Safety Factor Analysis in Ramp Operation with AHP Approach

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Nomenclature

AHP	Analytic hierarchy process
IATA	International Air Transport Association
IGOM	IATA Ground Operations Manual
MCDM	Multi-criteria decision-making

1 Introduction

Ramp operation in civil aviation is considered as one of the most important processes by airlines. Providing on-time ground operation is very essential, and any delay during this process will affect other steps, respectively, that might push ramp agents to be hurry. Therefore, time pressure on ramp may cause accidents or injury.

An airport ramp is the place where planes are parked, unloaded or loaded, refueled, or boarded. Both the airports and the carriers are responsible for the ramp area. By providing gates, cargo hard stands, passenger loading bridges, and fueling facilities to enable aircraft operations at the terminal, the airport gives passenger and cargo access to air transportation. Airlines are granted access to leased gates and are allowed to utilize the amenities. Ground operations, which include a range of

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T. H. Karakoc et al. (eds.), *Research Developments in Sustainable Aviation*,
Sustainable Aviation, https://doi.org/10.1007/978-3-031-37943-7_45

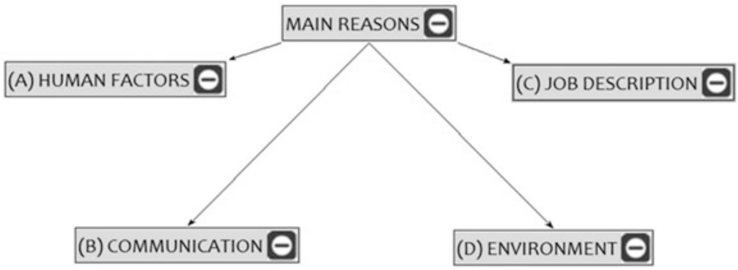

Fig. 1 General safety factors

services, take place at the ramp regions. The airlines may operate these activities themselves or contract them out to subcontractors (Landry & Ingola, 2011).

All ground service personnel must have operational and safety training in order to assist aircraft servicing. The training also includes the use of ground service equipment such as belt loaders, tugs, carriers, unit loaders, baggage carts, track loaders, and portable ground power units. Regardless of required training, the presence of a large number of people operating a variety of equipment in a small space, sometimes under time constraints, creates an environment prone to accidents and fatalities, as well as aircraft and equipment destruction (GAO, 2007).

This study aims to determine safety risks on the ground and measure them in order of importance among each other. Multi-criteria decision-making (MCDM) method is used to analyze these priorities under four main items, namely, human factor, communication, job description, and environment, as it is shown in Fig. 1. These main factors are mentioned in IGOM (IATA Ground Operations Manual) in Chapter 6 (IGOM, 2021).

2 Method

We present the analytic hierarchy process (AHP) to develop a weight model of safety factors by assessing and choosing the relevance of all sorts of factors, due to the complexity and unpredictability of factors.

AHP is a theory of relative measurement of criteria which are intangible, and it is proposed by Saaty (Saaty, 1980; Aragonés-Beltrán et al., 2014; Saaty, 1994). He proposes to use the ratio scales to compare the decision-maker's preferences and his Saaty's fundamental scale view that is shown in Table 1 (Saaty, 1980; Aragonés-Beltrán, 2014).

Figure 2 shows main steps of MCDM in order to find out AHP process (Aragonés-Beltrán et al., 2014; Saaty, 2001).

Table 1 Saaty's fundamental scale (Saaty, 1980)

Intensity of importance	Definition
1	Equal importance/preference
2	Weak
3	Moderate importance/preference
4	Moderate plus
5	Strong importance/preference
6	Strong plus
7	Very strong or demonstrated importance/preference
8	Very, very strong
9	Extreme importance/preference

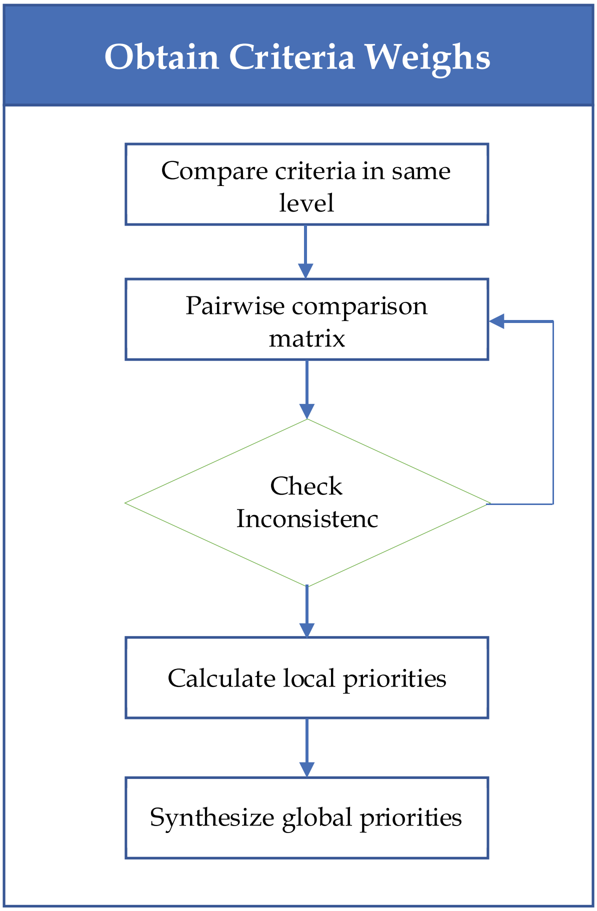

Fig. 2 AHP method scheme (Aragonés-Beltrán et al., 2014)

2.1 Data and Analyses

A survey is applied to experts who have experience in ramp operations in Istanbul Airport. The survey questions are asked with nine-point Likert scale to provide results in enough wide range. Each risk factor is matched with other in the same group, and the participants are required to answer them in terms of comparative degree.

The module of hierarchical safety considerations in the apron operation, as indicated in Table 2, is based on expert advice and a survey.

2.2 Determine Weight Value of Each Factor

We can specify a set of elements' weights sorted by the important degree based on expert opinion and surveys. The outcomes are represented in Table 3.

Table 2 The hierarchy module of safety factors in apron operation

First level	Second level	Third level
Effect factor	Human factors	Fatigue (A1)
		Overconfidence (A2)
		Unattending (A3)
	Communication	Lack of communication (B1)
		Marshaling (B2)
		Work shift (B3)
	Job description	Kneeling/bending (C1)
		Overtime work (C2)
		Repetitive work (C3)
	Environment	Bad weather (D1)
		Low visibility (D2)
		Noise (D3)

Table 3 The weight value of each factor

	w		*w*
A1	0.70886	B1	0.31081
A2	0.17862	B2	0.49339
A3	0.11252	B3	0.19580
(a) Human factor		(b) Communication	
C1	0.68698	D1	0.45996
C2	0.18648	D2	0.22113
C3	0.12654	D3	0.31892
(c) Job description		(d) Environment	

3 Results and Discussion

It is seen that ramp accidents occurring under “human factor” reasons are mostly caused by “fatigue” and take the first place with a rate of 70% in the whole process among the ramp operations. Overconfidence which has a rate of roughly 17% is in the second place. Finally, the “unattending” effect is in the last place with 11% (Table 3(a)).

Experts who answered the questions evaluated “marshaling” as the first among the communication-based reasons. Wrong hand signals used by marshalers might be thought of as a cause of why this rate is so high comparing to others. “Lack of communication” factor ranked second with 30%. The accidents caused by “work shift” are in the last place with approximately 20% (Table 3(b)).

The “kneeling/bending” body movement in the job description has been evaluated as the most remarkable risk factor for ramp operations, especially for ramp agents who are responsible for loading/offloading and technicians working in hangar. In addition to this, “overtime work” factor which is very common in aviation has taken the second place. Accidents caused by “repetitive work” follow them with a rate of 12% (Table 3(c)).

“Bad weather” effect comes first with a rate of 45% among the safety factors originating from environment. This triggers a significant risk for handling personnel working in very hot and cold weather conditions. The noise factor is considered in the second place with a rate of 31%. It is known that the ramp agents especially working very close to the aircrafts are being exposed to a great extent of noise from APU and engines. Finally, the “low visibility” factor ranks third with 22% due to heavy snowfall in winter (Table 3(d)).

4 Conclusion

We may utilize AHP as a form of convenient and effective evaluation method in the investigation of human factors in apron operation since it has features of dependable conclusion, practicability, and accuracy. It’s tough to assess aviation operations because of their intricacy, especially when they’re linked to the operators’ psyche and physiology, which is difficult to quantify. However, if we use the AHP to quantize all elements using the judgment matrix, we can address the problem.

We may logically judge the influencing elements and obtain the priority order of all factors’ effect on the final occurrences if the judgment matrix fulfills the consistency condition requirement. As a result, decision-makers may easily identify areas that need to be addressed as well as concealed dangers.

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