An Analysis of Communication, Navigation and Surveillance Equipment Safety Performance

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'Any mother could perform the jobs of several air-traffic controllers with ease'

(Lisa Alther)

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Introduction

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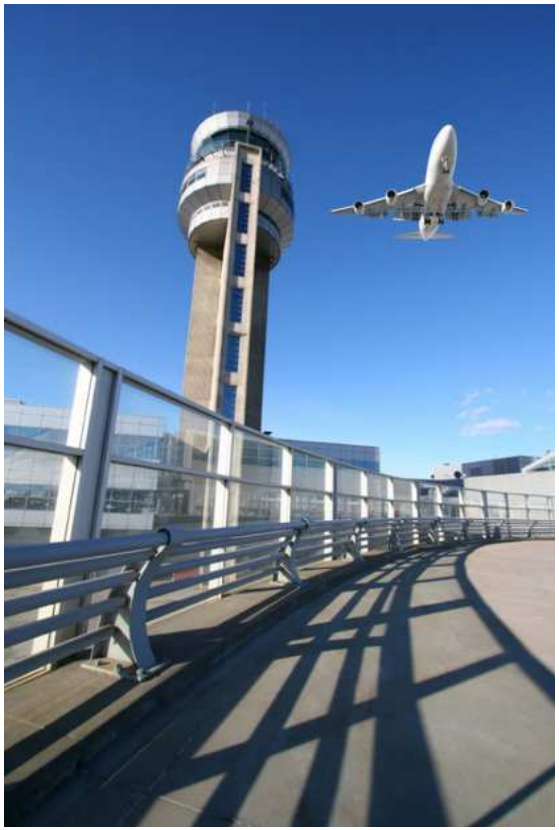
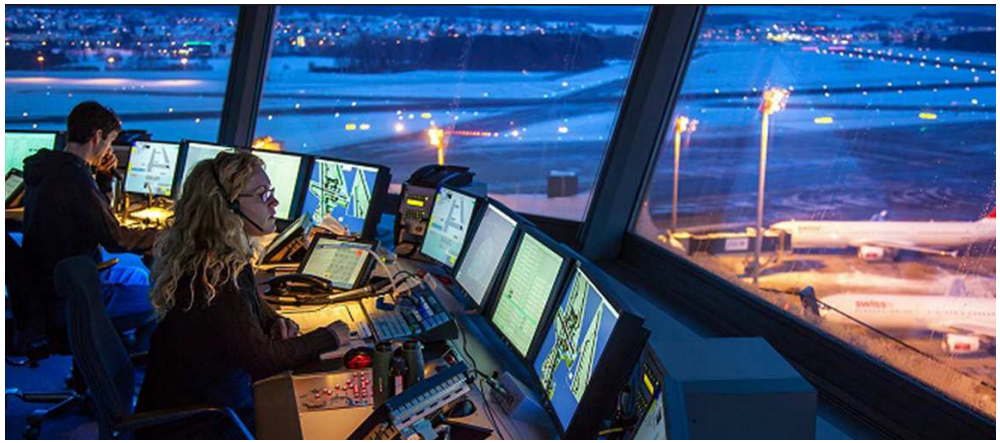


- Air navigation service providers (ANSPs) around the world are generally assigned the responsibility of Air Traffic Management (ATM)
- Success is highly dependent on a complex infrastructure of communication, navigation and surveillance (CNS) systems
- A study on *"Safety-Related and Safety-Critical Functions and Related Jobs in Air Traffic Management and Air Navigation Services"* identified 28 functions as safety critical out of 143 safety related functions (Allam, 2015)
- The International Civil Aviation Organisation (ICAO) requires that each state establishes a state safety programme (SSP) for the management of safety in civil aviation
- An organisation can select its own safety monitoring indicators, targets, and safety alerts – lack of standardisation

Problem Statement

- The average availability target set by DoT for CNS systems is 99.8% (very good), with the highest being 99.98% (excellent)
- For a one-year period, an availability value of 99.8% equates to 17 hours of downtime per year
- An availability value of 99.98% equates to 1.75 hours of downtime per year
- Current system availability measurement does not distinguish between navigational equipment failures that occur at different airports, e.g. Upington and OR Tambo International airport
- Upington airport has an average of 24 flight movements per day, compared to OR Tambo International airport which has an average of 618 flight movements per day (in 2016)



Research Questions

- Which service providers measure communication, navigation and surveillance equipment performance?
- How do these service providers/organisations measure equipment performance?
- What are the primary reasons for measuring equipment performance?
- How do these measurements relate to aviation safety?
- What is the risk posed by equipment failure, as perceived by air traffic controllers?
- How can these measurements be improved to enhance aviation safety, in line with the air traffic controller's perception of risk?

Literature and Theory

Literature and Theory

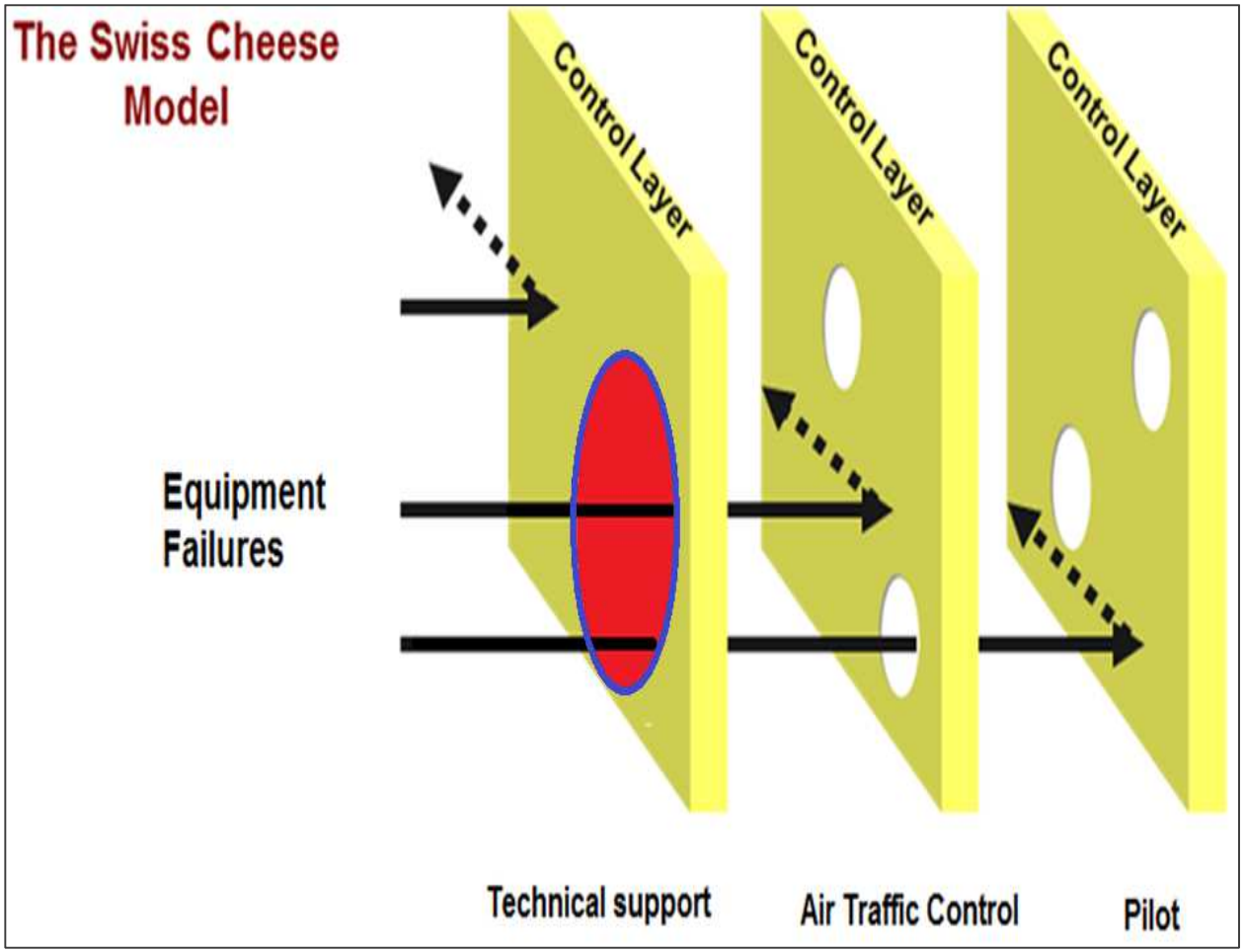
- Organisations cannot rely merely on the subjective perception of safety
- A practical and objective means of demonstrating assurance or the degree of safeness is required
- This requires quantifiable means of measuring safety (Hollnagel, 2014)
- However, measuring safety is not a simple process (Stolzer et al., 2015)
- This could be the reason why performance measurements like availability are still used for CNS equipment
- There is *"a genuine, practical need to measure how safe people are or how safe a certain kind of activity is"* (Hollnagel, 2014)
- When measuring safety, accident and incident rates are the most commonly used norm or standard (Chang and Yeh, 2004)

Literature and Theory

- Dekker (2014) proposed four accident models that give different explanations of what is a risk and how it can be contained
- One model, the Swiss Cheese Model, is discussed in this paper since it is useful to demonstrate defences to CNS equipment failure
- Reason (2008) explains how there can be deficiencies (holes) in all the defences (control layers), and still maintain a clean record since the deficiencies (holes) do not line up
- The first control layer represents the technical support defences, such as maintenance policies, skills, and related logistics
- The second control layer represents the air traffic control officers (ATCOs)
- The third layer represents the pilot of an aeroplane

Swiss Cheese Model

The focus of this research was to propose a model that can, figuratively, measure the size of the red hole in the first layer. By creating a model to measure the size or the number of holes in this layer, organisations can make informed decisions on policies and procedures, thus reducing the over reliance on control officers and pilots when CNS equipment failures occur



(Source: Reason, 2008)

Methodology

Methodology

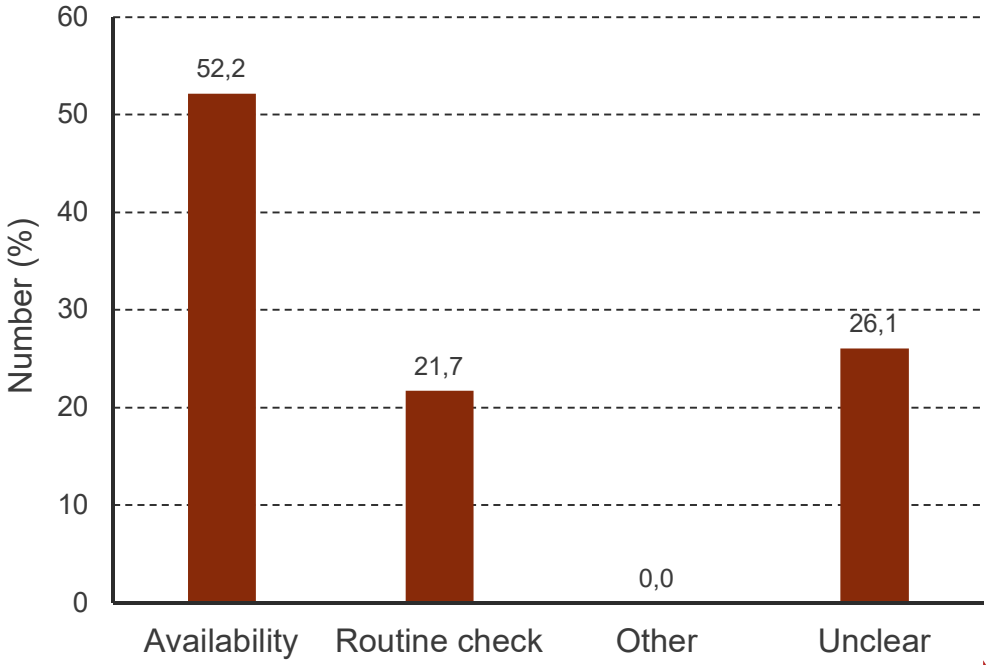
Two complementary approaches

- The first method comprised an international survey on what other air navigation service providers use as a measurement base for CNS equipment performance evaluation
  - This was done through questionnaires that were distributed at international conferences and through international visits
- The second part comprised paper-based questionnaires that were completed by air traffic control officers in South Africa
  - Respondents were requested to rate the perceived risk posed by each equipment failure on a 5-point scale, 1 being minor risk and 5 being a catastrophic risk

Research Findings

International Survey

- 92 responses from 16 countries were obtained
- 96% said they do measure CNS equipment performance
- *How do you measure CNS equipment performance?*
- About half of the respondents use availability as the only performance measure



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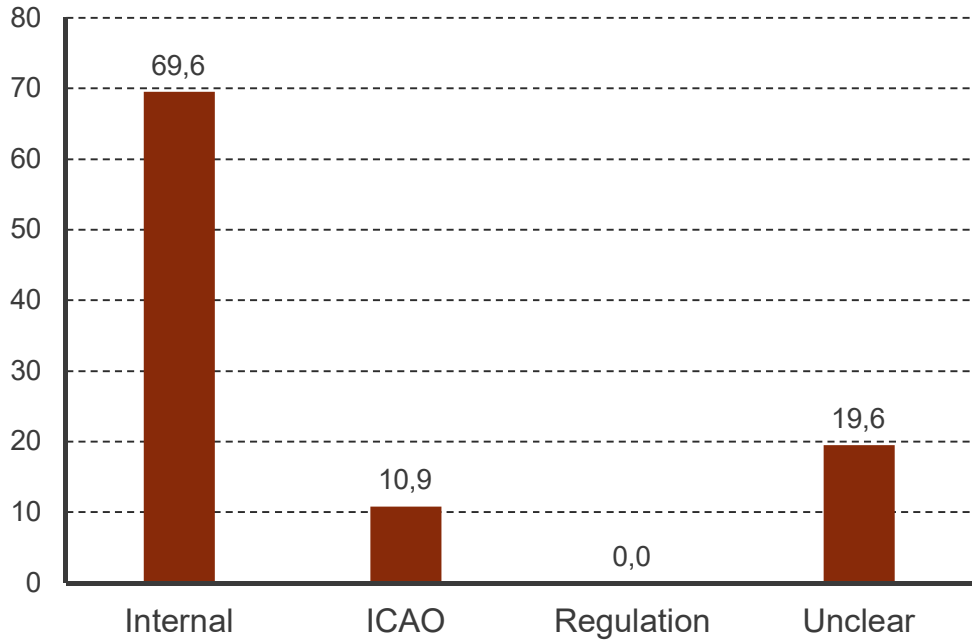
International Survey

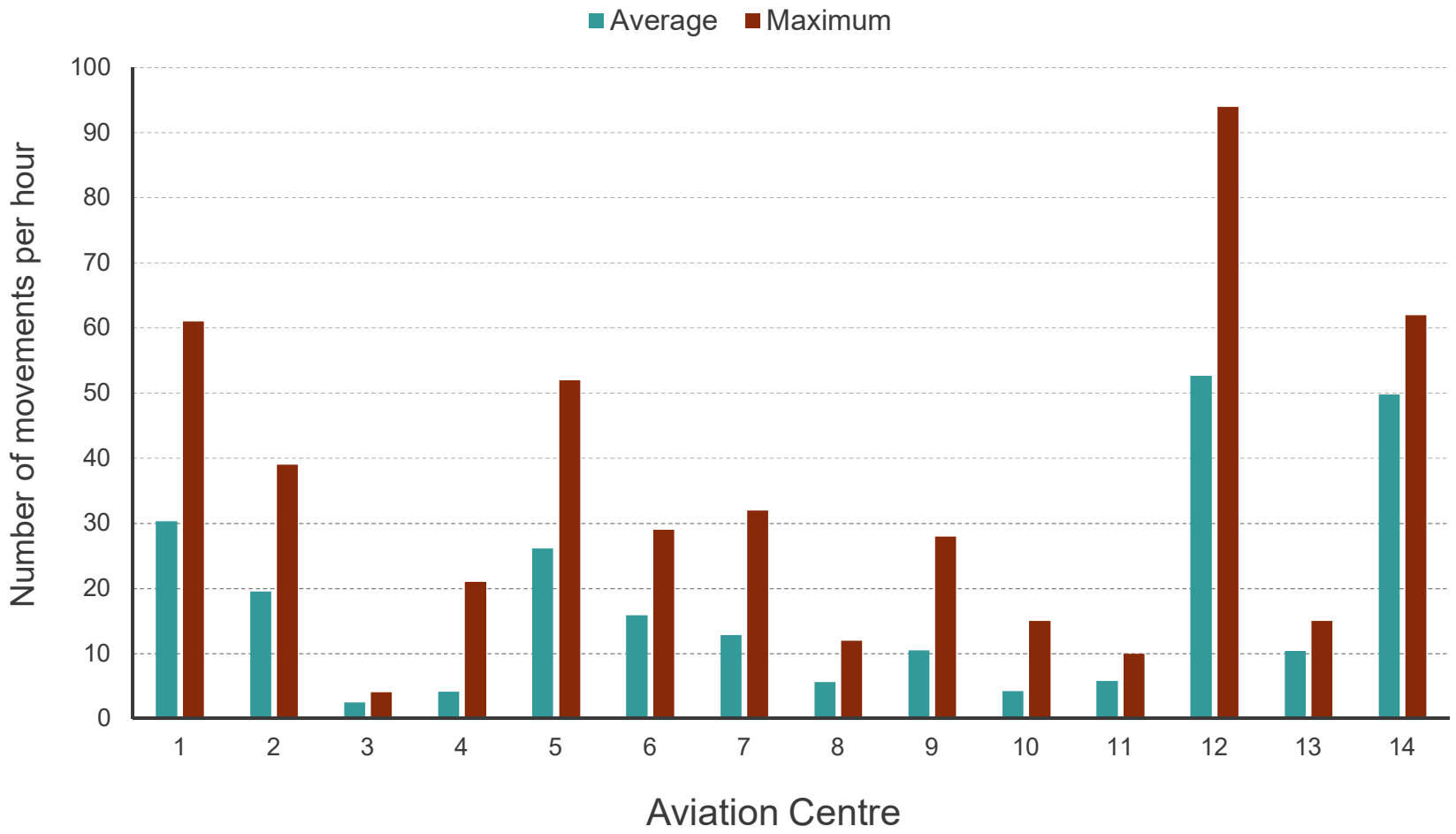
- *What is the main purpose of doing the performance measures?*
- Most respondents answered ‘Internal’, which included:
  - To maintain safety
  - To prevent accidents
  - Ensure integrity of the systems
  - To improve availability
  - To meet service level agreements
- ICAO provides a ‘guideline’ for availability of 97,5%



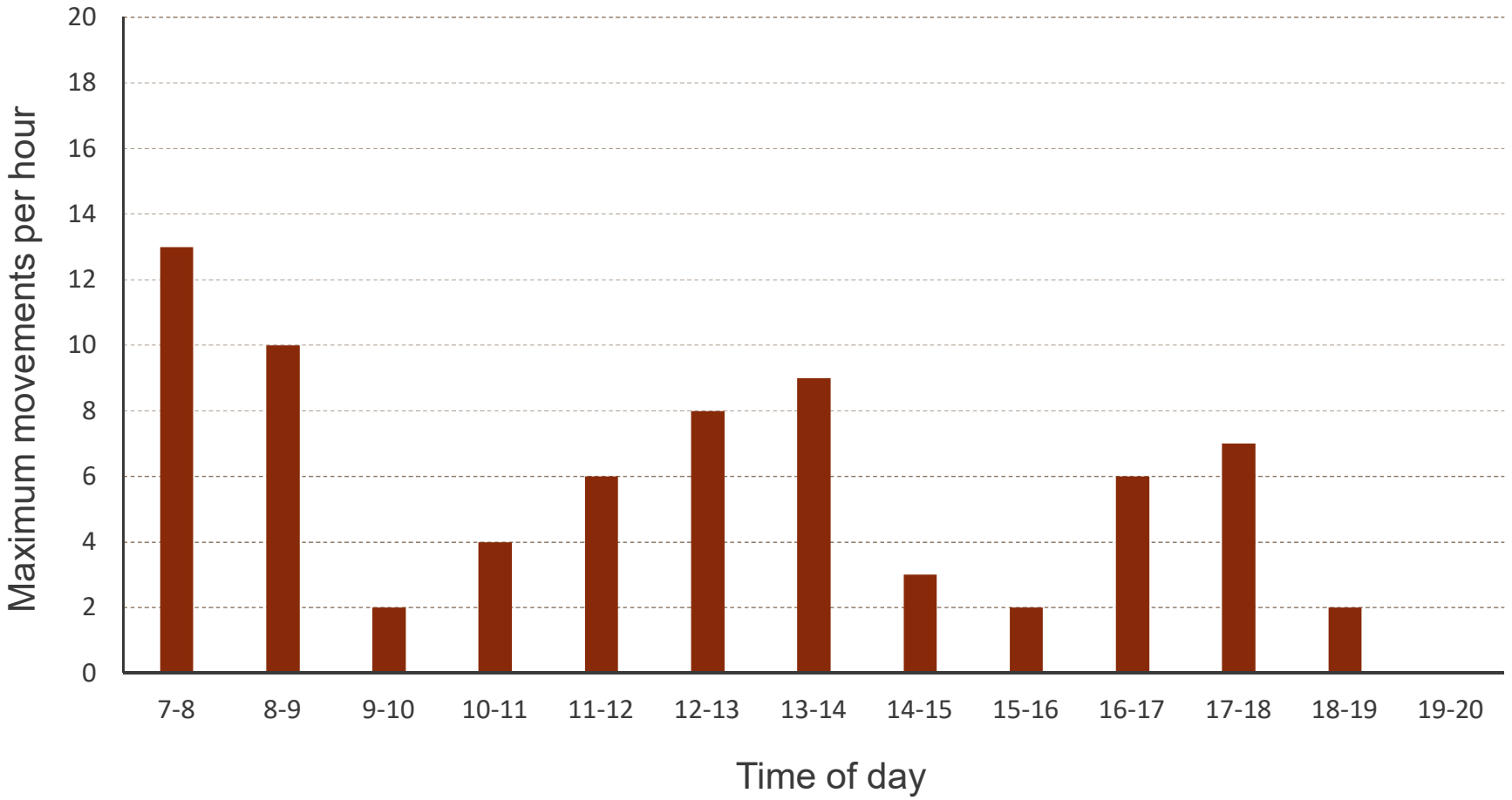
Air Traffic Control Officer Surveys (Local)

- A total of 165 responses were received from 15 different aviation centres across the country
- Three focus areas were addressed
  - High-volume aircraft movements analysis
  - Air traffic controller position analysis
  - Risk rating induced by CNS equipment failure
- For aircraft movement analysis, actual movements were captured over a 30-day period in June - September 2017

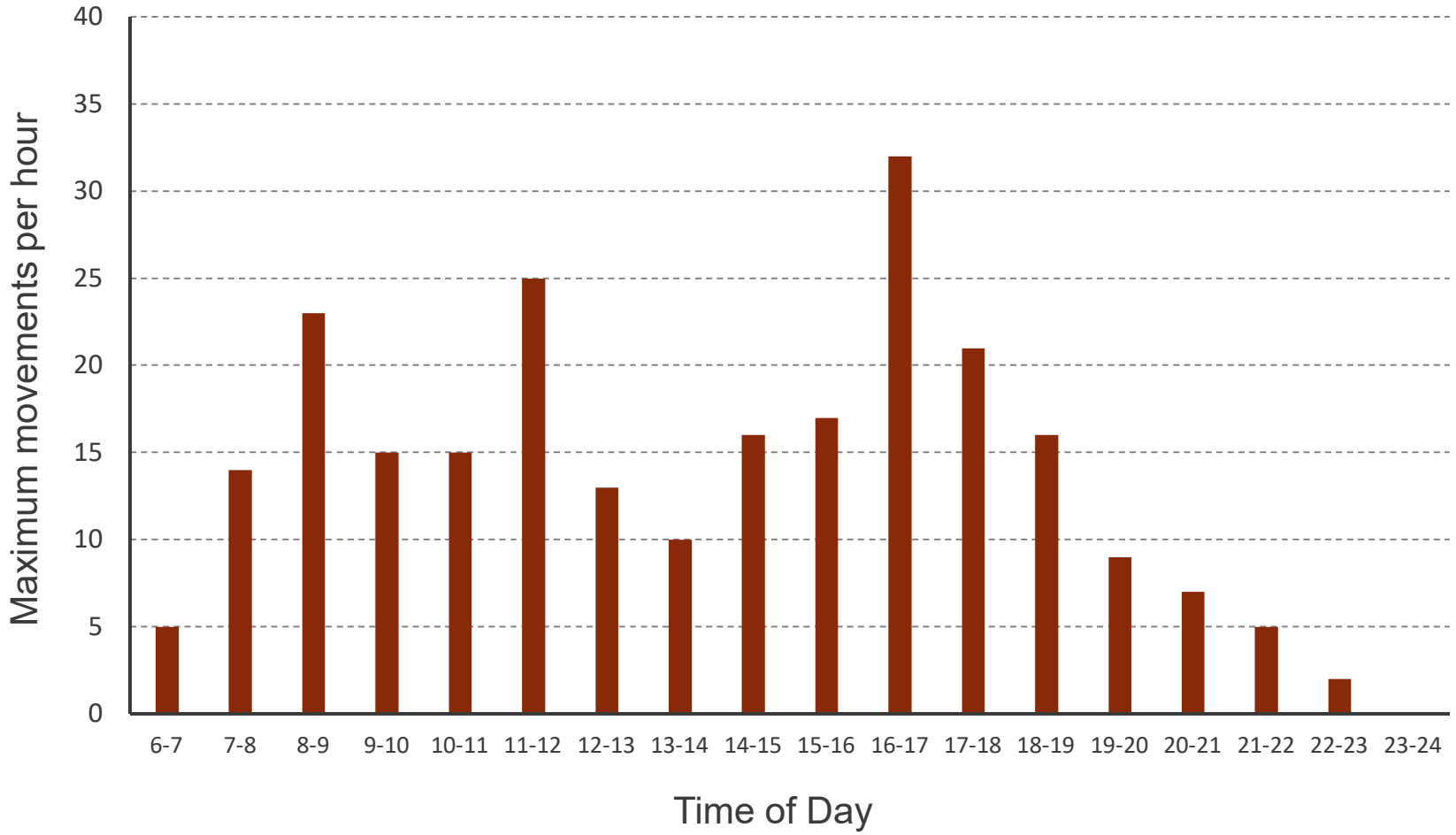
Aircraft movements for different centres



Movements during the day – Quiet centre



Movements during the day – Busy centre



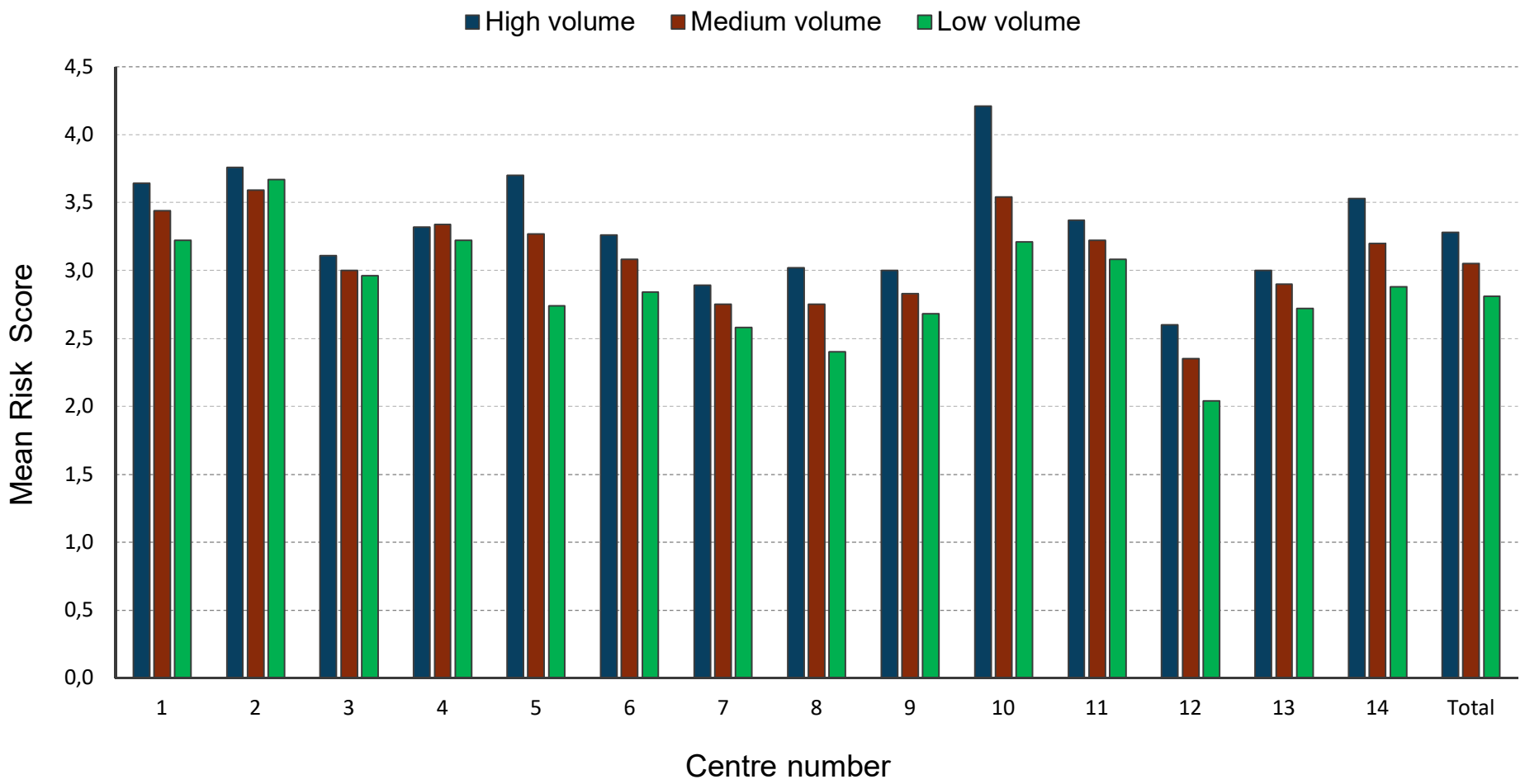
Traffic Volume Analysis

- Although some uniformity could be observed in some of the analysis (between what air traffic control officers consider to be busiest hours and the actual busiest hours), it becomes very vague to truly categorise what constitutes busiest or “high volume movements” per hour when no specific (station based) reference is in place
- What is evident from this analysis is the variability in the sense that what is considered “high volumes” for one station might not necessarily be “high volumes” for another station

CNS risk ratings under different aircraft volume movements

- This analysis required the air traffic control officers to evaluate the potential risk induced by the same CNS equipment failure under different traffic volumes, i.e. High, Medium, and Low
- The results showed a direct proportional relationship to the traffic levels
- However, each station had a different perception of what they considered as High, Medium, and Low aircraft movements

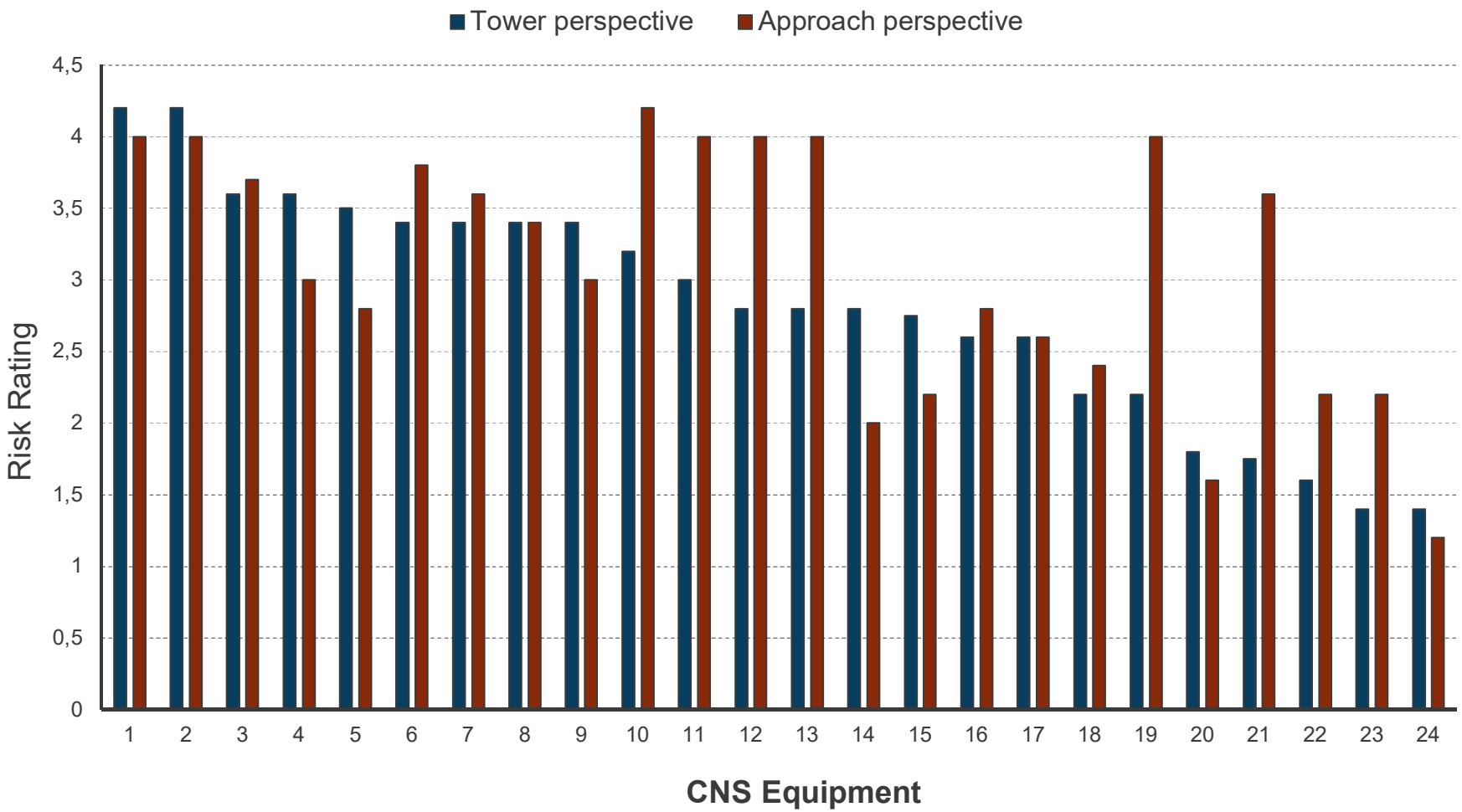
Risk rating under different traffic volumes



CNS risk ratings from different perspectives

- Five air traffic control officers holding both Tower (TWR) and Approach (APP) licence validations from the same centre were requested to complete the same survey from different perspectives
- First, the controllers completed the survey from a tower perspective; meaning that they rated different CNS equipment failure risk from a tower controller point of view
- Secondly, they completed another survey that was the same as the previous, but this time they had to respond from an approach controller perspective

Risk rating for different equipment and perspective



Conclusions

Conclusions

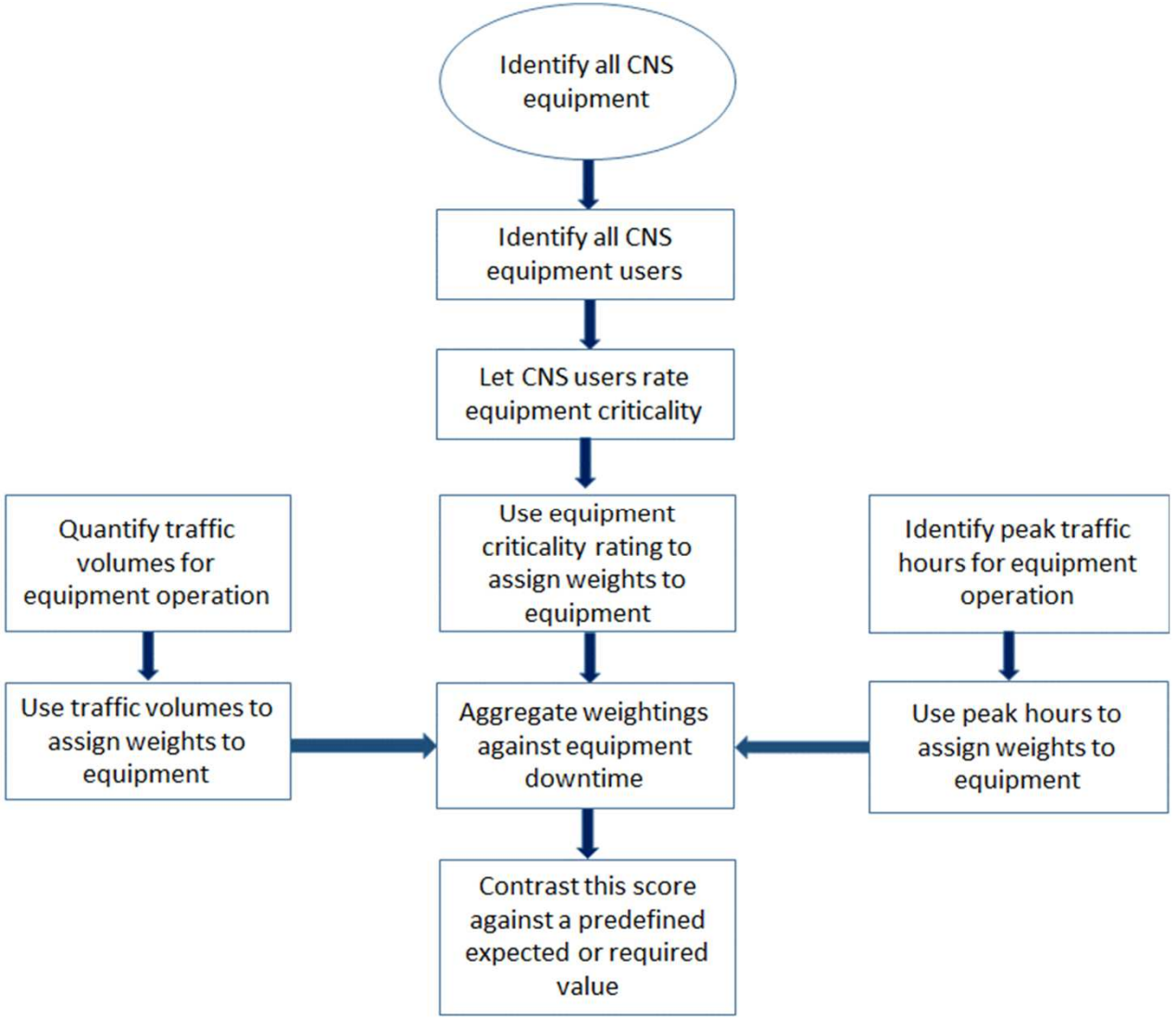
- The results from the two surveys validated the proposition that *“current CNS equipment performance measurements used by air navigation service providers (ANSPs) lack the ability to proportionate or quantify the risk induced on aviation safety when a failure occurs on these systems/equipment”*
- The biggest shortcoming with the availability measurements is that it does not quantify the potential outcome or consequence of CNS equipment failure
- The results showed the importance of taking air traffic control officers’ view into consideration when developing models for measuring CNS equipment performance
- Aspects like volume, peak traffic hours and controller perspective should be considered in setting performance standards

Recommendations

Recommendations

- Service level agreements should not be drafted in isolation of the Air Traffic Control Officers who use the equipment
- All possible stakeholders, i.e. traffic controllers and pilots who might be affected by the CNS equipment failures should be represented together with representatives from all the safety departments
- It is recommended that maintenance strategies be aligned to the critical nature of the equipment
- CNS equipment performance measurements should be relative to the use of the equipment in question and its contribution to aviation safety
- The proposed framework should be validated by relevant stakeholders like CNS equipment users and asset managers

Proposed Framework



ORT International Airport

Questions

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