aviation personnel can help in mitigating and resolving issues such as the designation of runways during landing, thereby enhancing safety through effective communication. Baker and McClusky (2005) also claimed that collaboration

among all stakeholders leads to a succinct and effective flow of communication between the aircraft, ATC, and gate operators.

The finding that was slightly different from previous literature was that, despite being beneficial in preventing runway incursions, automations and technologies can also contribute to distractions. Previous research suggested that an increased use of technology has the potential of increasing situational awareness, thus, reducing the prevalence of runway incursions (Darr, 2008). The findings of this case study indicate the need for caution when using automation to avoid distractions that may lead to an incursion.

Impact of Study Flaws on Findings

Study flaws may include negative cases, methodological errors, and design limitations. A major study flaw that impacted the findings was an over-reliance on interview data. The primary weakness of interviews is the high likelihood of researcher bias resulting from the tendency to construct questions that conform to their perspectives (Creswell, 2014). For example, in one instance, I asked the participants, "Collaboration, education, training can definitely be improved to enhance to prevent runway incursions?" In addition, the quality of interview data is dependent on the investigator's skills, the level of training and effective supervision of the participants, as well as the ability of the participants to delve into the relevant details and stories that address the interview questions (Yin, 2014). Some participants also lacked information to respond to some questions. For example, the participants used short responses such as "Yes," "No," and "Right" which created a lack of detail in addressing the problem. Ineffectively conducted interviews and failure to monitor participants may result in incomplete or inaccurate findings. However, I asked additional questions for clarification and prompt more in-depth responses from the participants.

My use of a focus group also limited the case study in various ways. Based on my experience moderating the focus group, I experienced the challenge of maintaining an active discussion and generating interest from some participants. A few participants dominated the focus group discussions, which may have negatively affected the quantity and quality of data collected. The ambiguities inherent in the human language were also a source of error in this case study. In qualitative research designs, as in this case study, researchers can make mistakes during interpretation because of words or phrases with multiple meanings (Creswell, 2014). The ambiguity of some interview and focus group responses led to errors during interpretation of the findings.

Design limitations involve the characteristics of a given research design, in this instance a case study, that influence or affect the interpretation of results (Shean, 2014). The design limitations involving this case study included the large volume of data that complicated data analysis and organization and my temptation to deviate from the focus of the case study. Another design-related limitation in this study was the overreliance on the participants' memory. Yin (2014) stated that participants' memory of past events and experiences are subject to distortions that may result in incorrect responses. Only a few individuals can vividly recollect various aspects of lives and the majority focus on elements they find important. In addition, the participants might be unaware of other potential factors related to the study topic. For example, the participants' memories of past runway incursions and how education, training, and collaboration may be improved varied, leading to inconsistent findings.

The methodological errors in this study included the judgmental bias I introduced into purposive sampling. Because purposive samples are created based on specific criteria and the researcher's judgment, the possibility of bias is more likely when compared to probability

sampling (Sharma, 2017). The use of a purposive sample increased the likelihood of judgmental error on my part because I selected the participants based on their suitability and availability. Since participants are selected based on the researcher's judgment, defending results and conclusions derived from purposive samples can be difficult (Creswell, 2014). In addition, it can be difficult to convince the audience that the researcher's criteria for selecting the study units were appropriate. Readers typically require the use of other data collection approaches to verify the validity of purposive samples.

Limitations

Research limitations involve the weaknesses of a study that are beyond the researcher's control. The limitations involved in this case study included the high likelihood of researcher bias, length of data collection process, and interpretation errors resulting from varying responses by participants. Multiple-case study research is also limited by context and bias. Though my approach provided adequate descriptions, they are highly susceptible to researcher bias because humans are naturally subjective (Green et al., 2015). Researcher bias may result from the participants, data collection method, or interpretation strategy (Creswell, 2014). For example, leading questions were at times used during the focus group and interviews, which may have suggested answers for the respondents. In addition, follow-up questions were used to elicit in-depth responses from the participants, increasing the likelihood of bias in the process. In addition, my interpretations of the focus group and interview data may have been aimed at addressing the research question with only a positive result in mind.

A major limitation of multiple-case studies is that the process of data collection and analysis is time-consuming (Creswell, 2014). For example, this study involved interviews with 12 participants from different airports in the mid-Atlantic area. Given demanding pilot schedules,

data collection was time-consuming because it was conducted on fixed appointment dates with the individual participants. Focus groups are also time-consuming and the participants may disagree or support each other's responses. The entire data collection process took 3 months. The data analysis process transcribing the interviews and focus group, coding, grouping and summarizing the codes, establishing patterns, and creating meaningful themes was also time-consuming.

Another limitation was the evaluation of the participants' varying responses, which was limited to my understanding of the problem. For example, the participants had varying responses regarding the need for standardized education and training for pilots and aviation personnel. Some participants claimed that standardization already exists and it is the DPEs' role to ensure aviation personnel are educated and are able to address every kind of situation. Data collection in the focus group involved personal interactions, and the discussions sometimes deviated from the main purpose of the study.

Implications of the Findings for Practice, Policy, and Theory

Practice

The community of practice in this case was the field of aviation, mostly pilots. In collaboration with other aviation personnel, pilots play a major role in preventing runway incursions at U.S. airports. The findings regarding effective communication can be applied by pilots to improve collaboration with ATC and ground personnel to prevent runway incursions. The finding on scenario-based training can be beneficial to pilots to increase their proficiency and situational awareness.

The parts of this study with the most practical implications include the application of the findings by the FAA and other stakeholders to guide resource allocation and to enhance existing

runway safety initiatives. For example, the findings have the potential to influence the FAA's decision-making in the allocation of resources for strategies and programs aimed at improving the current curriculum for pilots, ATC, and ground personnel. Considering that the current curriculum has not been updated since 1962, new courses that include new technologies and automations such as the use of GPS would be ideal. Evidence from this study will also be beneficial to aviation stakeholders in enhancing their own runway safety initiatives and programs aimed at preventing incursions. The FAA could use the findings about key safety practices by implementing CRM and enhancing the current RSP thereby increasing staff's situational awareness to minimize runway incursions resulting from pilot error.

To complement existing strategies, airlines should aim to align the requirements for education and training, including ethnically diverse characteristics of the pilots and other aviation personnel. For example, educational and training programs should be customized to aviation personnel while considering their ethnic backgrounds. Educational and training programs should include modules that improve aviation personnel's ability to communicate using their alternate language during emergencies to avoid miscommunications that may result in runway incursions.

The findings indicate that there is a need for recurrent education and training of aviation personnel to enhance their proficiency and prevent runway incursions. This finding may guide the FAA's efforts in developing continuous educational programs annually, especially in ethnically diverse regions in the country such as California and Miami. The findings about effective communication and its role in preventing runway incursions can also be used by airlines and FAA to introduce change at airports. For example, the FAA could recommend strategies for enhancing communication between pilots and ATC in towered and non-towered

airports during taxiing to minimize non-standard phraseology. Airline management can also use this finding to develop more detailed, comprehensive checklists for use by pilots and ground vehicle operators while taxiing. One specific item to add to the current checklist would be airdrome signage and lighting systems.

An analysis of data established that while pilots receive adequate training and education, they are still involved in runway incursions. Despite the introduction of new educational programs by the FAA, little progress has been made to decrease the frequency and severity of runway incursions. For instance, airlines and airport management could also utilize the finding about standardization of airport procedures to develop new procedures for avoiding runway incursions, like the use of EFBs to enhance situational awareness or when redesigning modern runways. Airline managers could also utilize findings of this case study to guide their decision-making regarding adequate funding of educational, training, and collaborative interventions for enhancing runway safety. The findings of this study about mandating education and training may guide the FAA and airlines in developing a comprehensive curricular and course material for pilots and flight crew that need additional resources in order to prevent runway incursions.

The majority of runway incursions at U.S. airports are associated with human error, in order, from pilots, ATC staff, or ground vehicle operators (Cardosi et al., 2010). Effective landing and take-off demand cognitive energy and intensive focus from pilots and ATC personnel (Rodriguez & Cusick, 2012). Pilots operating in high-traffic airports are faced by an increased likelihood of making errors that can cause runway incursions because of so many details and the possibility of miscommunication (Johnson et al., 2016). In addition, pilots may fail to effectively monitor their electronics and location on the runway to ensure adequate situational awareness, thus, increasing the risk of incursions (Johnson et al., 2016). The finding

involving the balance between automation and human interface could be applied by airlines to understand how factors such as human error resulting from deterioration of skills, lack of reviews, and faulty electronic technologies and miscommunication could be enhanced through education and training, specifically.

The findings also have important practical implications for the FAA and other agencies that contribute resources or develop strategies for preventing runway incursions. Currently, the FAA utilizes the RSP to reduce the occurrence of runway incursions at U.S. airports. However, the effectiveness of this program is unclear (FAA, 2012). Therefore, the finding of this study about the need for increased collaboration and partnership with stakeholders may guide aviation stakeholders in designing a new curriculum for pilots and flight crew. Kovalchik (2014) said that using English as a standardized aviation language would significantly reduce miscommunication and minimize the occurrence of runway incursions; hence, enhancing airport safety. The FAA and AOPA contribute a significant amount of educational materials and resources to airlines to guide the education and training of aviation staff (FAA, 2012). In addition, the FAA is tasked with identifying the most effective programs or strategies for preventing runway incursions (FAA, 2016b). The finding of this study relating to partnership with stakeholders such as the FAA and AOPA could also be used by airlines to identify specific programs and course materials and their effectiveness in preventing runway incursions.

Policy

In accord with findings, the areas ripe for policy modification include the design or modification of runways, technological improvements, and funding of runway safety programs. Though the FAA has made significant progress in preventing runway incursions, the current level of training, collaboration, and education have not effectively reduced the rate of these

events. The finding on key safety practices, specifically familiarization with airports, could have implications for policymakers in the aviation industry, for example, with constructive modifications of modern runways, such as the installation of an engineered materials arrestor system (EMAS), thereby increasing airport safety for passengers and all stakeholders, or could also be used by the FAA in its Next Generation Air Transportation System (NextGen) program to ensure modern airports have adequate resources, like hot spots to address runway incursions. The NextGen is an FAA program aimed at modernizing the current national airspace system (Spinardi, 2015). The program is composed of various initiatives directed at improving the efficiency and effectiveness of aircraft and the national airspace system (Spinardi, 2015).

The FAA could also utilize the finding about key safety practices to develop policies involving the design or modification of current runway safety programs. For example, the government may use the finding to develop safety requirements to be followed by airlines when implementing programs such as local runway safety teams (LRSTs). The findings of this case study about the use of automations to enhance situational awareness could be applied by the FAA as a basis for policy decisions regarding technological improvements for preventing runway incursions that are cost effective. For example, the FAA may use findings relating to technology to guide their regulations and rules regarding the use of electronics by pilots, ATC, and ground vehicle operators.

Because the FAA's resources are limited, it is important to ensure that programs aimed at improving training, education, and collaboration among aviation staff receive adequate funding to help enhance airport safety. The finding of this case study regarding key safety practices is important because it may guide the FAA's decision-making and funding of programs and strategies aimed at mitigating the risk factors for these events (FAA, 2012).

Theory

The theoretical implications of this study include fostering behavior adaptation to change, and the influence of environmental and social factors on individuals' choice of behaviors. Bandura (2001) stated that people's perceptions about themselves can influence their behaviors through adaptation and change. This study relied upon individual perspectives regarding some of the cognitive factors involving education, training, and collaboration, and how they impact the prevention of runway incursions.

Bandura's SCT postulates that an individual's ability to perceive how they execute a task effectively may be an assurance of success. However, these perceptions may elicit pessimistic or optimistic outcomes that may hinder or enhance the individual's ability to successfully execute a given task. Based on the SCT, individuals' explanation of positive and negative events can demonstrate or affect the amount of control they perceive. Thus, thinking in optimistic/self-enhancing or pessimistic/self-debilitating ways can considerable influence an individual's functioning (Bandura, 1999). Based on the SCT, believing that people's actions can influence their environment and experiences facilitates a self-sustaining optimistic perception of life, implying that irrespective of the situation, something can be done to achieve positive outcomes. Bandura stated that individuals are likely to participate in activities they feel capable of achieving. By enhancing education, training, and collaboration, airlines can increase aviation personnel's adaptive responses to the prevention of runway incursions. For instance, if pilots are pessimistic, their engagement in programs and strategies aimed at preventing runway incursions will be reduced. Conversely, optimistic pilots might be more likely to be collaborative and engage in educational and training programs to prevent runway incursions.

Bandura (2001) posited that individuals' choice of behaviors may also be affected by environmental and social influences making it difficult to maintain a standard in education, training, and collaboration. Bandura also noted that peoples' self-confidence can be improved by their perceptions of teamwork and cohesion. Therefore, peoples' interactions need to be simplified to facilitate a standardized understanding of the information being exchanged (Bandura, 1999). In this study, I explored how education, collaboration, and training could improve aviation personnel's ability to interact with colleagues effectively to detect and mitigate risk factors of runway incursions at U.S. airports. Bandura's (2001) SCT stipulates that social structures and rules vary in terms of enforcement, interpretation, compliance, and opposition. The targeted constructs in this case study included the participants' perceptions regarding how education, training, and collaboration may be improved to prevent runway incursions. Bandura's SCT can encompass behavioral, personal, and environmental factors, providing a comprehensive model to explain the role of education, training, and collaboration in preventing runway incursions. Based on Bandura's SCT people can intentionally act to alter their lives and their immediate surroundings, a concept known as human agency. Applying the SCT to pilots and other aviation personnel suggests that these individuals can exercise their actions individually and collaboratively to prevent runway incursions after education and training. Though the airport environment can influence aviation personnel's behaviors, it is also possible for these staff to adapt to and alter the environment, creating a reciprocal relationship.

From a conceptual-theoretical perspective, the strategies employed to prevent runway incursions focused on protective measures aimed at addressing existing threats. Implications of this study extend into education and training beyond the normal lessons provided to pilots and aviation staff. Updating educational and training content would include, for example, readbacks,

voice inflection, tone of voice, and introducing more effective scenario-based training methods like simulators would help general aviation pilots and staff to practice avoiding threats to runway incursions. Implementation of these strategies could improve aviation training and education, thereby enhancing runway safety.

The SCT indicates that individuals may gain knowledge and modify behaviors while interacting in their work environment (Bandura, 2001). As indicated by the SCT, learners make intentional decisions to learn and adopt new behaviors (Bandura, 2001). Through this study, aviation staff could better understand the importance of education, training, and collaborating with colleagues to prevent runway incursions. Thus, according to SCT, an improvement in aviation staff's perceptions of the importance of education, training, and collaboration in preventing runway incursions may increase their participation in prevention strategies.

While the primary research objective of this study was to understand how education, training, and collaboration may be enhanced to prevent runway incursions at airports, not all the findings were consistent with this objective. For example, the findings indicated that the increased use of automation and technology may cause distractions that increase opportunities for runway incursions. This finding is inconsistent with the study objective because I anticipated that an increased adoption of automation and technologies might have the potential to minimize runway incursions.

Recommendations for Further Research

The findings of this study indicated how education, training, and collaboration might be improved to prevent runway incursions at U.S. airports. Several recommendations for further study can be drawn from these findings, including the addition of airline managers and passengers as participants, additional research, evaluating the potential impacts of NextGen on

education, training, and collaboration, focus on the most effective runway prevention interventions, expansion to involve more airports, and combining quantitative and qualitative strategies.

First, while this study focused mainly on the perspectives of pilots, runway incursions are known to be caused by many factors (Rogerson & Lambert, 2012). Therefore, there is a need to understand the perspectives of other key stakeholders, including ATC and ground personnel regarding the problem. Hence, future studies should also involve airline managers and passengers in order to get a comprehensive understanding of the importance of training, education, and collaboration in preventing runway incursions.

Major stakeholders in the aviation industry are tasked with finding new and more effective strategies for improving aviation safety. One unexplored gap that needs more research is why pilots and other aviation crew, beyond their ability to collaborate effectively, are still involved in runway incursions despite their competencies, new technologies, and thorough simulation-based training programs. More research in this area might increase the understanding of the most effective runway incursion prevention strategies for pilots, ground personnel, and ATC crew.

In addition, expanding this study to include more airports across the country would provide more valid evidence about the role of education, training, and collaboration in preventing runway incursions. The inclusion of more airports and other professionals in addition to pilots would also increase the focus and scope of the study and provide essential evidence to inform the FAA, foreign governments, and other stakeholders about how runway incursions may be prevented through education, collaboration, and training. Future studies should also

incorporate quantitative methods in order to focus on the generalizability of findings (Creswell, 2014).

Although the use of automation and new technology was mentioned by some pilots, there is a need to evaluate the implementation of the NextGen program and its potential impacts on runway incursions. The FAA indicates that NextGen will reduce the complexity of commercial flights, and increase the difficulty of general aviation operations (Scovel III & General, 2013). Therefore, future studies should assess the potential impacts of NextGen on education, training, and collaboration in the general aviation industry, and whether it will reduce the incidences of runway incursions at U.S. airports.

This case study was only limited to the role of education, collaboration, and training in preventing runway incursions. However, many contributors to runway incursions cannot be effectively addressed through education, training, and collaboration. For instance, runway incursions resulting from airdrome design, late changes to departure clearances, and high workload may require more effective strategies as opposed to education, training, and collaboration (Skybrary, 2018).

Conclusion

The primary aim of this chapter was to interpret the findings of the study based on the research question in order to better understand how education, training, and collaboration might be used to prevent runway incursions. This chapter also provided a discussion of the findings and their implications for practice, theory, and policy. In addition, the chapter highlighted the limitations of the study and recommendations for future research. The FAA and NTSB have worked diligently on collaboration with airlines to minimize the incidences of runway incursions at U.S. airports (Scovel III & General, 2013). However, runway incursions are still a major threat

to airport and community safety in the U.S. aviation industry (FAA, 2012). The findings of this study revealed that education, collaboration, and training are essential tools for preventing runway incursions.

To effectively prevent runway incursions, airlines should adopt key safety practices including CRM, familiarization with airports, improved situational awareness, introduce mandatory training and education, and balance between automation and human interactions. The implementation of the sterile cockpit and use of airport maps and charts significantly enhance pilots' situational awareness, thus reducing the likelihood of runway incursions. In addition, airlines should utilize available resources including the ATC and the FAA and AOPA course materials on their websites. Increased education and training would enhance the aviation personnel's skills that may deteriorate with time. The ICAO (2007) and Eurocontrol (2017) also recommend that all pilots and vehicle operators should have adequate awareness of their location and those of other personnel on the runway to avoid potential incursions.

In addition, airlines should increase the standardization of communication, phraseology, and airport procedures to improve training, education, and collaboration, and potentially prevent runway incursions. Standardization of communication and phraseology will ensure effective exchange of information between pilots, ATC, and ground personnel reducing the possibility of runway incursions. The major areas of standardization should be updating read-backs and educational content, and tracking the time spent during taxiing. Despite pilots having adequate knowledge of runway incursions and prevention strategies, there is a need for recurrent training programs, preferably annually or biennially, to improve aviation personnel's proficiency in airdrome signage, markings, and lightings.

Ensuring effective communication is also an essential strategy for preventing runway incursions. Effective communication fosters increased clarity and collaboration among pilots, ground personnel, and ATC. Airlines are; therefore, advised to adopt SMSs involving verbal and audio communication. Monitoring readback procedures can also enhance communication between pilots and ground vehicle operators, facilitating the prevention of runway incursions. The ICAO recommends the use of clear, standardized phraseologies and aviation English to avoid miscommunication (ICAO, 2007).

This study indicated the need to increasingly utilize scenario-based training to increase aviation personnel's ability to identify and mitigate potential threats to runway incursions. There is an increased need for scenario-based training and increasing the use of simulators to enhance the pilots' situational awareness. In addition to enhancing the quality of training and education, scenario-based techniques allow personnel to identify and mitigate threats effectively. In addition, scenario-based training using simulators allows aviation personnel to continuously make mistakes and learn from them without the risk of aircraft damage or fatalities. Training could also be enhanced by developing a comprehensive syllabus that addresses every possible threat. A primary benefit of scenario-based training using simulators is the ability to record the sessions for future reference. However, simulating optimal situational awareness is difficult due to the real-time actual aircraft conditions under use for training.

Collaboration and partnership with stakeholders is also important if airlines are to prevent runway incursions in high-traffic U.S. airports. The multiple-case study highlighted the need for more collaboration and partnership with stakeholders. Increased collaboration and partnership with the FAA, AOPA, and other state agencies is important to address runway incursions collectively. Despite unavoidable disagreements, there is a need for pilots and ATC staff to

collaborate effectively and understand each other's roles. Phraseology plays an important role in promoting collaboration among pilots, passengers, flight crew, and ATC. Effective collaboration among aviation personnel increases situational awareness by improving their familiarization with the airport. Collaboration can be enhanced through effective communication and allowing staff to interact in open sessions. Partnerships with the FAA and AOPA are also important because they help in the prevention of runway incursions through the development of standard safety systems and technologies. The FAA also reiterates the importance of partnership with airlines and aviation personnel in redesigning the current runways to minimize the potential of runway incursions.

Despite improving the understanding of the role of education, training, and collaboration in preventing runway incursions, the current study was limited by its qualitative nature, the use of small sample size, a focus on airports in the mid-Atlantic area, and the time-intensiveness of data collection. However, the findings can be useful to foreign governments, the FAA, NTSB, and other stakeholders when redesigning modern runways and airports.

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Appendix A: Informed Consent

Interviewer. Hi, my name is Bill Metallinos.

I wish to invite you to a study involving the role of training, education, and collaboration in preventing runway incursions. Your participation is greatly appreciated, but we acknowledge that the questions we are asking are personal in nature. You are free at any point to choose not to engage with or stop the study. You may skip any questions you do not wish to answer. This study is not required and there is no penalty for not participating. If at any time you experience a negative emotion from answering the questions, we will stop asking you questions. The information you provide will not be distributed to any other agency and will be kept private and confidential. The only exception to this is if you tell us abuse or neglect that makes us seriously concerned for your immediate health and safety. Your identity will however be concealed in case such reporting were to happen. I will now explain the objectives and purpose of the study to you before we conduct the interview. Please, do not hesitate to ask for any clarifications about the study.

The purpose of this case study research is to learn how training, education, and collaboration may be improved to minimize the occurrence of runway incursions at U.S. airports. I will focus on evaluating the knowledge, attitudes, and practices among aviation personnel about how collaboration, training, and education may be improved to enhance aviation safety. The interview will take 45-60 minutes. If you choose to be in the focus group, this will also take 45-60 minutes.

There are no risks to participating in this study other than providing your information. However, we will protect your information. I will record interviews. The recording will be transcribed by me, the principal investigator, and the recording will be deleted when the

transcription is completed. Any data you provide will be coded so people who are not the investigator cannot link your information to you. Any name or identifying information you give will be kept securely via electronic encryption on my password protected computer locked inside the cabinet in my office. The recording will be deleted as soon as possible; all other study documents will be kept secure for three years and then be destroyed.

This study may benefit you, other aviation personnel, and the airline industry. First, this study aims to improve the general knowledge of runway incursions and the importance of education, training, and collaboration. Also, this study may guide the implementation of educational and training programs aimed at reducing the occurrence of runway incursions.

Participant. I confirm that all the concerns and questions regarding this study have been addressed sufficiently. I certify that I am [Age] years old and choose to participate in this case study voluntarily, and I may withdraw at any time with no repercussion.

Participant's Name _____Signature _____Date_____

Investigator's Name_____ Signature _____Date _____

Appendix B: Semi-Structured Interview Questions and Protocol

Hello, I am Bill Metallinos from Concordia University–Portland. Thanks for accepting to participate in this interview which is part of my doctoral research. I will begin by verifying the consent form and your permission to allow the documentation and use of this interview. I would also like to remind you that this interview is voluntary and you are free to discontinue participation at any time or avoid responding to any question you deem inappropriate. May we proceed with the interview? [If YES, welcome the participant and ensure he/she is comfortable before starting the interview. If NO, thank the participant for coming and inform him/her that they will not face any consequences due to their decision to withdraw].

Background Questions

- How long have you been working at this airport?
- Is your experience mostly with general aviation or commercial aviation? (please describe)
- What is your highest level of education Major/Degree?
- What formal training have you had in the aviation industry?

Inquiry Definitions and Experiences

i. Knowledge of Runway Incursions

- How many runway incursions have you witnessed in your department?
- What do you think was the cause?
- Do you have formalized runway incursion prevention plans in your department?
- Can you name at least two strategies that are used to prevent runway incursions in this airport?
- How did you know about these strategies?
- How familiar are you with the following five educational programs and tools? How and where did you study them?

- Runway Incursions Avoidance in Pilot Handbook of Aeronautical Knowledge.
- Runway Status Lights Program.
- The Aircraft Owners and Pilots Association (AOPA) Online Course: Runway Safety.
- Federal Aviation Administration (FAA) Runway Safety Program Website.

 In your opinion, for the purpose of avoiding runway incursions, which program or tool do you think has been the most effective for avoiding runway incursions? Why?

 What other training, educational materials, or experiences do you rely upon for runway safety? Why?

ii. Attitudes Regarding Runway Incursions

 What is your attitude regarding runway incursions?

 Do you believe that your level of training on runway incursions in sufficient?

 What is your attitude toward aviation collaboration?

 What is your attitude toward aviation education?

 What is your attitude toward aviation training?

 Do you believe that education, training, and collaboration can reduce the frequency of runway incursions this airport? Why?

Practices Regarding the Avoidance of Runway Incursions

 What are the major barriers to effective collaboration in this airport?

 What are the standard operating procedures and practices for guiding airport personnel while they work in an active airfield operations area?

 Has your department developed education, training requirements relating to runway incursions?

 How do you think collaboration can be improved or enhanced to prevent runway incursions?

 How do you think education can be improved or enhanced to prevent runway incursions?

 How do you think training can be improved or enhanced to prevent runway incursions?

 What might be missing from collaboration in relation to the prevention of runway incursions?

 What might be missing from education in relation to the prevention of runway incursions?

 What might be missing from training in relation to the prevention of runway incursions?

Participant Perspectives

 Do you think that improved training can help minimize human error and reduce the incidence of runway incursions? Please explain.

 Do you think that collaboration can be improved to reduce the occurrence of runway incursions in this airport? Please explain.

Do you think that education can be improved to reduce the occurrence of runway incursions? Please explain.

Appendix C: Focus Group Protocol

Hello, I am Bill Metallinos from Concordia University–Portland. Thank you once again for accepting to participate in this focus group meeting which is part of my research. I will begin by verifying the consent form and your permission to allow the documentation of this interview. I would also like to remind you that this interview is voluntary and you are free to discontinue participation at any time or avoid responding to any question you deem inappropriate. Due to the nature of open communication in focus groups if you feel that information you would like to share is too personal please feel free to speak generally about the experience. I will keep your information confidential, however, I cannot guarantee that all participants will keep that information in confidence. I, therefore encourage you to speak generally and use pseudo names if you must mention names.

1. First we can introduce ourselves and what we do in the aviation industry.
2. What are do you think of education as a strategy to minimize runway incursions?
3. What do you think of training as a strategy to minimize runway incursions?
3. What do you think about collaboration as a strategy to minimize runway incursions?
4. In your opinion, what is missing in either education and training or/and collaboration as strategies to minimize runway incursions?
5. Closing (ask any other question needing clarification that arose during the individual interviews).

Thank you for your participation!

Appendix D: Example of Coding and Chunking

Sample response:

> Yeah, scenario-based training is very important and really developing a syllabus where we're trying to touch on every possible outcome that we can see out there in the real world. So, that whole scenario-based training is fantastic. I think the FAA is on the right step and they're moving in the right direction to encourage this.
>
> It's difficult if you're going to come out and start talking about, "Well this can happen, or this can happen." If we don't have a syllabus, if we don't have something that we can really follow you might get off track and the detail and having a syllabus that's scenario-based training is important.

Chunking: The two paragraphs were reduced into one manageable chunk:

> Yeah, scenario-based training is very important and really developing a syllabus where we're trying to touch on every possible outcome that we can see out there in the real world. So, that whole scenario-based training is fantastic. I think the FAA is on the right step and they're moving in the right direction to encourage this.

Code: The resulting code for this chunk was "training: scenario-based" which together with similar codes formed one theme: "scenario-based."

Appendix E: Statement of Original Work

The Concordia University Doctorate of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically-informed, rigorously- researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of Academic Integrity

As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

What does "fraudulent" mean?

"Fraudulent" work is any material submitted for evaluation that is falsely or improperly presented as one's own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate's final work without full and complete documentation.

What is "unauthorized" assistance?

"Unauthorized assistance" refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:

- Use of unauthorized notes or another's work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

Appendix E: Statement of Original Work (continued)

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University-Portland Academic Integrity Policy during the development and writing of this dissertation.

2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication Manual of The American Psychological Association*

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Date: December 01, 2018