MCDM Risk Assessment in Ground Operation

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Nomenclature

IATA	International Air Transport Association
IGOM	IATA Ground Operations Manual
MCDM	Multi-Criteria Decision-Making
PROMETHEE	The Reference Ranking Organization Method for Enrichment Evaluation

1 Introduction

Aviation occupies an important place in passenger transport compared to other sectors. In addition, 35% of all cargo is transported by aircraft (ICAO, 2019). It is estimated that the total number of passengers travelling will be around 4 billion in 2024 (IATA, 2022). In this regard, the demand for air transportation is increasing day by day. Departing thousands of aircraft on scheduled time is possible with correct management of pre-flight processes. The aim is to carry out many ground operations such as loading/offloading cargoes, mail and bags, refueling aircraft and providing caterings without compromising safety. Airlines with a complex fleet have to manage all processes safely while performing aircraft maintenance on time. Otherwise, many risk factors arise, and this will cost millions of dollars (Studic

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et al., 2017). There are many causes of accidents in ground operations related to safety. For instance, ramp workers are exposed to high noise levels from engines and auxiliary power units when loading/offloading the aircraft. Hearing problems may occur shortly if personal protective equipment is not used (Basner et al., 2017). In addition, all operations are expected to be achieved as scheduled during the ground time of the aircraft. Therefore, time pressure causes haste among ramp agents. Many ground accidents can occur due to these processes, both among personnel and aircraft. Low awareness may also lead to undesired incidents (Wenner & Drury, 2000). On the other hand, aircraft maintenance involves a high level of safety (Ward et al., 2010). Thus, equipment used in the hangar should be calibrated, and sometimes incorrect instructions during maintenance may derive from a lack of technical training. Environmental risks are also considered external factors, such as heavy rain, wind, snow, and icing, which may lead to safety weaknesses. For instance, irregularities in de-icing operations may cause deterioration of the aircraft's aerodynamic structure, affecting take-off performance in terms of safety (Cao et al., 2018).

2 Method

Decision-making is a process that has significant importance in getting accurate results. There are many MCDM methods, and one of the effective methods is PROTMETHEE (The Preference Ranking Organization Method for Enrichment Evaluation). The approach determines the alternatives to be decided according to preference functions and then calculates the partial and complete priorities of the alternatives through a pairwise comparison technique. There are six preference functions introduced by Brans in 1982 and are shown in Fig. 1 (Dagdeviren & Erarslan, 2013).

2.1 Data and Analyses

The risk weights resulting from sub-criteria assessment of "human factor," "communication," "job description," and "environment" are examined using AHP method as shown in Table 1.

2.2 Risk Impact on Ramp Operations

Risk factors implemented in AHP are scored in PROMETHEE to determine impact on ground operations as shown in Fig. 2.

Impact of main risk factors on five ground operations are illustrated in Fig. 3.

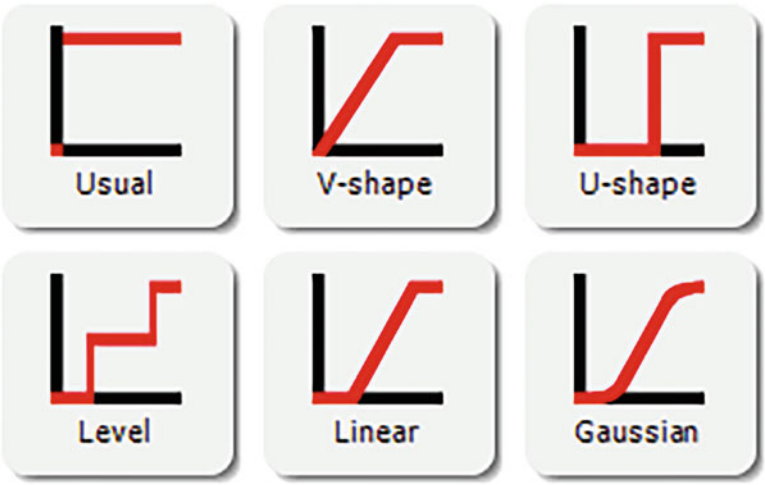

Fig. 1 Preference functions

Table 1 Risk factors in ground operation (Inan & Orhan, 2021)

Main factors	Sub-factors		Weight
Human factor	Fatigue	A1	0.70886
	Overconfidence	A2	0.17862
	Unattending	A3	0.11252
Communication	Lack of communication	B1	0.31081
	Marshalling	B2	0.49339
	Work shift	B3	0.19580
Job description	Kneeling/bending	C1	0.68698
	Overtime work	C2	0.18648
	Repetitive work	C3	0.12654
Environment	Bad weather	D1	0.45996
	Low visibility	D2	0.22113
	Noise	D3	0.31892

Each factor effect is examined and the impacts are shown based on operation in Figs. 4, 5, 6, and 7.

3 Results and Discussion

The sub-criteria obtained by comparing each one with the other through AHP method are shown in Table 1.

Results by grading and pairwise comparisons are evaluated according to the 5-point Likert scale with the PROMETHEE method, considering the expert opinions.

Fig. 2 Ground operations

The human factor, which covers fatigue, overconfidence, and unattended, has the highest rate in maintenance. Then ULD-BULK operation ranks second in loading/offloading due to fatigue (Fig. 4).

While the risks arising from communication has a significant effect on Pushback-Towing, it is also explored that accidents may occur due to marshalling in the de-anti icing process (Fig. 5).

Kneeling/bending movements have significant impact on ramp agents who are responsible for loading/offloading cargoes and bags in bulk aircraft operations. Similarly, technicians are also exposed to repetitive movements such as long-time working at height, bending/kneeling, holding the head in a fixed direction in maintanance action. Therefore, these sub-factors lead technician to take the second rank after the ramp workers in job description main factor (Fig. 6).

Weather conditions, considered external factors, have a more significant effect on ramp staff performing the operations while the aircraft is in the parking position. Moreover, exposure to excessive levels of noise is thought as a risk factor for both technicians and those working around the engines (Fig. 7).

4 Conclusion

Occupational accident causes and safety factors that may arise in ground operation have been examined based on the main items such as “human factor,” “communication,” “job description,” and “environment.” The risk factors calculated by pairwise comparisons are evaluated on a 5-point Likert scale according to the PROMETHEE method, taking weight percentages into account.

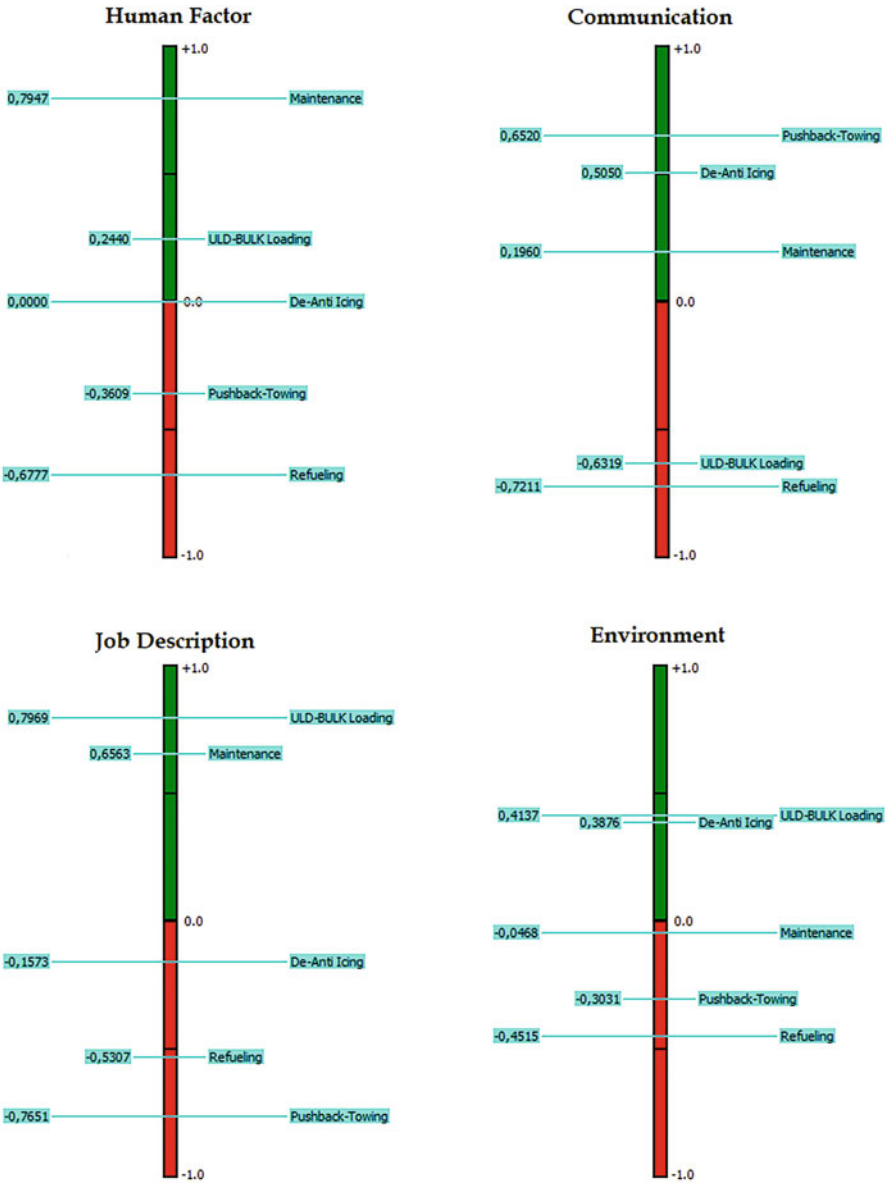

Fig. 3 Ranking analysis

This study, which can be recommended as a risk analysis method for airlines, presents an approach to the proactive accident prevention process.

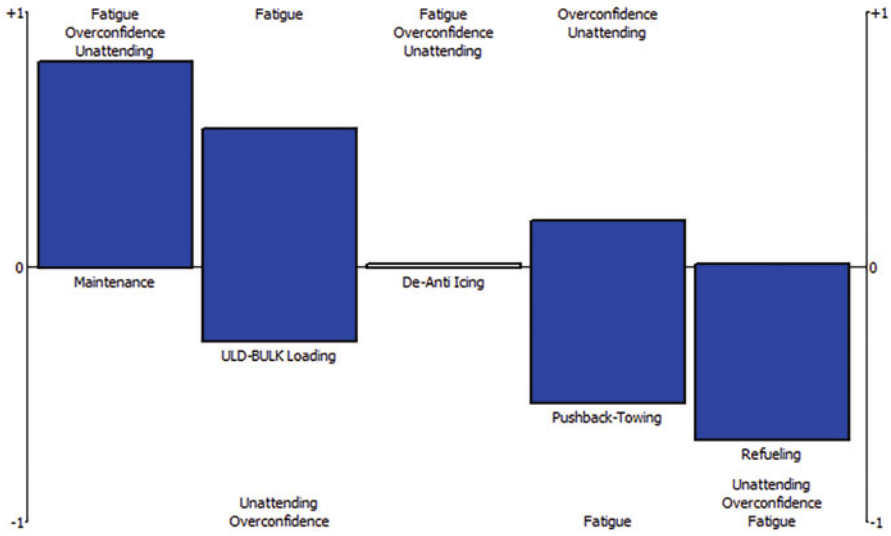

Fig. 4 Sub-factor analysis of human factor

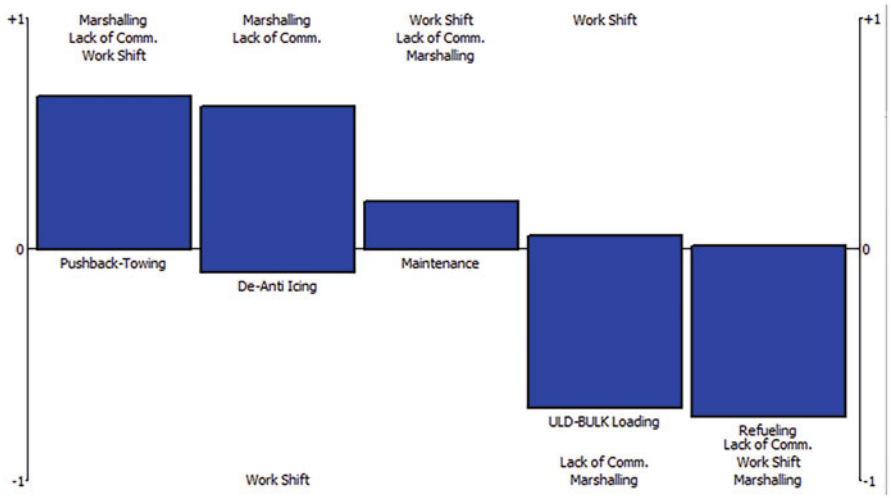

Fig. 5 Sub-factor analysis of communication

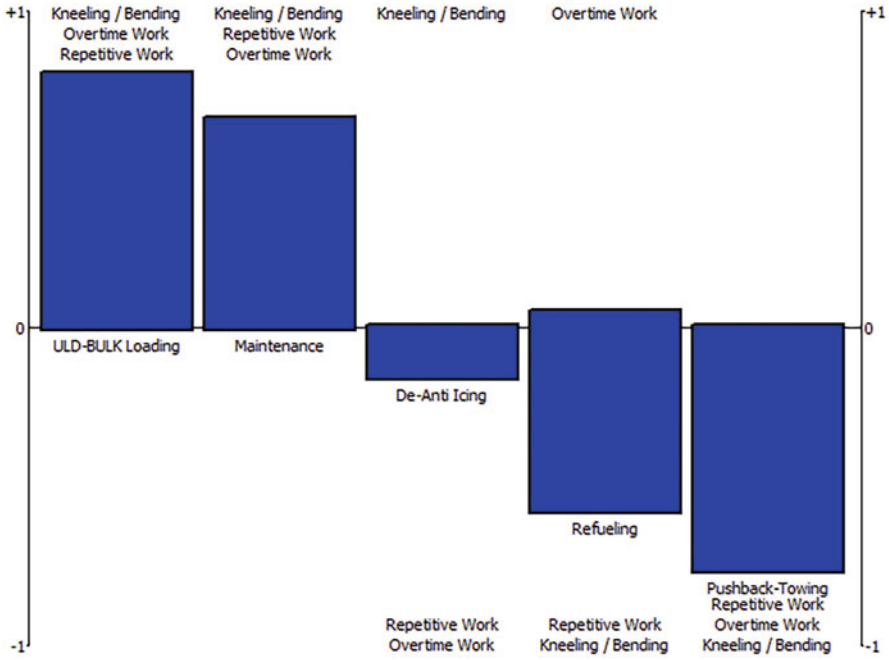

Fig. 6 Sub-factor analysis of job description

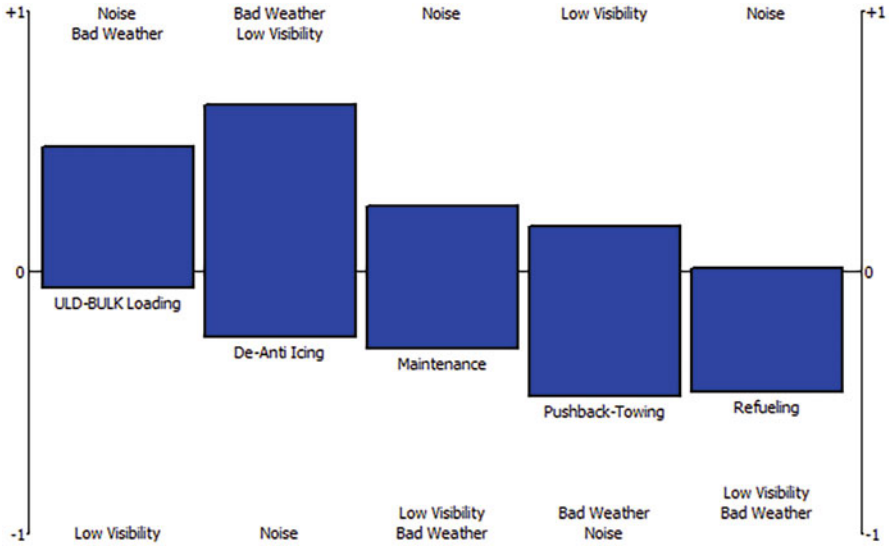

Fig. 7 Sub-factor analysis of environment

References

Basner, M., Clark, C., Hansell, A., Hileman, J. I., Janssen, S., Shepherd, K., & Sparrow, V. (2017). Aviation noise impacts: State of the science. *Noise & Health, 19*(87), 41–50. https://doi.org/10.4103/nah.NAH_104_16

Cao, Y., Tan, W., & Wu, Z. (2018). Aircraft icing: An ongoing threat to aviation safety. *Aerospace Science and Technology, 75*, 353–385. https://doi.org/10.1016/j.ast.2017.12.028

Dağdeviren, M., & Erarslan, E. (2013). PROMETHEE SIRALAMA YÖNTEMİ İLE TEDARİKÇİ SEÇİMİ. *Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi, 23*(1). Available at https://dergipark.org.tr/en/pub/gazimmfd/issue/6675/88291

IATA. (2022). *Air passenger numbers to recover in 2024*. Available at https://www.iata.org/en/pressroom/2022-releases/2022-03-01-01/

ICAO. (2019). *International Civil Aviation Organisation. Aviation benefits report*. Available at https://www.icao.int/sustainability/Documents/AVIATION-BENEFITS-2019-web.pdf

Inan, I., & Orhan, I. (2021). *Safety factor analysis in Ramp operation with AHP approach*. Paper presented at the International Symposium on Sustainable Aviation, Kasetsart University, Bangkok, 25–27 November 2021.

Studic, M., Majumdar, A., Schuster, W., & Ochieng, W. Y. (2017). A systemic modelling of ground handling services using the functional resonance analysis method. *Transportation Research Part C: Emerging Technologies, 74*, 245–260. https://doi.org/10.1016/j.trc.2016.11.004

Ward, M., McDonald, N., Morrison, R., Gaynor, D., & Nugent, T. (2010). A performance improvement case study in aircraft maintenance and its implications for hazard identification. *Ergonomics, 53*(2), 247–267. https://doi.org/10.1080/00140130903194138

Wenner, C. A., & Drury, C. G. (2000). Analyzing human error in aircraft ground damage incidents. *International Journal of Industrial Ergonomics, 26*(2), 177–199. https://doi.org/10.1016/S0169-8141(99)00065-7