

# Intelligent Modeling of Risk Factors Contributing to Runway Incursion

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## ABSTRACT

*The purpose of this paper is to validate the use of an intelligent neural network model to identify the risk factors contributing to runway incursions. The study utilized multi-dataset fusion and a neural network model to identify risk factors. Historical runway safety data, weather data, and data on the physical characteristics of airports were obtained from multiple publicly available government websites. The results of the analysis showed that a neural network model was able to determine the factors most strongly associated with runway incursions, without the need for subjective weighting by safety experts used in most previous runway incursion studies. The Federal Aviation Administration could use a cyber-physical system, which combines human and computer processes, to analyze the runway incursion factors identified in the present study to determine which aspects of runway safety could be improved to reduce future incursions and save lives.*

*Keywords:* Airport Safety Management, Data Management, Neural Network Models, Risk Management, Runway Collision Avoidance, Runway Safety, Safety Systems Engineering

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## INTRODUCTION

Each year for the past ten years, the National Transportation Safety Board has reported that runway safety is one of the leading concerns in the Top Ten Wanted list, which it publishes annually. The safety of passenger airplanes of varying sizes all converging onto a mile-long runway at various speeds has long been a concern for the board. Runway incursions are defined as events that occur where aircraft, vehicles, or pedestrians enter an unauthorized or undesired position within the runway safety area (Federal Aviation Administration [FAA], 2013a). The severity of the incursion is classified into categories based on whether it could have led to a dangerous situation, the

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speed, distance to other targets, and likelihood of collision. For example, if a pilot was directed by air traffic control to land on Runway 18L, but the pilot landed on Runway 18R in the middle of the night when no other airplanes were on the airport runway, then the incursion category is classified as less severe than an incursion that occurred due to the same situation when another airplane was on or entering 18R. It is important to track any mistake made by pilots, air traffic controllers, vehicle operators, and pedestrians. If an airport is consistently experiencing severe incursions due to multiple factors, then the government may need to review the airport, pilots, airlines, air traffic controller training, airport's physical characteristics, markings, and other controllable factors to derive a realistic assessment of the potential dangers.

Following a meeting of government and industry at a collaborative safety summit in 2007 to create and implement mechanisms to increase safety, the Federal Aviation Administration (FAA) made a commitment to provide the public with incursion information (FAA, 2013a). New technological advances mean that the FAA has access to recorded audio, video, and global positioning data that can be combined with archived incursion data at the FAA's Office of Runway Safety. Though it is not currently available, this information could be made available to the public and used to improve safety. Airport planners, airlines, pilots, safety experts, Congress, and the FAA could all benefit from having data that provides a historical account of the human-related factors (i.e., avoidable errors) and physical conditions (i.e., runway length, weather events) that led to an incursion. Since 2007, the FAA has invested in pilot, vehicle operator, and air traffic controller training, in addition to runway markings and controller technologies, to increase safety. These actions have reduced the number of incursions annually. An exception to this consistent improvement was in 2012, when the number of runway incursions increased slightly (FAA, 2014). However, this increase could have been attributed to changes in the methods used for tracking and for categorizing data (FAA, 2013a).

To maintain the steady improvement in runway safety demonstrated in previous decades, the U.S. must continue to enhance its current safety strategies and implement secure, modern technologies. The U.S. is embarking on modernization strategies to match the updated satellite transportation infrastructure established in other countries. The government is currently funding efforts to modernize technology and create safe runways. Congress wants to ensure that the large government expenditures in airport infrastructure are actually resulting in runways that are safer (GAO, 2014).

Runway safety has been a major focus for many levels of government for the past one hundred years in the U.S., and it has gained worldwide attention in the past thirty years (ICAO, 2007). Historically, laws, policy, and technology in the U.S. relating to runway safety have focused on avoiding loss and tragedy due to runway events involving aircraft, rotorcraft, vehicles, and pedestrians. Quantifying the benefits of extra expenditures to U.S. taxpayers would make it easier for U.S. airports to develop tools and technologies to automate measurement tools for runway safety and runway incursions.

The FAA is the only organization tasked by Congress to regulate civil aviation, although there are many bodies that promote and develop safety solutions. These include the Air Line Pilots Association, Aircraft Owners and Pilots Association, National Aeronautics and Space Administration, airlines, and cockpit hardware designers and manufacturers.

Worldwide, the International Civil Aviation Organization (ICAO) is the main body responsible for fostering safety and aviation growth in all countries (Huang, 2009). The ICAO's mission is similar to that of the FAA: to make the airspace safe and efficient. The FAA created the Office of Runway Safety to lead the world by example (FAA, 2008). The office is charged with overseeing safety aspects of a cohesive network of aviation industry leaders as well as influencing safety enhancements in order to meet annual goals to reduce the frequency and severity

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