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Risk Assessment of Passenger Behaviour During the Taxiing Process

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Abstract

In the aviation industry, flight safety is always a top priority and holds great significance not only during takeoff, landing, or flight but also during maneuvering on the ground. The mobility or unsafe actions of the passengers during this maneuver should be restricted in accordance with regulations, as they are critical in ensuring in-flight safety and reducing operational risks to acceptable levels. Even with these clear and frequently repeated rules, some of the passengers can still be seen moving around the cabin during taxiing, opening overhead bins, and trying to remove their belongings. All of these, especially during sudden braking or turns, may cause passengers to be injured.
This study aims to conduct a qualitative risk assessment on the possible risks associated with the mobility of the passengers during the aircraft maneuver on the ground. A total of 75 participants from the cockpit, cabin crew, and passengers took part in an online qualitative risk assessment, and the assessments were interpreted using the risk matrix defined by ICAO. Results have shown that, though all of the participants managed to assess the similar likelihood of risks, their perceived magnitude of impact varied depending on the group of participants and their level of experience.

1. Introduction

Air travel is widely considered the safest mode of transportation, with an annual average injury rate of 0.01 per 100 million passenger miles. This contrasts with ground transportation, which reports 48 injuries for every 100 million passenger miles traveled. (USAFacts Team, 2023). These data highlight the aviation industry's exceptional safety standards, achieved through sustained efforts by manufacturers, airlines, governments, and regulators. However, perceptions of safety often focus on in-flight operations and underestimate critical ground operations such as taxiing.

Taxiing is defined as the movement of an aircraft between the runway and the apron, playing a crucial yet overlooked role in flight operations. While taxiing may seem like a routine process, but due to its dynamic nature and the interactions among multiple stakeholders, including pilots, air traffic controllers, cabin crew, and passengers, it poses safety challenges. At this point, human risk factors interact with complexities such as ground traffic and scheduling, highlighting the importance of focusing on ground operations for safety management.

The behavior of passengers during taxiing is crucial for aviation safety. Despite clear safety instructions, some passengers are unable to follow safety protocols—such as not fastening seat belts or accessing overhead bins while maneuvering —can lead to injuries and operational disruptions, especially during sudden stops, sharp turns, or unexpected braking, which can frequently occur during taxiing.

Studies on aviation safety have primarily concentrated on the takeoff and landing phases, as these are statistically the most dangerous phases for accidents and incidents (Hsu et al., 2010; Zimmermann & Duffy, 2023). Ground movement of aircraft, including taxiing, have not received as much attention, even though it plays a crucial role in flight safety. Studies examining ground collisions—such as push-backs and apron accidents—underscore the potential for serious consequences. For instance, between 1995 and 2008, a total of 429 commercial aircraft were involved in ground collisions, resulting in 973 fatalities (Wilke et al., 2014). These data reinforce the importance of addressing safety risks during all phases of flight, including taxiing.

This study aims to address the gap in the literature by examining the risks of reckless passenger movements during the taxiing process. Research on how passenger behavior influences safety during aircraft maneuvers on the ground remains limited even though the operational and technical factors of aviation safety are studied in detail (Hollnagel, 2008; Reason, 2016). By assessing the risk associated with maneuvering on the ground with the participation of pilots, cabin crew, and passengers, this study also aims to provide insights for improving safety management practices.

2. Safety, Security and Risk in Aviation

According to the International Civil Aviation Organization (ICAO), risk is the assessed potential for adverse consequences resulting from a hazard. It is the likelihood that the hazard's potential to cause harm will be realized (ICAO Doc 9859). Risk management is the process of identifying, assessing, and controlling risks in order to mitigate or eliminate them (ICAO, 2013). According to ICAO, safety is "the condition where the probability of harm to persons or property is reduced and maintained at an acceptable level through identification of hazards and management of safety risks" (ICAO, 2013).

By its nature, the aviation system is dynamic and open, requiring the continuous assessment and mitigation of hazards and risks. Effective safety models can be established by eliminating hazards, preventing potential incidents, and protecting against threats (Hollnagel, 2008).

As a global industry, aviation can operate effectively only through the consistent implementation of international standards, rules, and definitions, as well as the development of a shared safety culture (Reason, 2016; Eurocontrol, 2013; ICAO, 2018; ICAO, 2022; Hollnagel, 2018). In this regard, ICAO has mandated all member states to implement Safety Management System (SMS) programs in their aviation industries. SMS encompasses the procedures, documentation, information systems, and processes used to control and enhance organizational safety performance (Gupta et al., 2022). It is also defined as "promoting a safety culture, identifying hazards, taking proactive measures to mitigate risks, and ensuring the overall protection performance of aviation organizations" (FAA, 2015).

For SMS to be effectively implemented in the aviation system, it is essential to clearly understand errors and violations and distinguish between these two concepts. The fundamental difference lies in intent: Errors are unintended occurrences, whereas violations are deliberate deviations from procedures or practices. In aviation safety, errors are defined as "actions or inactions by operational personnel or organizational structures that deviate from intentions or expectations" (Reason, 2016; Wiegmann & Shappell, 2001; ICAO, 2013).

Completely eliminating human errors in aviation is not feasible, as these errors stem from factors such as state policies, product and service providers, technology, education levels, and industry constraints. Hence, the primary goal of aviation safety management is to implement measures that reduce the likelihood of errors, sustain these measures, and minimize the consequences of errors that occur, which require errors to be identified, reported, and analyzed.

A risk management system establishes a risk database to assess and quantify risks (Taherdoost, 2021). To eliminate risks and ensure safety, it is first necessary to identify these risks or bring them to light. This process begins with conducting a risk assessment (Aven, 2012).

Safety risk management emerges as a critical component of the safety management system. Safety risk is defined as the predicted likelihood and severity of an event or outcome resulting from an existing hazard or condition. This outcome may range from a full-scale accident to a less severe condition termed an "intermediate unsafe event". Managing safety risks involves evaluating the likelihood of potential consequences from hazards associated with an organization's aviation activities (Hollnagel, 2008; FAA, 2015; ICAO, 2018).

Safety risk probability is described as the frequency of an adverse event or condition occurring in terms of safety. Table 1 illustrates a typical safety risk probability table on a five-point scale. This table provides five categories to describe the probability of an unsafe event or condition, accompanied by explanations for each category and their corresponding numerical values (ICAO, 2018).

Table 1 Safety Risk Probability

Value	Probability	Description
1	Extremely improbable	Almost inconceivable that the event will occur
2	Improbable	Very unlikely to occur (not known to have occurred)
3	Remote	Unlikely to occur, but possible (has occurred rarely)
4	Occasional	Likely to occur sometimes (has occurred infrequently)
5	Frequent	Likely to occur many times (has occurred frequently)

Source:(ICAO,2018).

Once the probability assessment is complete, the next step is to determine the risk's severity by considering the hazard's possible consequences. The severity of the risk is defined as the magnitude of harm that could reasonably result from a possible consequence of an identified hazard. The severity assessment should thoroughly evaluate all potential consequences linked to a hazardous situation or object, considering the worst-case scenario (Reason, 2016; Hollnagel, 2008; FAA, 2015; ICAO, 2018). This approach enables the prioritization of risks based on the extent of possible damage. Table 2 illustrates a safety risk severity matrix within this context.

Table 2 Safety Risk Severity

Value	Severity	Description
A	Catastrophic	•Equipment destroyedMultiple deaths
B	Hazardous	•A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely • Serious injury • Major equipment damage
C	Major	•A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency. • Serious incident • Injury to persons
D	Minor	• Nuisance • Operating limitations • Use of emergency procedures • Minor incident
E	Negligible	•Few consequences

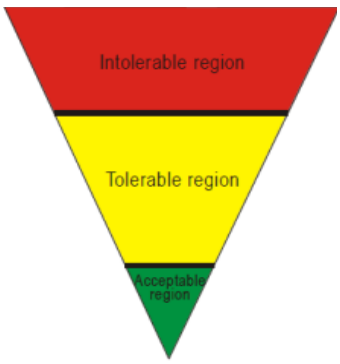
The third step in risk management is determining the degree to which a risk can be tolerated. First, it is necessary to establish the indices in the risk assessment matrix. For example, consider a situation where the probability of the risk is rated as "Occasional" (4) and the severity of the safety risk is classified as "Hazardous" (B). In this case, the combination of probability and severity (4B) creates the risk index (Reason, 2016; Hollnagel, 2008; Eurocontrol, 2013; FAA, 2015; ICAO, 2018).

Table 3 Risk Assesment Matrix

Likelihood/ Severity	Risk Matrix Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Probable 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Occasional 2	2A	2B	2C	2D	2E
Extremely improbable 1	1A	1B	1C	1D	1E

The obtained index should then be transferred to a safety risk matrix (Table 4) that defines the tolerance criteria (Reason, 2016; Hollnagel, 2008; Eurocontrol, 2013; FAA, 2015; ICAO, 2018).

Table 4 Safety Risk Tolerability Matrix

Tolerability Description	Assessed Risk Index	Suggested Criteria
	**5A, 5B, 5C, 4A, 4B, 3A**	Unacceptable under the exising circumtances
	5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C, 1A	Acceptable based on risk mitigation. It may require managemetn decision.
	3E, 2D, 2E, 1B, 1C, 1D, 1E	Acceptable

Safety risk management is a process that involves the evaluation and reduction of safety risks through appropriate measures. The primary goal of this process is to analyze the risks associated with identified hazards and to develop and implement effective and feasible risk mitigation strategies. In this regard, safety risk management forms a critical element of safety management both at the government level and among product or service providers. Conceptually, safety risks can be classified as "acceptable," "tolerable," or "unacceptable." This classification guides the determination of risk management strategies.

Risks in intolerable zone are unacceptable under any circumstances. The probability and/or severity of these risks are extremely high and pose a significant safety threat. So, immediate intervention is necessary to mitigate intolerable risks. Safety risks assessed within the acceptable zone are considered acceptable, provided that the organization implements appropriate risk reduction strategies. A safety risk initially deemed intolerable can be moved into the acceptable zone and managed effectively once it is controlled through appropriate and effective strategies (ICAO, 2018).

3. Apron, Taxiing Process, and Taxiways

The primary focus of airlines today is to manage safety risks effectively. In the ever-evolving aviation industry, airlines aim not only to make a profit but also to continue their operations safely and securely (Başdemir, 2020). Failure to ensure safety and security can result in severe negative consequences, such as loss of life, financial damage, and reputational damage to airlines and countries (Çoban & İpek, 2020). The safety and security of flight operations are crucial during takeoff and landing and during the aircraft's movements on the ground.

Aviation accidents encompass events that occur in the air and those that occur on the ground. Airport movement areas, including ramps, taxiways, runways, and the personnel and vehicles involved in-flight services, form a complex system (Watnick & Ianniello, 1992). Airports are complex transportation systems where hundreds of air and ground vehicles operate simultaneously. As a result, airports often experience ground traffic congestion, leading to safety and security risks in airport ground operations. For example, between 1995 and 2008, various ground collisions (such as push-back and taxiing) affected 429 commercial aircraft, resulting in the deaths of 973 people (Wilke et al., 2014).

The airport apron is a designated area where aircraft are parked, passengers are disembarked, baggage and cargo are loaded, fueling takes place, and passengers board the aircraft. The apron is typically located next to the terminal building and is a critical area for aircraft departure, landing, and taxi operations (Isarsoft, 2024). In recent years, the increasing demand in the civil aviation sector has led to a continuous rise in the number of flights at airports. This has brought operational and safety challenges, particularly with the growth of aircraft and operations in the apron area. Ensuring apron safety has thus become even more crucial (Sun et al., 2024) since apron safety plays a significant role in airport management.

In the air transportation system, airports consist of surfaces facilitating aircraft ground movements and connecting air and ground operations (Blom et al., 2003). One of these surfaces is the taxiway. Taxiing is defined as "the movement of an aircraft on the surface of an airport, using its own power, excluding takeoff and landing" (Skybrary, 2024). Aircraft perform maneuvers such as taxiing from the runway to the apron, making turns, stopping, braking, and approaching parking areas while using taxiways to connect the runway and apron (Jiang & Hao, 2024). Taxiing is a critical process for maintaining orderly and safe aircraft operations.

Taxiways are areas that connect the runway with the apron, where aircraft move (Jiang & Hao, 2024). Before departure, aircraft are pushed back from their parking positions with the help of push-back vehicles and follow designated routes, guided by air traffic controllers, as they taxi along the taxiways. After landing, it is crucial for aircraft to exit the runway quickly and enter the taxiways to avoid obstructing other aircraft's takeoffs and landings. This process provides a consistent spatial connection between the runway, taxiway, and aircraft parking systems.

The taxiing process is a complex and dynamic component of airport operations. Due to the great number of aircraft in air traffic, it is required that these aircraft move at slower speeds and in an orderly manner. Any unforeseen delays during such operations will create scheduling problems and negatively affect the efficiency of operations (Simaiakis et al., 2014). It is, therefore, imperative that the concerned parties collaborate during the taxiing process (Wilke et al., 2014). Airport ground operations, being a complex operation, call for implementing a safety management system (Blom et al., 2003).

3.1. Roles and Responsibilities During the Taxiing Process

During taxiing operations, pilots must control the aircraft, monitor cockpit instruments, observe external ground conditions, and communicate with air traffic controllers to avoid any possible conflicts (Blom et al., 2003; FAA, 2015; ICAO, 2018). Moreover, pilots and cabin crew follow standard operating procedures, which are specifically developed to provide safety during abnormal situations (Dekker, 2014; Kanki et al., 2019). The performance of these roles requires collaboration and effective communication, which are very important in an industry that is characterized by inherent complexity and risks (Wilke et al., 2014; Hollnagel, 2008).

Also, cabin crew members ensure passengers comply with safety rules, even during taxiing, through pre-flight checks, briefing passengers to fasten their seatbelts and properly stow their baggage, and intervening as needed (FAA, 2015; ICAO, 2018). During instances of unexpected braking or other sudden movements, cabin crew are expected to act fast and communicate with passengers effectively and in a timely manner to ensure safety is maintained (Krivonos, 2005; Liu et al., 2022). Better control of safety risks, including situational awareness and monitoring of passengers during taxiing, is possible through constant coordination with the cockpit crew (Green et al., 2019).

Adhering to safety guidelines, ensuring that seatbelts are fastened, and correctly stowing their luggage are actions through which passengers significantly contribute to improving safety and mitigating injuries during the taxiing process (FAA, 2020; ICAO, 2018). They must follow regulations and avoid prohibited behaviors, such as standing up too early (SHGM, 2013). Airlines are responsible for fostering passenger awareness through briefings and materials, as informed passengers are better equipped to comply with safety protocols, reducing risks during ground operations (Chang & Liao, 2009; ICAO, 2024).

4. Methodology

This study examined the impact of passengers' reckless behaviors (such as unbuckling seatbelts and standing up) on flight safety during the taxiing process of passenger aircraft using a qualitative research approach. The study's primary aim was to evaluate the risk perception related to flight safety in the aviation sector and to analyze the participants' views in this context systematically.

Participants were selected through a convenience sampling method and volunteered for the study. There was no hierarchical or professional connection between the participants; the individuals in the study came from diverse experience levels within the aviation sector. The study involved 30 pilots with at least two years of flying experience, 25 cabin crew members of varying experience levels, and 20 passengers with diversified experiences and travel frequencies. At the initiation of this research, each participant received detailed information on the purpose of the study, confidentiality of data, and anonymity principles. Data collection was made possible by structured interviews formulated within the ICAO risk matrix framework. Structured interviews are defined by the standardized delivery of questions to the subjects while minimizing their subjectivity (Punch, 2013). The interviews were conducted online.

Qualitative studies aim to understand a particular phenomenon in depth and not generalize with respect to the results. Hence, the number of participants must keep increasing until the saturation point is reached. In other words, the number of participants must be increased until data is not linked to new information or themes appearing and familiar or repeated information is found (Guest et al., 2012). The sample size was determined to be suitable depending on the research problem as well as the method by observing the homogeneity and heterogeneity of the different classes of participants.

Statistical techniques were systematically reviewed and analyzed for the purpose of the data. The average was calculated to find the difference in risk perception among cabin crew, cockpit crew, and passengers. The data were analyzed qualitatively, emphasizing the association of years of experience with risk perception. Such methods aim to comprehensive assessments of the study while uncovering major findings in flight safety in the aviation industry.

5. Findings

Based on the probability and severity categories, the study examined risk evaluations conducted by passengers, cabin crew, and cockpit crew. While severity was assessed using a letter scale (E: 1, D: 2, C: 3, B: 4, A: 5), probability was assessed by a number scale ranging from 1 to 5. The results of the probability and severity evaluations for the risk assessments made by the cabin crew are shown in Table 5.

Table 5 Cabin Crew Risk Assessment

Cabin Crew Risk Assessment			
Participant	**Experience (Years)**	**Probability Assessment**	**Severity Assessment**
P1	1 (Month)	1	D
P2	2(Month)	2	E
P3	3 (Month)	2	D
P4	1	2	C
P5	2	3	C
P6	3	3	C
P7	4	3	C
P8	4	3	C
P9	4	3	C
P10	5	3	C
P11	5	5	C
P12	5	3	B
P13	5	3	B
P14	6	3	C
P15	6	5	C
P16	6	4	C
P17	6	3	B
P18	8	4	C
P19	11	3	C
P20	11	4	C
P21	12	3	C
P22	14	3	C
K23	14	4	C
K24	15	3	C
K25	16	3	C

The Cabin crew rated the probability of risk during taxi as moderate, with an average score of 3.00, indicating that the risks were "likely" but not frequent. The average ratings for severity were 2.96, indicating that the perceived impact of these risks was moderate and manageable.

The cabin crew members' risk perception was greatly influenced by direct interactions with passengers and repeated exposure to nonconforming behaviors, such as not wearing seatbelts or standing up too early. These interactions made them more conscious of the potential for escalating these actions in the event of sudden braking or sharp turns.

More experienced cabin crew members tended to perceive risks as more probable and serious. Their increased exposure to previous events likely made them appreciate much better how seemingly minor safety infractions can snowball into major operational problems. The less experienced the crew member was, the lower the risk of perception, a narrower point of view given their more limited exposure. This agrees with much research where experience enhances hazard recognition and awareness, leading to better judgments on the probability of consequences. It also underlines that the crew is essential in establishing safety measures and mitigating hazards. Therefore, their role is very critical in ensuring complete flight safety.

Table 6 Cockpit Crew Risk Assessment

Cockpit Crew Risk Assessment			
Participant	**Experience (Years)**	**Probability Assessment**	**Severity Assessment**
P1	1	4	C
P2	2	3	C
P3	2	4	C
P4	2	3	B
P5	2	4	C
P6	2	2	C
P7	2	4	D
P8	2	4	D
P9	2	2	E
P10	2	4	C
P11	2	4	B
P12	2	2	D
P13	2	5	C
P14	2	4	C
P15	4	3	C
P16	4	3	B
P17	4	4	C
P18	5	4	E
P19	5	3	D
P20	8	4	C
P21	9	3	B
P22	9	2	D
P23	10	2	C
P24	10	5	C
P25	10	4	C
P26	10	4	C
P27	11	3	C
P28	12	4	C
P29	14	2	E
P30	15	3	D

The cockpit crew's mean risk probability rating was 3.40, indicating that this group judged the likelihood of risk higher than other groups. Their average severity ratings were 2.77, indicating a relatively lower judged potential impact. This might be because the cockpit crew heavily relies on advanced operational systems, specialized technical knowledge, and continuous communication with air traffic controllers, which helps them identify and reduce risks effectively.

More experienced pilots, in particular, were given higher ratings regarding the probability and severity of risks than their less experienced peers. This is so because such pilots have had greater exposure to diverse operating conditions, and their ability to anticipate disturbances—technical failures or sudden movements—is enhanced. However, the low ratings on the part of the cockpit crew indicate a very high level of confidence in their ability to control such conditions. That means a proactive approach to risk management, emphasizing preparation and coordination rather than reaction. Their ratings underline the most important issues of technical competence and efficient communication in ensuring a strong safety culture.

Table 7 Passengers' Risk Assessment

Passengers' Risk Assessment			
Participant	**Experience (Air travel)**	**Probability Assessment**	**Severity Assessment**
P1	1	5	B
P2	1	4	A
P3	2	3	B
P4	3	1	B
P5	3	4	A
P6	4	1	E
P7	4	3	D
P8	7	4	D
P9	8	4	B
P10	8	4	C
P11	8	3	A
P12	10	3	C
P13	10	4	C
P14	10	3	C
P15	15	3	D
P16	15	3	C
P17	15	3	B
P18	35	3	B
P19	50	3	D
P20	50	3	B

The highest average severity scores were those of the passengers at 3.35, meaning that they are more sensitive to the potential consequences of risk. The mean probability assessment was found to be 3.20, indicating that, on average, people viewed risks as being moderately likely.

The passenger's perception of risk was found to be strongly influenced by their level of travel experience. Less experienced travelers were likely to overestimate the likelihood and consequences of an accident, mainly because of a lack of understanding of aviation procedures and a poor grasp of safety arrangements. Actions such as sudden braking during taxiing may be hazardous in the opinion of an inexperienced passenger, but for the most part, these are part of standard operational procedures and carried out with adequate skill. On the other hand, more seasoned travelers would render more balanced assessments using their greater knowledge of aviation processes and their trust in the systems put in place to ensure safety. The greater sensitivity shown by less experienced passengers underscores the need for tailored safety education. Thorough and engaging safety briefings, complemented by readily available pre-flight information, may help close the knowledge gap and reduce unease.

Encouraging knowledgeable passenger behavior reduces risk during taxiing and enhances overall flight safety.

6. Discussion

The findings of this research reveal the differences in risk perception among the passengers, cabin crew, and pilots in the taxiing operation and the numerous factors affecting it. The likelihood of risk was perceived by the cabin crew as moderate, given the proximity of cabin crew to passengers and the potential for cabin crew to observe disregard of instructions regarding safety. Despite this, the severity ratings were low, which shows that they are confident in being able to manage these risks through processes in place. This result is consistent with the current literature, which places cabin crew as the first line of defense in terms of passenger safety management (Green et al., 2019; Liu et al., 2022).

By comparison, the cockpit crew showed a greater likelihood of risk but lower severity compared to the other groups. This can be explained by the fact that they greatly depend on technical expertise, operational controls, and contact with air controllers in case of risks. Pilots are able to anticipate and counteract operational difficulties, which perhaps results in a lower level of perceived severity of the risk. This result aligns with earlier studies highlighting pilots' systematicity of behavior in risk control (Dekker, 2006; Wilke et al., 2014). On the other hand, heightened sensitivity among crew members to the possibility of risk exposes sharp awareness of possible perturbations, e.g., sudden braking while taxiing or equipment malfunction that could escalate if appropriate interventions are not undertaken. The passengers, on the other hand, demonstrated the highest severity levels, depicting that they were very sensitive to the possibility of risk consequences while taxiing. This may be due to the fact that they were not used to the aviation procedures and safety protocols for safe operations. Especially, the inexperienced passengers demonstrated a higher tendency of overestimating both the probability and severity ratings, whereas the experienced passengers had a balanced estimation. This is consistent with human factors research literature: one would anticipate that exposure and familiarity with complicated systems lead to lower perceived risks (Hollnagel, 2008; Reason, 2016). The variation in risk perception between these groups clearly demonstrates the significant influence experience has on attitudes towards safety development. For instance, older cabin crew would have been more mature in their sense of risks and would perhaps have benefited from previous experiences where there had been problems of non-compliance and emergencies. Likewise, older passengers had a more realistic view of risks and seemed to be better informed about procedures and safety in the aviation industry.

The findings also reveal important information on the interface of human factors and operational errors that are experienced during taxiing. Non-compliance by passengers, i.e., not fastening seat belts or attempting to retrieve carry-on bags, is a real hazard that needs to be anticipated. Despite seemingly innocuous, such actions can indeed exacerbate the impact of sudden movements during taxiing, thus the risk of injury or disruption. The cabin crew plays a vital role in reducing these risks through proper communication strategies, vigilance, and compliance with safety protocols. Operationally, this research finds the necessity of greater coordination between cockpit and cabin crews. Effective communication and coordination of risks while taxiing, especially in emergency cases, are of the utmost importance. Joint training sessions and scenario simulation can augment that collaboration to solidify a unified strategy to passenger safety.

These findings have more general implications for the development of targeted interventions to improve safety. For instance, passenger safety briefings could be made more interactive and contextual to encourage better compliance with the safety instructions. Additionally, a mobile app or online course specifically designed for frequent travelers could be used to inform the public about the importance of following safety procedures while taxiing. Additionally, airlines may purposely emphasize pre-flight briefings to right common misconceptions passengers hold, and instill a sense of shared responsibility for safety. Finally, this work contributes meaningfully to the growing literature on ground operations by highlighting the crucial aspect of human factors in aviation safety. While technical and procedural safety measures are indispensable, the behaviors and perceptions of all the stakeholders involved—pilots, cabin crew, and passengers—are equally crucial in ensuring a safe taxiing process. In such cases, human factors can only be dealt with through a holistic approach that unites education, training, and system-level interventions. In conclusion, study participants' differences in risk perception call for a collaborative and inclusive approach to safety management. The aviation industry can further its commitment to safety, reduce risks, and raise the overall passenger experience by solving the unique challenges associated with passenger behavior during taxiing. Table 8 provides the average probability and severity assessments for the cockpit crew, cabin crew, and passenger group.

Table 8 Comparing The Groups

Group	Average Probability Assessment	Average Severity Assessment
Cabin Crew	3.00	2.96
Cockpit Crew	3.40	2.67
Passenger Group	3.20	3.35

The cockpit crew perceives the risk probability as higher than the other groups. The perception of the cabin crew and that of the passenger group are similar. The effects of risks were seen to be most severe by the passenger group. This means that passengers are most sensitive to the consequences of risks. On the other hand, both the cabin and cockpit crews assess the severity of risks lower.

Nevertheless, as can be seen from the ranking of the probability score, the cockpit crew assesses the severity as lower compared to the other groups. This hints at the operational experience and crisis management skills playing a relevant role in shaping this perception difference.

The passenger group scored higher on the probability and severity scales than the others. This finding would suggest that ignorance of, and lack of experience with, aviation procedures may elevate the perceived risk for the passenger group. Conversely, the cabin crew seemed to be more balanced in both tests and had lower ratings of risk perception when compared to the other two groups. That might be because the cabin crew is proficient in risk identification and mitigation due to their professional responsibilities.

7. Conclusion

This study used qualitative methods to investigate the influence of careless passenger behaviors, such as standing up or unfastening seat belts, on flight safety during the taxi phase. The results demonstrate how cabin and cockpit crew members perceive and assess passenger behaviors as potentially threatening flight safety.

The results of the research show that cabin crew members rated the probability of passenger behavior during taxi as higher and had a greater perception of the risks involved because of their more direct interaction with passengers. On the other hand, cockpit crew members rated the operational severity of the incident and the event's probability as higher than other groups. Passengers' risk perception depended on their awareness and previous flight experience; passengers with less experience generally perceived levels of risk to be higher. Although passengers' judgments of probability and severity were generally low, inexperienced passengers were found to have a higher risk perception.

As a result, the contribution of passenger behavior during taxiing to flight safety was perceived differently among the groups. While the cabin crew and passengers showed a more sensitive approach to risks, the cockpit crew, under the influence of technical knowledge and operational controls, presented a lower perception of risk. In view of the overall risk assessments from the participants, the risk is tolerable and may be considered acceptable with adequate risk reduction measures in place. According to the evaluations provided by the participants, the likelihood of the risk materializing was deemed "likely," and it was anticipated that such an occurrence would lead to severe accidents and injuries.

Implications for Practitioners

Effective communication and educational resources are necessary to enhance passenger safety and awareness. Safety regulations can be communicated through pre-flight safety videos and announcements designed to show their importance in aviation safety. Additionally, digital platforms, including mobile applications and airline websites, can provide safety instructions and awareness materials, especially for frequent flyers (Chang & Liao, 2009). Such measures enhance passenger compliance and contribute to a stronger safety culture in the aviation industry.

Specific training of cabin crew is required to prepare them with a swift and effective response to emergencies or non-compliant passengers. Simulator-based training courses must enhance situational awareness, communication, and decision-making in high-stress situations. Moreover, the collaborative scenario-based training of the flight deck and cabin crew and the provision of common procedures will enhance teamwork and coordination for ground operations hazard mitigation (Kanki et al., 2019).

Review and revision of security procedures must also be performed regularly to uphold high levels of operational safety. Regular checks of passenger communication media guarantee that security information is accessible, clear, and relevant. Concurrently, the successful deployment of a safety management system effectively controls the complexity and risk entailed in airport operations (ICAO, 2018). Combined, these actions enhance overall airline operation performance by improving operational efficiency and safety and advancing industry standards

Ethical approval

Approval for this research was authorized by Istanbul Bilgi University Ethics Committee under decision number 2024-40900-178, dated November 21, 2024.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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