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Prioritizing risks via several expert perspectives with application to runway safety

Ellen C. Rogerson, James H. Lambert

Department of Systems and Information Engineering and Center for Risk Management of Engineering Systems, University of Virginia, PO Box 400747, 151 Engineers Way, 112 Olsson Hall, Charlottesville, VA 22904, USA

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Abstract

Factor hierarchies have been widely used in the literature to represent the view of an expert of what factors most contribute to reliability or safety. The methods for rating and aggregating the influences across a set of expert-elicited factors to risk or reliability are well known as multiple criteria decision analysis. This paper describes a method for distinguishing levels of risk across a set of locations via the use of multiple factor hierarchies. The method avoids averaging across experts and is thus useful for situations where experts disagree and where an absence of expert consensus on the causative or contributing factors is important information for risk management. A case study demonstrates using seven expert perspectives on the airport-specific factors that can contribute to runway incursions. The results are described for eighty towered airports in the US. The expert perspectives include differing relative emphases across the following set of factors: airport geometry, operations, weather, geography, and days since last safety review. Future work is suggested to include human factors issues as pilot-and-controller communications styles at airports.

Highlights

► We examine influential factors in seven expert perspectives on the problem domain. ► We assess eighty US airports with qualitative measurement scales for each risk factor. ► Results show robustness and sensitivity of the risk index to expert perspective. ► We examine factors of several types including runway geometry, operations, weather, and geography.

Keywords

Program management; Decision analysis; Risk assessment; Runway safety; Aviation safety; Expert elicitation

Figures and tables from this article:

Fig. 1. Flow chart of approach of paper incorporating multiple expert perspectives into factor hierarchies.

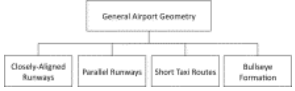

Fig. 2. Factors related to *general airport geometry*, to be used in factor hierarchies.

Figure options

Fig. 3. Factors related to *cumulative airport geometry*, to be used in factor hierarchies.

Figure options

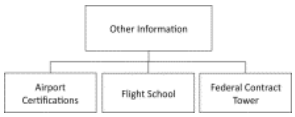

Fig. 4. Factors related to *other information*, to be used in factor hierarchies.

Figure options

Fig. 5. Hierarchy H01: General, airport-specific hierarchy, representing a complementary perspective on the organization and emphasis of runway incursion factors for prioritization of airports for risk of runway incursion.

Figure options

Fig. 6. Hierarchy H02: Emphasis on specific counts, representing a complementary perspective on the organization and emphasis of runway incursion factors for prioritization of airports for risk of runway incursion.

Figure options

Fig. 7. Hierarchy H03: Emphasis on operations and incursions, representing a complementary perspective on the organization and emphasis of runway incursion factors for prioritization of airports for risk of runway incursion.

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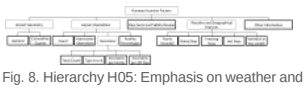

Fig. 8. Hierarchy H05: Emphasis on weather and geographical features, representing a complementary perspective on the organization and emphasis of runway incursion factors for prioritization of airports for risk of runway incursion.

Figure options

Fig. 9. Hierarchy H04: Extension to include weather and geographical features, representing a complementary perspective on the organization and emphasis of runway incursion factors for prioritization of airports for risk of runway incursion.

Figure options

Fig. 10. Hierarchy H06: Emphasis on factors that can be affected by a safety meeting, representing a complementary perspective on the organization and emphasis of runway incursion factors for prioritization of airports for risk of runway incursion.

Figure options

Fig. 11. Hierarchy H07: Emphasis on factors that cannot be affected by a safety meeting, representing a complementary perspective on the organization and emphasis of runway incursion factors for prioritization of airports for risk of runway incursion.

Figure options

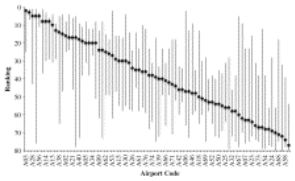

Fig. 12. Aggregation results using an adaptation of AHP, where sensitivity to stakeholder perspective is demonstrated by examining the difference between the highest and lowest ranking for an airport across each of the seven hierarchies.

Figure options

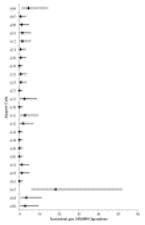

Fig. 13. 95% confidence intervals on number of incursions per 100,000 operations.

Figure options

Table 1. Runway incursion factors developed in this analysis (denoted by italics) or adopted and modified from variety of sources as described in the narrative.

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Table 2. Definitions of aggregate incursion factors to be used in factor hierarchies for characterizing risk of runway incursions.

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Table 3. Quantitative definitions of *high*, *moderate*, and *low* ratings for each factor to be used in the multiple factor hierarchies.

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Table 4. Summary of results from aggregation across seven hierarchical expert perspectives.

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Table 5. Historical data and 95% confidence intervals on number of incursions per 100,000 operations.

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Corresponding author. Tel.: +1 434 982 2072; mob: +1 434 531 4529; fax: +1 434 924 0865.