

# AN INTELLIGENT SYSTEM FOR THE PRE-MISSION ANALYSIS OF HELICOPTER EMERGENCY MEDICAL SERVICE OPERATIONS: STATUS REPORT ONE

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## Abstract

*Research is currently being undertaken, in close collaboration with Air Ambulance Victoria, to develop an intelligent system for the pre-mission analysis of Helicopter Emergency Medical Service (HEMS) operations. This research is being conducted for the next three years as a project under the Australian Research Council. The aim of this research is to develop a knowledge based expert system that will assist flight-coordinators and crew in the decision-making processes faced prior to aero-medical operations.*

*The time constrained environment and the occupational stresses faced by aero-medical decision-makers create non-ideal conditions. It is susceptible to misjudgement, thereby leading to accident prone decisions. It is expected the project will assist in the management of risks associated with HEMS operations by the provision of a structured decision support system that limits erroneous decisions and by holistically capturing all factors of pre-mission analysis. The holistic analysis considers functional, technical, human and environmental factors to address the mission requirements.*

## 1. Introduction

The versatility of the helicopter has made it highly valuable in the recovery, resuscitation and transfer of critically ill patients to major hospitals and in the search and rescue of people at land and sea [1,2,3] As a result of this versatility HEMS operate world-wide to provide medical and rescue support.

The high HEMS accident rate in America has prompted HEMS operators across the globe to address the management of risks inherent to their operations [4]. Presently most HEMS operations depend upon the crew and their experience to perform pre-mission analysis. This unstructured decision-making process is susceptible to overlooking important information and producing erroneous decisions. Subsequent reports have identified the need for intelligent systems to reduce the likelihood of such erroneous decisions in the pre-mission analysis phase of HEMS operations [5].

Working in close collaboration with Air Ambulance Victoria this project aims to develop a prototype intelligent system for the pre-mission analysis of HEMS operations. The system will provide decision support to the crew through the holistic analysis of operational, technical, environmental and human factors relating to HEMS operations. The project aims to reduce the risk associated with HEMS operations by providing a structured decision support system that ensures all factors are considered in the pre-mission analysis of operations.

## 2. Overview of AAV operations

Air Ambulance Victoria (AAV) is part of the Metropolitan Ambulance Service (MAS) and operates three helicopters based at Essendon, Latrobe Valley and Bendigo. They provide rapid MICA Flight Paramedic response and transport of time critical patients to hospital. Details of these three helicopters is presented at Table 1. The helicopters transported a total of 1392 patients in 2003, involving a mixture of

inter-hospital transfers and primary responses to the scene. Since 1998, AAV's HEMS operations has increased in the number of patients handled, however operations have stabilised from 2001 with the introduction HEMS 3 (Figure 1). AAV also undertakes fixed wing operations to support the Victorian Ambulance Service in the transportation of patients with a fleet of four dedicated Beechcraft Kingair B200C [6].

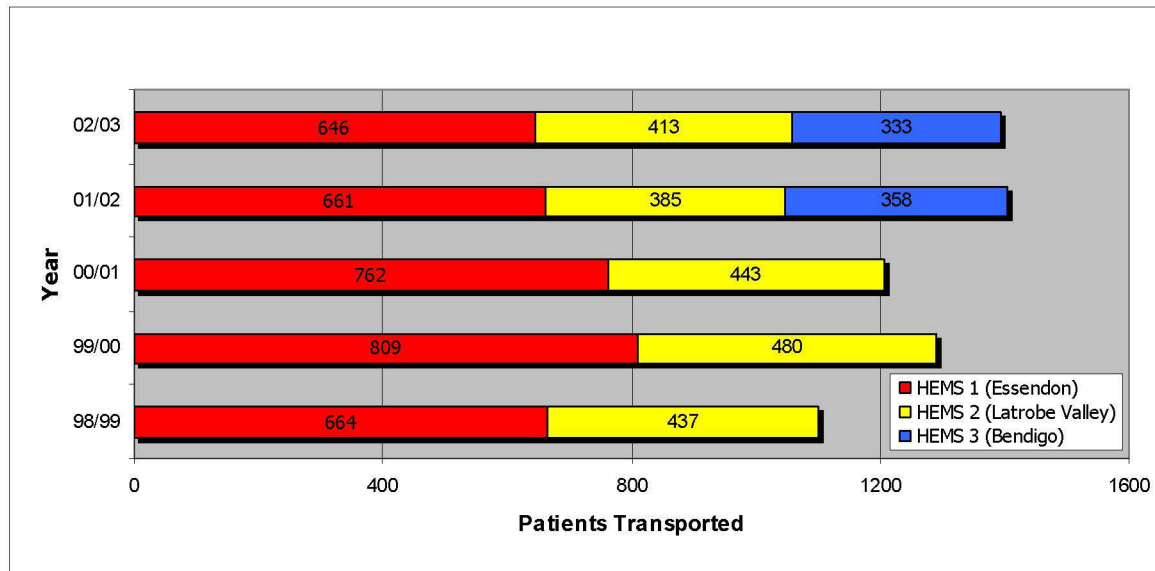
AAVs resources are also a critical component of Victoria's medical retrieval system, providing medical teams with quick access to critically ill newborn babies and critically ill or injured children and adults. During the last financial year Air Ambulance provided transport to 111 Neonatal Emergency Transport Service (NETS) cases, 91 Paediatric Emergency Transport Service cases and 77 Medical

Emergency Adult Retrieval Service cases [6].

AAV has recently refined its dispatch processes and increased accountability through the Flight Coordination Centre at Essendon Airport, which is responsible for supporting the appropriate utilisation and the efficiency of helicopter response.

**Table 1. Type and make of helicopter in service with AAV and their operational bases**

Name	Based	Aircraft
HEMS 1	Essendon	Eurocopter Dauphin AS 365N3
HEMS 2	Latrobe Valley	Bell 412 EP
HEMS 3	Bendigo	Bell 412 EP



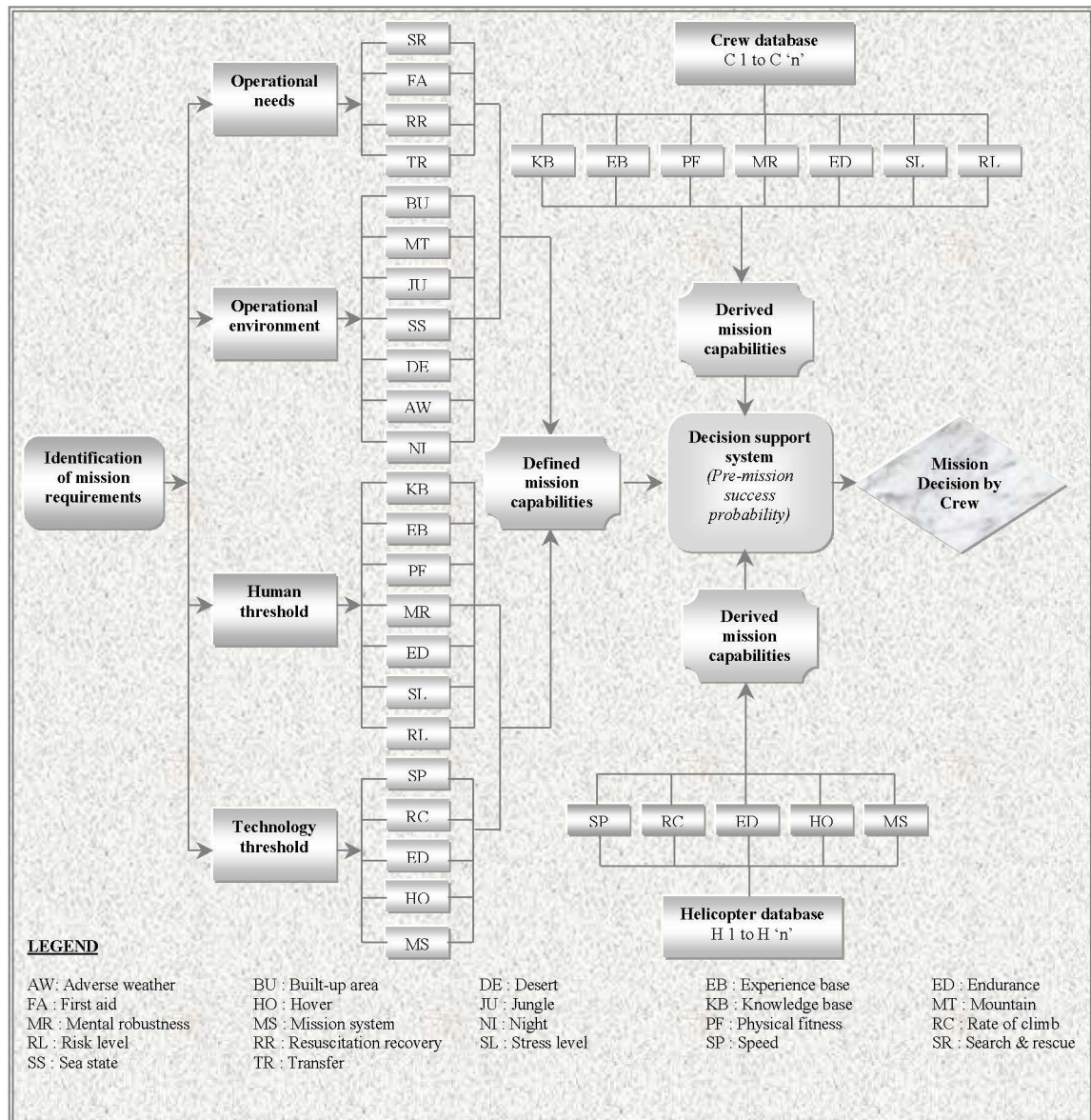
**Figure 1. Total number of patients transported in HEMS operations by AAV**

### 3. System Framework

Crew error is one of the key causes of accidents in HEMS operations [7][8][9]. Whilst the HEMS accident rate is lower in Australia [10][11], the American HEMS accident rate has prompted HEMS organisations worldwide to assess the management of risks inherent to their operations [12]. In-flight decision-making, pre-flight planning, failure to follow standard operating procedures, delayed remedial actions, and misinterpretation of environmental cues are areas that need to be addressed for safe HEMS operations [13]. Sinha et al. [5] have acknowledged the need for a decision support system

(DSS) to reduce the probability of erroneous decisions in the pre-mission analysis phase of HEMS operations.

Sinha et al. [5][14], developed a conceptual framework for a system to assist mission analysis and decision making in HEMS operations. This work suggests that available mission capabilities be compared against required mission capabilities to quantitatively determine the probability of mission accomplishment and to suggest actions to address the shortfalls in the required mission capabilities. The framework of the DSS is presented in Figure 2.



**Figure 2. Conceptual framework of an intelligent system for pre-mission analysis of helicopter emergency medical operations**

Aven and Korte [15], contrasted two different approaches of thinking in order to reach a good decision;

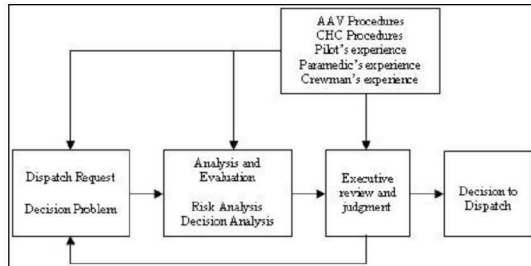
1. Decision-making as an exercise of modeling alternatives, outcomes, uncertainty and values, and choice of the alternative which maximises/minimises some specified criteria.
2. Decision-making as a process with formal risk and decision analyses to provide decision support, followed by an informal managerial judgment and review process resulting in a decision.

On the basis of Aven and Korte [15], the second approach has been adopted for the design of an intelligent system for pre-

mission analysis in HEMS operations. The result is that the decision analysis conducted by the system is seen strictly as an aid for decision making. The decision maker must take the results of the system and make their decision, following a review and judgment process.

In light of the decision making model presented in Figure 3, the Intelligent System or Decision Support System will be responsible for the analysis and evaluation phase of the process. The Decision Support System will model the mission governing factors for analysis and will cover the required mission capabilities vis-à-vis the available mission capabilities.

Based on this analysis the system will recommend the best available resource; and if deficiencies are noted then remedial actions will be recommended. It will then be the responsibility of the flight coordinators to take the results of the system and make decisions, following review and judgment processes.



**Figure 3. Pre-mission Analysis Decision making model**

#### 4. Present Research

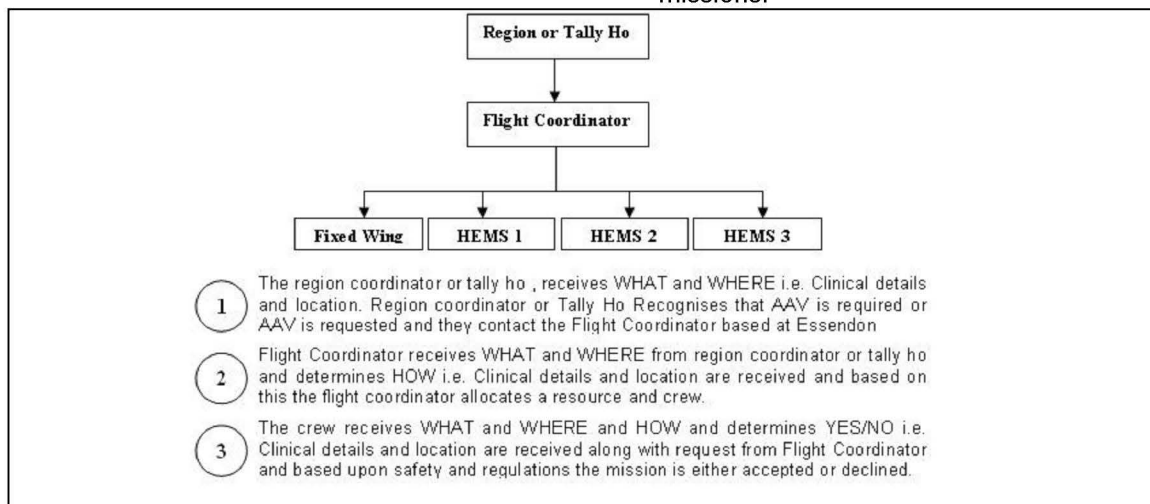
Previous research efforts at RMIT University have resulted in a conceptual framework [5][14] which supports the development of a DSS for pre-mission analysis of HEMS operations (Figure 2). Present research, in conjunction with Air Ambulance Victoria, is aimed at developing this framework in order to demonstrate an operational system. Consultation with pilots, crewmen, paramedics, flight coordinators and AAV management is being undertaken at present to establish tangible and achievable requirements that will allow the conceptual framework to develop into an operational system. Consultation thus far has identified the simplified dispatch and pre-mission analysis process as shown Figure 4. At each stage in the process a number of specific and different factors or

criteria are evaluated. These include but are not limited to:

- clinical urgency,
- clinical details,
- clinical requirements,
- location
- weather,
  - icing levels,
  - visibility,
  - temperature,
- landing areas,
- alternates,
- lower minimum safe altitude,
- crew mix (appropriate skills),
- range, and
- fuel availability.

Research is currently being directed at identifying each of these criteria and defining any inter relationships. For example the degree of clinical urgency or the priority of the mission is directly related to the location and clinical details of the patient. In addition to these criteria discussions between RMIT University and AAV have identified a number of other requirements for the system, these include but are not limited to the ability to:

- convert map references to GPS coordinates,
- calculate lower safe altitudes for routes as well as local 10 nautical mile lower safes,
- cross cross-check icing levels with minimum lower safes,
- determine case priority,
- automatically prepare flight plans, including relevant refuelling,
- determine required the required level of patient care, and
- re-task resources to higher priority missions.



**Figure 4. Simplified AAV Dispatch Process**

## 5. Future Work

Following the completion of this consultation, the requirements of the system will be defined and AAV's dispatch and pre-mission analysis processes documented. All factors and criteria considered in such processes will be included and interrelationships made clear. From these a design specification will be developed, and a technical investigation undertaken to establish decision support system technologies, applications and architectures suitable for building such a system. Upon selection of suitable technologies the system will be prototyped and developed. Testing and validation of the prototype in the HEMS environment will be undertaken in conjunction with AAV, and further development undertaken if shortcomings are identified.

## 6. Concluding Remarks

HEMS operate around-the-clock, in all-weather, and often with no fore-warning about the next mission. In a time critical operation, where precious minutes may cost lives, the crew must decide which cases dictate a HEMS response and if so, whether the conditions are safe to conduct the mission.

At the conclusion of this project, it is planned to have successfully demonstrated decision support software capable of supporting the dispatch and pre-mission analysis of HEMS operations. It is planned that this prototype will then be commercially developed and customised to meet the individual needs of HEMS operators.

Recent consultation with AAV has also lead to an increased project scope. AAV operate a mixed fleet of rotary and fixed wing resources, and as such the dispatch process and pre-mission analysis involves determining the most appropriate resource (fixed wing or rotary). Therefore, it is desirable that the decision support system possess the ability to support both rotary and fixed wing aero-medical operations.

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