MODELING THE RISK OF ABNORMAL CABIN INCIDENTS IN TAIWANESE AIRLINES: AN APPLICATION OF THE BROWN-GIBSON MODEL AND FAA SAFETY RISK MATRIX

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ABSTRACT

While most of the research related to aircraft cabin safety has focused on fire, evacuation, and survival factors, it has been recognized that there are some other incidents that might affect flight safety and merit special attention. In Taiwan, a broad array of cabin incidents that have the potential to affect flight safety have been investigated and labeled as "abnormal cabin incidents," which include abnormal passenger behavior on board and medical problems. In the present study, the Brown-Gibson Model and Safety Risk Matrix were applied to investigate various ACIs. According to the results, sickness, injury, cell phone usage, the use of mobile electronics, unruly behavior, smoking, and carrying dangerous goods were categorized in the category of "acceptable with mitigation" proposed by the FAA. Excessive drinking, oral abuse, sexual harassment, physical assault, and other types of incidents were categorized in the "acceptable" group. These research results can be used to identify significant incidents related to flight safety and to allow appropriate resources allocation.

Keywords: cabin abnormal incident, cabin safety, aviation security, Brown-Gibson Model, FAA Safety Risk Matrix.

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1. INTRODUCTION

Issues related to cabin safety have been investigated for decades. While most of the research has been focused on fire, evacuation, and survival factors, it has been recognized that some other cabin incidents that take place in flight due to passenger misconduct could affect flight safety and merit special attention (e.g., Hsu and Liu, 2012). In the US, the most frequently reported incidents through the NASA's Aviation Safety Reporting System were "unruly passengers" and "drunken passengers" (ASRS, 2000). It has been recognized that such incidents have a significant bearing on the cabin crew's obligation to ensure the observance of safety regulations and the comfort of other passengers on board, as well as to prepare for unexpected accidents that might call for emergency evacuation (Kao et al., 2009; ASRS, 2003; Edwards, 1990). Additionally, these incidents may affect flight operations that are directly related to flight safety. For example, according to ASRS (2000) 43% of the incidents distract flight crews from their duty, and in 22% of cases, a flight crew member had to leave the cockpit to assist cabin crew in dealing with an unruly passenger. The situation becomes even worse if the distraction takes place during the crucial approach and landing phases.

There is no unique definition of these cabin incidents in aviation practice or academia. In Taiwan, a broad array of incidents have been investigated and labeled as abnormal cabin incidents (ACIs) by the Flight Safety Foundation –Taiwan (FSF-Taiwan, 2007) and their implications on flight safety addressed. According to FSF-Taiwan, ACIs involve abnormal passenger behavior on board such as the usage of cell phones/electronics, excessive drinking, smoking, oral abuse, physical assault, sexual harassment, unruly behavior, carrying dangerous goods, and others. Additionally, passenger sickness and injury are also included in the investigation. In total there are twelve categories of ACIs under investigation. FSF-Taiwan has analyzed ACI data reported from all six Taiwanese airlines since 2001. Statistics from FSF-Taiwan (2007) showed that there were 471 ACIs reported in 2001. This number increased to a record high of 1748 in 2006, a 3.7 fold increase. The present study recognizes the potential impact of ACIs on flight safety and is aimed at applying the concept of risk assessment to investigate the risk of various ACIs. Specifically, a Brown-Gibson model is also used to combine subjective judgment and information obtained from objective data.

The concept of risk assessment and Brown-Gibson modeling is discussed in the next section, followed by a presentation of the empirical study. Research findings and their implications on risk mitigation are discussed in section four. Finally, some conclusions are offered.

2. METHODOLOGY

2.1 Definition of Risk, Frequency and Consequence

In the safety research literature, a risk can be considered as a combination of the probability or frequency of a defined occurrence or hazardous event and the magnitude of consequences or severity of the occurrence or event (Netjasov & Janic, 2008; Bahr, 1997). In the present study, since ACIs might affect the safety-related duties of flight and cabin crew, they can be considered an occurrence or hazardous event which needs to be investigated. In terms of the probability or frequency of each occurrence, data collected by FSF-Taiwan from six Taiwanese airlines were used as an objective measure of relative frequency. On the other hand, it is recognized that data from carriers' reports might not reflect the full range of actual events (Kao et al., 2009). Additionally, Boksberger et al. (2007) addressed the issue of perceived risk in air travel and cited Peter and Ryan's (1976) definition of perceived risk as the judgment on the likelihood of negative outcomes and the degree of negativity. Therefore, opinions about how frequently each occurrence might take place were obtained from fifteen experts. These opinions were used as a subjective measurement of relative frequency. Additionally, the FAA (2010) defines likelihood as the estimated probability or frequency, in quantitative or qualitative terms, of an occurrence related to the hazard. Hence the term "likelihood" is used hereafter in this paper when assessing the risk of each ACI. The objective and subjective measurements of likelihood are then combined to represent the likelihood of each ACI and used in the risk assessment. The Brown-Gibson model is employed to combine the objective and subjective data as described in the following section.

2.2 Brown-Gibson Model

The idea of the Brown-Gibson model (BGM) was first proposed to select plant locations (Brown & Gibson, 1972) and has been used for strategic decision analysis (Feridun et al., 2005; Punniyamoorthy & Ragavan, 2003). In the BGM, both subjective and objective factors related to a specific decision problem are converted into consistent and dimensionless indices. The weighted measurement is calculated by a weighting sum of both converted indices as presented in equation (1). The BGM is applied to estimate the likelihood of each ACI of interest.

$$WL_i = (\alpha)\ (OM_i) + (1- \alpha)\ (SM_i) \qquad (1)$$

In equation (1), WL_i is the weighted measurement of the likelihood of ACI i; OM_i and SM_i are the objective and subjective measurements of the likelihood of ACI i, respectively; α is the objective weightage with an interval between 0 and 1. Since both the values of OM_i and SM_i are also between 0 and 1, the calculated WL_i is less than one and greater than zero, with the highest likelihood of occurrence being 1 and the lowest one 0. By definition, when α is set to be one WL_i is equal to OM_i and is equivalent to the objective measurement. On the other hand, when α is set to be zero WL_i is equivalent to the subjective measurement (SM_i).

2.3 Risk Assessment

The FAA Safety Risk Matrix (SRM) can be used as a vehicle to assess the risk of each ACI. The risk analysis and risk assessment of FAA uses a conventional breakdown of the risk of an identified hazard based on two components: likelihood of occurrence and severity of consequence. Five categories were suggested for each component by the FAA. The likelihood ranges from 5 (the highest level) to 1 (the lowest level). The severity is categorized from A (the most severe) to E (the least severe). According to the FAA, each aviation operator’s specific definitions for severity and likelihood may be qualitative or, preferably, quantitative. Thus a common SRM can be constructed in Table 1 (FAA, 2010) to evaluate the acceptability of risk.

As shown in Table 1, the FAA defines three areas of acceptability: unacceptable, acceptable, and acceptable with mitigation (AWM). For a risk categorized as “unacceptable,” further work is required to eliminate the associated hazard or to control factors that lead to higher risk likelihood or severity. Where the risk assessment falls into the AWM category, the risk may be accepted under the defined conditions of mitigation. When the assessed risk falls into the "acceptable" category, it may be accepted without further action. However, the FAA suggests aviation operators always reduce risk to as low as practicable regardless of whether or not the assessment shows that it can be accepted as is.

Table 1: The Safety Risk Matrix Proposed by the FAA

severity likelihood	E	D	C	B	A
5			5C	5B	5A
4	4E			4B	4A
3	3E	3D			3A
2	2E	2D	2C		
1	1E	1D	1C	1B	

Note: unacceptable (3A-5A, 4B, 5B, 5C); acceptable (1E-4E, 1D-3D, 1C, 2C, 1B); acceptable with mitigation (AWM; other cells)

3. EMPIRICAL STUDY

3.1 Weighted Measurements of Likelihood

The purpose of the present study is to assess the risk of each ACI and thus assist the related authorities and airlines to identify the higher risk ACIs. As mentioned in section 2, the risk of an ACI is the combination of its probability or frequency and its magnitude of consequences or severity. To consider both objective and subjective information, the probability of each ACI is represented by the weighted likelihood as formulated in equation (1), based on the BGM. FSF-Taiwan (2007) has collected the numbers of each ACI reported by six Taiwanese airlines in 2006. The objective measurement of the likelihood of each of the twelve ACIs was obtained by calculating the relative frequency of each ACI, and is listed in the fourth column of Table 2.

The subjective information was obtained by conducting a survey to elicit opinions from fifteen experts in the aviation arena, including government officers, airline management, researchers, and senior cabin crew members. Every expert was asked to express his/her judgment on the likelihood of each ACI. The likelihood was divided into three categories low, medium, and high indicated by numbers 1, 2, and 3, respectively, for calculation of the subjective measurements of likelihood. The calculation is shown below.

$$SM_i = \Sigma_n SL_{ni} / \Sigma_i \Sigma_n (SL_{ni}). \qquad (2)$$

In equation (2), SL_{ni} is the subjective measurement of the likelihood of ACI i, elicited from the expert n. SL_{ni} could be a number such as 1, 2, or 3. The notation of $\Sigma_n(SL_{ni})$ represents the summation of the subjective measurements of SL_{ni} across all fifteen experts. By definition, both OM_i and SM_i can be considered to be dimensionless indices and can be applied to equation (1) to calculate the weighted measurement of the likelihood of ACI i. The calculated results of the SM_i, i=1,2, ..., 12, and associated WL_i are also listed in Table 2, with α varying from 1.0, 0.0, to 0.5. The numbers in Table 2 indicate the standardized likelihood of each ACI from the point of view of objective measurement (α=1.0), subjective measurement (α=0.0), and equally weighted measurements (α=0.5).

As mentioned in section 2.3, the FAA defines five categories of likelihood for each hazard in the SRM, without explicitly explaining how to obtain these categories quantitatively. Since the purpose of this study is to identify the relative significance of twelve ACIs as defined in Table 2, the relative frequency (likelihood) of each ACI is used to define the likelihood category. As shown in Table3, if the standardized likelihood of ACI i is greater than the mean value (MEAN) plus one unit of standard deviation (SD) ACI i is categorized as level 5, the highest likelihood of occurrence. On the other hand, if the standardized likelihood of ACI i is less than the MEAN minus 0.5 units of SD ACI i is categorized as level 1 with the lowest likelihood. The likelihood category of each ACI is also included in the parenthesis right after the associated standardized likelihood in Table 2. As listed in the objective measurement column (OMi) of Table 2, sickness (SI) has the highest likelihood of occurrence and is the only item included in the highest likelihood category 5, which is followed by injury (IN), the only one in category 4, and using cell phones (CP), the only one in category 3. The likelihood category 2 contains four ACIs, namely unruly behavior (UB), others (OT), smoking (SM), and excessive drinking

(ED). The category with the least likelihood includes all five other ACIs, that is using mobile electronics (ME), oral abuse (OA), sexual harassment (SH), physical assault (PA), and carrying dangerous goods (DG).

Table 2: Measurements of Likelihood and Severity of Each ACI for Taiwanese Airlines

Abnormal cabin incident		Objective measurement of likelihood (OM_i)		Subjective measurement of likelihood (SM_i)	Weighted measurement of likelihood (WL_i)	Subjective measurement of severity
		Number	Standardized likelihood (α=1.0)	Standardized likelihood (α=0.0)	Standardized likelihood (α=0.5)	1: not at all; 2: a little; 3: neutral; 4: severe; 5: very severe
sickness	SI	745	0.426 (5)	0.112 (5)	0.269 (5)	3.13 (E)
injury	IN	278	0.159 (4)	0.088 (3)	0.124 (4)	3.80 (C)
cell phone usage	CP	179	0.102 (3)	0.096 (4)	0.099 (3)	4.07 (B)
unruly behavior	UB	127	0.073 (2)	0.063 (1)	0.068 (2)	4.47 (A)
Others	OT	125	0.071 (2)	0.084 (3)	0.078 (2)	3.13 (E)
Smoking	SM	124	0.071 (2)	0.100 (4)	0.086 (3)	3.80 (C)
excessive drinking	ED	103	0.059 (2)	0.092 (3)	0.076 (2)	3.67 (D)
using mobile electronics	ME	31	0.018 (1)	0.096 (4)	0.057 (2)	3.73 (D)
oral abuse	OA	19	0.011 (1)	0.084 (3)	0.048 (1)	3.27 (E)
sexual harassment	SH	10	0.006 (1)	0.068 (1)	0.037 (1)	3.13 (E)
physical assault	PA	5	0.003 (1)	0.060 (1)	0.032 (1)	4.20 (B)
carrying dangerous goods	DG	2	0.001 (1)	0.060 (1)	0.031 (1)	4.93 (A)
Total (mean)		1748	1.000 (0.083)	1.000 (0.083)	1.000 (0.083)	(3.78)

Table 3: Algorithm for Categorizing Twelve ACIs

Levels of likelihood (severity)	Category interval
5 (A)	> MEAN + 1.0 SD
4 (B)	(MEAN + 0.5 SD, MEAN + 1.0 SD)
3 (C)	(MEAN, MEAN + 0.5 SD)
2 (D)	(MEAN - 0.5 SD, MEAN)
1 (E)	< MEAN - 0.5 SD

The subjective information elicited from fifteen experts (the SMi column) has the most similarity with the OMi column, with SI, IN, and CP being included in the highest three categories and SH, PA, and DG being included in the lowest category. There are two major differences between the objective and the subjective measurements. First, the difference of likelihood between the ACIs with the highest likelihood and the second highest likelihood from objective measurements (SI vs IN) is much greater than the one obtained from subjective measurements (SI vs CP). Secondly, there are substantial differences in the categories of SM, ME, and OA from different measurements, with aviation experts perceiving higher likelihood than what is actually reported by airlines. Not surprisingly, the information revealed by the equally weighted measurement (WLi, $\alpha = 0.5$) falls between that revealed by the objective and subjective measurements.

3.2 Measurements of Severity

Severity is the other important component when measuring the risk of a hazard. Severity can be defined as the degree of loss or harm resulting from a hazard. The severity of the consequences of some ACIs is easy to identify. For example, it is apparent that the consequences of a bomb explosion on the airplane would be extremely severe. Fire caused by smoking in the cabin may result in a disaster if the fire is not extinguished immediately. The risk of passenger sickness results from the likelihood of diversion and the possibility of disease transmission onboard. On the other hand, the consequences of some ACIs are not easy to identify or they may depend on the situation when the ACIs occur. For example, the severity of the consequence of excessive drinking depends on whether or not flight crew experience distraction from their flying duties due to this incident or the behavior of the drunken passenger such as trying to open the exit door in the air.

Studies related to the objective measurements of the consequences of each ACI are limited. The present study employs subjective measurements. In addition to eliciting the subjective measurement of the likelihood of each ACI as mentioned in the previous section, each expert was asked to express his/her judgment about the influence of each ACI on flight safety should the incident take place. There were five levels of influence for the respondent to choose from, not at all, a little, neutral, severe, to very severe, with equivalent scores of 1, 2, 3, 4, and 5, respectively, when calculating the severity of each ACI. The average level of severity of each ACI across all fifteen experts is listed in the last column of Table 2. As indicated in Table 2, DG (carrying dangerous goods) has the greatest average score of 4.93, with almost all experts rating as the highest level of severity (5). Experts rated UB (unruly behavior) as having the second highest level of severity, which is followed by PA (physical assault) and CP (using cell phone). All of these four ACIs have rating scores greater than 4.0, which is equivalent to the severe level. On the other hand, SI (sickness), SH (sexual harassment), OA (oral abuse), and OT (others) are rated with relatively low levels of severity, with scores less than 3.5, equivalent to the neutral level.

As discussed in section 2.3, the FAA divides the severity of a hazard into five categories, from the most severe A to the least severe E. The same algorithm (Table 3) of categorizing likelihood is employed to divide twelve ACIs into five categories using data in the last column of Table 2, with the severity category of each ACI included in parenthesis right after the associated average score. As shown in Table 2, category A consists of DG and UB, category B contains PA and CP, category C includes SM and IN, and category D comprises ED (excessive drinking) and ME (using mobile electronics). Finally, SI, SH, OA, and OT are contained in category E.

3.3 The ACI Safety Risk Matrix

The safety risk matrix (SRM) proposed by the FAA (2010; 2006) is used to obtain the risk of each ACI. In the FAA SRM, both the likelihood and severity of occurrences are divided into five categories as mentioned in section 2.3. The categorization of empirical data in terms of likelihood and severity is conducted in sections 3.1 and 3.2, and the results are listed in Table 2. The resulting SRMs based on the categorization of twelve ACIs are presented in Tables 4, 5, and 6, with the values of alpha setting as 1.0, 0.0, and 0.5, respectively.

As indicated in Table 4, the SRM with the alpha setting of 1.0 (using objective measurements of likelihood only), there is no ACI within the unacceptable area. Five types of ACIs are contained in the AWM area: SI, IN, CP, UB, and UB. Taking the information in Table 4 a step further reveals that SI falls into this area because of its high level of likelihood, while DG and UB are in the same area because of their high level of severity. Additionally, IN has a relatively high level of likelihood and a medium level of severity, whereas CP has a relatively high level of severity and a medium level of likelihood. The other seven ACIs fall into the acceptable area because of their low level of likelihood, with PA and SM having relatively high levels of severity.

Most of the information shown in Table 5, obtained with an alpha setting of 0.0 and using only subjective measurement of likelihood, is similar to the information revealed in Table 4, with only a little variation. First, CP moves from the AWM area to the unacceptable area. Secondly, SM and ME move from the acceptable area to the AWM area. Both of the above movements are due to the increase in the likelihood of the subjective measurement, compared with the objective measurement.

Table 4: Results of the FAA Safety Risk Matrix (□= 1.0)

severity likelihood	E	D	C	B	A
5	SI				
4			IN		
3				CP	
2	OT	ED	SM		UB
1	OA; SH	ME		PA	DG

Table 5: Results of the FAA Safety Risk Matrix (□= 0.0)

severity likelihood	E	D	C	B	A
5	SI				
4		ME	SM	CP	
3	OT; OA	ED	IN		
2					
1	SH			PA	DG; UB

The information in Table 6 (alpha setting of 0.5) is shared with that in Table 4 with only one exception, which is the change of SM from the acceptable area in Table 4 to the AWM area in Table 6 due to the increase in likelihood.

Table 6: Results of the FAA Safety Risk Matrix (□= 0.5)

severity likelihood	E	D	C	B	A
5	SI				
4			IN		
3			SM	CP	
2	OT	ED; ME			UB
1	OA; SH			PA	DG

The commonality of information in Tables 4, 5, and 6 indicates that the SRM of ACIs is fairly stable in various cases where the weights of the objective and subjective likelihood measurements vary. According to the commonality revealed in those three tables, the twelve types of ACIs can be grouped into two areas. The AWM area includes SI, ME, SM, IN, CP, UB, and DG while OT, OA, SH, ED, and PA, on the other hand, are in the acceptable area.

4. PRACTICAL IMPLICATIONS OF THE RESULTANT ACI SAFETY RISK MATRIX

The objective of this research is to identify significant abnormal cabin incidents related to flight safety and then suggest appropriate measures to reduce the risk arising from these incidents. The results of FAA SRM shown in Tables 4, 5, and 6 provide fundamental information regarding the risk of each ACI and its associated likelihood of occurrence and severity of effect. This information is essential to further develop suitable measures to reduce the risk for each ACI. To achieve this goal the twelve types of ACIs can be regrouped into seven categories as shown in Table 7, based on the information provided in Tables 4, 5, and 6. For comparison, categories 1 (*Acceptable I*) and 2 (*Acceptable II*) are equivalent to the acceptable area in the FAA SRM, and are considered as ACIs with lower risk. Categories 3 to 7 (*AWM I* to *AWM V*) are equivalent to the AWM area with medium risk.

Table 7: Regrouped Categories of ACIs with Measures to Reduce Risk

Category	ACI	Reasons to be in this category		Practical measures
		Level of likelihood	Level of severity	
Acceptable I	OA; SH; OT	relatively low	lowest	Accept without further action.
Acceptable II	PA	lowest	relatively high	Reduce the severity of consequences should the incident occur.
AWM I	DG; UB	lowest	highest	Keep the likelihood as low as practical and reduce the severity of consequences should the incident occur.
AWM II	SI	highest	lowest	Reduce the likelihood and prevent possible transmission of disease.
AWM III	CP	medium	relatively high	Reduce both the likelihood of occurrence and the severity of the consequences.
AWM IV	SM; IN	medium to relatively high	medium	Reduce the levels of both likelihood and severity with equal priority.
AWM V	ME; ED	medium to relatively low	relatively low	Reduce the levels of both likelihood and severity with the former being a higher priority.

ACIs included in *Acceptable I* are OA, SH, and OT because of their lowest level of severity and relatively low level of likelihood (levels *1-3*). According to the suggestions made by the FAA, the risk of these incidents can be accepted without the need for further action. To further reduce the risk, however, we suggest that airlines take actions to reduce their likelihood. Flight attendants are usually the targets of oral assault/sexual harassment. As mentioned by some experts in our interview panel, the organization's support and assistance to flight attendants when OA or SH takes place can reduce the likelihood of these incidents. The most useful support and assistance is to provide flight attendants with the necessary resources to take legal action against the offenders.

Physical assault (PA) is categorized in *Acceptable II*, with the lowest likelihood but relatively high severity of consequence. It is essential for the airline to reduce the level of severity of this type of incident in order to mitigate its risk. In most cases, physical assaults take place between passengers. In these types of situation, an immediate aircrew/cabin crew intervention can alleviate the severity of the incident. Additionally, other passengers may be useful resources for assistance.

The category of *AWM I* is similar to *Acceptable II* with the lowest level of likelihood but the highest level of severity. DG and UB fit within this category. Carrying dangerous goods is considered the ACI with the highest level of severity because they could cause explosion or fire onboard or function as a weapon to attack flight/cabin crew. Unruly behavior includes incidents such as trying to open the exit door while in the air, destroying smoke detectors in the lavatory, or physically assaulting flight/cabin crew. Although DG and UB have the lowest level of likelihood, aviation operators (including airline and other security-related authorities) need to do their best to keep the likelihood as low as possible. Well-designed security checks with respect to passengers and check-in/carry-on luggage is of paramount importance to lower the likelihood of DG or to prevent pans to use carry-on weapons to assault flight crews/attendants. When either DG or UB incidents take place, the intervention of a well-trained crewmember or an air marshal on some specific flights is critical to prevent the worst consequences.

Sickness (SI) is contained in category *AWM II*, with the highest level of likelihood and the lowest level of severity. The priority should be to reduce the likelihood of sickness during the flight. Ill passengers with certain specific diseases should be denied boarding to prevent transmission in the cabin. Screening for passengers' temperatures before boarding or requiring ill passengers to obtain medical approval prior to boarding is a good measure to reduce the likelihood of SI incidents. Additionally, placing a health information card in the seat pockets to remind passengers to avoid "cabin-related risk factors" will decrease the possibility of deep vein thromboses. Making antiseptic liquid soap or alcohol-based hand gels available to passengers has the potential to reduce the transmission of some infectious diseases. Although the severity level of sickness is rated as the lowest one from the prospective of flight safety, recruiting flight attendants with nursing/medical training or hiring third-party services to supply in-flight diagnostic and medical advice via direct radio links is a useful measure to reduce the severity should a sudden serious medical condition occur.

Categories *AWM III* and *AWM IV* are similar, with both likelihood and severity being above the medium level. The former is comprised of CP (using cell phones; medium likelihood and relatively high severity). The latter contains SM (smoking) and IN (injury), both with the medium to relatively high level of likelihood and the medium level of severity. In both categories, likelihood and severity are of the same importance to reduce the risk of ACIs in these two categories. For example, using cell phones on board might affect the electronic devices on the airplane and thus might influence flight safety. The safety briefing before takeoff will reduce the likelihood of using cell phone or smoking in flight. Increasing the monetary penalty or including the behavior of CP and SM on board under criminal law will also reduce the likelihood of occurrences. Additionally, smoke detectors in the lavatory and well-trained flight attendants can reduce the severity should a passenger smoke on the airplane which could cause a fire.

ME (using mobile electronics) and ED (excessive drinking) are included in category *AWM V*, with a medium to relatively low level of likelihood and a relatively low level of severity. Similar to the previous two categories, both likelihood and severity need to be reduced in *AWM V*, with likelihood being a higher priority. Measures to reduce the likelihood of ME are the same as CP mentioned in the previous section. Although the consequence of ED seems to not to be severe, it might cause other incidents such as UB, PA, SH, and OA and needs to be carefully dealt with. Discontinuing the supply of alcoholic drinks to a passenger with a sign of intoxication is a good way to avoid ED in flight and prevent other associated abnormal behavior. Additionally, if passengers can be monitored for erratic behavior prior to boarding, especially for signs of intoxication, and denied boarding if their behavior is likely to continue during flight, the likelihood of drunken behavior on board can be reduced.

5. CONCLUSION

The issue of abnormal cabin incidents has been recognized for decades. Systematic study of this topic based on empirical data, however, has been limited. The present research employs the FAA safety risk matrix to investigate the risk of twelve types of ACIs. According to the FAA, a risk is a combination of the likelihood of a defined hazard and the severity of the hazard. To establish the SRM, two sets of data need to be obtained, namely the likelihood of occurrence of each ACI and the associated severity should it take place. In terms of the likelihood of each ACI, both objective and subjective measurements are used, with the former reported from six Taiwanese airlines and the latter elicited from fifteen aviation experts. When the objective measurement of the severity of each ACI is not available, only subjective opinions from those fifteen experts are included in the analysis. Based on the analysis of three types of data combinations with respect to the likelihood of each ACI, namely objective measurements, subjective measurements, and equally weighted measurements, the resulting three SRMs are consistent to some extent. That is, the empirical data reported by airlines and subjective opinions elicited from experts share a substantial level of similarity. Hence, we have confidence that the research results are robust enough to interpret the risk of each type of ACIs. The associated measures proposed to reduce risk are thus useful to aviation operators.

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