Situation Awareness amongst Emergency Care Practitioners

by Harris Shah Abd Hamid

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Certificate of Originality

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified in the acknowledgements or in the footnotes, and that neither the thesis nor the original work contained therein has been submitted to this or any other institution for a higher degree.

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Abstract

The increase and changes in the demand for emergency care require pro-active responses from the designers and implementers of the emergency care system. The role of Emergency Care Practitioner (ECP) was introduced in England to improve the delivery of emergency care in the community. The role was evaluated using cost-benefit approach and compared with other existing emergency care roles. An analysis of the cognitive elements (situation awareness (SA) and naturalistic decision making (NDM)) of the ECP job was proposed considering the mental efforts involved. While the cost-benefit approach can justify further spending on developing the role, a cognitive approach can provide the evidence in ensuring the role is developed to fulfil its purpose.

A series of studies were carried out to describe SA and NDM amongst ECPs in an ambulance service in England. A study examined decision-making process using Critical Decision Method interviews which revealed the main processes in making decision and how information was used to develop SA. Based on the findings, the subsequent studies focus on the non-clinical factors that influence SA and decision making. Data from a scoping study were used to develop a socio-technical systems framework based on existing models and frameworks. The framework was then used to guide further exploration of SA and NDM. Emergency calls that were assigned to ECPs over a period of 8 months were analysed. The analysis revealed system-related influences on the deployment of ECPs. Interviews with the ECPs enabled the identification of influences on their decision-making with respect to patient care. Goal-directed task analysis was used to identify the decision points and information requirements of the ECPs.

The findings and the framework were then evaluated via a set of studies based on an ethnographic approach. Participant observations with 13 ECPs were carried out. Field notes provided further insight into the characteristics of jobs assigned to the ECPs. It was possible to map the actual information used by the ECP to their information needs. The sources of the information were classified according to system levels. A questionnaire based on factors influencing decision-making was tested with actual cases. It was found that the items in the questionnaire could reliably measure factors that influence decision-making.

Overall, the studies identify factors that have direct and indirect influences on the ECP job. A coherent model for the whole emergency care systems can be developed to build safety into the care delivery process. Further development of the ECP role need to consider the support for cognitive tasks in light of the findings reported in this thesis.

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List of Acronyms and Abbreviations

A&E	Accident and Emergency
AMPDS	Advanced Medical Priority Despatch Systems
CDM	Critical Decision Method
ECP	Emergency Care Practitioner
EMAS	East Midlands Ambulance Services
EPR	Electronic patient records
GP	General Practitioner
GTDA	Goal Directed Task Analysis
NDM	naturalistic decision making
NHS	National Health Services
SA	situation awareness

CHAPTER 1: INTRODUCTION

1.1 Chapter Overview

Modern healthcare is a big industry that involves both the public and private sectors. The issues surrounding healthcare span a range of economic, social, and political dimensions and are of great concern to the public, practitioners, policy makers, researchers, and the government. Designing a healthcare system that meets the demand and need of the population is a daunting task.

This thesis is concerned with a work role within an Ambulance Service in England that was designed to deliver emergency care in the community. The Emergency Care Practitioner (ECP) work role was developed to extend the ways by which emergency care can be delivered to patients. The different options can meet different needs of patients and at the same time hopefully improve the quality and safety of patient care.

Chapter 1 presents the rationale for studying the ECP role using a human factors approach. Recent changes affecting health services in the UK are presented to show the forces that are shaping the emergency care system. One of the outcomes of the changes was the introduction of the ECP role in England. The future development of the role would benefit from a systematic study. The design of the role, and the emergency care system in general, can benefit from the systems perspective used by human factors specialists. This approach is presented to show its suitability for the present topic. Based on this approach, the specific objectives

and goals of the thesis are outlined. Finally, an overview of the rest of the thesis is provided at the end of this chapter.

1.2 Emergency Care in the UK

At a basic level, the demand for healthcare can be classified as either scheduled or unscheduled. The unscheduled care falls under a medical specialisation of emergency medicine. According to the College of Emergency Medicine (CEM) in the UK, “emergency medicine is a field of practice based on the knowledge and skills required for the prevention, diagnosis, and management of the acute and urgent aspects of illness and injury affecting patients of all age groups with a full spectrum of undifferentiated physical and behavioural disorders” (College of Emergency Medicine, 2010). The American College of Emergency Medicine defines emergency medicine more briefly as “the medical specialty dedicated to the diagnosis and treatment of unforeseen illness or injury” (The American College of Emergency Medicine, 2008).

According to these definitions, practitioners of emergency medicine require the skill and knowledge to assess and manage a wide range of unscheduled medical needs. The context of their work can be viewed by using a framework such as an emergency medical system (EMS). Table 1 shows that the EMS practitioners are one component of a larger inter-dependent system. Other components must be in place to integrate pre-hospital care with hospital-based care. Key elements for the administration of pre-hospital care include a lead national agency, regional and local support, local administration, medical direction and political support (Sasser, Varghese, Kellermann, & Lormand, 2005). These elements correspond to the planning and

organisation component in Table 1 and point to the extensive range of macro level factors involved in the deployment of emergency practitioners.

Table 1. Components of an EMS System

Recognition of the emergency and first aid by bystanders
Initiation of the EMS response system
Treatment at the scene by members of the system
Transportation with advanced life support by members of the system
Treatment in the hospital
Communications
Education and training
Planning and organisation

(Source: Caroline, 1991)

In England, ambulance services cater for the need for unscheduled care. The services are organised and managed by National Health Services (NHS) Ambulance Trusts that operate at the local level. Before 1 January 2006, there were 31 Ambulance Trusts (The NHS Confederation, 2006). Following a national reconfiguration of ambulance services, East Midland Ambulance Service (EMAS) NHS Trust was established as one of the 12 Ambulance Trusts in England.

Figure 1 and 2 illustrate the scope of EMAS's responsibilities. Between 2004 and 2009, the number of emergency calls handled by EMAS was 473, 200 (2004/2005), 459, 700 (2006/2007) and 523, 300 (2008/2009) (The Information Centre, Workforce and Facilities, 2009) that translates into an annual increase of 11.8% on average.

Figure 1. Geographical coverage of EMAS

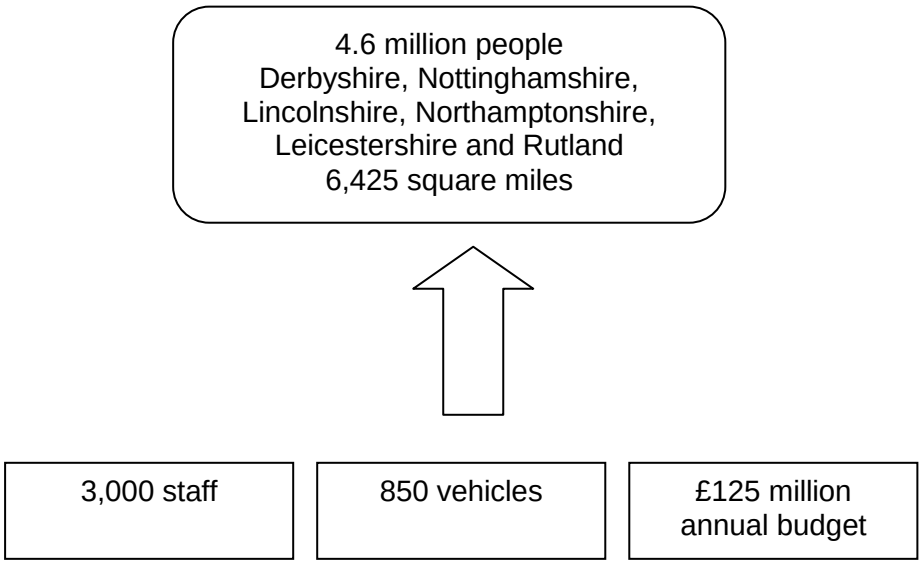

Figure 2. EMAS' scope: resources and responsibility.

Besides the ambulance services, emergency care needs can be met by other services provided by the NHS. In England, patients requiring emergency and urgent care can access services listed in Table 2. These services, while being distinct from each other, are interrelated to each other and to the ambulance services. The ambulance services are used to transport patients who are required to go to the accident and emergency department. Another example is calling the NHS 111

telephone number and being referred to walk-in centres or the ambulance services. The range of services means there are more options available to suit patients' needs in line with the NHS slogan "Your Health Your Choice". It also means the ambulance services are operating with other services to better deliver emergency and urgent care to patients.

Table 2. NHS urgent and emergency care

Services	Location	Cases Handled	Care Providers
Accident and Emergency Departments	Hospitals	serious injuries or illnesses, an appointment is not necessary	Nurses and doctors
Minor Injury Units	Hospitals	minor injuries or illnesses, an appointment is not necessary	Nurse
Walk-in Centres	Independent site	minor illnesses and injuries	Doctors, nurses
GP-led health centre	Independent site: GP	appointments and walk-in services	General practitioners, nurses
NHS 111 number	Virtual	urgent and not life threatening conditions, Single point of access for all non-emergency NHS healthcare services	Advisers, nurses

The core business of the ambulance services in England had gone through a significant transformation. The previous primary focus was on resuscitation, trauma and acute care. Now the ambulance services are moving towards becoming the mobile health resource for the whole NHS in line with the agenda of taking healthcare to the patient in the community (DOH, 2005). Subsequently, new performance targets were introduced when the Call Connect measurement came into effect on 1 April 2008 (DH Ambulance Policy, 2008). Under the new performance measurement system, response times are measured from the moment the call is connected to the ambulance control room rather than when the key information has been obtained from the 999 caller. Targets that are more specific were set nationally and locally under the Call Connect scheme.

The functional transformations happened around the same time that a structural transformation (reconfiguration of ambulance services into 12 Ambulance NHS Trusts) occurred as described earlier. These transformations are an acknowledgement that the demand for emergency medical services is changing. Consequently, the existing systems need to be redesigned to achieve a better fit for purpose.

The increase in the demand for emergency care can be attributed to an ageing population and an increase in the number of people living with chronic diseases (The Ambulance Service Network, 2008). The projected population growth shows that in the next 20 years, the number of people over 65 will increase by just under half, those over 85 in England will double, and the number over 100 will quadruple (DOH, 2009a). The number of people aged 85 and over reached 1.4 million in mid-2009, accounting for more than 2.2% of the total population compared to 1.1% in 1981 (ONS, 2010).

Other factors affecting demand for urgent and emergency care have been indentified. These include social and attitude change, seasonal factors, alcohol use, seasonal factors, and frequent callers (DOH, 2009b). An ageing population and changing lifestyle choices are related to long-term conditions like heart disease, diabetes, and asthma. Presently, there are already measures to reduce hospital admission among the elderly by providing adequate intermediate care and social care in the community (Care Quality Commission, 2010).

The demand for ambulance services is influenced by a set of complex and interrelated factors. These factors underlie the increase in the 999 calls and resources spent on handling these calls. The number of calls handled by the ambulance services increases by 6.5% on average in England and the increase costs an additional £60 million each year (DOH, 2009b). On a related issue, there was an 11.8% increase of emergency admission to hospital in England between 2004/05 and 2008/09 and this has been described as 'unsustainable' (Blunt, Bardsley, & Dixon, 2010).

This extra expenditure has to be met with increase in revenue. For the 60 year period starting from the formation of NHS in 1964, the budget for the NHS has an average rise of 4% (NHS, 2010). However, in recent years, there has been pressure for the NHS to find savings of their expenditure limit. For example, the 2009 budget reduced spending overall expenditure limit by £2.6 billion from £104.6 billion in the previous year (Gainsbury, 2009). Meanwhile, as a response to the 2010 budget proposed by a newly elected government, the NHS has to find efficiency savings of £15-20 billion by 2013/14 (DOH, 2010a). Clearly, financial funding is an important factor in shaping the future of emergency care in England.

The context of emergency care in the UK is highly dynamic. Recently, the newly elected UK government presented a white paper in July 2010 that outlined changes to the NHS. The proposals in the paper to make improvements to the NHS are focused on three plans (DOH, 2010a).

Patient-centred care will be realised by giving more choice and control to patients and facilitating their decision through easier access to information. A focus on clinical

outcomes will be favoured against bureaucratic process targets. Health professionals will be empowered by giving them more ownership of healthcare and decision-making responsibilities.

More specifically, for paramedics, the Department of Health put forward a proposal to extend the prescribing responsibilities of paramedics, including ECPs, in March 2010. The Department of Health (2010b) considered extending the range of medicine made available to paramedics. The medical conditions that paramedics can treat with drugs could also be expanded. Thirdly, paramedics may become independent prescribers – able to write prescriptions for patients. This proposal is part of another effort to make take healthcare into the community.

Frequent changes in demand for emergency and urgent care means the ambulance services has to change the way it delivers pre-hospital care (DOH, 2005). The ambulance services had been catering to emergency cases as well as cases that do not necessarily require admission to the A&E. The demand on the ambulance services resources can be managed better by offering different options to meet different needs of the patients. One option is providing the care in the community.

The extent to which this alternative can produce desirable clinical outcome while maintaining financial effectiveness is a point of debate. For example, Anderson et al. (1987) reported little evidence for the clinical benefits of advanced pre-hospital care for cardiopulmonary and trauma cases. However, published studies show that it is economically viable to shift the resources for emergency care away from the hospital and into the community (Roberts & Mays, 1998). More studies are required to

evaluate the efficacy of care in the community in relation to the prevailing social, economic and political context.

1.3 The role of emergency care practitioners (ECPs) and other emergency personnel

The role of Emergency Care Practitioner (ECP) was introduced in England in 2002 (Mason, 2006). The role is one of the initiatives by the government to provide alternative pre-hospital care. This thesis examines the ECPs as emergency medicine practitioners with a focus on the cognitive aspect of their job.

The ECP is defined as “a healthcare professional who works to a medical model, with the attitude, skills and knowledge base to deliver holistic care and treatment within the pre-hospital, primary and acute care settings with a broadly defined level of autonomy” (ECP Team Skill for Health, 2007, p 9). In terms of what they do, an ECP is an “advanced practitioner capable of assessing, treating and discharging/referring patients at the scene” (DOH, 2005, p 51). The ECP has also come about as a result of recent increases in emergency calls (in the UK 999 calls) for urgent care (i.e., non-life threatening) while the demand for emergency care remains constant (The Ambulance Service Network, 2008). In other words, the demand for urgent care rises faster than for emergency care. Therefore, it makes good sense to provide pre-hospital care to save patient journeys.

Compared to ambulance technicians and paramedics, the ECP has more autonomy. This autonomy means the ECP has relatively more say about treatment for patients. In other words, the ECPs are entrusted to make decisions on the course of treatment. The autonomy aspect is also apparent in the assignment of ECPs as solo

responders. Unlike paramedics and technicians, ECPs can attend to a patient on their own. The higher degree of autonomy is gained through the advanced training that the ECPs undertake. Nevertheless, it is the triage nurses in the control room who mainly assign calls to the ECPs. These triage nurses would consult a patient who were initially categorised into Category C (Cat C) calls by the call takers. If the case is deemed to be correctly categorised as Cat C, the triage nurses may pass on the cases to ECPs. In the current system, the ECPs have autonomy to treat patients to whom they were assigned.

ECPs can make decisions on the pathways of treatment for the patients. By making available alternative pathways of treatment, the demand on hospital resources is reduced. The ECPs make it possible that the decisions about the treatment be made in pre-hospital setting. In other words, the decision to treat, and the pathway of choice are partially shifted away from the hospital system.

The performance target in terms of time is very clear, however, clarity regarding the quality of care is less so. A national evaluation of ECP schemes concluded that the "ECP schemes are moving forward in line with original objectives and could be having a significant impact on the emergency services workload" (Mason, et al., 2006, p 435). The dimensions covered in that study were patient outcomes, patient satisfaction, and cost. The estimated cost per ECP patient contact is £26, compared to £55 per Emergency Department (ED) contact. Another study also shows the cost saving in deploying ECP both in the urban and rural areas (Modernisation Agency DOH, 2004).

To examine the clinical effectiveness of ECPs, Gray and Walker (2008) examined the reduction of admission to the ED. They compared cases where patients attended to by ECP to patients were admitted to the ED. Patient data for two types of patients were studied: patients with breathing difficulties and elderly patients who had experienced a fall. The results show that the rates of admission to hospital are lower for patients attended to by an ECP both at initial contact and at 28 days. This study also showed that ECPs are effective at lowering the rates of admission to hospital. In addition, Mason, O'Keeffe, Coleman, Edlin, and Nicholl (2007, p. 239) found that "care provided by ECPs appears to reduce the need for subsequent referral to other emergency and unscheduled care services".

Previous researches on the ECP role have been based on post-task aggregated data and focus on resource-oriented issues (e.g. costs, numbers of hospital admittance). There is a need to examine individual ECPs in action and understand the finer-scale details of their work. Moreover, the consideration of ECPs as individuals working within a complex system might inform the design and management of patient safety for this part of the overall healthcare system. Given that the responsibility of decision-making are partially shifted within the system (from clinical staff to the ECP), it is important to study how ECPs cope and manage increased skills and autonomy. In order to address these issues a socio-technical framework is put forward with the aim to integrate cognitive variables (SA and decision-making) within the context of job design and other system variables.

1.4 Problem statement

The ECP role has much to offer in delivering pre-hospital care in the community. This role needs further empirical evidence for its development. The existing published

evaluation of the role is presented in Chapter 3. This thesis presents a work design analysis where the main aim is to describe the cognitive aspect of ECP job. An immediate outcome of the study will be the identification of the ways by which the decision making process are supported. This is important to complement the other existing evidence for a more holistic development of the role.

Attention to cognitive aspects of work to ensure safety is important considering the workload that are inherent in the job as well as workload induced by the work systems (Sträter, 2005). ECPs work with wide range of patients presenting with various medical conditions, requiring extensive knowledge and skills. They can work as solo responders, or as part of transient teams comprising other ambulance service personnel like paramedics and ambulance technicians. The ECPs are expected to be exposed to unpredictable work pattern, episodes of high concentration, and complex situations requiring good use of analytical and judgement skills (NHS Pay, 2003). The ability of the ECPs to manage patients on scene, or make referrals requires considerable mental effort. Decisions has to be made quickly considering the limited number of tools and devices available for them on scene, compared to A&E departments.

1.5 Human Factors and Emergency Care

In this thesis, the term human factors is used interchangeably with ergonomics to refer to “the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance” (IEA, 2010). The last few years have seen a huge growth in research focusing on human factors (or ergonomics) and patient

safety. There seems to be common agreement that ergonomics or human factors can contribute to improve patient safety (see Weinger & Slagle, 2002; Carayon & Friesdorf, 2006; Karsh, Holden, Alper, & Or, 2006; (Henriksen, 2007).

Within this growing body of literature, human factors' methods and techniques, and the systems approach in particular, have been used in order to gain a better understanding of human error and decision-making and how these relate to patient safety. The healthcare domain is seen as a developing area where much research and application efforts can be expanded to produce positive effects in the domain. The interest in patient safety can be partly attributed to the fact that hospitals are high-risk environment and human factors can contribute towards understanding and solving the problems that result in harms to the patients.

Organisational ergonomics, also known as macroergonomics, is a discipline of ergonomics that is concerned with socio-technical systems (Carayon, 2007). The founding of socio-technical system (STS) theory is attributed to Trist and Bamforth and their colleagues at the Tavistock Institute of Human Relations (Hendrick, 2007; Waterson, 2005) . Their work on coal miners led to the need to make distinction between the different subsystems in work organisations. There are five major elements or characteristics of a socio-technical system (Kleiner, 2007). Pre-hospital care systems can be viewed as a socio-technical system where the practitioners (social subsystem) interact with the tools, devices, and other materials (technical subsystem) necessary for work. These elements and examples of relevant questions for emergency practitioners' work system design are presented in Table 3. Some of these questions are relevant to the studies reported here.

Table 3. Elements of an STS

Elements	Questions for work system design
technological subsystem	What is the procedure for assigning jobs to an ECP? What vehicles and medical equipments are used?
personnel subsystem	What are the practitioners' socioeconomic backgrounds? What training did the practitioners have?
external environment	How are the political forces influencing the work policy? What are the economic challenges for the ambulance services?
internal environment	Do the available communication devices support transfer of patient information? What are the potential harms when working in the community?
organisational design	Who provide medical direction for the practitioners? standardised? Who assess the practitioners' work?

1.6 Aim and Objectives

On the practical side, the purpose of this project is to assist EMAS in understanding, and improving pre-hospital care delivery provided by ECPs. On the theoretical side, this project's purpose is to extend the application of SA in a novel domain. In order to fulfil these purposes, the project is aimed at describing SA and NDM amongst ECPs.

Two main objectives have been set to meet this aim. The first objective is to construct a socio-technical systems framework for investigating the SA and NDM among ECPs. This will be done by integrating relevant existing frameworks with new data. The reason for doing this is the gap in the literature in the healthcare domain. Further explanation of this gap is presented in Chapter 3.

The second objective is to validate the framework by conducting in-the-field observation of ECPs. By doing so, the adequacy of the framework in describing SA and NDM among ECP can be assessed. At the same time, the suitability of existing framework for application in a new domain can be tested.

1.7 Thesis outline

The structure of this thesis is based on the two objectives described in Section 1.5. The sequence of the investigation is presented in Figure 3. It shows the building blocks of the thesis in terms of the chapters and how content of the chapter contributes to other chapters.

Chapter 2 presents background information of the main topics in this study namely situation awareness and naturalistic decision making. For the purpose of this thesis, the topics are presented as distinct but interrelated cognitive processes. This is followed by a literature review of SA in pre-hospital care setting in Chapter 3. The purpose of the review is to define the scope of the study, both in terms of domain of application and theoretical coverage.

Chapter 4 presents a study based on the critical decision method interview. It provides the clinical aspect of the ECP role. Chapter 5 describes the wider context of the ECP role, with the clinical factor viewed as a given factor in the ECP decision making. This description provides the overview of the ECP role by considering macro-level systems elements. Micro level elements are discovered through a scoping study to provide a more complete picture of the system. This led to the formation of a socio-technical system framework.

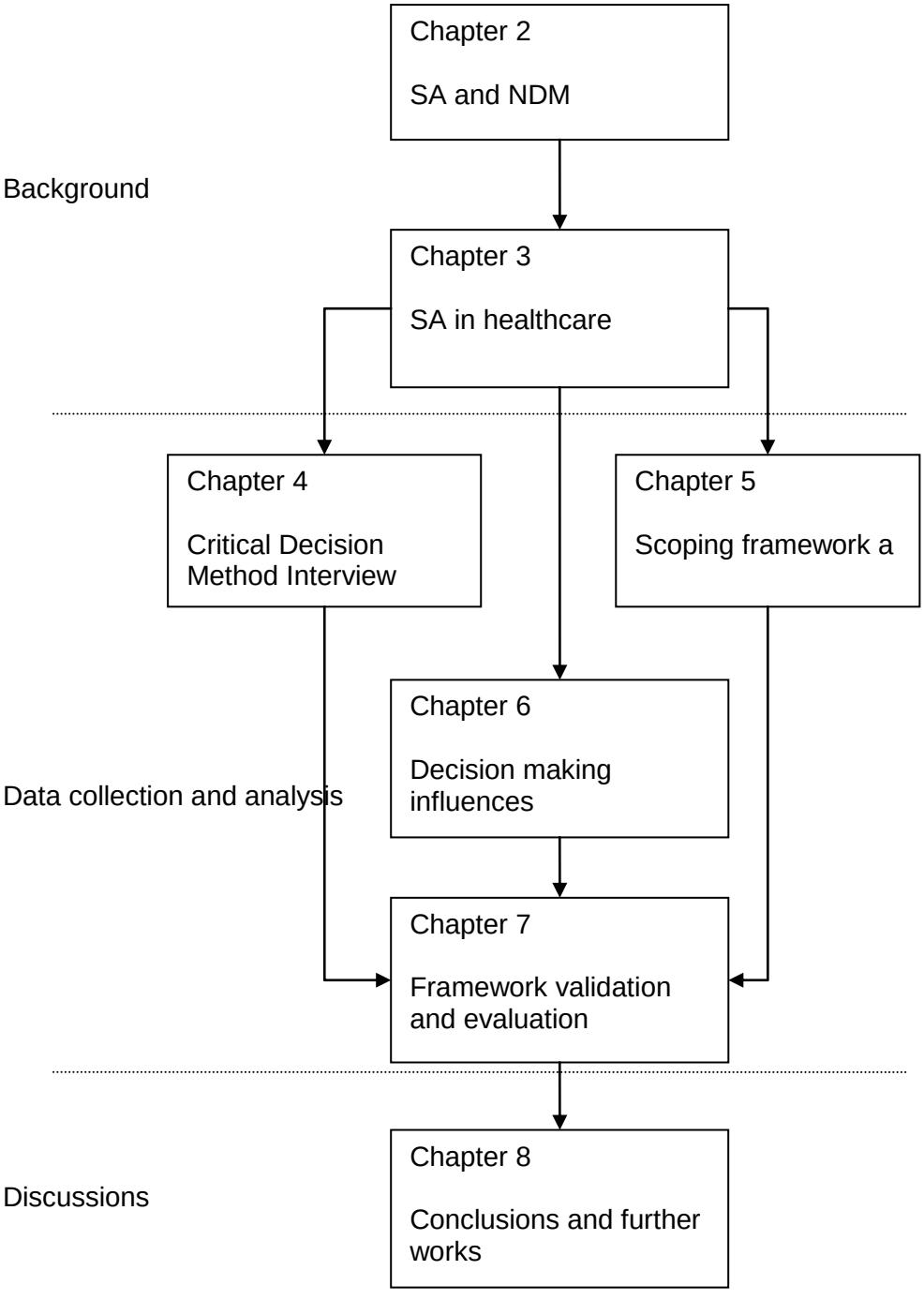

Figure 3. Chapters of the thesis

The next two chapters examine decision-making and SA using different approaches. Chapter 6 present the analysis of primary and secondary data sourced from the Ambulance Services to show system-related influences on ECP decision-making. It presents the analysis of calls assigned to the ECPs as recorded in the Advanced Medical Priority Dispatched System. Statistical analysis is provided to show the patterns of job assignment for the ECPs from a quantitative perspective. Data from interviews are presented to show the factors influencing ECPs' decision making.

Chapter 7 is related to the second objective of the thesis. Two set of qualitative data (observation) and one set of quantitative data (questionnaire) are presented. After describing the procedure and presenting the findings of each data collection procedure, a summary is provided. The findings from the validation study are used to evaluate the framework presented in Chapter 5.

This concluding chapter evaluates the work done in this study. It will examine how much the study has answered the research questions. It will also identify further questions that can be followed up. Limitations of the study are presented to provide a scope of the findings.

CHAPTER 2: SITUATION AWARENESS AND NATURALISTIC DECISION MAKING

2.1 Introduction

Complex work systems necessitate the investigation of inter-dependencies between the humans and other system elements. Healthcare is a complex system addressing many types of problems within a geographically wide setting using many coupled subsystems with different degree of coupling (Carayon & Friesdorf, 2006). Decision-making about patients relies on information that is presented accurately and timely (Nemeth, Cook, & Wears, 2007).

With the increase of automation, computer-mediated interaction, and other factors contributing to the complexity, the human operators may find themselves out of the loop; their role being underplayed and put in the background. The systems should be designed so as to make the humans aware and understand what is going on with regard to the task they are performing. Situation awareness has been proposed as a construct to capture this aspect of human performance. Situation awareness can help to achieve the desired performance and reduce undesirable outcomes such as medical errors. This chapter provides background information on situation awareness with a specific focus on naturalistic decision-making.

2.2 Definitions

2.2.1 Situation awareness

The term situation or situational awareness has been used interchangeably. However, they may not necessarily refer to the same thing. To add to the confusion, the acronym SA has been used to refer to both *situation* and *situational* awareness. The main difference between them is in the immediacy or the time frame of the phenomena. Situational awareness, with roots in sports, implies a more immediate concern than situation awareness, with roots in the military (Hone, Martin, & Ayres, 2006). It is argued that the acronym 'SA' has lost its merit for describing awareness due to its deviation from describing *situational* awareness. However, the acronym SA has increasingly been associated with situation awareness (Hone et al., 2006). In the remainder of this chapter, SA refers to situation awareness.

A definition of situation awareness as given by Endsley (1988) is "…the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future". A list of other definitions of SA is available in Dominguez (1994) which is reproduced with additional definitions by Jeannot (2000). The numerous definitions reflect the elusive nature of SA.

For this thesis, Endsley's definition of SA is adopted in lieu of other definitions. The other definitions are presented in this chapter as part of the background information. The following sections are a general, rather than in-depth, introduction to SA.

2.2.2 Naturalistic decision making

The second topic of interest in this thesis is naturalistic decision making (NDM). The move towards understanding decision making process in the applied setting stems from the lack of success of formal (statistical and mathematical) models to describe how people make decisions and to help people improve their decision quality (Klein, 2008). NDM shifts the emphasis from formal and rational models to an experiential model to describe and understand cognition in the field.

One model of NDM is the recognition-primed (RPD) model that describes how people choose a course of action from a repertoire of patterns (Klein, Alderwood, & Clinton-Cirocco, 1986). The RPD is well suited to study decision-making by experts in dynamic and complex environments. The link between NDM and SA is a close one. NDM describes how decisions are made based on the generation and maintenance of SA (Endsley, Hoffman, Kaber, & Roth, 2007). The subjective confidence of the quality of one's SA may affect the decisions made and work outcomes (Endsley, Bolté, & Jones, 2003). Such a close relationship between SA and decision making processes are evident in the models such as the Integrated Decision Model (Wong, 2000) where situation assessment, and the resulting comprehension of the situation, aids selection of action. Thus, while this thesis focuses on SA, the associated decision making processes are implied.

2.3 Origin and Context

The aim of this section is to demonstrate the development of SA in terms of its breadth and depth. SA is being applied in different domains, and may find other domains of application in the future. As it gains breadth, SA also gains depth. The

domain-specific idiosyncrasies of SA contribute to rethinking and also further refinements to SA.

2.3.1 History and Domains of SA research

There seems to be a general consensus that situation awareness is rooted in the military aviation domain (see Endsley, 2006 and Stanton, Chambers, & Piggott, 2001) . The importance of SA among jet fighter pilot is such that those who have better SA tend to be more successful in aerial combat. It was very important for the pilots to have a better SA than the enemy.

From its root in military aviation, the research on situation awareness branches out in many other domains. However, the needs for the study of SA are slightly different. If the study of SA in the military is within the context of war (national security), the study of SA in other domains is within the context of operational safety. In most industries, the human operators may be faced with too much data and a complex system. The failure to cope in this environment can lead to accidents. For complex systems, accidents may spell disasters. To operate safely, the system – which is complex and overflowing with data – must be understandable to the human operators. It is achieving this understanding that pose a challenge. As Endsley (2006) pointed out, "(d)eveloping and maintaining a high level of *situation awareness* is the most difficult part of many jobs and is one of the most critical and challenging tasks in many domains today" (p 528).

The investigation of situation awareness in the military is not restricted to jet fighters. It is also investigated at a bigger scale, for example military command and control operation (Riley, Endsley, Bolstad, & Cuevas, 2006). Attentions were also given to

the impact of different technologies in commercial aviation, for pilots (Foyle, Andre, & Hooey, 2005) and air traffic controllers (Hauss & Eyferth, 2003). SA is also studied in another public transportation, railroad operation (Roth, Multer, & Raslear, 2006). Far more directly relevant to the masses, situation awareness studies have been conducted for driving cars (Beusmans, Aginsky, Harris, & Rensink, 1995; Kass, Cole, & Stanny, 2007). Other domains where SA is studied are healthcare (Blandford & Wong, 2004; Riley, Kaber, & Draper, 2004), nuclear energy (Patrick, James, Ahmed, & Halliday, 2006), hydro energy (Li, Sanderson, Memisevic, & Wong, 2007) and offshore oil drilling (Sneddon, Mearns, & Flin, 2006). It is evident that the SA researches gravitate around transportation, energy production industry, and healthcare. As these industries employ more automation, and become more complex, we can expect SA to make inroads into those industries, especially those that are safety critical.

While many of the studies mentioned earlier were done on human subjects, a different trajectory for SA studies had been observed. There are attempts to simulate human situation awareness by means of artificial intelligence. Studies in this area try to develop computerised system that would have awareness. For example, basic psychological processes like pattern-matching and template matching are used to simulate situation awareness in virtual humans (Zhang & Hill, 2000). Adams (2007), on the other hand, tried to formalize situation awareness for unmanned vehicles based on Endsley's definition of SA. Meanwhile, Kokar, Matheus, and Baclawski (2009) proposed a formalization of SA using computer language. In other words, situation awareness studies are not restricted to human subjects. Advances in the study of artificial SA can perhaps inform the study of human SA. These two strands of research can recursively inform each other.

2.3.2 Extended situation awareness

There have been efforts to expand the concept of situation awareness. These efforts reflect the need to adapt to new challenges and organisational changes. They are also partly due to the limitations of SA measures observed in applied settings. Another reason for pushing the boundary of SA is a theoretical one. While an individual-based conception of SA may be appropriate in engineering psychology, it is limited within the context of systems ergonomic. Human cognition must be understood within the overall work systems even though the person-centred approach is more convenient for the purpose of investigation, remedial action, and public relation (Dekker, 2006). Models of human cognition that ignore the context of work are not adequate to understand and prevent errors and adverse events in the workplace. Having most effective and highly trained workers is not a guarantee against accidents (Sträter, 2005). Moreover, work circumstances are more likely than workers to explain the non-random pattern of adverse events (Reason, 2000). Indeed, models for errors include other interrelated factors such as the management, organisational process, environment, work team, and institutional context (Vincent, Taylor-Adams, & Stanhope, 1998).

Researchers have also attempted to assess team awareness (for example, see Gorman, Cooke, & Winner, 2006; Patrick, James, Ahmed, & Halliday, 2006; Prince, Ellis, Brannick, & Salas, 2007; Shu & Furuta, 2005). These researches represent a shift from an individual-based conception of SA to a team-based or distributed SA. An example of an attempt to understand team SA is a study conducted by Sneddon, Mearns, and Flin (2006). They interviewed on-shore and off-shore drill personnel from oil and gas operators and contractors. Their study revealed several indicative factors that influence the creation, maintenance and degradation of SA. In addition, the study also offered insights into factors that contribute towards team SA, such as

having a good supervisor and consistency of staffing. However, the authors cautioned that fundamental attribution error may bias the response gotten from the participants. Therefore, more studies are needed to uncover the external (circumstantial) factors that contribute towards the creation and maintenance of team SA.

Not only SA should be studied across individuals, there are other dimensions, such as time, space, work teams, which can be used to expand SA. These proposed ideas are presented in the section on limitations of SA measures. To extend the concept of SA, the re-examination of the theoretical underpinnings of SA is necessary. Stanton et al., (2006) describe an example of the development of such a theory. The next section discusses this and other theories.

2.4 Theory and Frameworks

To develop SA further as a construct, a theoretical basis is needed. In this section, selected theories of SA are outlined. Special emphasis is given on showing the implications of the theories to the measurement of SA.

2.4.1 Human Information Processing Theory

Given that SA is concerned with awareness, it is not surprising that people try to describe and explain it by relating it to many cognitive processes. One of the most influential theories of SA was put forward by Endsley. The theory is based on an information-processing theory that was proposed by Christopher Wickens (Endsley, 2000).

In Figure 4, the three main components of SA definition are labelled as Level 1, Level 2 and Level 3. This distinction has practical implications. Errors related to SA can be stated explicitly in terms of these levels. Therefore, the task of 'designing for SA' can be redefined into 'designing Level 1 SA'. For this level, the design is concern with supporting the sensation and perceptual processes. For example, a control display should be designed to ensure the operator will be able to notice different signals (i.e. to be able to perceive the elements in current situation).

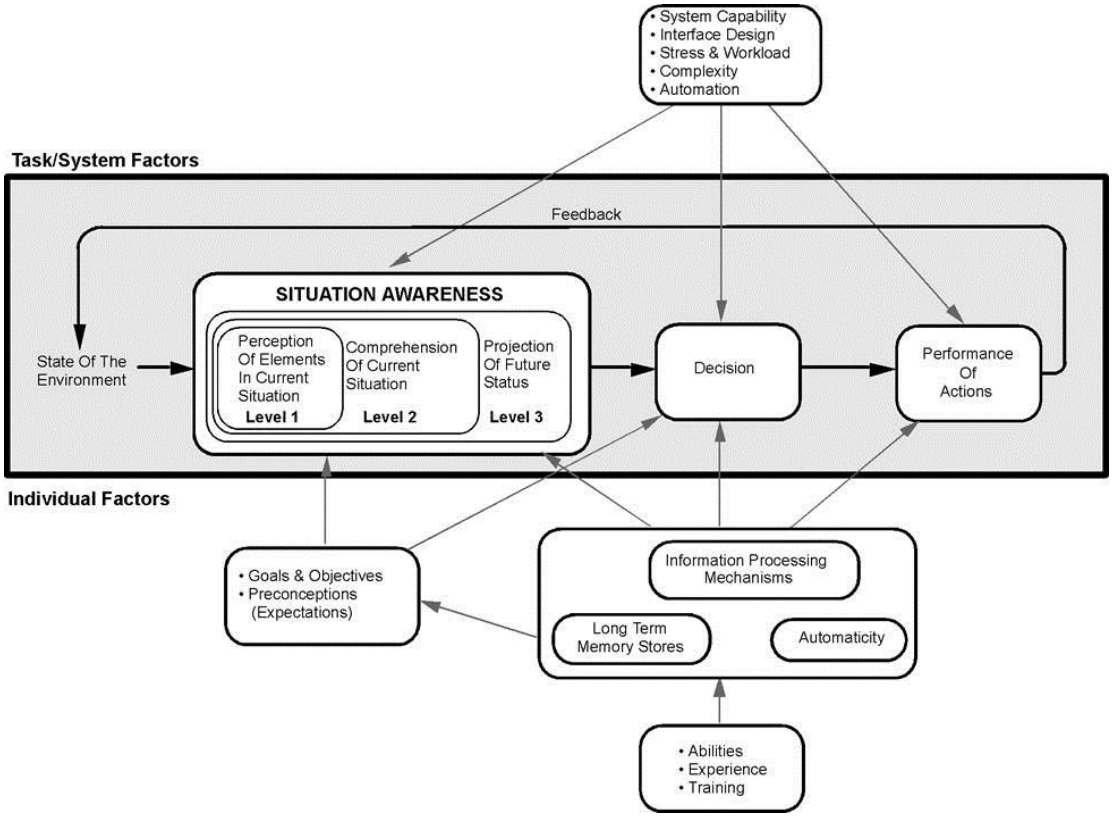

Figure 4. A model of situation awareness in dynamic decision making. (source: Endsley, 1995).

The model in Figure 4 shows the many cognitive processes that supports and are related to SA, most of which are present in Wicken's model of information-processing. The challenges to build and maintain SA can be explained by invoking

these cognitive processes. For example, training increases one's ability to achieve SA due to its effect on the long term memory. Furthermore, the LTM can be analysed further into semantic memory (does the operator possess accurate knowledge about the elements in the situation?) and procedural memory (has the operator automated the motor sequences of a task in the situation?). The factors that undermine SA are summarised as attentional tunnelling, requisite memory trap, WAFOS (workload, anxiety, fatigue, and other stressors), data overload, misplaced salience, complexity creep, errant mental models, and out-of-the-loop syndrome (Endsley, Bolté, & Jones, 2003).

While the model is suited for the study of individual SA, Endsley did not exclude teams as a possible unit of analysis. However, the definition of team SA is couched in terms of individual's SA. Based on this definition, one important variable to consider is the degree to which team members have shared or overlapping SA.

2.4.2 Distributed Cognition Framework

Endsley's model is suited to explain individual's situation awareness. To account for team performance, other models have been suggested. One such model is the distributed cognition framework (Hollan, Hutchins, & Kirsh, 2000; Hutchins, 1996). Within this framework, the focus, and the level of analysis, is the interactions between operators, resources and materials in the environment (Hollan, Hutchins, & Kirsh, 2000; Rogers, 2006). The focus is not on the individuals who process information, but on "how information is represented and how the representations are transformed and propagated through the system" (Hutchins, 1995, p 287 cited in Artman & Garbis 1998). This is based on the principle that cognition is more about

functional relationships than about structural entities (Hollan, Hutchins, & Kirsh, 2000).

Artman and Garbis (1998) argued that a distributed cognition framework is better suited to study systems operated by teams. Based on two field studies, they concluded that the “future development of the concept of SA must take into account the distributed nature of cognition" (p 156). One such development is the explanation for a shift from non-shared (individual) to shared (team) situation assessment and co-ordination in collaborative work (Wærn, Garbis, & Artman, 1999). Stanton *et al*. (2006) provide an account of the development and application of an ergonomics methodology to study distributed situation awareness in dynamics system. They argue that individuals working in a dynamic system have unique SA suited for their goals and that sharing of the SA may not be necessary. Another study shows the utility of distributed cognition framework in analysing successful management of a heart surgery team, with implied situation awareness (Hazlehurst, McMullen, & Gorman, 2007). Both of these studies demonstrate the development and direction of research for situation awareness.

With the emphasis on the interaction between agents in collaborative system, the description of SA takes on a different route. SA is not measured as the knowledge held by individuals, but by the network comprising interacting humans and technologies (Stanton, Salmon, Walker, Baber, & Jenkins, 2005). Approaches like these attempt to overcome the limitations of individual-based approaches for describing and measuring SA. For collaborative systems, ‘transactive’ and ‘compatible’ SA are better in ensuring the SA of the entire system, instead of its individual component, is accounted for (Salmon et al., 2008). Transactive SA emphasises the exchange of information to support SA: each individual agent

(humans and artefacts) in the system does not need to have the same SA, they just need to be aware of who has what knowledge. Similarly, compatible SA is more parsimonious and relevant than the concept of sharedness for team SA.

2.4.3 Activity Theory

Much like the theory of distributed cognition is used to study situation awareness, activity theory has also been proposed to better understand SA. Based on the works done by Russian psychologists, activity theory in general can offer a theoretical framework for ergonomics practice (Zarakovsky, 2004). Activity comprises "a coherent system of internal mental and motivational processes and external behavior that are systemically combined and directed to achieve the current conscious goal" (Bedny, Karwowski, & Bedny, 2001, p 402). Activity theory is concerned with understanding human activity not in isolation, but within its social contexts: the meaning of an activity is not separable from its context (Decortis, Noirfalise, & Saudelli, 2000). This theory echoes the concerns of distributed cognition framework. Sandom and Macredie (2003) argue for the using AT "to support analyses of interactive system use, to inform system design, and mitigate against the situated interaction hazards inherent in safety-related systems" (p 218).

SA is involved in assessing the changes that occur due to actions towards a conscious goal. Perceived gap between observed state and the desired state (goal) motivate people to perform actions to reduce this gap. As illustrated in figure 5, information sampled from a situation modify one's awareness and direct one's action in a cyclical manner. More specifically, SA is a functional mechanism in the reflective-orientational activity (Bedny & Meister, 1999). Orienting activity, unlike SA, includes motivational aspect and motor actions in aiding comprehension to achieve goals (Bedny, Karwowski, & Jeng, 2004).

The theory also makes provision for a hierarchy of activity along a temporal dimension. A long term *activity* is motivated by an objective. A shorter term *action* is motivated by goals relevant to the objective. *Operation*, meanwhile, is motivated by environmental conditions. The behaviour at each of these three levels differs in the type of information processing required i.e. planned (proactive), or automatic (reactive) (Bedny & Meister, 1999). This differentiation can refine methods to identify SA requirements such as goal-directed task analysis (Endsley, Bolté, & Jones, 2003) to take into account the temporal dimension.

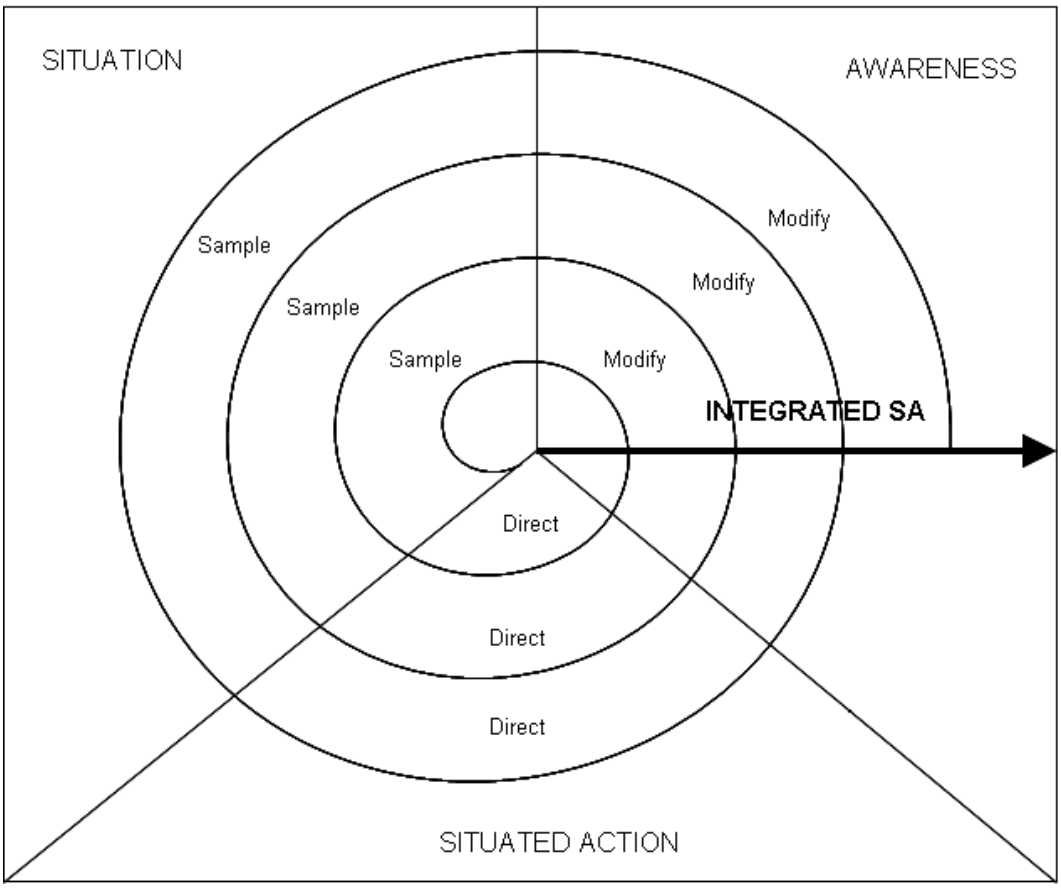

Figure 5. An activity-based awareness model (source: Sandom & Macredie, 2003).

There are several implications of this theory as outlined by Sandom and Macredie, (2003). For the purpose of research, the appropriate level of analysis is activity. Hence, the focus is not the cognitive processes occurring within a single individual. Secondly, because SA is described in terms of activity, *activity-based awareness* is a more proper term to use. This term emphasises the inseparability of awareness and its context. Another implication is that SA is both a process and a product in a continuous cycle of feedback. This theory removes the need to separate SA into a process and a product.

2.4.4 3-Q SA Model

The arrangement of the activity along the time dimension is similar to the proposal put forward by Hone, Martin, and Ayres (2006) for a model of SA (figure 6). By reducing Endsley's three levels of SA into 3 basic questions (Who is where/ What are they doing? What will they do?), the measurement of situation awareness is more straightforward. When a time line is included, we have Transitory Awareness (TA), Local Awareness (LA), and Global Awareness (GA). It can be argued that an *activity* is supported by GA, *action* supported by LA, and an *operation* supported by TA (the equivalent of Endsley's SA). In effect, this model is a variant of Endsley's model. However, considered together with an activity-based awareness model, the concept of SA diverges further away from that proposed by Endsley.

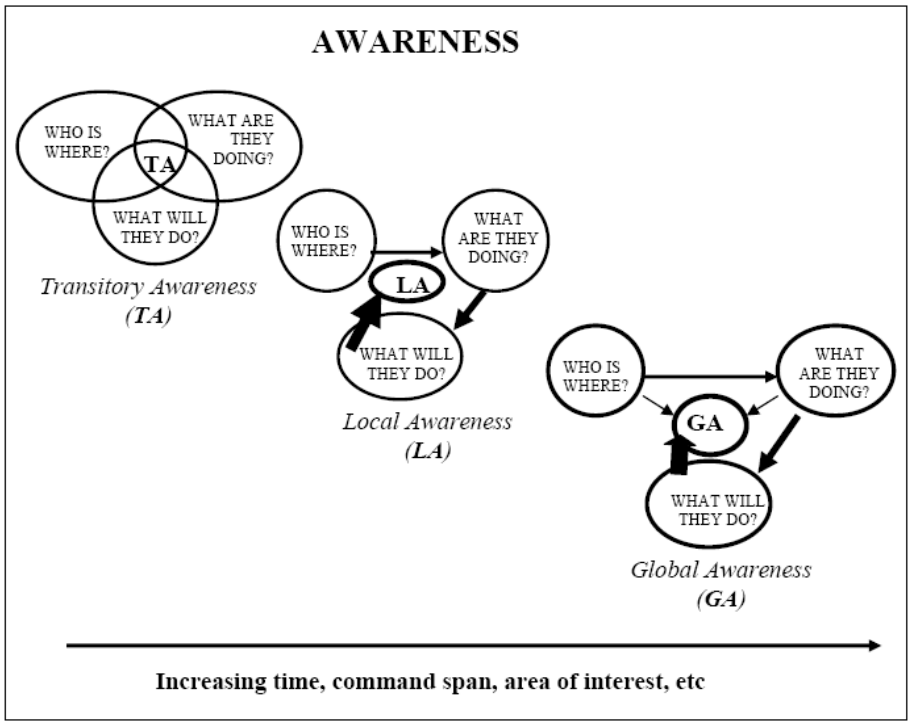

Figure 6. 3-Q SA model showing three types of awareness

2.4.5 Quantitative Models

There are attempts to establish quantitative models of awareness. Mathematical modelling offers a different perspective and practical benefit. For example, Kirlik and Strauss (2006) construe SA as a judgement under uncertainty. This conceptualisation is based on the tenet that an operator's SA is essentially the correlation between actual and judged system states. Using a quantitative model, the correlation can be decomposed into independent factors. These factors, in turn, can be guidelines for designing and supporting SA. Mathematical models are also useful to predict SA-related error (McCarley, Wickens, Goh, & Horrey, 2002).

2.5 Related Concepts and Constructs

In commenting on the cognitive approach to SA, Flach (1995) cautioned against adding another box in the information-processing theory. The extent to which the

cognitive processes and mechanisms are distinguishable and separable from SA is still debatable. It is difficult to pinpoint conceptually exactly what is SA. In fact, there are myriads of other concepts and construct that can add to the confusion.

2.5.1 Mental Workload

SA has been said to replace *mental workload* as a buzz word among human factors researchers. It has been argued that SA and mental workload are really different constructs (Endsley, 1993; Tsang & Vidulich, 2006). SA, unlike mental workload, does not refer to the capacity of information-processing but to the process and the resulting outcome of a goal-oriented information processing.

2.5.2 Mental Models

One of the information-processing mechanisms involved in building SA are *mental models*. It is postulated that "the mind constructs models of the world that it uses to reason" (Johnson-Laird, 2006, p28). This postulate is in accord with the relationship between SA and mental model depicted by Endsley, Bolté, and Jones, (2003). Mental model refers to the systematic ways of understanding how something works (Endsley, Bolté, & Jones, 2003), whereas SA refers to the process of gaining understanding of what is going on in a particular situation and time.

2.5.3 Cognitive Readiness

SA is listed as one of the individual characteristics influencing cognitive readiness (C A Bolstad, Babbitt, Semple, Vestewig, & Russo, 2006). It is defined as "possessing the psychological and sociological skills, knowledge and attitudes that individuals and team members need to sustain competent professional performance and mental wellbeing in the complex and unpredictable environments of military operations"

(Bolstad, et al., 2006, p 77). The definition makes is sounds more like a trait than a state. In contrast, SA is more commonly conceptualised as a state than a trait.

2.5.4 Sensemaking

To repeat, the three elements of Endsley's definition of SA are perception, comprehension, and projection. Those three elements are also found in the definition of *sensemaking*. "Sensemaking is a motivated, continuous effort to understand connections (which can be among people, places, and events) in order to anticipate their trajectories and act effectively" (Klein, Moon, & Hoffman, 2006, p 71). The element of perception is implied, while comprehension and projection are explicitly stated as *understanding* and *anticipate*. However, the scope of sensemaking is larger. Similarly, team sensemaking is defined as the process by which a team manages and coordinates its efforts to explain the current situation and to anticipate future situations (Klein, Wiggins, & Dominguez, 2010). Indeed, a sensemaking conceptual framework explicitly includes SA as one of the input variable for sensemaking (Leedom, 2001).

Sensemaking is applicable at the individual and organisational level. It is akin to creating a global awareness - that Hone *et al.* (2006) proposed – in the sense that it is a relatively longer process. Viewed at the organisational level, sensemaking is "turning circumstances into a situation that is comprehended explicitly in words and that serves as a springboard into action" (Weick, Sutcliffe, & Obstfeld, 2005, p 709). To compare with the 3Q-SA model again, sensemaking seems to be concerned with making the transitory and local awareness explicit.

Compared to other similar psychological concepts like creativity, curiosity, mental model and comprehension, sensemaking is most similar to situation awareness with the main difference being the emphasis on the process - instead of state - of achieving knowledge and understanding (Klein, Moon, & Hoffman, 2006). The relatedness of the two concepts is demonstrated in the listing of sensemaking as a macrocognitive function alongside naturalistic decision making, and situation assessment (Klein et al., 2003).

In healthcare, sensemaking is relevant for patient safety. As a framework, sensemaking encourages the involvement from across all levels of organisation to understand what leads to failure and errors that negatively impact patient safety (Battle, Dixon, Borotkanics, Rabin-Fastman, & Kaplan, 2006). Specific examples of the application of the framework in healthcare are available, though not abundantly. Conversations among healthcare workers can improve sensemaking when participants are diverse and demonstrate good listening skills while lack of time and space for conversation can inhibit sensemaking (Jordan et al., 2009). It was consequently possible to identify strategies to create conducive environment and work structures to aid sensemaking. Another study focuses on sensemaking processes of scanning, interpretation, and action. The findings show that it is possible to model the linkages between these sensemaking processes to organisational performance (Thomas, Clark, & Gioia, 1993). Further work need to be done to investigate the extent of benefits of supporting sensemaking to organisational performance.

Studies on sensemaking can provide insights into relationships between different levels of systems. As mentioned earlier, sensemaking can be investigated at the individual, team, and organisational level. On one hand, sensemaking approach

fosters integration of different levels of analysis. For assessing risks and hazard, sensemaking combines approaches that investigate issues at single event level, process level, and system level (Battle, Dixon, Borotkanics, Rabin-Fastman, & Kaplan, 2006). On the other hand, sensemaking perspective can identify influences on workplace issues such as safety and creativity that lie in the interactions between levels of organisation (Drazin, Glynn, & Kazanjian, 2010). Like situation awareness, sensemaking goes beyond finding simple and convenient answers to problems in complex systems.

2.5.5 Crew Resource Management

From a slightly different angle, the concept of SA is embedded in crew resource management (CRM). SA exists as part of the syllabus (Civil Aviation Authority, 2006) across different generations of CRM training (Helmreich, Merritt, & Wilhelm, 1999). From the perspective of management, CRM attempts to develop cognitively ready team members who then are expected to be able to build satisfactory situation awareness. SA is one of the non-technical skills required in aviation personnel. In a similar vein, SA is included in the list of non-technical skills for surgeons (Yule, Flin, Paterson-Brown, Maran, & Rowley, 2006) and surgical teams (Catchpole et al., 2008).

2.5.6 Experiential and Reflective Cognition

Norman (1993) made the distinction between experiential cognition and reflective cognition. The former is data-driven (or bottom-up processing) while the latter is event-driven (or top-down processing). The practical implication of this distinction is in designing technology to balance the engagement of both cognitions in performing technology-assisted tasks. A routine task can be performed using (mostly) experiential cognition. When things out of the ordinary occur, reflective reasoning has

to be used. People rely on experiential cognition which can be supported by accretion and tuning learning (Norman, 1993) to achieve and maintain situation awareness in routine task. Another type of learning, restructuring, supports reflective cognition. It can be argued that in non-routine event, reflective cognition is necessary to maintain SA.

It is of interest to note that the discussion on cognitive and learning types were followed by a discussion on optimal flow – absolute absorption in an activity. It is not difficult to imagine situation awareness is embedded, as a pre-requisite perhaps, somewhere in the optimal flow. At the very least, there seems to be a general framework to understand situation awareness by relating it to cognitive types and learning types. Prince, Salas, and Brannick (1999) showed the results of a research on situation awareness could be related to learning processes to inform situation awareness theory.

2.6 Measurement

Based on human factors, ergonomics, and the psychometrics literature, this section discusses the extant method and techniques of SA measurement. It is not meant to provide detailed information on existing measures of SA. Rather, it presents the nature and issues of SA measurement. Table 4 lists measures of SA. This sample of SA measures shows the growth of SA measure within the last 22 years. SAGAT is "by far the most commonly used approach, and also the technique with the most associated validation evidence (Salmon, Stanton, Walker, & Green, 2006, p 225).

Table 4. SA measures and their primary reference(s)

Abbreviation/ Acronym	Full name	Key reference(s)
SAGAT	Situation Awareness Global Assessment Tool	(Endsley, 1988)
SART	Situation Awareness Rating Techniques	(Taylor, 1990)
SACRI	Situation Awareness Control Room Inventory	(Collier & Folleso, 1995)
C-SAS	Cranfield Situation Awareness Scale	(Dennehy, 1997)
SAPS	Situation Awareness Probes	(Deighton, 1997; Jensen, 1999)
SABARS	Situation Awareness Behaviourally Anchored Rating Scales	(Neal, Griffin, Paterson, & Bordia, 1998)
SPAM	Situation Present Assessment Method	(Durso et al., 1998)
SALIANT	Situation Awareness Linked Indicators Adapted to Novel Tasks	(Muniz, Stout, Bowers, & Salas, 1998)
SAVANT	Situation Awareness Verification Analysis Tool	(Willems, 2000)
QUASA	Quantifying and Analysing Situational Awareness	(Edgar, A. J. Smith, H. E. Stone, Beetham, & Pritchard, 2000)
SALSA	Measuring Situation Awareness of Area Controllers within the Context of Automation (translated from German)	(Hauß, Gauss, & Eyferth, 2000; 2001)
SASHA_L	SA for SHAPE on-Line	(Jeannot, Kelly, & Thompson, 2003)
SASHA_Q	SA for SHAPE Questionnaire	(Jeannot et al., 2003)
	Propositional Networks	(Stanton, Salmon, Walker, Baber, & Jenkins, 2005)
TSAM	Team Situation Awareness Model	(Ma, Lu, & Zhang, 2010)

The criteria in considering the measurement of SA are outlined by Tsang and Vidulich (2006): sensitivity, diagnosticity, intrusiveness, validity, reliability, ease of use, and operator acceptance. Another list of considerations includes domain of application, training and application times, tools needed, reliability and validity, advantages, and disadvantages (Stanton, Hedge, Brookhuis, Salas, & Hendrick,

2004). These considerations reflect the need to use measures that are sound theoretically and robust in practice. However, there are trade-offs that must be made because the existing measure may not be able to satisfy demands from both sides.

Salmon, Stanton, Walker, and Green (2006) reviewed several classes of methods for measuring SA. The classes of method include freeze probe techniques, real-time probe techniques, self-rating techniques, observer-rating techniques, process indices (eye tracker), and performance measures. These classes cover measures that provide objective, subjective, and physiological data. All of the proper (as in 'proper name') measures included in the review are domain specific. This limited scope of application could contribute to the lack of validation of the measures. Quite surprisingly, none of the measures, which are relevant for command, control, and intelligence, measures team SA. This finding points to one of the main reason to extend the concept of SA. Kardos (2004) contributed towards this aim by reviewing SA measures with a focus on team SA.

Discussions and reviews of SA measures tend give the impression that there is still a long way to go. Adopting a different stance, Pew advised "(t)o search for the universal measure is to search for the Holy Grail" (Pew, 2000, p 45). Rather than being inundated with the shortcomings of each measure, researchers should chose a measure (or measures) for its strength for a given situation. Different measures of SA view and assess SA differently and may not correlate with each other (Salmon et al., 2003). The different measures are not equally suited for different purposes such as qualitative investigation into SA processes, design testing, (Endsley, 2000) understanding SA requirements at initial stages of research, and evaluating individuals' ability to meet scenario-specific SA requirements (Pew, 2000).

Despite the limitations and challenges, efforts to improve measures of SA must continue. Among other reasons, measurement of SA can be used to evaluate system design, evaluating training techniques, and understanding human cognition (Endsley & Robertson, 2000). SA is very useful for system evaluation (Tsang & Vidulich, 2006). SA is a valuable tool for systems ergonomics approach.

2.6.1 Limitations of Existing Techniques and Methods to Measure SA

Hendy (1995) reminds SA researchers that SA and mental workload are separate concepts. Hendy shows that a purported SA measure could actually be measuring mental workload instead. The validity of such measure is questionable. In fact, there are many other concerns about the existing ways and techniques to measure SA.

In their review of the measurements of SA, Salmon, Stanton, Walker, and Green (2006) highlighted the inadequacy of the current assessment of SA for C4i (command, control, communication, computers and intelligence) systems. They concluded that the techniques themselves have inherent problems for data collection. Moreover, the "techniques fail to meet the requirements to assess SA across multiple locations at the same time, assess both individual and team SA for the same task and also assess SA in real time" (p 236).

Meanwhile, Patrick *et al.* (2006) cautioned against the separation between awareness and the situation in measurement. They argued that the existing measures like SART, SAGAT, and SACRI might not be able to capture the details and context of an individual's or teams' SA.

In her review of human factors for complex socio-technical systems, Carayon (2006) concluded that "(f)urther integrating the different dimensions and elements of socio-technical systems is necessary to anticipate the implications of working across organizational, geographical, cultural and temporal boundaries". Her conclusion emphasized the necessity to go beyond the individual understanding of SA. With a complex socio-technical system such as the hospitals, an extended SA – as in SA for teams and SA for tasks in different temporal spaces – is indeed important to be understood.

Siemieniuch and Sinclair (2006) echo Carayon's proposal. They identified SA as one of the areas of concern for systems integration. However, rather than merely considering individual's SA, they proposed to extend the concept. Their argument for extending the concept is to integrate it with instantaneous and long term workload assessment. Moreover, the concept should be extended to include better understanding of team-working scenario.

This section show the limitations of the measurement to be two pronged: the measures themselves, and the scope of measurement. The extant measures may not be sufficient to capture SA in all domains. Furthermore, there is a need to expand the measurement of SA beyond the individual level. Given the limitations, the use of multiple measures may be desirable. For example, Dekker (2000) provided a review of a selection of converging or complementary tactics (both field observations and various forms of simulator studies) that can gain empirical access to crew situation awareness and discusses the trade-offs these tactics represent in terms of experimental validity and reliability.

2.7 Criticisms of SA

Earlier in its development, SA might be considered a redundant concept when mental workload is already in existence. However, Tsang and Vidulich (2006) concluded, mental workload and SA are separate, though closely intertwined, concept. Thus, being an old wine in a new skin is not a major concern. This section outlines some of the more serious critiques and contentions regarding SA.

Hone *et al.* (2006) contend that the SA model proposed by Endsley does not lend itself to operationalised definition – with implications for 'formal measurement'. This contention stems from the way Endsley delineate the 3 levels of SA – perception, comprehension, and projection. Hone et al. assert that a "critical assessment of Endsley's three "levels" will show that they are more properly components of that state that can be termed awareness". This critique leads to the 3-Question (3-Q) model. Interestingly, this model is based on Endsley's model, albeit with a different focus. Instead of probing the cognitive processes underlying SA, the model outlined 3 questions that correspond to the 3 levels of SA. Thus, the 3 questions facilitate the formulation of operational definition of awareness.

The merit of Hone *et al.* (2006) critique is not so much in debunking Endsley's model, but in showing how the model can be used to generate operational definitions. The concern might be one of avoiding confusion, or committing the fallacy of equivocation. Questioning the value of the acronym 'SA' is an off point considering many abbreviations with different meanings and connotation are shared by different disciplines. What is important is to use a term with a clear definition consistently. What is more damaging is the liberal use – or rather abuse – of the construct (represented by its full name or abbreviation) to gain scholarly credentials. For

example, the term ‘ergonomic’ has been used liberally to describe products – regardless of the actual ergonomic input that went into the design of that product. When the popular media start to pay attention to SA, then we can raise the question whether the term SA has any merit or meaning.

A deficiency of Endsley’s model was showed by way of elucidating on the opposite of situation awareness. Saying that someone having a poor SA should be interpreted as a “shorthand for saying that the person has failed to perform the task of achieving SA satisfactorily, i.e. lacks the necessary awareness or knowledge” (Patrick *et al.,* 2006, p 395). However, they did not provide a definition of the SA which is to be achieved. They view SA as a goal in task performance. It is not clear whether they assumed that operators would explicitly create a goal of achieving and maintaining SA when performing a task, e.g. to control a system.

In so far as SA is supported by perception, memory and expertise (Tsang & Vidulich, 2006), there is paucity in the literature on how SA, either as a process or product, might be influenced by cognitive heuristics. The process of perceiving information, for example, might be biased due to stereotypes. Projection and prediction of future event might suffer due to confirmation bias. That is to say cognitive short cuts that people, both novice and expert, use, might theoretically influence the creation and maintenance of SA. It is not safe to assume that experts are not misled by cognitive heuristics and perceive wrongly a situation and making the wrong conclusion. Turk and Salovey (1985) have discussed this point concerning clinicians.

More generally, the literature of SA seems to have not found strong connection to the field of social cognition, a major topic in social psychology. The case for connecting

SA to social cognition can be found in the following summary about social cognition research: "..the impetus for virtually all social-cognitive research on memory and information processing stems from interest in understanding how the social perceiver makes sense of others" (Quinn, Macrae, & Bodenhausen, 2003, p 71). The understanding of mental processes underlying social behaviour – such as forming impression and making attribution – could potentially inform, or at least be applied for SA studies. The relevance of social cognition is even greater for studies on team SA. The limitations of social cognition, including cognitive heuristics mentioned above, would enrich the understanding of how individuals, working as a team, form and maintain SA.

One possible reason for this neglect can be traced to the situation awareness theory itself. Endsley's model of SA, in particular, is based on the information processing theory. Sträter (2005) differentiated between sequential and parallel information processing theory. Criticisms of Endsley's model include the separation of Level 1 and Level 2 (Hone et al., 2006). In other word, a sequential processing is implied. The extent to which the model is seen as a sequential processing model precludes inclusion of cognitive processes that require parallel processing. It is exactly these parallel processes that Sträter outlined: availability bias, representational bias, confirmation bias, and central bias. All of these heurism can only be considered within a parallel information processing theory. As a result, the Endsley's model of SA can benefit from using a parallel processing consideration. In other words, by making the model more explicitly parallel in nature, it can be developed further.

2.8 Summary

This chapter highlights one area of human factors that can contribute to safety at the workplace. It is argued that an understanding of situation awareness can be beneficial towards achieving improved safety. SA theories and systems ergonomics approach act as a support for the investigation into SA in safety critical domains.

This chapter attempts to give an overview of situation awareness by presenting its background and the scope of research. Additionally, considerations for SA research are presented by outlining its limitations, issues and challenges. There are complementary theories to guide research. The researchers can make use of the different measure of SA to advance practice and enrich the knowledge on human cognition. SA is indeed a fertile area of research for theory and its application. Chapter 3 presents a review of the SA literature with a focus on complex work systems.

CHAPTER 3: SITUATION AWARENESS IN HEALTHCARE

3.1 Introduction

Chapter 2 provides background information on situation awareness. It was argued that SA can yield important insights for promoting safety in complex work systems. Healthcare organisations, which are complex work systems, are one of the domains for studies on SA that is getting increasing attention from researchers. Chapter 3 expands the ideas from Chapter 2 by presenting a review of the literature on SA in healthcare. The focus on SA takes into consideration the relationship between SA and NDM. There are common mechanisms for NDM and developing and maintaining SA (Endsley, 1997). Efforts to understand SA can provide insights into stages of naturalistic decision making (Randel, 1996). Moreover, there is little published work on NDM in healthcare.

The literature review is prefaced with a discussion on patient safety as an issue within complex systems. Resilience engineering, an approach to design safety into a system by taking into account its complexity, is presented to provide a more detailed context for patient safety.

3.2 The Importance of Patient Safety

Patient safety is increasingly emphasised in the delivery of health services. For example, in the United Kingdom, the NHS was launched in 1948 with three core principles. The principles have since been revised and expanded to include patient

safety (DOH, 2000). The new core principles made it clear that patient safety is an important priority: it is not enough to provide good healthcare to everyone, it must also be safe.

Patient safety is defined as “the avoidance, prevention and amelioration of adverse outcomes or injuries stemming from the process of healthcare” (Vincent, 2006). Issues like leadership, management, information technology and equipment designs are relevant to the study of patient safety. These issues can be investigated at the individual, team, organisational, and cultural level. Compared to engineering, individual, and psychological perspectives, an organisational perspective (a system model) has the advantage of considering both the sharp (front-line workers) and blunt (managerial personnel) end of accidents or error (Vincent, 2006). A systems ergonomics approach is well suited to analyse patient safety because it takes into account the wider context (e.g. organisational structures and policies) of individuals’ behaviour. This approach is less likely to explain accidents as due to human error and thus discouraging blaming culture. This approach has been proposed to the NHS to manage medical errors (DOH & Design Council, 2003). Conventional risk management approaches, like the “Old View” of human errors (Dekker, 2006) are not sufficient to explain safety and improve performance. In healthcare organisations, conventional approaches to investigate and prevent errors that ignored the complexity of the system have not produced satisfactory patient safety outcomes (Ebright, Patterson, & Marta, 2002). Equally important, a systems perspective may help uncover issues, such as causal relationships between interacting levels of systems, that otherwise will be missed by the conventional approaches (Waterson, 2010).

Ergonomics and human factors can contribute to design patient safety into the healthcare systems. For example, Galvan, Bacha, Mohr, and Barach (2005) showed the use of a human factors method to study patient safety practices during paediatric cardiac surgery. Their study demonstrates the utility of a human factors approach to understand behaviours that are related to patient safety. Another example, Weinger and Slagle (2002) studied factors affecting job performance of anaesthetist with an emphasis on cognitive processes. They argued that understanding the job performance factors could lead to improved outcomes and reduce errors. Other studies show the relationship between patient safety and medical device usability (Rose, Blake, Norris, & C. Lowe, 2007), and manual handling (Jones & Hignett, 2006; Pinder, Marlow, & Gould, 2006). These examples show how human factors can contribute to patient safety. However, there is a gap between the potentials and their realisation. A successful adoption of ergonomics guidelines, interventions, and applications need committed involvement from all layers of healthcare organisations (Stone & McCloy, 2004).

3.3 The Complexity of Healthcare Systems

Healthcare organisations' characteristics may affect the extent to which ergonomics can contribute to patient safety. Ergonomics has only recently made in roads to healthcare, compared to the military, aviation, and manufacturing. As Vincent (2006) cautioned, there are enough differences between healthcare and other industries to warrant new thinking and different ergonomics solutions. This section tries to highlight the differences by focusing on system complexity.

Kuras and White (2005) defined a system as "an instance of a set of elements having relationships with one another sufficiently cohesive to distinguish it from its

environment". A system can be described by how much the elements are interdependent (tight or loose coupling) and the way the elements are organised (simple or complex). A tightly coupled system is one where a disruption of one element will greatly affect another element. For example, a team working in an operation theatre (OT) is tightly coupled with a team at the intensive care unit (ICU). The ICU team have to make sure a bed is available for a patient who undergoes an operation at the OT.

On the other hand, complexity refers to the organisation or connections among the elements. A simple system has few elements with shallow levels of organisation. A complex system may have many elements that are organised in many layers. Sinclair (2007) distinguishes between intrinsic and induced complexity. This distinction is akin to saying that there are complexities inherent in a work and those that are imposed to it. The importance of understanding complexity cannot be overemphasised. As Woods, Patterson, and Cook (2007, p 462) stated, "the enemy of safety is complexity".

Healthcare services are delivered to the patients through clinical and support departments. Hospitals may have different departments offering generic, specialist, and sub-specialist consultations. These numerous departments need to be structured well to have positive outcomes on patient safety (West, 2001). The structure of hospitals also has to take into account the management hierarchy. The chains of command in hospitals are not necessarily similar to other complex organisations. Hignett (2003, p 882) identified "three hierarchical lines in the management structure: an administrative line, a professional line and a patient-focused clinical management line". This sets healthcare apart from the military (many professions, but only one management line) and education (one profession, one management line).

To compound the complexity, healthcare personnel may work across organisational, geographical, cultural, and temporal boundaries (Carayon & Friesdorf, 2006). The customers – patients and their family – add to the complexity by their increasing involvement in the creation of products and services. In the UK, at least, this increase in involvement is encouraged by the government. The NHS aims to provide a patient-centred healthcare. This means the patient will have more say about the way health services are designed and delivered.

It is evident that the healthcare system is complex indeed. In the future, more complexities may be imposed upon it. To defend against this enemy of safety, simplifying the system may not be a feasible solution. Instead, it is suggested that healthcare operations engage in the activity of "monitoring, managing, taming, and coping with the changing forms of complexity" (Woods, Patterson, & Cook, 2007, p 462). Sinclair (2007) argued that people can act as complexity absorbers: their ability to tame the intrinsic and induced complexity depends on trust in other system components, situation awareness, shared situation awareness, excellent communication, knowledge, experience, and governance.

3.3.1 Resilience

The complexities of socio-technical systems pose challenges to people who design, implement, and maintain the systems (Carayon, 2006). Risks or threats to safety – of the human and technical sub-systems – need to be managed in response to changing complexities towards achieving patient safety targets. Resilience engineering is an alternative to the conventional approaches to better manage risks in complex socio-technical systems (Steen & Aven, 2010).

Resilience engineering is an approach that encourages proactive actions for maintaining safety. The main difference between resilience engineering and conventional safety management paradigm is the treatment of “safety as a core value, not a commodity that can be counted” (Woods & Hollnagel, 2006 p 6). Thus, safety is something that the system performs, rather than what it has (Hollnagel & Woods, 2006). In other words, safety and resilience are dynamic aspects of a system (Carthey, Leval, & Reason, 2001).

There are two main views on resilience (Gaël, René, & Christine, 2009). The first view of resilience refers to the ability of a system to recover after being shocked. This view is based on a definition of resilience as “the ability of an organization (system) to keep, or recover quickly to, a stable state, allowing it to continue operations during and after a major mishap or in the presence of continuous significant stresses.” (Wreathall, 2006, p 275). This definition states that safety is maintained by having the ability to recover after a loss of control.

The second view of resilience looks at safety in the prevention of loss of control. Thus a definition of resilience is given as the “ability to manage severe pressures and conflicts between safety and the primary production or performance goals of the organisation” (Hale & Heijer, 2006, p 35). The trade-off between production and safety can be seen in the fishing industry where fishing firms make sacrificial decisions in balancing between the safety of the workers and the safety of the vessels (Gaël et al., 2009). Similarly, helicopter pilots make sacrifice judgements (against initiating helicopter maintenance cycle) to ensure their helicopters are operational (Gomes, Woods, Carvalho, Huber, & Borges, 2009). These sacrifices are

done within the context of organisational and financial pressures. It is not surprising then that resilience engineering requires the involvement of people making major decisions in organisations. Top-level commitment is an important principle or theme for resilient organisations (Costella, Saurin, & Guimarães, 2009; Wreathall, 2006). Top management has to recognise the concerns regarding human performance and provide continuous support, thus making safety a core value for the organisation.

The advantage of a resilience approach to safety is the focus on designing an adaptable system, instead of fault-finding or blaming. Gains towards patient safety can be made by learning how errors can be prevented (Alberti, 2001) instead of merely counting medical errors. Research on resilience in healthcare has been conducted to further develop the concept. For example, the properties of a resilient organisation were identified. Buffering capacity, flexibility, margin of operation, tolerance, and cross-scale interaction were identified as properties of a resilient organisation based on a study in a hospital emergency department (Anders, Woods, Wears, Perry, & Patterson, 2006). The study shows how personnel cope with fluctuations in the number of patients in the emergency department. Similarly, shocks to a system, which relate to the first definition of resilience engineering, was demonstrated by sudden surge in patient volume at an emergency department (Nemeth, Wears, Woods, Hollnagel, & Cook, 2008). The strategies and adaptations shown by the personnel in dealing can be used to inform application of resilience in other domains.

Studies on resilience had also produced tangible interventions and strategies to be used in healthcare. For example, a list of guidelines was developed for collaborative cross checking, where two or more people examine each others' assumptions and actions (Patterson, Woods, Cook, & Render, 2007). The practice of cross checking

was found to be able to detect erroneous assumptions and actions. The design of devices and their interfaces can also make a difference. Infusion pump devices that are designed by considering the cognitive activities of clinicians using the devices are more likely to be capable for adaptation and have a more resilient interface (Nemeth & Cook, 2007).

3.4 Past Research: Identifying the Trend and Gaps

One of the most recent key text in the area of human factors and healthcare ('Handbook of Human Factors and Ergonomics in Health Care and Patient Safety', Carayon, 2007) does not include a chapter on situation awareness. The phrase situation awareness does not even appear in the index section. This may reflect the lack SA research in healthcare or the lag in the integration of the research into the main body of the literature. This section provides an overview of the literature with an aim to identify its trend and gaps.

A search was conducted on ScienceDirect and PubMed databases to sample papers published in journals that are related to healthcare. Search entries used were 'situation awareness' and 'situational awareness'. Papers were accepted for analysis if the search terms appear in their title, abstract or list of keywords. No other restrictions or filtering were imposed on the search.

A total of 60 papers were retrieved. However, one paper was dropped from further analysis because the abstract, though for different journal, were identical. NVivo7 was used to analyse the remaining 59 papers (Appendix A). Each paper was listed

with attributes related to the type of paper, healthcare domain, level of analysis, and relevant patient safety factors. The values for each attributes are mutually exclusive.

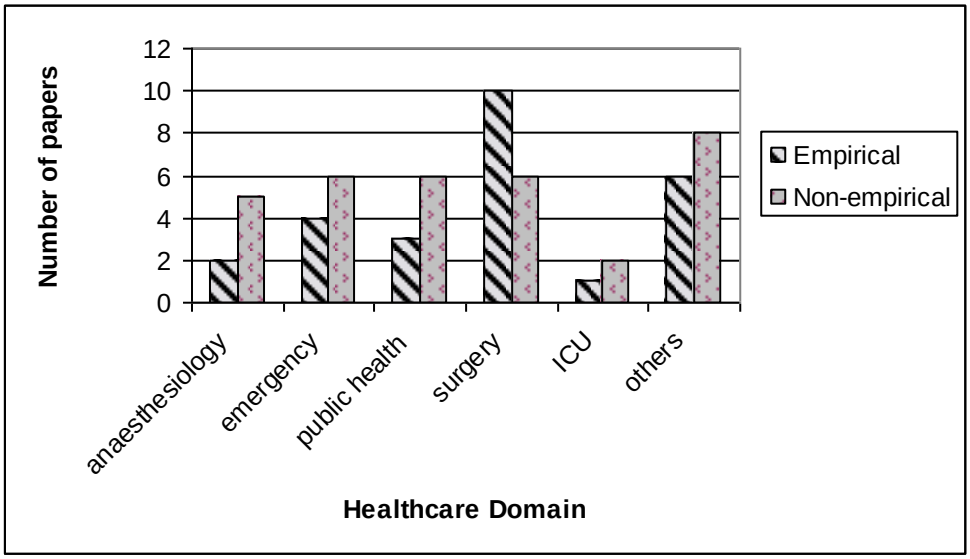

Figure 7. Distribution of types of papers by healthcare domains.

Figure 7 displays the distribution of empirical (with primary data presented – has Results section) and non-empirical (review, report, and theoretical proposition – no Results section) papers in different healthcare domains. Papers that do not specify a domain are grouped in 'others'. From Figure 7, it can be summarised that empirical papers are fewer than non-empirical papers across all domains, except surgery.

The next analysis looked at the distribution of papers according the level of analysis in the reported study. The concern here is how SA is measured or described in the study. Thus, for example, if a paper reports SAGAT being used to measure team SA, then the paper is classified as 'team'. In cases where both individual and team measures were used, 'team' classification takes precedence. To weight the information in Figure 8, the following details are necessary: the number of papers: anaesthesiology = 7; emergency = 10; public health = 9; surgery = 16; ICU = 3; and others =14.

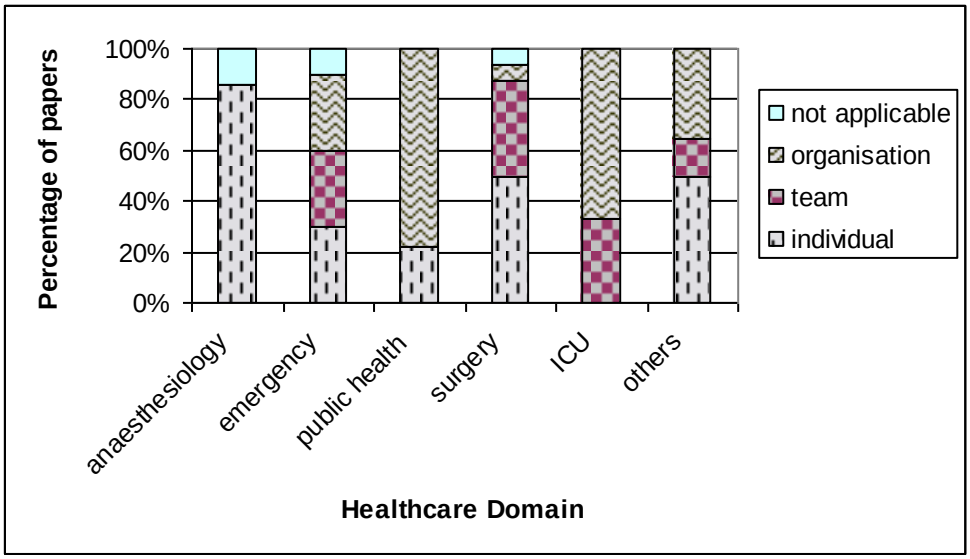

Figure 8. Distribution of papers using levels of analysis by healthcare domains.

Figure 8 shows that individual analysis of SA still dominates the sampled literature. There is still a lack of study on team SA. The label 'organisation' may seem to include team SA, but rarely explicitly. Rather, the papers categorised in the 'organisation' group described SA in a general manner; they describe SA in an organisation, but did not specify any team within that organisation. In contrast, the 'others' category includes papers that review SA and its applicability in healthcare.

There are limitations to the summary of papers featured here. Both empirical and non-empirical papers may not have SA as either an endogenous or exogenous variable. Rather, SA is implied in the discussion. One paper actually has the term 'situation-awareness' as a keyword, and nowhere else in the body of the paper. Another good example is the paper by Hazlehurst, McMullen, and Gorman (2007). They focused on coordinated communications between the surgeon and perfusionist during cardiac surgery. The conclusion is that SA is a natural by-product of coordinated communication. However, they did not measure or describe the quality of the SA as a product. Their conclusion, on the processes that give rise to SA, is

based on an analytical process. They did not set out to measure team SA in the operating room. Rather, they decomposed Endsley's levels of SA to summarise their finding. For example, Status, Alert and Explanation verbal exchange corresponds to the second level SA (i.e. comprehension of facts for the current situation).

Their study contributes to the theoretical underpinnings of team SA. Whether, and how, coordinated communication contributes to the creation of team SA needs to be verified with an empirical investigation.

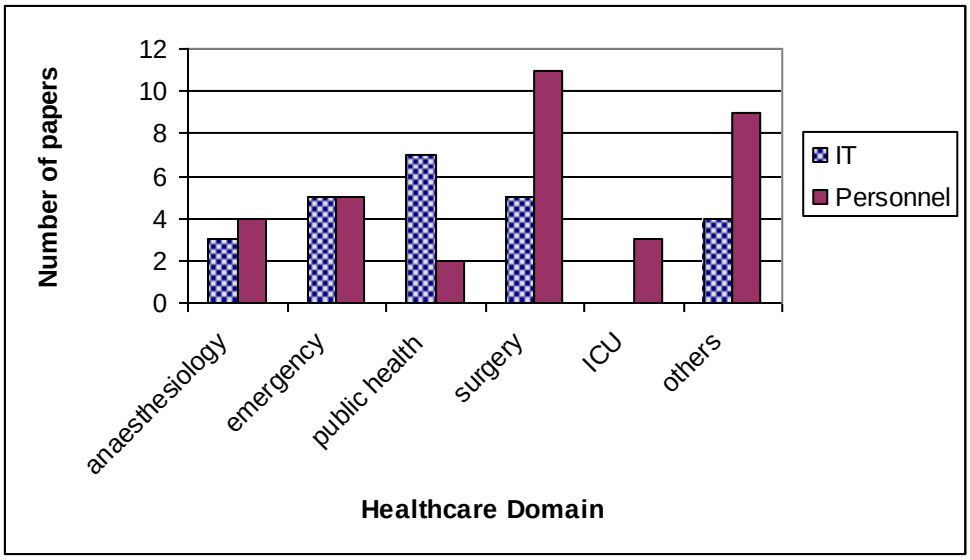

Figure 9. Distribution of papers by domains of SA research according to factors relevant for patient safety.

As was mentioned in the previous section, there are few variables in a work system that can impact patient safety. For this analysis, one paper was excluded because it did not fit any domain; neither information technology (IT) nor personnel (see figure 9). 'IT' refers to information technology and devices that communicate through any channel with humans in the system. For example, Zhang et al. (2002) evaluated a graphical display for anaesthesiologists and its effect on SA. In the study, they used SAGAT to measure Level 1 and Level 2 SA via the freeze-probe technique. They

concluded that the anaesthesiologists' SA can be improved by having an integrated graphical display.

Meanwhile, 'personnel' covers the psychological perspective and management perspective. For example, the ability to communicate clearly with another team member was seen as important to maintain SA. Training of non-technical skills is also considered as personnel issues.

Overall, studies on SA favour the individual angle in describing the relationship between SA and patient safety. SA is an individual skill that can be trained. This echoes the dominance of the individual level of analysis as mentioned before. However, because management and training are included in 'Personnel', the prominence of the individual angle may be inflated. Of course, management, training, selection, and other personnel functions are part of the important elements in a systems approach. So, even though there seems to be a bias towards an individual's level of analysis, a systems' approach is certainly not lagging too far behind.

3.5 Constraints and Opportunities for Research

In addition to the considerations outlined by (Tsang & Vidulich, 2006), a few more should be added for choosing appropriate measurement of SA in healthcare. These additional requirements reflect the specific need, regulations and policy of conducting research in the healthcare system. First, the measure must be acceptable to the patient. Healthcare is not the same as the aviation industry because the range of possible persons in the domain is great. Patient age ranges from zero to the maximum limit of life. Thus, the measure needs to take into account the suitability of

administration with a large variation of people. Thus, a self-administered survey is not suitable for younger sample or for samples that are experiencing a disability, either permanent or temporary.

While patients present practical constraints, agencies regulating the healthcare system present technical constraints. A researcher must be aware of the agencies' (e.g. National Health Services in the UK) policy with regard to conducting research. The agencies' set of ethics may not be identical to an academic institutions' ethics.

The investigation of SA, and patient safety in general, in healthcare could benefit from experiences gained in other high reliability organizations (Bagian, 2006) such as aviation and nuclear power plant. Lessons learned from aviation on team training (Kao & Thomas, 2008) and team briefing (Gore et al., 2010) can be applied to improve safety in healthcare. In particular, SA was identified as one of the team training criteria that can cross over from aviation to medicine (Hamman, 2004). In a similar vein, Salas, Wilson-Donnelly, and Priest (2004) outlined the contents of team training for interdisciplinary medical teams based on the aviation and military team training. The suggested teamwork competencies include variables that may relate to SA such as mutual performance monitoring, backup behaviour, and team/collective orientation.

3.6 SA/NDM and the ECPs

As mentioned in Chapter 1, the nature of the ECP work justifies the study on SA and NDM. The two topics are relevant to understand the dynamics of the work performed by the ECPs. ECPs are expected to perform collaborative, complex, high-hazard, and high-tempo work (Nemeth et al., 2007) like other practitioners in emergency

care. The characteristics of the job can potentially impose high levels of mental workload. To maintain a high quality of care, ECPs have to be able to be in the loop (i.e. develop sufficient levels of SA) and make appropriate decisions quickly.

3.7 Conclusions

This chapter highlights the research work on SA in healthcare domain. To conduct research on SA in healthcare, there are several issues and challenges that must be considered.

1. On the theoretical side, the literature on SA for healthcare is not as mature as for other domain (e.g. aviation, military).
2. On the measurement side, the measurement of team SA is still in its infancy.
3. On the technical side, as faced by other researchers in the healthcare domain, data collection techniques must pass the stringent approval process imposed by healthcare regulating agency.

There is a great potential to be realised by conducting more research on SA in the healthcare domain. Its applications and implications could contribute greatly to the improvement of patient safety. Healthcare is also a good domain to expand the work carried out in other domains. The next Chapter presents a study that examines decision making and situation awareness using critical decision method.

CHAPTER 4: CRITICAL DECISION METHOD INTERVIEWS

4.1 Introduction

The aim of cognitive task analysis (CTA) is to describe “cognitive demands and skills required for a task” (Militello & Hutton, 1998). Such analysis is important for tasks that put great demand on mental resources. In complex systems, and with the use of automated system, the demand on the operators’ mental resources needs to be understood. CTA has been used to study tasks performance in military, aviation, air traffic control, and driving (Prasanna, Yang, & King, 2009) The outcomes from such analysis can inform the design of the systems and their elements. This Chapter presents a cognitive task analysis that lays the foundation for examining the ECP role within the context of a wider work system.

The Critical Decision Method (CDM) interview is one of the most documented and widely used methods for analysing cognitive tasks among practitioners (Roth, 2008). CDM interviews are retrospective accounts of practitioners’ decision making process with the aim to uncover their tacit knowledge. The outcomes of CDM can be descriptive decision model, situation assessment inventory, and critical cue inventory. In this Chapter, the CDM was conducted to produce a description of decision process by focusing on the activities, cues, knowledge and limitations. A description of situation awareness was also obtained by looking at the source and the usage of information.

4.2 Methods

4.2.2 Participants

The interviews are usually done with experts who have more than 10 years working experience (Klein, Calderwood, & MacGregor, 1989). For this study, none of the ECPs had more than 10 years' experience because the role itself is in existence for less than 8 years. Therefore, it was not possible to select expert practitioners. This lack of strict selection criteria is also affected by the practical limitations in the participant recruiting process. Nevertheless, the ECPs invariably have related experience in emergency care as nurses, paramedics or patient transport. Therefore, they cannot be treated as novice within the emergency care domain.

The research aimed to observe between 10 to 13 ECPs which is considered an adequate sample size to generate data for the model used in the study. A similar sample size had been reported in a qualitative study using critical decision method (CDM) interviews with ambulance dispatchers (Blandford & Wong, 2004).

ECPs were recruited using letters of invitation sent by regular mail or electronic mail. A convenience sampling method was used based on the rate of response from the previous studies. Invitations were sent to as many ECPs as possible using the mailing list provided by EMAS and also via personal contact developed from the previous data collections. Agreement to participate was followed by completion of consent forms before data collection commences. As before, no compensation was offered to the ECPs for their involvement. They were offered access to the study outcomes upon the completion of the study.

4.2.3 Procedures

The ECPs were given the option to be interviewed during their shift hours or post-shift. The interview probes (Table 5) are based on a CDM interview schedule (Taylor, 2005) which in turn is based on Klein, Calderwood, and MacGregor (1989). The ECPs were asked to recall a job that they performed as an ECP. The job must be one that stands out so that the details can be recalled.

Table 5 . CDM Interview schedule

Area	Questions
Problem description	Describe the situation What happened leading up to the situation? (context, environment) What did you do? What was the outcome?
Planning	Had you anticipated the possibility of this problem at the planning stage? Did your plans include contingency measures for a problem like this? Did the contingency measures work? Did you deviate from the plan – how, what factors cause the deviation?
Cues	What key points alerted you to… ? How did you know that ….?
Options	What alternatives did you consider? What limitations did you face regarding possible actions?
Interactions	Did you have direct control? Who were the key players?
Analogues	Were you reminded of any previous experience ..?
Goals	What were your specific goals at this point?
Basis	How did you decide on your choice of action/rejection of other options?
Knowledge	What information did you use for deciding .. ? What training or experience was useful in making this decision? How did you learn about ?
Hypotheticals	With hindsight, what would you have done differently? What training or experience would have helped? What do you think a novice might have done in this situation?
Exceptions	Can you think of another situation where you would have done things differently?
Results of actions	Did your action work as expected? If not, why do you think that was? If so, what might have caused it not to work? What would have happened if your action hadn't worked? What would you have done?

The probes were used as guide to obtain information on the decision making process in terms of the activities involved, cues attended to, planning, and knowledge used. The interviews were audio-taped and then transcribed.

4.2.4 Data analysis

The interview transcripts were analysed in NVivo7 using emergent theme analysis (Wong & Blandford, 2002). The data analysis involves identifying codes that are broadly related to decision-making process. Based on these codes, broad themes are identified. The codes that are collated under the broad themes are examined further to identify sub-themes. The themes and the sub-themes are then summarised using the Wong and Blandford (2002) framework that describes the activities, cues, knowledge and limitations of the decision making process. The summary would be used to describe how ECPs develop SA in arriving at decisions.

4.3 Results

A total of 13 ECPs were recruited. The ECPs' age range from 32 years to 54 years (n=13, M=44.0, SD=6.27). Their years of working experience (as ECPs) range from 3 months to 5 years (n=13, M=3.35, SD=1.71). Eight of the ECPs had paramedic background, three had a nursing background, and two had patient transport backgrounds. All major geographical areas under EMAS were represented in this study. There were 3 ECPs working in Leicestershire and Rutland, 2 in Derbyshire, 3 in Nottinghamshire, 2 in Lincolnshire, and 3 in Northamptonshire.

Of the 13 ECPs who participated, one withdrew from the interview. Three broad themes were identified namely 'assessment of situation', 'selection of action', and

'referral and safety netting'. These three themes are described by focusing on activities, cues, knowledge and experience as well as limitations. Interview excerpts support the descriptions where applicable. Summaries for each theme are presented in tables at the end of the descriptions.

4.3.1 Assessment of Situation

4.3.1.1 Activities

The assessment activities involve two stages of appraisal that the ECPs call primary and secondary survey. The primary survey is meant to determine the seriousness of the situation and relates directly to the presenting medical complaint:

> *"We work on the basis of primary and secondary assessment. The primary assessment looks at things like their airways, breathing, and circulation" (ECP10)*

> *"The initial assessment was to establish the extent of her injuries. It was to establish how bad the injuries were." (ECP2)*

The primary survey may involve visual examination as well as examination with specific device. For example, the primary survey for patients complaining of chest pain would involve the use of ECG:

> *"When somebody has a chest pain you give them an ECG fairly quickly." (ECP5)*

The secondary survey is done to address more specific aspects of the medical complaints posed by the patients. When life-threatening conditions have been ruled out, the ECPs can assess the patients in a more thorough manner:

> *"If she passes all those [primary survey], then it's a matter of doing an exam from head to toe." (ECP2)*

Besides noting what had happened, the ECPs also take note on what had not happened. This is necessary to help focus the assessment and ensure critical injury (which may not be obvious and not reported by the patient) is not overlooked. For example, a patient who had injured her arm from a fall was assessed for symptoms of head injury:

> *"There was no loss of consciousness. She did not bang her head, or sustained any other injury except for her arm." (ECP3)*

4.3.1.2 Cues

The cues for the assessment activities cover a wide range of sensory information. Patients' presentation are observed in terms of how they look, sound, move, and feel (temperature). When meeting a patient, ECPs looked at the following:

> *"How does he look? Does he look well? Does he look unwell? Does he have a normal gait? His facial reaction to you, his colour, his texture. Is he hot? Is he cold?" (ECP11)*

The wider surrounding of the patients are also cues that are involved in assessing the situation. The ECPs go beyond the patients' physical self in making an assessment:

> *"When you get into the house, you're looking at the patient, you're looking at the patient's surrounding, [and] you're looking at who the patient is with. You also [are] looking at his surroundings and whether or not there's anything else that needs to be addressed beside just the patient. You actually generally tend to take in a lot of information as you walk through the door." (ECP6)*

One example of the cues used by the ECPs is smell. The detection of the smell guided the treatment plan that the ECP formulated for the patient:

> *"I walked into the house; there was quite a strong smell of urine. The smell of the urine suggested one of the things I would certainly be checking for was to see whether or not he had a urine infection." (ECP6)*

Information passed on to the ECPs by control room staff are useful cues. However, ECPs may not be given the information for every job. The ECPs may also use reference materials like those on the internet or books that can help them understand the information that they are gathering.

4.3.1.3 Knowledge and Experience

Clinical scripts guide the assessment process. The primary survey involves observing vital information to assess the urgency of medical intervention. In treating a patient with a head injury, an ECP included a set of assessment in the primary survey:

> *"The plan was to assess the patient using normal assessment procedure of ABC [airways, breathing, circulation]" (ECP6)*

A more general method in the ECP repertoire is the skill to make holistic inquiry. The skill allows the ECPs to obtain a more comprehensive picture of the patient's condition:

> *"The holistic inquiry using the medical model of examination, to take a full holistic history was very important." (ECP4)*

This skill has been reported as a significant gain from the ECP training:

> *"Every little bit that I've done from the ECP training was helpful. You know you're not just looking at that person. It is not just a medical problem, it stretches wider than that and you have to encompass everything, which before I never thought of as a paramedic. It really opened my eyes up." (ECP11)*

4.3.1.4 Limitations

Good communication with patient would certainly facilitate the assessment process. The corroboration of the information by other reliable persons is also seen as useful:

> *"The patient himself was able to provide most of the information I wanted. As far as I can recall, the family really just reinforced what he had already told me." (ECP6)*

In cases where the patients are living alone and not able to communicate clearly, the assessment process is limited to the information that can be gleaned using other sensory channels. The absence of cue materials such as medical record can also hamper assessment.

Additionally, the cues used in the assessment may not point to the same conclusion. The conflicting or uncertain information poses a limit to the assessment.

> *"It didn't look as if he was having a heart attack. Although looking at the history, observations from the machine, he probably was." (ECP5)*

In addition to that, working as solo responders limits what the ECPs can do. This is especially true for cases where patients have to be handled physically, such as patients who had fallen.

"You got that one pair of hands. It takes longer to assess. Not always longer to come to a decision, but I think longer to deal with the patient in the position that you find them." (ECP2)

Table 6 . Summary of 'Assessment of Situation' process

Activities	Cues, sources, and considerations	Knowledge and experience	Limitations
1. Conducting primary survey 2. Conducting secondary survey 3. Conducting holistic assessment	1. Information relayed via radio and MDT screen 2. Patients and their presentation 3. Patient's surrounding including other people 4. Reference materials	1. History-taking skill 2. Clinical assessment skill	1. Communication with patient 2. Uncertainties 3. Practical feasibility

4.3.2 Selection of Actions

4.3.2.1 Activities

The selection of actions process is anchored on the pre-arrival plan that the ECPs make upon receiving and accepting a job. An ECP reported pre-arrival plan that errs towards safety:

"You, as we should, think the worst until we get there. So I was thinking for all those things and the fact that if it was less than that, I still may need somebody to help me manoeuvre her into a position where I can treat her." (ECP2)

ECPs also made plans that were not biased in one direction or the other. An ECP reported keeping an open mind before arriving on scene even though he did get information from the control room staff. His plan was based on the appreciation that the control room staff may not have received enough information:

> *"Although I knew I got [a patient with] an arm injury, I also kept an open mind as to exactly what had happened." (ECP3)*

Upon arrival, ECPs has to select and execute appropriate actions based on the assessment of the situation. Thus, the ECPs have to interpret the outcomes of the assessment. In addition, ECPs also has to iteratively assess patients for changes that occur as a response to any treatment:

> *[I] gave her a nebuliser to try easing her breathing a little bit. It did to a degree but then shortly afterwards, she de-saturated again." (ECP9)*

Once a course of action has been selected, the ECPs need to get support for performing the action. The support may be in the form of cooperation from the patient. The ECPs may also hold a discussion with attending colleagues or the patient's GP (by phone) on the best action for the patient:

> *"So I gave him some more antibiotics with the permission of the GP. I phoned the GP and spoke to him, and got his approval." (ECP13)*

"The ambulance crew arrived which was paramedic and technician I think. We just worked as a team then. Were able to go through his signs and symptoms again and my observations. We were all of the same opinion that he had a cardiac problem and he needed to go to a CCU." (ECP5)

In the example above, the ECP corroborated his diagnosis and decision with ambulance crew. The sharing of information about the patient helped the process of selecting the best action for the patient.

4.3.2.2 Cues

The results from the assessment process are used to guide the course of action. Readings from the examinations (blood pressure, temperature, ECG print-out), medical history, and written records about the patients are used in arriving at a diagnosis. The use of the assessment's outcome is illustrated in a case of patient complaining of chest pain. When asked why thrombolytic drugs were not given to the patient, the ECP gave the following explanation:

"Because of recognising what the ECG was telling me. Thrombolysis was contraindicated also because his blood pressure was very high. It was too high to give that drug. So, there was there was two reasons why we didn't". (ECP5)

Another consideration in choosing a course of action is the patients' preference. The patients' agreement with the ECPs' suggestion is a sign to proceed with the course of

action. Conversely, a disagreement may require the ECPs to revise their course of action. However, according to the ECPs, most patients comply with the given advice.

> *"The patient himself didn't want to go to the hospital. He was more than happy to stay at home. He was very pleased that actually we were able to do." (ECP6)*

4.3.2.3 Knowledge and Experience

Knowledge gained from the ECP education and training is the main foundation for selecting appropriate action. The emergency medicine knowledge and skills are necessary for them to deal with a wide range of problems. The knowledge cited by the ECPs tended to be related to practical work experience. For example, an ECP used his knowledge about pneumonia in dealing with a patient complaining of shortness of breath:

> *"Knowledge of respiratory system is essential, and the medications and the path of physiology which is associated with pneumonia developed working in A&E and working with the doctors." (ECP9)*

Reflection on one's knowledge is also important. ECPs are aware of their limitations in carrying out medical intervention. One example is the knowledge that ECPs are not able to close wound that have underlying structure damage:

> *"Understanding knowledge and skills you've attained as an ECP are limited compared with further treatment i.e. if the patient had got*

some underlying structure damage, and require further consultation with the A&E or forward on to plastic surgeon." (ECP1)

In addition to medical knowledge, ECPs also rely on work guidelines and policies. There exist specific guidelines for falls. Thus, ECPs has to be aware of "the guidelines for taking a patient into hospital" (ECP2).

4.3.2.4 Limitations

As mentioned earlier, the scope of the ECP role may exclude certain course of actions. The type of medical intervention depends on the severity of the patient's condition. The ECPs are also limited by the assessment tools that they have. Patients who presented ambiguous chest pain symptoms would be referred to the hospital for blood test, which cannot be done by the ECPs. The type of medication or drugs that the ECPs can provide for the patient is regulated by the Patient Group Direction. A way to overcome this limitation is by gaining further qualification:

"Non-medical prescribing course would be brilliant. That would give me more flexibility on the care pathway that we got." (ECP9)

The ECPs also can face obstacles from the patients. Uncooperative patient would limit the type and amount of interventions that can be performed. This is illustrated in the following example of an elderly patient with dementia:

"I was trying to change her (incontinence pad), she said you just wanted to look at my bottom, and she tried to hit me." (ECP8)

Table 7. Summary of 'selection of actions' process

Activities	Cues, sources, and considerations	Knowledge and experience	Limitations
1. Formulating pre-arrival plan 2. Interpreting assessment results. 3. Getting support for course of action	1. Assessment's outcomes 2. Changes in patient's condition 3. Patient's preference	1. Clinical knowledge 2. Work guideline	1. Scope of practice 2. Patient's cooperativeness

4.3.3 Referral and Safety-Netting

4.3.3.1 Activities

Another important aspect in the decision-making process is making patient referral and providing safety nets as necessary. Patients who require further treatment, assessment, or support must be referred to suitable care providers. The ECPs can make phone calls to patient's GP, out-of-hours GP, intermediate care team, district nurse, social services, A&E department, respite care (temporary care home), medical admission unit, surgical admission unit, and hospital ward:

> *"I put in place a structure where she will be observed and she will be able to be in a place of safety for the concern that she now has." (ECP7)*

The communication with the other care providers would involve the sharing of information about the patient and getting a care plan ready for the patients:

"[The patient] could have been referred directly to an A&E unit or to a CCU department which would have been the most appropriate. They were called directly on their direct line by me. I explained the history and the symptoms and he was accepted." (ECP5)

Patients who were assessed as being safe to leave at home are given a safety net in terms of advice on follow-up care. The ECPs ensure that the patients, or someone else who can look after them, understand the advice given:

"[I] advised the lady that there [will be a] need to follow up on the finger to establish there is still good movement in the finger. She may need a physiotherapy assessment to maintain a full use of that second finger. Also with regard to repair the wound, she may need the sutures removing about a 6 days." (ECP2)

Additionally, the safety net may involve other care providers. For example, after treating a patient who was living alone, an ECP contacted social services to arrange for carer visits and risk assessment of the patient's house. So, the safety-netting activity may include the referral activity as well:

"[I] treated the actual illness itself with the antibiotics and the analgesia, gave him the health advice that he required, and then it was a case of getting in touch with social services and trying to get him supported." (ECP11)

4.3.3.2 Cues

For contacting care providers like the GP and social services, the ECPs use the telephone number stored in their mobile phone, or asked the control room to find the number for them. Alternatively, ECPs can search for contact details in written records that are available on the patient's medical records, the patient's personal contact list.

For ensuring the patients understand the safety net set up them, ECPs make use of the assessment in the earlier stage of patient consultation. They ascertain the mental and physical capacity of the patient for understanding and following advices.

4.3.3.3 Knowledge and Experience

The experience gained on the job helped the ECPs to know which care providers are likely to be suitable for their patients. Additionally, the ECPs' background gave them personalised knowledge and experiences of what resources are available. Familiarity with other parts of the healthcare services enables ECPs to generate different options for the patient. For example, an ECP with a nursing background has more knowledge about the resources in the A&E:

> *"Because I have worked in A&E, I tend to know what things are out here that you can access. The paramedics don't know because it is all new to them. So, they are not still sure what sort of things they can do." (ECP8)*

The experience of making referral is also a basis for making future referral. One ECP reported a problem that she had in trying to admit a patient to a psychiatric ward.

Based on the resolution of the problem, she would be able to reduce the likelihood of facing the problem again for future referrals:

> *"The problem that I encountered was that the gentleman [ward manager] was sticking to his protocols. I think if I had spoken to the doctor directly, I wouldn't have encountered problem." (ECP7)*

4.3.3.4 Limitations

Choosing the best referral for the patients is limited by the access granted by the receiving care providers. Some hospitals do not allow ECPs to admit patient directly to the department that the ECPs think is best for patient. Therefore, the patients need to be referred through the A&E department:

> *"Accident and emergency [department] is not the appropriate place [for the patients], but either a medical admission unit or surgical admission unit is. And we struggled to get a direct pathway to those two particular areas for the patient; whereas in another [hospitals], the ECPs have access to available beds." (ECP1)*

> *"There is only one hospital in this area that we have problems with. [The hospital] don't accept from us, and everything has to go through A&E." (ECP11)*

Another problem faced by the ECPs in formulating the best care pathway for the patient is the availability of the receiving care providers. Some of the care providers,

like the intermediate care team, are not available outside of the normal working hours (9am to 5pm Monday to Friday) as reported by an ECP:

> *"I used to find that it was quite difficult at any point out-of-hours, and especially Saturdays and Sundays, and it always seems to be the Saturdays and Sundays that you need the most." (ECP11)*

Access to other care pathways may be restricted due lack of professional recognition of the ECP role and also due to operating time. Another access issue is the time needed to communicate. For example, ECPs make a phone call to the office of a patient's GP; but there is no guarantee that the GP can speak to the ECPs straightaway. There may be a considerable delay before the GP return the call and respond to the case on hand:

> *"Had the GP had not been available, because GP are often unable to come promptly because of their other constraints, then I would have to have considered referring this gentleman for care at residential care or inpatient treatment." (ECP13)*

Table 8. Summary of 'referral and safety-netting process'

Activities	Cues, sources, and considerations	Knowledge and experience	Limitations
1. Giving advice to patient 2. Request access to resource from Ambulance Services 3. Request access to resource from other healthcare and social services	1. Contact list on mobile phone 2. Control room staff 3. Patient's records 4. Patient's ability to comprehend advice	1. Awareness of available resources 2. Awareness of available services	1. Access to referral pathway 2. Availability of the receiving care provider 3. Speed of communication with care providers

4.3.4 Situation awareness

4.3.4.1 Sources of information

The jobs recalled by the ECPs can be broadly categorised into two types: 'despatch jobs' and 'nurse jobs'. The despatch jobs were those assigned to ECPs usually with little information given prior to arrival. The nurse jobs were those that had gone through the triage nurses. This type of jobs has more information, and in some instances has goals already set up for the ECPs:

> *"It was a Cat C call from a Nurse triage to an 89 year old lady who had a fall. I was just to go and all I need to do is to dress the arm and have a look at the problem and basically sort out the laceration to her right arm." (ECP3)*

The pre-arrival information from Control Room can potentially guide the development of SA. The issue with the information are two-fold: the amount and the reliability of the information. In many cases, the amount of the information given to them leaves much to be desired:

> *"It was just the address and abdominal pain. That's all that we get. We get nothing more than that." (ECP11)*

Additionally, the ECPs reported that there is an issue of the reliability of the information relayed by the Control Room. Details received about patients were welcomed but not necessarily accepted at face value:

"I was obviously aware that the patient have got an arm injury, but due to the fact that the nurse had only spoke to the patient's niece over the phone, you're always aware that they can only passed on the information to you what they received" (ECP3)

More useful and vital information were gained when ECPs arrived on scene. As found in section 5.1.3.1.2, the patients themselves are importance source of information and cues. The patients are a more reliable source of information to support Level 1 SA (perception of elements). The observations of the patients' condition were complemented with observations of their surroundings to get a more complete picture of the patients' clinical needs. In addition, conversations with the patients or other persons in attendance were instrumental in getting additional or confirmatory information that the ECPs need.

4.3.4.2 How the Information was used

The interaction with the patient helped to develop the ECPs' SA beyond Level 1. The process pertinent to Level 2 SA (understanding) can be described as a summative process. It involved combining evidence from various sources. The ECPs described how evidence were 'added up' and pieced together:

"It was a case of listening to the lady's chest, finding out that she had consolidation and a high temperature. I put two and two together, making the diagnosis of pneumonia." (ECP9)

"The ECG showed changes in his heart rhythm and which were out of the ordinary. His (medical) history as well how he described his

pain, the onset of his pain, and how he felt all added up to needing him to be referred quickly to hospital." (ECP5)

"It was part of the jig-saw that I was putting together." (ECP3)

The examples cited above demonstrate how evidence from different sources can be used to confirm earlier findings. This confirmation made the information more reliable and thus more useful for developing Level 2 SA. Alongside finding confirmatory evidence, ECPs also tried to find disconfirming evidence. To use the jig-saw metaphor, the ECPs were consciously trying to find pieces of the puzzle that did not fit to rule out other possible pictures (i.e. diagnoses). In the following example, the ECP examined the colour of sputum to distinguish between two different diagnoses.

"The giveaway was the brown sputum which is usually associated with pneumonia. The standard chest infection is usually greenish." (ECP9)

In another example, an ECP ruled out that a patient who had a fall did not have injuries other than laceration based on the observation that the patient could stand upright albeit with aid:

"Basically after I've assessed that she hadn't hurt herself apart from the laceration, I assisted her up to her feet, lifted her to a standing position and she was weight-bearing fine." (ECP7)

Existing knowledge and skills were important to integrate the information gathered via observation and conversation to gain an understanding of the patients' clinical need. Clinical assessment skills are necessary to get accurate and reliable observations (e.g. listening to the chest to check for lung consolidation) and this is backed up by physiological knowledge of the respiratory system.

> *"The respiratory assessments really sort of backed up what the history said." (ECP4)*

Previous experience with similar cases also helped the ECPs to piece together the information. The experience helped them to group pieces of puzzles in a coherent picture. In other words, the ECPs formed schemas based on experience:

> *"All of those things I learned from previous experience generally are signs and symptoms of urine infection." (ECP6)*

The experience made the ECPs more alert to certain cues that may trigger a line of investigation. In one job, the smell of urine triggered the assessment for urine tract infection even though the patient had called for a head injury suffered from a fall:

> *"The smell of the urine suggested one of the things I would certainly be checking for was to see whether or not he had a urine infection." (ECP6)*

The time scale for consultation required the ECPs to make quick decision especially for patients who need treatment at the hospital. There was less opportunity for the ECPs to have lengthy consultation to observe drastic changes to the patients. Nevertheless, the ECPs did reported thought processes that are pertinent to Level 3 SA (projection). The time frame for Level 3 SA is much longer than for Level 1 and 2. It involved the projection of the patients' condition if they were left home. The patients' clinical condition was perhaps not immediately life-threatening, but poor enough to be unsafe to leave at home:

> *"The decision was made it wasn't safe to leave her at home. At that stage she'd deteriorate and call back." (ECP9)*

In other instances, the projection that guided the decision process was based on patients' surroundings more than patients' clinical condition. In the following example, the ECP, having noticed the lack of physical support (e.g. grab rails) around the patient's house, decided to contact social services to arrange for further support for the patient:

> *"It was evident by the by the state of the house that at some point he is going to start having falls and then end up in hospital." (ECP11)*

4.4 Discussion

The main themes identified for the ECPs ('assessment of situation' and 'selection of actions') are similar to the ones identified for dispatchers. However, where the dispatchers 'coordinate and plan' (Blandford & Wong, 2004), the ECPs are doing

‘referral and safety netting’. This difference reflects the nature of the work with regards to management of resources. Where the dispatchers are concerned with mobilising resources to patients, the ECPs are concerned with mobilising patients to resources. This reiterates the statement provided in section 4.5.2.4 regarding the difference of SA requirements for the ECPs and Control Room staff.

The ECPs’ schemata for guiding their assessment of situation are developed through training, and experience either prior to or after becoming ECPs. The ability to conduct holistic assessment has been cited as a significant gain and important for the role. In addition to personal knowledge and skills, the patients’ surrounding is also important for assessment of situation. The focus on the surrounding is part of the schema for getting a holistic view on the patients’ need.

The limitations to the selection of actions for the ECPs concern the scope of practice. For example, the types of drugs that the ECPs carry and can administer to the patients are controlled by the PGD. However, this limitation can be overcome by providing the ECPs with extra qualifications. This raises the issue of widening the job design to enlarge the ECP role. One ECP wanted to take a prescription course to enable her to deal with more patients without having to refer them to other care pathways.

The interviews revealed the information that the ECP use. The interviews again confirmed the findings reported earlier. Patients are an important source for reliable information. This raises the issue of making available other sources of reliable information (e.g. electronic patient records) for cases when patients have limited ability to communicate. The technical support is especially important considering the

observed correlation between patients' communication ability and the access to hospital. There would be a bias towards transporting patients to hospital when reliable information cannot be obtained. Thus, to support the ECPs in realising their role, more support should be given to provide them with reliable information.

The way the ECPs use the information to develop Level 2 SA is consistent with what is expected for safeguarding patient safety. ECPs searched for confirming as well as disconfirming evidence before committing themselves to a course of action. An understanding of the patients' clinical and social needs helped the ECPs to select the best intervention. However, as noted earlier, the interventions may be limited by the scope of their practice, or by the access to the receiving service providers.

This Chapter reveals the clinical and non-clinical factors that were considered by the ECPs in making a decision to choose the best path for patient treatment. The clinical needs of the patients are indeed very important. However, there seems to be various other factor that may influence the final decisions made by the ECPs. In the next Chapter, the non-clinical factors are examined in further in an effort to construct a socio-technical framework for the ECP job.

CHAPTER 5: A SOCIO-TECHNICAL SYSTEMS FRAMEWORK

5.1 Introduction

Chapters 3 builds a case for studying SA and NDM in pre-hospital care domain. While studies on SA and NDM had been done at the individual level, in general, there is a need for a wider and more inclusive systems approach (Schutz, Counte, & Meurer, 2007; Waterson, 2009). In order to achieve this, research needs to take into account aspects of macro/micro influences on the SA along the lines of different system levels. There already exist frameworks that model system levels that can be used (figure 10). This type of framework might provide an appropriate means of aligning the three dominant perspectives on SA namely cognitive psychology, engineering, and system ergonomics (Stanton, Salmon, Walker, & Jenkins, 2010). The alignment of the views can make for a richer and a more complete description of SA.

This chapter presents a socio-technical systems framework to describe the ECPs in an ambulance service organisation. It explains how an integrated socio-technical systems framework is developed by using data from a scoping study and existing literature. Initial data collected from the scoping study show system-related influences on the job of the ECPs. These influences are presented in a more formal manner to show the linkages among system elements. The chapter concludes by suggesting ways to test and validate the framework.

5.2 The continuum of emergency care

Emergency care can be divided into a number of stages, decision-making points (e.g., the decision to transport a patient to hospital as compared to discharging the patient once treatment has been administered by ambulance personnel), types of roles and technological support. Figure 11 shows a simplified pathway for emergency care alongside example of the types of decision-making made by the various personnel associated with stages in the pathway.

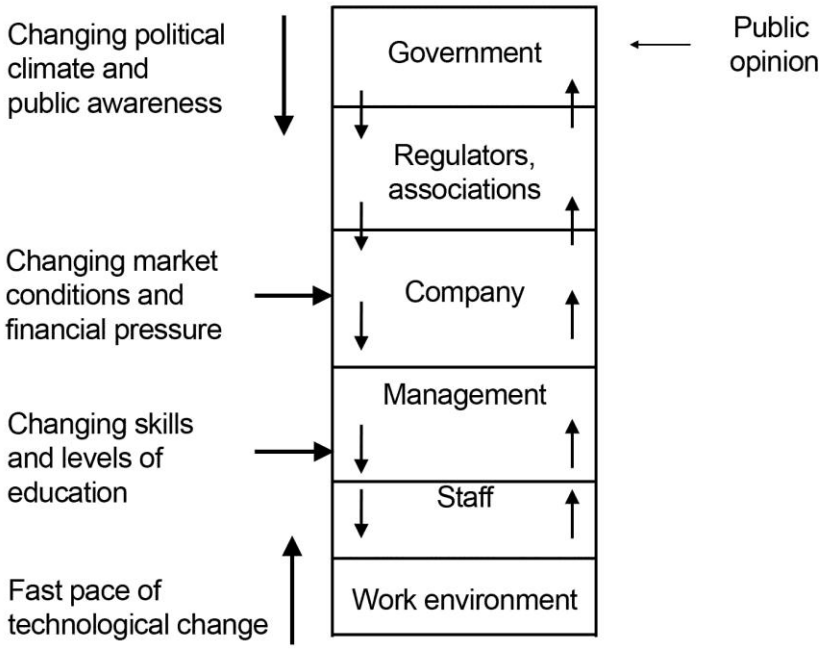

Figure 10: System levels and associated influences (source: Rasmussen, 1997)

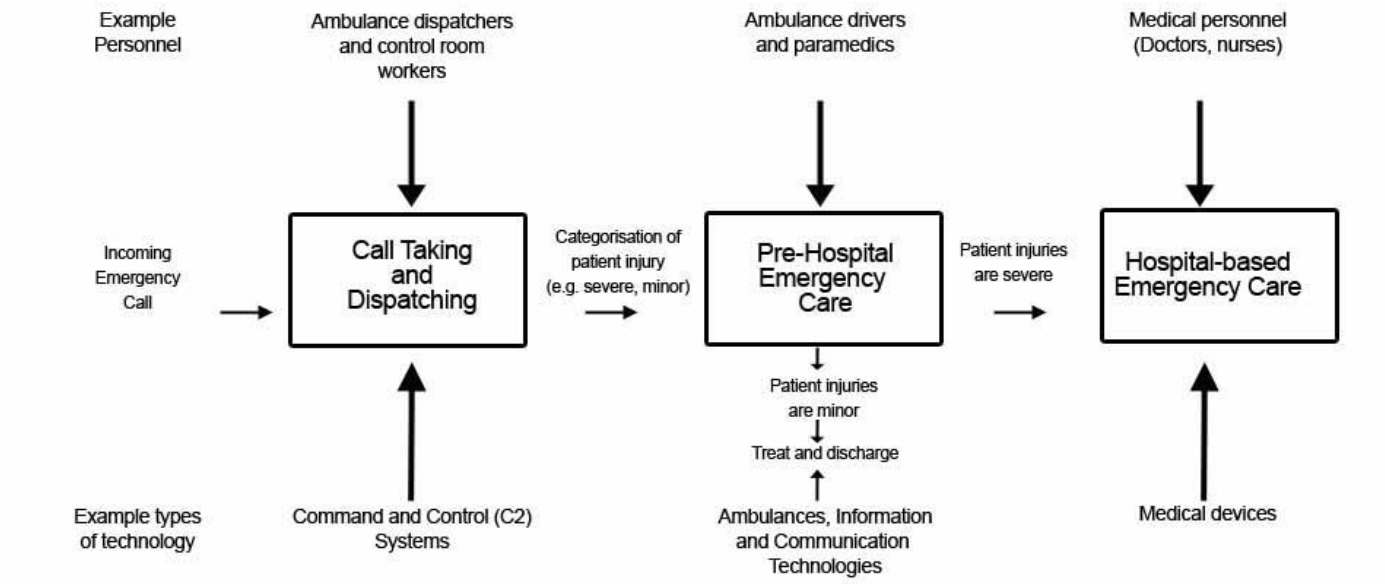

Figure 11: Stages of pathway for emergency care

The first part of the emergency care pathway in figure 11 (call taking and dispatch) has been investigated in detail by Blandford and Wong (2004). Their work focused on SA and decision-making among Emergency Medical Dispatch (EMD) operators in the control room of London Ambulance Services. Through observations and interviews, they found that the EMD operators' work involves both routine and non-routine behaviour. Routine behaviour is interpreted in terms of recognition-primed decision-making whilst non-routine events (e.g., the location and availability of ambulances) are interpreted in terms of dynamic changes to SA over time. Wong and Blandford (2001) also made use of what they termed the "Integrated Decision Model", or IDM (Wong, 2000), to review the decision concepts revealed in studies of ambulance dispatch. The IDM is a naturalistic decision-making model built upon existing NDM models. It describes decision-making by highlighting the goal, priorities and constraints, decision process, and SA.

Other work has examined in detail the dynamic and fluctuating nature of emergency care. Observations of an emergency department within a hospital as the department coped with the challenges of limited resources (e.g., staff shortages) and uncertainties (e.g., quiet and busy periods of activity) revealed the strategies used to maintain safe work performance (Anders et al., 2006; Wears, Perry, & Mcfauls, 2006). The researchers interpreted their findings as they related to decision-making using a resilience engineering perspective. For example, in facing increasing demands, personnel within the department had to make decisions on the availability (buffering capacity) and usage of resources within the immediate work environment, the whole department, or across other departments in the hospital (cross-scale interaction). In general, the emergency department copes with limited resources by reconfiguring spare resources from other departments in the hospital. In some cases this involved allowing paramedics to take over patient care for less critical patients and using the available resources (i.e., doctors and nurses) to attend to more critical cases.

5.3 The need for an integrated, socio-technical framework for SA and decision-making in emergency care

The Integrated Decision Model (IDM) (Wong, 2000) is a cognitive engineering-oriented framework that had been applied to the emergency medical service domain. Wears et al. (2008) have documented a more resilience engineering oriented approach to understand the complex pattern of performance variability in the emergency department. The IDM might be said to focus on the micro elements of individual and team SA and decision-making in emergency dispatch, the resilience approach by contrast, examines the macro properties of hospital-based emergency care (e.g., how the system degrades and the relationship between demand and performance quality). What is currently missing from our understanding of how

emergency care operates as an integrated system are the wider, external constraints on the various personnel involved. These types of constraints are especially important within a UK (National Health Service - NHS) healthcare context where macro-level variables such as government policy and targets, alongside the implementation of these by local management groups, have a direct impact on the day-to-day work of emergency care personnel. In addition, little is known about SA and decision-making as it applies to pre-hospital emergency care (i.e., the second stage in figure 11).

One of the main aims of the chapter is an attempt to fill in the missing part of the model, namely the process of SA and decision-making as it applies to pre-hospital emergency care. In order to do this, this chapter describes a study examining the requirements for SA and decision-making alongside an account of the types of constraints that apply to these processes within this context. A second aim of the chapter is to outline an account of SA and NDM across macro/micro levels of analysis. This is done by using the findings from the case study to present an outline of an integrated socio-technical framework for emergency care. A final section of the chapter describes a set of research questions that could serve to further develop and test the framework.

5.4 Setting

Within the UK ambulance service control rooms receive 999 calls which are then categorised into Categories A, B, C, or urgent as listed in Table 5. The performance targets for each call category are different and national and locally agreed targets are in operation. For example, one national benchmark is to respond in under eight minutes for at least 75% of the Cat A call (NHS Information Centre, 2008).

Table 9. Response time for different categories of calls

Category of Calls	**Types of Cases**	**Response time**
A	immediately life threatening	8 minute response
B	serious but not life threatening	19 minute response
C	not immediately serious or life threatening	locally agreed response time standards
Urgent	request for transportation via a separate phone line	usually in response to a GP/midwife/health care professional

As described in the Chapter 1, East Midlands Ambulance Services (EMAS) is one of the 12 Ambulance Trusts in England. In the operating year of 2006/07, EMAS employed 62 ECPs with 20 staff enrolled in BSc program to be qualified as ECPs (East Midland Ambulance Service NHS Trust, 2007).

5.5 Methods of study

The study adopted an observation approach. The observation was conducted during the participants' normal working hours. All of the participants are employed full-time and no compensation was given for their participation. The observations were conducted during the participants' normal working hours. All of the participants are employed full-time by EMAS. No compensation was given for their participation.

5.5.1 Participants

The study involved two ECPs, seven control room staff (4 triage nurses, a dispatcher, a call taker, and a control room manager) and the Director of Operations, all of whom works full time with the ambulance service. The participants have between 1 to 11 years of experience in their current work and their age ranges from 33 to 48. Convenience sampling was used to select the participants. The ECPs were recruited

through the Director of Operations. Other participants were recruited through invitation letters sent to the address given by the Director of Operations.

The participants signed a consent form before the start of the interviews and observations. Participation was voluntary and there was no incentives offered to the participants.

5.5.2 Procedures

The ethical approval for the study was obtained from the NHS Research Ethics Committee prior to the start of the data collection. Ride-out sessions were organised with the aim of describing the nature of the role of ECP. The author followed two ECPs during their regular shifts. The ECPs were shadowed two shifts each for a total of 36 hours. To increase the probability of attending a variety of patient cases, both day and night shifts were covered during weekdays and weekends. During the observation period, notes were made regarding the use of technology and equipment (vehicle, mobile phones, and satellite navigation system), task procedure, related systems (ambulance control room, external medical services), environment, and task outcomes. The observation was structured around the System Engineering Initiative for Patient Safety (SEIPS) model of patient safety (Carayon et al., 2006). SEIPS describes a work system by looking at the structure (e.g., technology and tools, work organisation), processes (e.g., care processes) and outcomes (e.g., patient outcomes). Specific SA-related issues were noted and categorised using Endsley's (1988) 3-level classification of SA.

In addition, two observation sessions on separate days were carried out with three Triage Nurses at a control room of the Ambulance Services each lasting four hours.

The ECPs that took part in the observation study were also interviewed using a semi-structured interview schedule, along with one of the Triage Nurses. The primary aim of these interviews was to gain an overview of the operation of the control room and the communication between dispatchers, ECP personnel and other groups (e.g., General Practitioners, Police). The findings from the observation and interview sessions were subsequently used to develop a communication map of the role of the ECP within the Ambulance Services. The map was iteratively improved via interviews with five control room staff and the Director of Operations.

5.6 Findings

5.6.1 Communication between the control room and the ECPs

Figure 12 shows a diagram of the communication and coordination of activities between the dispatch control room and the ECPs. An incoming emergency ("999") telephone call is filtered down in the control room and assigned to ECPs via various staff and information systems. Two medical information systems (labelled MIS1 and MIS2) alongside the Advanced Medical Priority Dispatch System (AMPDS) are used in triage work. Landline phones and mobile phones are not included in the map although they are used by the staff to reduce the complexity of the diagram.

A 999 call would be answered by an emergency operator who then transfers it to the local ambulance service. In parallel, the Emergency Information System would automatically detect the location of the caller where possible. The call taker at the despatch desk would dispatch an ambulance immediately (to an address supplied by the Emergency Information System) before passing the call to the Emergency Medical Dispatchers (EMDs). The EMDs use the AMPDS to gain further information from the caller. Using the AMPDS classifications, the EMDs would update the resource currently sent to the caller (e.g. to supply patient information or ask the

resource to halt and return to base). A call may be passed to a Triage Nurse where appropriate (e.g. for Category C cases). The Triage Nurse would call the patient to collect more information. Where possible, the patient is given medical advice over the phone or referred to other medical services. If further ambulance service resources are required, an ambulance crew or an ECP would be dispatched.

During work shift, colleagues (ambulance technicians, paramedics) who require assistance may contact the ECPs for their advanced knowledge. In cases where the attended patient died, the police had to be notified. Additionally, like the Triage Nurses, the ECPs may liaise with other medical services like walk in health centre, general practitioner's (GP) clinic, District Nurses, and Social Workers.

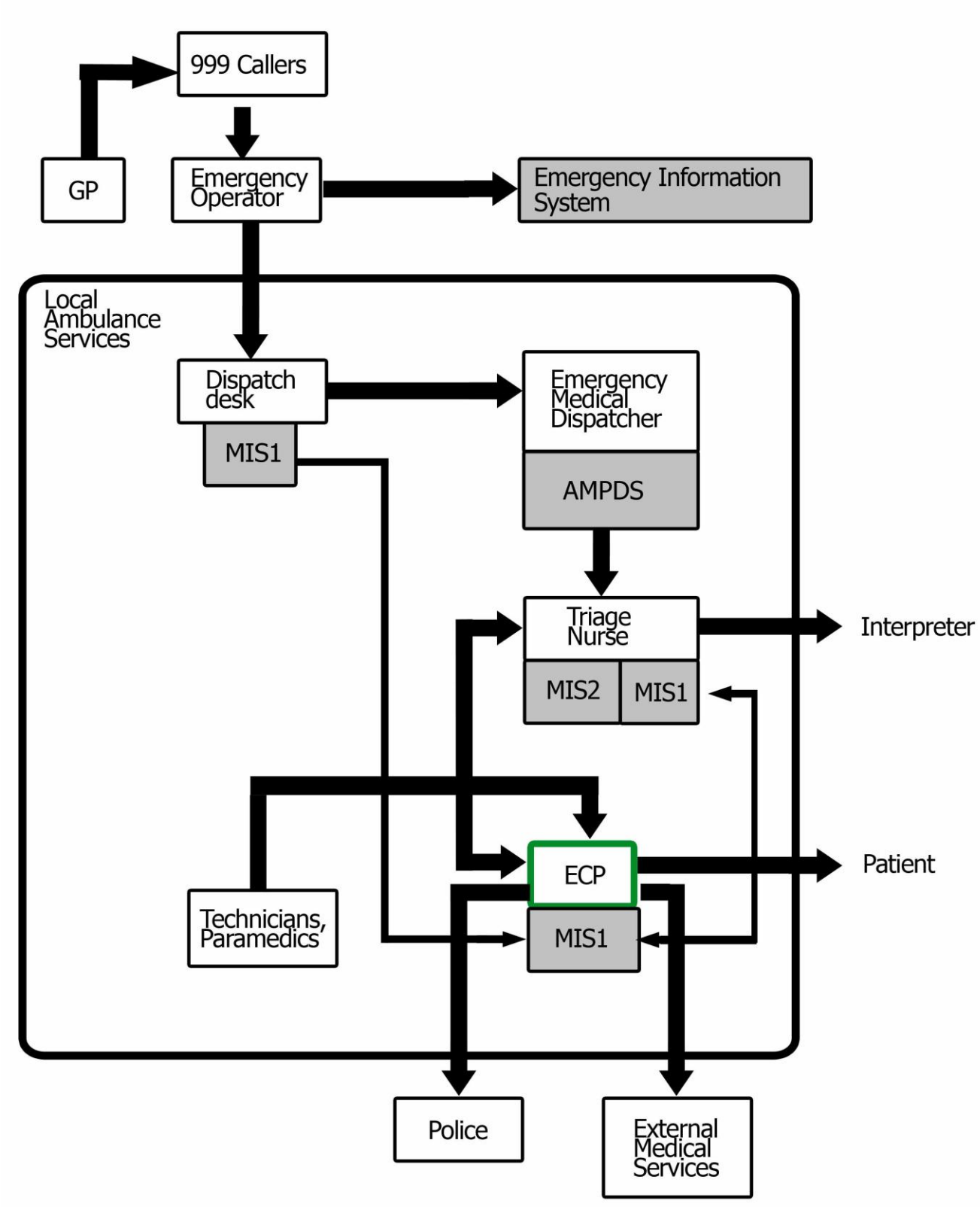

Figure 12. Communication map of the ECPs

5.6.2 SA, decision-making and other factors influencing the work of the ECP

5.6.2.1 Performance targets

External influences on the system such as levels of resources and performance targets are important performance shaping factors for the system as a whole. Both national and local standards are set for the ECPs, these standards impact upon the way in which work is allocated to the ECPs. For example, one ECP explains the reason for him being assigned a non-ECP type of job:

> *"I've been talking to my colleagues who had worked a lot longer... I think when they originally started they were just used as ECPs but there is an immense pressure at the moment to respond to calls within a certain time and so you're often called in." (ECP2)*

The quote above demonstrates the changes in the types of job assigned to ECPs. The pressure to meet response time target means ECPs are sent to a wider variety of jobs, some of which are not ones for which the role was designed. When ECPs are the nearest ambulance personnel to a patient, they may be sent by Control room staff to increase the likelihood that the patient is seen within the response time target.

5.6.2.2 Levels of resources

Resources which are allocated for technology also impact the effectiveness of ECPs. One ECP, for example, thought that investment should be made with regard to communication technology in order to enable him to meet performance targets. He compared the current work place with his previous workplace (a different Ambulance Services) where the Management Information System (MIS1) would automatically

input the postcode into the satellite navigation system, thus bypassing the need to input the postcode manually:

> *"They have not fully invested in it [speaking about the MIS1 system]. If they want us to respond immediately, you should really provide the equipment to be able to achieve that." (ECP2)*

Another example is the mobile data terminal screens (which are linked to the MIS1) for the ECPs' vehicles. According to a control room staff, there are instances where she had to relay job details (e.g. job number, patient's age, address) by phone because not all of the ECPs have the screens fitted on their vehicles. Direct transfer of job details to the screen is imaginably a good information redundancy strategy to support emergency responses. The redundancy removes the need for the ECPs to rely on their own memorisation ability under time pressure.

The vehicles allocated use may not fit all the jobs associated with the ECP role. With Category C call, ECPs have up to 2 hours to get to the job location. Being called upon to respond to emergency cases (Category A and B) means the vehicles are used differently:

> *"With the demand of doing Cat A and B, it puts the strain on the resource because the vehicle isn't really designed for doing all three (categories)." (ECP1)*

5.6.2.3 Quality and nature of information presented to the ECP

The dispatch team in the Control Room also influence the work of the ECP by filtering the tasks before they are assigned. The dispatch and attendance of an ECP to an emergency is only one of the treatment pathways handled by the Control

Room. As such, the Control Room can be seen as the gatekeeper of the emergency calls. An issue that rises from this type of organisation is the quality of the information relayed to the ECP. For example, one ECP commented that the patient information from the control room (as displayed on the MIS1 screen) does not help much in assessing a patient's condition. The usage of the computer-assisted triage system does not necessarily lead to a correct summary of the patient's condition. There is additional evidence from other research that this type of computer system causes problems in terms of the selection of cases for ECPs (Gray & Walker, 2008).

In some cases, the code used to represent a medical condition, does not represent the patient's actual illness or complaints accurately. The initial information provided by the dispatchers via AMPDS (Advanced Medical Priority Dispatch System) may not match the actual problems presented by the patients:

> *"They (the 999 callers) may be diabetic or they may be pregnant, but they (call takers) have not picked that up because it is not in their question set (the AMPDS)." (Triage Nurse 1)*

In those instances where the ECPs are given inaccurate presenting problems, the ECPs may be exposed to confirmation bias (Nickerson, 1998) - the tendency to find information that agrees with an existing hypothesis provided by the AMPDS. The bias can be overcome by direct observation of the patient, or by getting more information from the Control Room staff:

> *"We are not really getting the appropriate information unless I then can manage to speak to the nurse who took the call." (ECP1)*

In this example, the ECP would have to speak to Control Room staff directly in order to get information that is more accurate and complete. The control room staff's situation assessment did not seem to transfer well via the electronic communication technology.

On the other end of the information availability spectrum, ECPs may not receive any information about the patient at all other than the address. In some cases, the transfer of information did not happen at a personal level. The information was transferred between MIS1 without making personal radio or phone calls:

> *"Sometimes they don't ring you. They just send you a job... I've gone to job where I hadn't spoken to them [Triage Nurses] at all." (ECP2)*

ECPs may be dispatched before enough information has been gathered from the callers. These instances are likely to occur for emergency cases (category A calls) where the time frame to mobilise a responder is much smaller than for urgent cases. Based on an AMPDS dataset covering the period from 1 August 2008 to 31 January 2009, category A calls account for 34.3% (4,358 of 12,722) of all calls assigned to ECPs.

The problem regarding the quality of information relayed to the ECP can be understood by looking at the influence of time-based performance targets mentioned above. Time targets may mean a call has to be assigned to ECPs before a complete assessment of the patient can be made:

> *"Because of our targets, around Category A and B, we haven't got the time to [assess patient's need in detail]. We got vehicles moving*

even before we know what is the problem. If the nearest one is an ECP, then the ECP will be sent." (Triage Nurse 1)

The information transferred to the MIS1 can be also ambiguous. The computer-aided triage system used by the control room staff aims to support fast decision-making. It may not necessarily support comprehensive evaluation that will yield better quality information. A feature that was found to be problematic is the use of alphanumerical code (which is sent to the MIS1) as a summary or keyword for the complaints reported by callers:

"The nurse may have [been informed] that a patient hasn't passed water for 6 hours and is therefore likely to be in acute urinary retention. I would get it as 1-alpha-1 [the AMPDS code] which is abdominal pain." (ECP1)

In this instance reported by the ECP, the triage nurse received information that was processed using the AMPDS. The system generated a code that represents abdominal pain which masked the fact that the patient hasn't passed water for a long time. The AMPDS gave information that is not consistent with what the patient told the nurse. Therefore, the ECPs are less likely to be able to predict the possibility of the patient having acute urinary retention. In short, the information from the AMPDS does not support accurate understanding of the patient condition and may hinder the ECP from making proper plan for the patient.

The quality of information presented to the ECP also has a strong influence on SA. A threat to Level 1 SA is due to the limited screen area of the MIS1 hardware installed in the ECP's vehicle. The missing part of the patient's address (e.g. postcode)

increased the time needed to input the correct information into the satellite navigation system (which is separate from the MIS1).

5.6.2.4 Patient-related influences

At a micro-level within the system, information originating from the interaction with the patient (e.g. pulse patterns) might affect SA as indicated in Table 6. Additionally, the patients themselves, who are viewed as the main source of information, may not be able to convey the information well. They may be confused, unstable, or have limited English skills:

> *"Sometime [the patients] are frightened. They don't know how to explain their condition." (ECP2)*

The information conveyed by the patients to the triage nurses or dispatchers at the control room may not have been accurate as mentioned in the previous section. Patients might convey a different set of information once they are face-to-face with the ECPs compared to talking to someone over the phone:

> *"It's quite it's quite amazing when you actually sit down and talk to people and just slowly go through it you actually get a different picture." (ECP 2)*

Patient's social need also matters: the decision to treat in the community or send to the hospital is not always based on clinical needs:

"You haven't found anything [clinically] wrong, but if they can't cope at home well, probably they would go in the hospital as well." (ECP2)

ECPs have to assess and evaluate the psychosocial needs of the patients including risks and threats of leaving the patient in the home environment. The decision to send patients into the hospital could be based on the assessment that the patients can cope better in a hospital. For example, the lack of social support might influence an ECP decision on the patients care plan:

"Someone in their mid-30s or 40s that has some family structure as opposed [to an] elderly person on their own ... that would influence your management of that patient." (ECP1)

Patients may also dictate the decisions for the ECPs. Patient may go against the decision proposed by the ECPs. If patients want a second opinion, they might still go to the hospital. In other cases, patients can refuse to go to the hospital as far as their capacity to give (or refuse) consent is present.

5.6.2.5 Training and knowledge

The decision-making process of the ECPs may be influenced by experience and expectation. One ECP reported being more confident in leaving patients at home as a result of his training. Training makes it easier for the ECP to detect the conditions in the patients that require hospitalisation. The problem regarding the incomplete postcode can be compounded by relative unfamiliarity with local geography. For example, an ECP who has just started working in the new area was not familiar with the street names:

"You press that you're responding and you're moving and actually you're not because I don't know the area that well, and you're spending time putting it in the SatNav [Satellite Navigation System], which takes time." (ECP2)

Familiarity with the local area and its geography is an advantage and as a result response times are faster when the ECP is operating in a familiar area. In addition, the information displayed on the MIS1 screen does not directly lead to understanding (Level 2 SA) of the geographical destination. A rough estimate of the destination would enable the ECP to respond faster by driving towards the general area, and fine-tuning the direction as more understanding develops. The management team could mitigate this personal factor by stationing and training the ECPs so that they become familiar with the geographical area in which they are working:

"If you have a rough idea of an area you can be heading in the direction while the SatNav's firing itself up…rather than if you were to put me in a completely different city or area." (ECP1)

The importance of geographical knowledge would also help the control room staff in dispatching other resources. As an example, an ECP helped a control room staff (who had access to graphical display of the location of ambulances across the region) to identify an ambulance that would take less time to reach the patient. As Patrick and Morgan (2010) pointed out, simply making information available at an interface (e.g. display screen) does not necessarily improve SA:

"The job I was given yesterday which would take me over an hour to get to because the nurse that was designating the job to me has got

no geographical knowledge. I pointed out to her that there was someone 25 minutes away." (ECP1)

The ECP and nurse in the above example had different understanding of the relative location of ambulance personnel (understanding – L2 SA) which would influence the estimate of how soon the destination can be reached (projection - L3 SA). The tasks of ECP and nurse are different; the ECP requires SA for navigation while the nurse requires SA to allocate resources to incoming calls. The solution for each task may not be the same. For the ECP, better support of SA can be achieved by customising the existing navigation system. Further understanding of the ECP work would also help in designing a better navigation system to support ECPs' SA.

5.6.2.6 Job design issues: feedback, task completion and skill variety

The example for level 3 SA in Table 6 shows how SA is related to job design. The ECP reported that a feedback for a completed task would be beneficial.

"[I] always try to reflect and think … was that the best plan of action or have I put them in the hospital for no real reason and … quite often there is no real feedback." (ECP2)

In other words, the knowledge of patient's outcome would constitute a learning component that is important for the development of better or more accurate SA in the future. Another job design issue is skill variety which relates to the first factor (performance target) described earlier. The opportunity to work on different clinical cases is regarded as valuable. Thus, the ECP did not mind being asked to respond to emergency calls that are usually given to ambulance crews:

"My skills got better. I've been to [emergency] calls and actually been able to deal with them and involved ECP skills as well." (ECP2)

"Because we are so specific in what we're doing, we're not really performing the full gamut of ECP tasks. Working in different clinical areas and being exposed to different clinical things on a regular basis is [going to] stop the skill erosion." (ECP1)

Communication with staff in Control Room, as mentioned in section 4.2.3, was identified as a factor that affects job performance. In this regards, one ECP envisaged enlargement of the role to better facilitate the relationship between the Control Room staff and the ECP. He suggested the ECP to be given the opportunity to spend time in the Control Room as call takers:

"[call taking task] should be a part of the role so that we build .. relationship with the control staff." (ECP1)

The enhanced relationship would allow better understanding among the Control Room staff about what the ECPs can do so that they will be sent to patients that are more suitable.

5.6.3 Summary of findings

ECP communicate using multiple channels with multiple parties. The process of communication can be improved to better support the quality and timeliness of information relay. Issues related to different levels of systems elements were also identified with regards to ECP SA and decision-making. Table 6 provides examples

of problems at three levels of SA. Their causes and possible solution are also presented.

5.7 Steps toward an integrated socio-technical framework for emergency care

5.7.1 Micro level components

To provide an account of an integrated socio-technical system for various stages in the emergency care pathway (figure 11), it is useful to first describe the systems components at different levels. The availability and utilisation of tools and technology which represent more micro-level influences was found to be affected by performance standards, and resources made available to the ECPs. Other micro-level issues could be examined, for example, the role played by individual differences. There is some evidence for consistent individual differences in SA. Endsley and Bolstad (1994) reported correlations between cognitive attributes and SA scores.

Table 10. Causes and possible solutions for examples of SA issues

SA Levels	Problem	Outcome	Cause	Possible solution
Level 1: Perception	The MIS1 screen in the ECP's vehicle displayed truncated postcode	ECP cannot perceive complete information	Investment in technological resources	Integrated communication devices
	Control staff assigned job without relaying information about patient	ECP does not have any information about patient prior to arrival	Time constraint	Semi-automated information relay system
Level 2: Comprehension	ECP reported that ECG output is different from what was expected based on pulse pattern	ECP cannot comprehend the contradictory symptoms the patient presented	Access to clinical lead is not provided	Clinical review and training
	AMPDS code assigned to patients summarises the presenting complaint	ECP are not able to understand the underlying problem	Characteristic of the decision-support system	Supplementary patient information
Level 3: Projection	ECP reported that he wish he know whether the patients are all right after taken to the A&E	ECP cannot make accurate projection of patients' future health condition	Patient follow-up is not part of job description	Clinical review and assessment
	Control does not tell ECP whether ambulance back up was sent	ECP cannot estimate when the ambulance will arrive	Work procedure	Automated information updates

Within a socio-technical framework, these attributes can be considered as they apply to job design. Individual differences should be recognised and considered as each ECP bring a unique set of knowledge, skills and abilities (KSAs) into the job. One ECP reported that “a large part of the role of the ECP is a person-specific role” (ECP1). The importance of expertise and knowledge for constructing and maintaining SA has also been reported for operator of signalling and rail control (Golightly, Wilson, Lowe, & Sharples, 2010). Hence, other factors affecting the formation of the schemata like cognitive attributes, job design and technology could be considered.

In terms of job design, compared to ambulance technicians and paramedics, ECPs have more autonomy. This autonomy means the ECPs have relatively more say about treatment for patients. In other words, the ECPs are entrusted to make decisions on the course of treatment. The autonomy aspect is also apparent in the assignment of ECPs as solo responders. Unlike paramedics and technicians, ECPs can attend to a patient on their own. Other than autonomy, skill variability and feedback mentioned earlier, other aspects of job design can also be considered for a more complete examination of the work role.

With regard to technology, the communication devices have been shown to be important to support the ECPs’ SA and rapid decision-making. However, the quality and reliability of information conveyed through the devices could be improved. From a work systems perspective, the tools and technology should be able to reduce the complexity of interdependence (Cordery & Parker, 2007) between the ECPs and other work sub-systems (e.g. the Control Room).

5.7.2 Macro level components

The standards, performance targets and resource allocations have been described as macro-level influences for SA and decision-making among ECPs. Macro-level frameworks that describe safety in complex organisations are useful to understand the impact of such factors on the individuals' performance. According to Rasmussen's risk management framework (figure 10), individuals may expand efforts in a safe manner as long as they do not breach functionally acceptable performance, workload, and resources boundaries. The dynamics of resources and demand are echoed by Wears et al. (2008) in their description of resilience of an emergency department. They describe performance in terms of stress-strain relationship. Wears et al. uses the term "horizon of tractability" to describe the way in which emergency departments, and in our case, pre-hospital care, operate within safe boundaries.

One thing that is clear from these frameworks is the role of macro-level influences in defining safe and resilient operations. In the present study, standards, performance targets, and resource allocations are parts of the definition of safe and resilient operations. In fact, the ECP role itself is a way in which resilience in built into the emergency care system. The inclusion of the role means that overall the systems can better manage fluctuations in demands for hospital-based care (ECPs' can provide care in the community and refer to other care providers). Improvements to ECPs' SA can have a positive effect on system outcomes. From the point of view of patients, it means emergency care can be delivered at the right time and the right place. For the systems, it means resilience, a desired state, is designed into the system.

We can postulate a 'trickle-down' or 'cascade' effect, in line with Rasmussen's (1997) Risk Management Framework, from the macro- to the micro-levels of the system. Taking the example of the limited MIS1 screen size, we can speculate what will

happen to the interaction between the social and technical subsystems over time. The Strategic Health Authority (SHA - social subsystem) may review the role of ECP and decide to further support the development of the role. Following instruction from the SHA, the Directors of the Ambulance Services (social subsystem) can allocate financial resources to procure communication devices (technical subsystem) that better support the ECPs' SA and decision making. The time frame for this trickle effect differs at each levels of the system. The actions of the SHA and Directors of Ambulance Services could take months to have an influence on the ECPs' SA. Once introduced, the devices themselves would require far shorter time in influencing the SA. In this example, the social and technical subsystems interact in a top-down manner (in the organisational sense of the phrase), across a differing time frame.

5.7.3 Relationships between macro and micro system components

The findings point to a range of influences on the SA and decision-making aspects of the ECP role. These influences mainly relate to the availability and allocation of resources to the ECP role. Some of these influences and linkages between system levels are indirect in the sense that decisions made at upper levels of the system (e.g., budget levels set by government) determine the nature of training given to ECPs or the types of IT support provided to them. Other influences are more direct since decision-making is subject to greater freedom, scope and choice. For example, the Ambulance Services are largely responsible for deciding how tasks are allocated to ECPs (e.g., allocating ECPs to specific categories of emergency call outs when workload is high). In this case, the decision-making responsibilities of the ECPs' may well be stretched and greater reliance put on their ability to cope under circumstances of high work pressure (e.g., dealing with patients where limited clinical support is provided).

Figure 13 sets out to summarise some of the links between macro and micro elements of the overall system for emergency care. The examples of SA issues identified in Table 6 are used here to show how they link directly and indirectly to different system elements. The system components in Figure 13 each have their tasks and functions. The dispatch component operates within a context set by the Trust Governance and Ambulance Service which in turn are influenced by constraints set by the government and regulatory agencies. The functions and tasks of the macro-level system components affect the attributes of a set of operational issues which are labelled as global impacts on ECPs' SA and decision-making. For example, financial budget set by the government dictates the procurement of technology and equipment by the Ambulance Service. The context shaped by these system components affect the appropriateness of the technological support given to the ECPs. The quality of the technological support (curved arrow 1 in figure 13) affected level 1 SA. In this example, an ECP was not able to perceive complete information from the hardware (i.e. data screen) he was provided with.

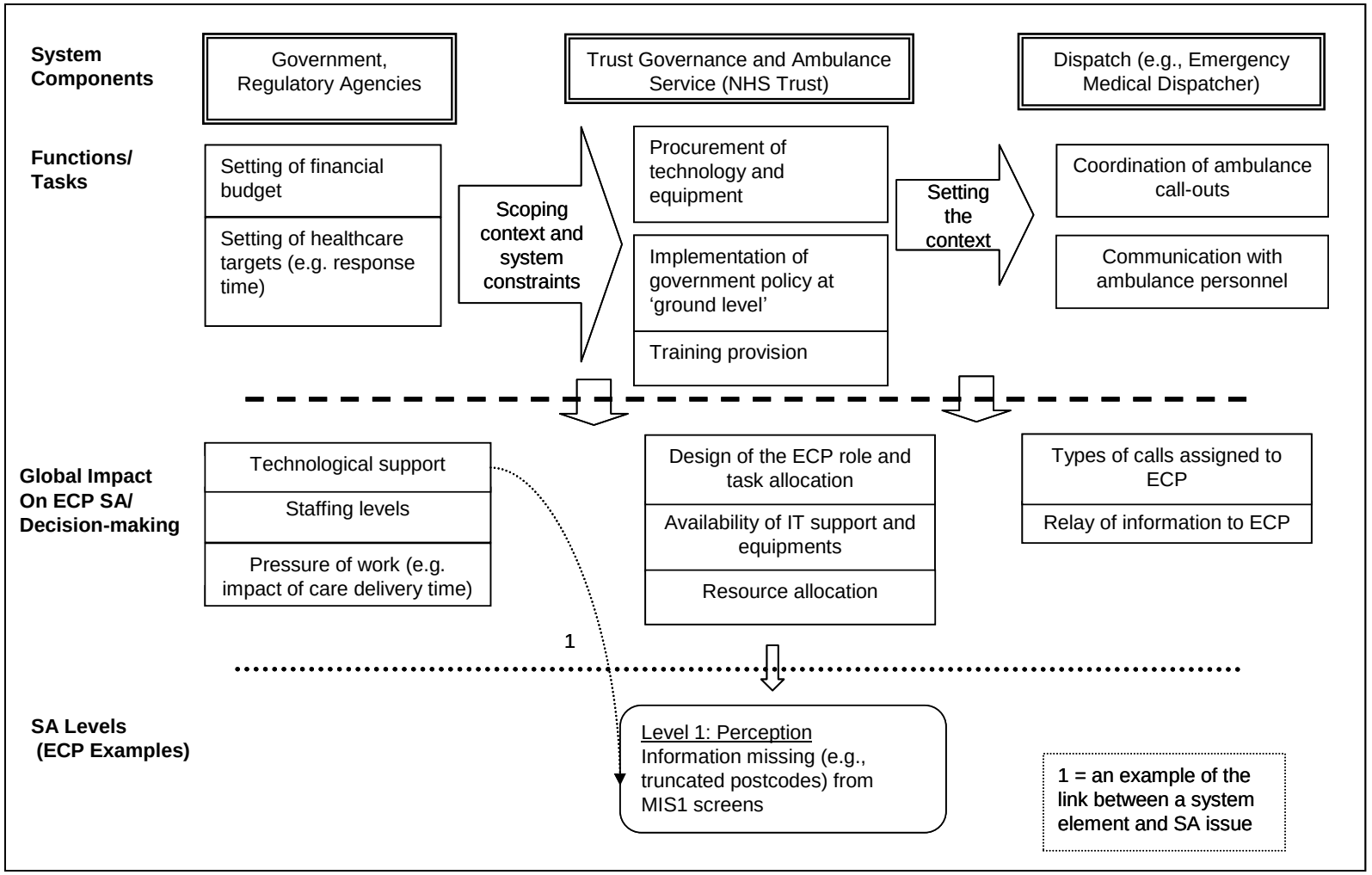

Figure 13. Relationship between system components

5.7.4 An integrated socio-technical framework for emergency care

One way of capturing and visualising our findings within the context of a larger integrated socio-technical framework is to adapt parts of the IDM model (figure 14). In the present domain, the situation of concern would be the patients themselves instead of calls and ambulance locations. In the original IDM model developed for ambulance dispatch, cognitive schemata influence attention (selecting what cues to attend to) and the assessment of a situation. Our findings show that factors influencing SA and decision-making can be assigned appropriate places in the diagram. For example, local geographical knowledge affects how quick ECPs are able to form a mental picture of a particular location of the patient.

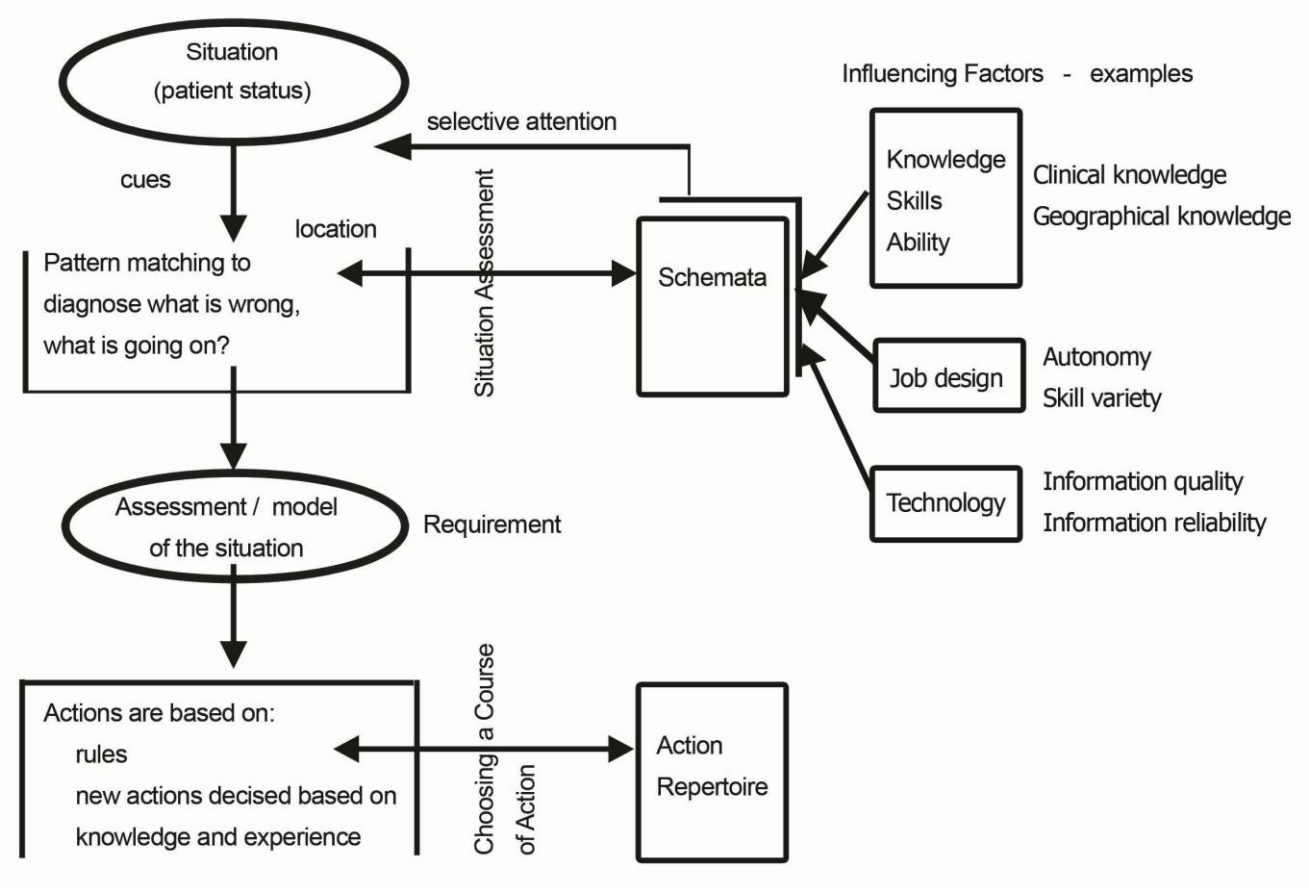

Figure 14. A Modified IDM model for ECP

The situation as stated in the diagram is defined in terms of patient status, which refers to the patients' clinical needs and psychosocial needs. Concerning the model, the needs can be divided into two categories: those that can be met on scene by the ECPs and those that cannot. These situations do not perfectly match the patient status as conveyed by the Control Room in terms of the Category of the call. Not all Category A calls were made by patients who require medical attention in the hospital. Conversely, not all Category C callers have clinical needs that can be treated on scene. Additionally, demand on time (emergency and urgent) can also define the situation. An emergency situation is one where there is immediate life threatening condition. In contrast, patients with an urgent situation have clinical needs that do not pose immediate danger. Therefore, a two by two matrix of the situation can be developed. Along one dimension is the time demand (emergency vs urgent) and the other dimension is the treatment demand (ECP on scene vs other care pathway). The emergency situation is likely to be related to the other care pathway situation rather than ECP on scene situation. For the urgent situation, the reverse is true. However, when the psychosocial needs are taken into account, the urgent situation may be coupled with the other care pathway situation. Thus, for the ECPs, the situation that they assess is the sum of the patients' clinical and psychosocial need.

Schemata guide attention by selecting aspects of the situation that are relevant to include in the assessment. ECPs also match features of the situation (cues) with their existing schemata. The development of the schemata can be influenced by training, job design and technology. Training develops the ECPs' knowledge, skills, and ability that help them to modify and create new schemata relevant to task performance. As mentioned in Chapter 4, the ECPs make use of the history-taking skill and clinical assessment skill in the process of assessing a situation. In terms of job design, the variety of tasks assigned to ECPs can help them to develop schemata for different

types of clinical needs. Meanwhile, the technology made available to the ECPs influence their schemata by providing information that can support or challenge their understanding of the situation.

To further describe the schemata, it is useful to relate it to different phases of responses. For this purpose, the phases of response can be divided into three: receive a call, en route, and on scene. Initial information about the patient serves as cues that the ECPs use to make preliminary assessment of the patient. Relevant cues include the AMPDS code (e.g. a code for fall activates schema for different causes and context of the incident), the address (e.g. a housing area is known to have alcohol-dependent dwellers), and the time of day (e.g. traffic tend to be busy at five o'clock in the evening). When they are en route to the patient, the preliminary assessment may be updated as further information is received. Control Room staff may call the ECPs to give extra information either voluntarily, or upon request. The ECPs can use the information to update their assessment. If the new information does not fit into the schemata that they had activated, they may revise their assessment. Other more relevant schemas may be used. Similarly, when they are on scene, additional information is received. The cues from the patient's surrounding (e.g. the cleanliness of the house, smell, availability of food in the kitchen) are used to update, modify, or even challenge the assessment of the situation. The initial assessment made when the ECP receive the call and en route to the scene will be revised based on the schemata activated by the new information. Therefore, it can be said that the schemas are activated when calls are received, and they are updated along the phases of response based on additional information received or perceived.

It is also beneficial to examine schemata across situation. It was mentioned earlier that the situation is defined in terms of the treatment demand and time demand.

Using the two by two matrix described earlier, it can be postulated that four types of schema are used by the ECPs: (1) emergency-on scene, (2) emergency-other care pathway, (3) urgent-on scene, and (4) urgent-other care pathway. In condition 1 and 2, the EPCs have less time to modify or challenge their understanding of the situation (i.e. challenge the features matching based on their schema). Thus, the ECPs may use schema that are immediately relevant to the situation. However, in condition 3 and 4, several relevant or even competing schemas may be activated. The ECPs have more time to obtain cues and information to refine their assessment of the situation. With on scene situations, the ECPs may call up schemas related to safety netting. Meanwhile, for the other care pathway situations, relevant schemas may include the expected waiting time for ambulance (based on day and time of day).

Based on the assessment of the situation, ECPs will decide on a course of actions. For familiar situations, the actions are based on skills and rules. If the situation is not familiar, the actions will be guided by knowledge and extrapolation from relevant experience. There are constraints on the behaviour and action at different phases of response. When the ECPs are en route, the traffic conditions will constraint the time saving and route planning behaviour. During consultation with the patient, the constraints are scope of practice (e.g. patient need to have a blood test which the ECP cannot perform on scene), and completeness of information (e.g. patient was not cooperative in supplying information).

To visualise the concepts that influence SA and decision-making in emergency care, a socio-technical framework integrating both the cognitive and resilience oriented frameworks (figure 15) is proposed. Elements from other frameworks (figures 10-14) are integrated into this framework. The system levels and the associated influences follow the risk management framework (Rasmussen, 1997). Rasmussen's framework

is used here because it explicitly aims to draw out the wider social system such as the government, regulators, and management. Some elements (e.g. detailed descriptions of influences on SA for the dispatchers) are excluded from the diagram in order to highlight the pre-hospital care component in more detail.

As an alternative to a safety management paradigm, resilience "focuses on how to help people cope with complexity under pressure to achieve success" (Woods & Hollnagel, 2006, p.6). A resilient system would support workers to work within a given set of limitations to respond and adapt to sudden and unanticipated demands while maintaining acceptable levels of performance (Nemeth, Nunnally, O'Connor, & Cook, 2006). Appropriate feedback, either to the individual human operator or to the system as a whole, can contribute to increased resilience. The social subsystem should design a job so that the operators can get appropriate feedback. As can be seen in Table 6, the Ambulance Services (the macro level) do not have feedback about patient's clinical outcome designed into the ECP work role. Consequently, it can be said that the system design can be improved to support the ECPs' SA. Specifically, improvements can be made to the design of tasks and responsibilities. For example, the ECP role can be expanded to include a clear structure and procedures for the ECPs to get feedback in terms of the patient's clinical outcome. They could be encouraged to be more proactive and have more discretion in their consultation with patients.

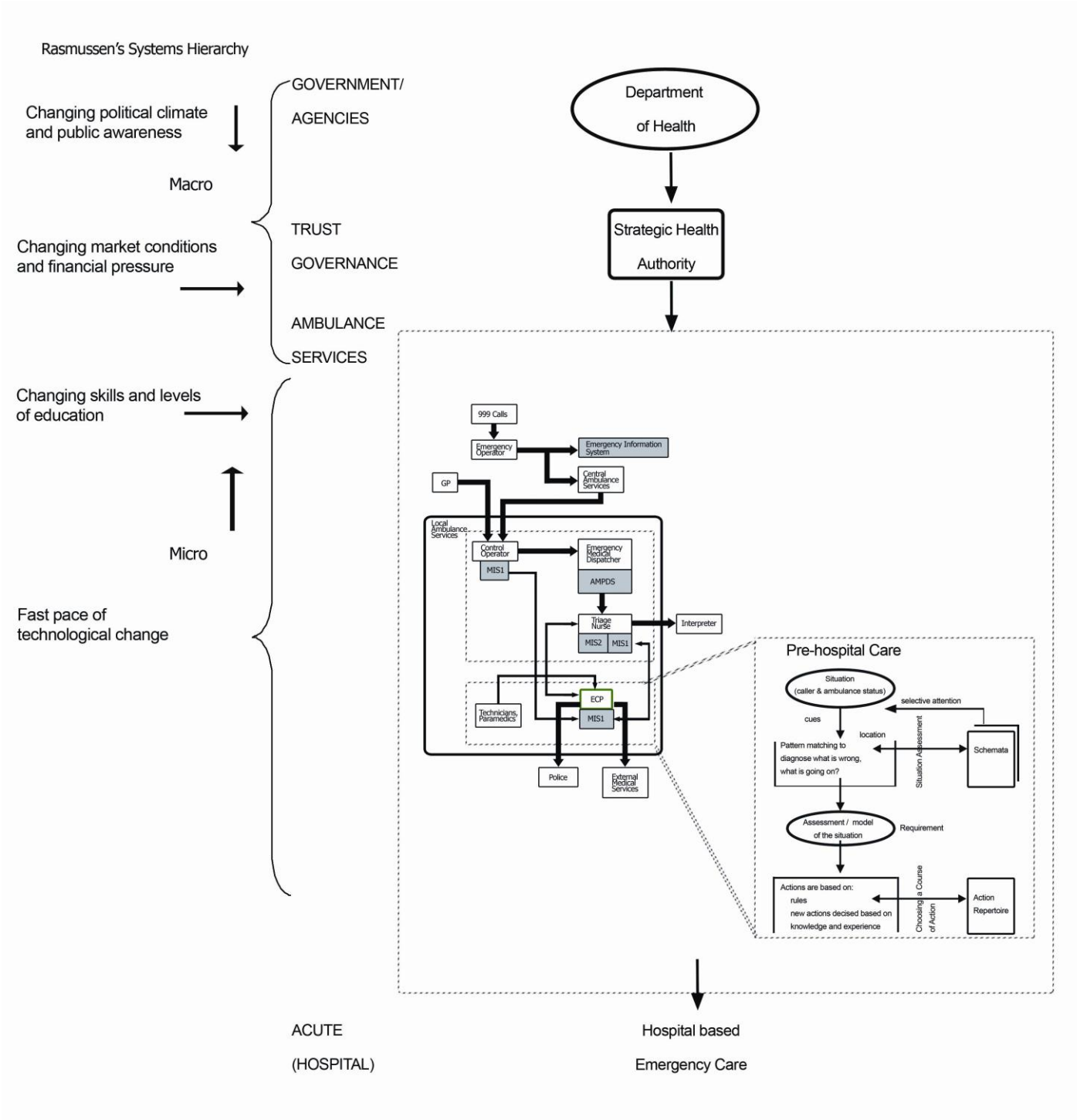

Figure 15. An intergrated socio-technical model of SA and decision making in emergency care

As mentioned in Chapter 1, the role of the ECP is part of a bigger effort to meet the changing demand of emergency care. The Department of Health recognised the need to distinguish the emergency and urgent cases to reduce the demand on

hospital-based resources. The ECP role was proposed to cater the patients who require urgent response with the potential of on-location treatment. However, the role was parked under the Ambulance Services.

In a related strategy to improve emergency service, time based performance targets were imposed by the Department of Health. These targets had to be achieved with the resources available. When the ECPs are included in the resource pool (most of them are originally from the pool anyway), they are used alongside other Ambulance Service resource to meet the performance target. Thus, the original objectives of the role had been compromised by the fact that the ECPs were deployed within the Ambulance Service's original operational framework. In other word, the existing framework does not enable the ECPs to be deployed independently from the other resources to meet the urgent care demand.

It can be argued from the discussion above that the macro policies may at times be conflicting. The results of the conflict, as mentioned earlier are the ECPs attitude towards the patients that they are assigned to. Some view the task variety positively because it prevent deterioration of skills. On the other hand, the ECPs also found that their new skills is not used optimally. Besides influencing their attitude, the decision making behaviour of the ECPs are also influenced by the conflicting macro policies. Their autonomy in making decisions may be limited according to the type of jobs they were asked to attend to. With some of the jobs, the decisions are already made for them. An example of such job is a patient with category A call where the ECPs were asked to attend in addition to an ambulance crew. The patient clearly need to go to the hospital, but the ECPs are dispatched anyway because they can arrive earlier than the ambulance crew.

The conflicting macro level policies highlights the lessons learned from the application of sociotechnical systems theory. Introduction of a new system into an existing systems may not yield the intended outcome because operators treat the new systems as an extension of the existing one (Eason, 2008). This lead to underutilisation of the full functions of the new system. Similarly, the full potential of the ECPs are not used. For example, the ECPs reported that some nurses at the Control Room did not fully appreciate what they can do with their upgraded knowledge and skills.

Furniss, Back, and Blandford (2010) describe resilience by making a distinction between creating and reusing adaptive strategies. “Big R” involves creation of new strategies. This is in contrast to reusing established or existing strategies to deal with regularly occurring events – “little r” resilience. Efforts to change the job design add to the systems’ resilience at the Big R level. Within the framework presented, knowledge of patients’ outcome (feedback) is said to improve the ECPs’ Level 3 (projection) SA. In other words, by improving the ECPs’ SA, the system’s resilience and tolerance to breakdown can potentially be increased.

The autonomy and discretion afforded to the ECPs, such as making decisions on the pathways of treatment for the patients, can also contribute to the emergency care resilience. Firstly, their autonomy means ECPs should be able to get access to different resources of the healthcare systems. In the example given in Table 6, having access to a clinical lead or supervisor may help in assessing a patient’s heart rhythm. Secondly, having accurate SA is not useful by itself if the decision latitude (i.e. their freedom to take an appropriate course of action in treating patients) is very

limited. The ECPs' SA would be more relevant and beneficial if they have autonomy. Autonomy and discretion are necessary to choose the best care pathway after the ECPs had assessed the situation. By having the say in choosing alternative pathways of treatment, the ECPs can reduce the demand on hospital resources. In other words, the decision to treat, and the pathway of choice are partially shifted away from the hospital system. With autonomy and discretion, the ECPs can use reusable strategies to alleviate the demands on hospital resources: an example of resilience at the "little r" level. The resilience of the system can be improved by encouraging the ECPs to search for alternative treatment pathways to the patients. This is akin to making the whole system 'bumpable' (Cook, 2006). The communication map (figure 12) shows the link between the ECPs and external medical services (non-hospital based services). During a ride out session, one ECP reported having a list of contact numbers for such services on his own mobile telephone. A formalised contact list procured by the Ambulance Services, perhaps integrated with electronic patient record systems, would reduce individual variations in the list content. Access to the information about the non-hospital resources are especially important and useful in busy times when hospitals are running out of resources to deal with incoming patients. As indicated in figure 12, the ECPs are operating at the sharp end of the system: they deal physically and directly with the patients. Allowing the ECPs to have the autonomy to allocate the patients away from the hospital is a positive step towards improving resilience of hospital-based care. When hospitals are operating at maximum capacity, the ECPs can ease the pressure by redirecting patients to other resources. Resilience provides one way of evaluating SA and decision-making within the context of emergency care and patient safety.

5.8 Scope of the framework and comparisons with previous research

The primary aim in constructing the framework was to extend the systems-based (macro-micro) coverage of existing models of situation awareness (e.g., Endsley, 1988; Endsley, Bolté, & Jones, 2003) and naturalistic decision-making (G. Klein, Orasanu, Calderwood, & Zsambok, 1993) as they apply to the domain of emergency care. The framework goes some way towards achieving this objective, in particular:

1. The framework highlights the indirect role played by macrocognitive factors such as the decisions made by actors external to the Ambulance Services (e.g., Government and regulatory agencies) in scoping the situation awareness requirements and opportunities for decision-making amongst ECPs. These include the ways in which targets impact ECP workload and scope for decision-making based upon their training;
2. The framework also points to a number of microergonomic factors within the Ambulance Services which impact upon ECP SA and decision-making. These include the way in the tasks which are allocated to ECPs made by managers within the Ambulance Services (e.g., call-out categories) are impacted by lack of knowledge and skills amongst ECPs and therefore limit their decision-making ability;
3. The framework attempts to map these macro-micro factors together and suggest some causal connections between them. This means the framework can be used to describe the threats on SA at the macro/micro level beyond those described by Endsley and Robertson (2000);
4. The framework also highlights job design issues like autonomy and skill variety and how they influence the SA and decision-making among ECPs;

5. The framework attempts to bring together existing models and frameworks within previous work on SA and naturalistic decision-making within the domain of emergency care;
6. Finally, the framework makes explicit the narrative of SA and decision-making across a domain with discrete stages (pathway). The framework highlights the despatch and community-based care (ECP) pathways of emergency care. This framework can be expanded further by including the hospital-based care to complete the picture.

While the focus of the framework is on the individual ECPs, the socio-technical system context means that the ECP is presented as part of a team. The framework presented here looks at individual SA in relation to a larger team. It does not claim to add new processes and composition in models of team SA (Endsley & Jones, 2001; Endsley & Robertson, 2000; Salas, Prince, Baker, & Shreshta, 1995; Shu & Furuta, 2005; Wellens, 1993) . The framework is compatible with the existing models of SA and team SA in that it provides a domain-specific example of the application of those models. For example, it is possible to use the framework as a mean to examining SA using a Distributed Situation Awareness (DSA) model (Stanton et al., 2006). In summary, the framework presented here is not an attempt to add new component or elements to existing models of SA and decision-making. Rather, it attempts to show how the existing models can be integrated to describe cognitive functions across different systems levels and the linkages among them.

5.9 Limitations and the Next Steps

The main limitation of this study is the low participant sample size. The study reported in this chapter represents the first step towards a better understanding of SA and decision-making in pre-hospital care and in the longer term, an integrated socio-technical framework for emergency care as a whole. In order to achieve these aims the framework needs further evaluation and validation in the light of other findings from a more extensive data set. Chapters five to seven demonstrates how these aims are addressed.

The utility of SA as a systems concept can be investigated by examining the interaction between the social and technical subsystems. In other words, the framework provides a way to evaluate the role of SA in a system and how it relates to important outcomes like patient safety. Using the pre-hospital care domain as an example, it can be shown how this model can be validated. In the Ambulance Services, for example, macro-level influences such as performance targets, staffing, resource allocation, and communication are bound to be different across organisations, health authorities and trusts. One way to examine the effect of organisational variability is by looking at how the emergency calls from the public are processed by the control rooms. Chapter 6 demonstrates how the AMPDS data, for example, could be sampled in order to show if differences exist in terms of the rate of calls for each category and the pathway assigned to each call, alongside the variations amongst ambulance stations which may exist.

For the ambulance service, the test and validation of the framework would provide an empirical evidence for further development of the ECP role. At the macro level, questions can be asked regarding SA and decision-making. For example, SA issues (at all 3 levels) can be identified and the ECPs' information requirements to achieve

good SA can be supported (e.g. by using method such as goal-directed task analysis (Endsley, Bolté, & Jones, 2003).

There is additional potential in examining issues affecting the performance of the ECPs, and emergency pre-hospital care in general, and linking these data to patient safety outcomes. In general, the framework can be helpful in investigating issues in emergency pre-hospital care in a more comprehensive manner. Further testing and validation of the framework, such as that reported in Chapter 7, remains a priority and is in line with the suggestions for future SA research made by Stanton (2010).

CHAPTER 6: EMERGENCY CARE PRACTITIONER ROLE AND DECISION MAKING

6.1 Introduction

Emergency care practitioners (ECPs) within the UK ambulance services are equipped with advanced skills and knowledge to provide emergency and urgent care in the community. Continuous development, changes and refinement of the role has taken place since the role was introduced in 2002 (Mason, Coleman, O'Keefe, Ratclife, & Nicholl, 2006). A number of dimensions of the ECP role have been evaluated as mentioned in the Introduction chapter. However, the procedures which are used to select cases to be assigned to the ECPs need further attention. For example, an analysis of the AMPDS data from Yorkshire Ambulance Services revealed that the computerised dispatch system is not a suitable way to assign cases to the ECPs (Gray & Walker, 2008). The dispatch system is not a predictive tool in terms of matching the ECP skills and the patients' needs. It was argued that the AMPDS is used as a trigger for a time-based response for which it was not designed. However, it is not clear what other factors are limiting the utility of the system for dispatching ECPs. More evidence however, is needed in order to further design the role so that it can meet its original objectives.

An important decision that ECPs have to make is whether patients can be treated on scene or requires transport to hospital. As can be seen in Chapter 5, there are micro and macro level influences on the ECP job. A way to examine the influence of the management and the performance targets that they set is though analysing patterns of ECP deployment. Thus, Chapter 6 presents an examination of the information

given in an AMPDS dataset, alongside additional data from interviews with ECPs. The objective of this study is to understand the pattern of ECP deployment within East Midlands Ambulance Service (EMAS). The primary aim was to identify factors that influence the successful deployment of the ECPs alongside resulting patient outcomes. Chapter 5 identified factors influencing ECP work based on an initial set of data. Chapter 6 focuses on decision making aspect of the work and the resulting evidence can be used to validate the framework presented in Chapter 5.

6.2 Methods

6.2.1 AMPDS

A request for the AMPDS data from EMAS was made after ethical approval was obtained from the NHS Research Ethics Committee (Appendix B). Data from two operational areas within the Ambulance Services were not given by EMAS due to technical limitations. The data include 999 calls received by the EMAS in a six-month period (August 2008 - January 2009) that were assigned to ECPs. The data were analysed using SPSS 12.0 for frequencies and dependencies. The calls were tabulated by call category and the outcome for the patient (i.e., transportation to the hospital or not transported). The AMPDS data set allows an examination of factors such as time (days of the week, month of the year), and local administration offices (Primary Care Trusts associated with ambulance stations).

6.2.2 Interviews

Convenience sampling was used to recruit ECPs. A semi-structured interview schedule (Table 7) was develop based on types of interview questions (Kvale, 1996). Each interview were reviewed and additional probes were added where necessary. This was done to facilitate achieving theoretical saturation point in relation to the aim

of these interviews which was to examine the factors related to the ECP deployment and patients' conveyance. The interviews were transcribed and analysed in NVivo7 using Emergent Themes Analysis. Themes were grouped into categories to identify factors that influence ECPs' decision and the resulting care pathway for patients.

Table 11. Interview schedule for factors influencing ECPs' decision

Type of questions	Sample items
Introducing question	In your experience, has there been cases where patients who don't have strong clinical need were recommended for transport to hospital?
Probing question	Can you elaborate on ..?
Specifying questions	How do you assess ...?
Direct questions	What happens for Category A calls?
Interpreting questions	Would it be correct to say that your job involve ...?

6.3 Results

6.3.1 AMPDS data

Table 12. The number and percentage of calls by call category

Call Category	Number	Percent
Cat A	4358	34.3
Cat B	5269	41.4
Cat C	3036	23.9
Urgent	59	.5
Total	12722	100.0

From 1 August 2008 to 31 January 2009, a total of 12,722 of calls were recorded in the AMPDS dataset. Table 12 shows that ECPs were assigned to Category B call more than to Category A and C. Only a small percentage of call was urgent cases. These figures are not very different from the percentages of cases reported in other studies (e.g. Gray & Walker, 2008). Of these calls, the percentages of patients

transported to the hospital are 6.56% (Category A), 7.99% (Category B) and 3.89% (Category C) respectively. The percentages are very low compared to Gray and Walker's (2008). It is also very low when compared to the percentages of patient conveyance (38.2%) for observed cases as reported in Chapter 7. These percentages were verified by the Control Room staff who supplied the data. It is felt that the data does not tell the whole story of the outcomes of ECP deployment. Similar to the problem with the data in Table 15, the details (e.g. stopped call reason) for a large number of calls were not recorded. Thus, the actual number of patient conveyance may be under recorded. Additionally, it is not clear whether the figures refer to cases where the patients were transported by ambulance crew or by the ECPs themselves.

There was a definite increase in the rate of calls assigned to ECPs, for example, in the second half of November, more calls were assigned to ECPs than before. More than 60% of all calls were handled in the last 40% of days in the data set. Looking at a smaller unit of time, there does not appear to be a significant variation of the number of cases attended by the ECP during each day of the week (Table 13). A Chi-square test shows that the proportion of patients transported in each category does not depend on the day of the week. The statistical test result for category A, B and C calls are $X^2(6)=4.437$, $p=0.618$, $X^2(6)= 3.862$, $p=0.695$, and $X^2(6)=4.01$, $p=0.675$.

The AMPDS data set contains records regarding the ambulance station that is the dispatch point upon allocation. These ambulance stations are associated with their respective Primary Care Trusts (PCTs). Figure 16 compares the percentage of patients transported to the hospital for all PCTs. It shows clear differences among the PCTs. Calls that falls under PCT 6 resulted in more admission to the hospital than for

PCT 4. The data also shows that not all PCTs had a higher percentage of hospital admission for category A calls compared to category B and C. Only two PCTs had a higher percentage of hospital admission for category A calls.

Table 13. Number of calls by call category and day of the week

Day	Call Category					
	Cat A		Cat B		Cat C	
	Transport		Transport		Transport	
	No	Yes	No	Yes	No	Yes
Monday	596	49	701	59	407	15
Tuesday	547	30	696	67	421	14
Wednesday	524	37	713	63	424	23
Thursday	588	41	659	67	375	15
Friday	608	45	736	60	431	18
Saturday	629	38	701	58	430	13
Sunday	580	46	642	47	430	20
Total	4072	286	4848	421	2918	118

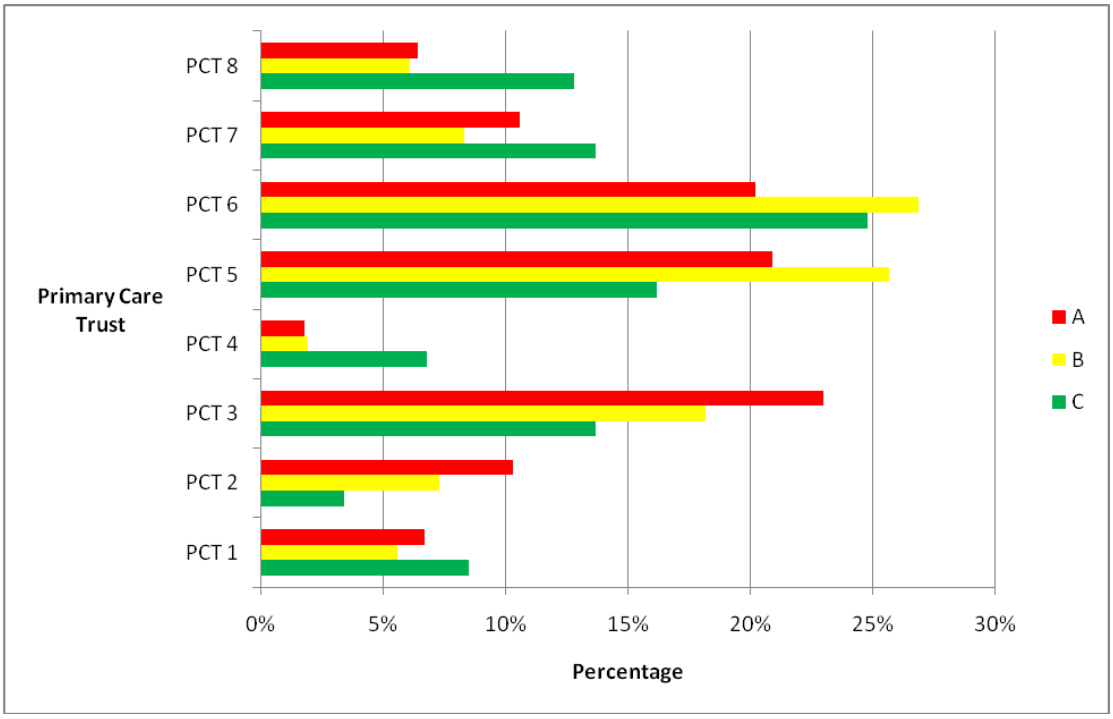

Figure 16. Percentage of patients transported to the hospital after being seen by ECPs by category of calls from different PCTs

The AMPDS data set also has records on termination of calls. The system has a list of reasons that can be used to describe why a call was stopped or concluded. These reasons were categorised into themes. These themes include: “Stood Down” (i.e. ECP did not have to attend to patient); “Managed in Community” (i.e. ECP assisted other care giver or defer treatment to patient); and, “Non-existing Patient” (i.e. no patient to treat). The list of reasons according to their theme is as presented in Table 14. More than half of the calls do not have reasons recorded.

Table 14. Frequency for call stopped reasons.

Call Stopped Reason	Number	Percent
No reason recorded	6614	52.0%
Stood down		
Cancel Before AMPDS Code	112	.9%
Cancel pre-arrival (AMPDS coded)	98	.8%
Patient Said Making Own Way	113	.9%
Downgraded - Emergency to Urgent	8	.1%
Hear and Treat by Nurse Triage	121	1.0%
Nurse Agreed Plan	4	.0%
Fire Service Dealing	26	.2%
EMAS treated on scene	3675	28.9%
Police Dealing	232	1.8%
Refer and Treat - Nurse Triage referred to other provider	175	1.4%
Sub-total	4564	36.00%
Managed in Community		
Intermediate Care on Scene	34	.3%
Left in care of Patient Transport Service	8	.1%
Lift Assist	70	.6%
Referred to Intermediate Care by attending resource	263	2.1%
Refused any treatment & signed form	779	6.1%
Refused treatment & won’t sign form	81	.6%
Sub-total	1235	9.80%
Non-existing patient		
Hoax Call - No Resource Required	45	.4%
Certified dead at scene – Doctor	4	.0%
Certified dead at scene – crew	160	1.3%
No Patient Found On Scene	100	.8%
Sub-total	309	2.5%
Total	12722	100%

6.3.2 Interviews

Table 15. Factors influencing ECP decision to transport patients

Influencing factors	Components
1. Social Needs	
a. *External threats for leaving at home*	
i. Availability of social support	Presence of care giver
ii. Risks	Abuse, stressors
iii. Home environment	Cleanliness, design, falls risk
b. *Patient's social capacity*	
i. Patient's ability to cope at home	Available general resources
ii. Access to get help	Resource to timely get help
iii. Communication	Ability to describe own state of health
c. *Personal characteristics*	
i. Age	Frailty, self-care ability
ii. Vulnerability	Mental state, attentiveness
iii. Patient's preference	Make own decision
2. Geographical factor	
a. Distance to hospital	Likelihood to require further treatment
b. Time to reach hospital	Administer treatment on location if takes too long to reach hospital
c. Transport options for patient	Patient refuse ambulance transport to make use of own transport (easier to get back)
3. Staffing issue	
a. ECP as Ambulance Service	Gets Cat A calls as well
b. ECP being nearest to patient	Used as fast responder
c. ECP as back up to ambulance crew	Assist ambulance crew
4. Technical factor	
a. Restrictions of computerised triage system	Flagging may be too rigid (overestimate patient's need)
b. Inaccurate triage	System does not include other relevant decision aids
c. Overestimation of patient's need	Call takers' and triage nurses' clinical background
5. Connectivity to other care pathways (CP)	
a. Existence of other suitable CP	Other supporting health and social services
b. Temporal availability of other CP	Outside of service hour; too long to get response
c. Professional recognition of ECP to make referral	Professional boundary and acceptance of ECP referrals
6. Information factor	
a. Insufficient information to triage accurately	Communication barriers, patients panicking, scared,
b. Case out of scope of practice	Sudden deterioration

A total of 17 ECPs were interviewed. Their age range from 36 to 51 years (*M*= 43.9, *SD* = 4.68) while their years of working experience range from 1 to 6 years (*M* = 3.4, *SD* = 1.57). Theoretical saturation point was achieved with the 17 ECPs. An analysis of the interviews revealed six main themes about the influences, other than clinical needs, on ECPs' decision to treat patients on location or refer to the hospital. The main themes that were identified (table 15) reflect patients' psychosocial characteristics, the way the ECPs are deployed, and the wider healthcare structure. The themes are elaborated further with quotes from the participants.

6.3.2.1 Patient's social needs

The deployment of ECPs would be beneficial in reducing hospital admission. This benefit is one of the objectives for the creation of the role. However, the decision to treat in the community or send to the hospital is not always based on clinical needs. ECPs also evaluate the psychosocial needs of the patients. For example, the level of vulnerability – which may not be related to presenting illness – of the patients and lack of social support might influence an ECP to send the patients to hospital:

> *"Vulnerable patient, might be age [factor], the patient's mental ability would not allow you to leave them at home." (ECP 14)*

> *"The factors that I would consider are the vulnerability of the patient whether they got a network around them to monitor the patient to raise the alarm if need be." (ECP 17)*

The decision to send to the hospital is based on the assessment that the patient can cope better in a hospital:

"If that patient was on their own unable to cope alone .. they are unable to get out of the chair or go to the toilet.. and there was nobody around to care for them." (ECP 12)

The patients' rights to make their own decision are respected. They can say where and from whom they want to get the treatments. Patient may go against the advice given by the ECPs. When patients want a second opinion, they might still go to the hospital. In other cases, patients' refuse to go to the hospital:

"Some patients demand [to go to the hospital], and they go. [They] are in charge of their own medical healthcare. If the patient doesn't want to go [to hospital], what can I do?" (ECP3)

6.3.2.2 Geographical Factor

The distance to the nearest hospital may influence the ECPs' decision for sending patients to hospitals. There is a bias for sending the patients due to the expected longer time required to get an ambulance to the patient. In other word, the safety net is in favour of hospital admission:

"[Patients] could possibly be sent to the hospital more in rural areas. That's what I found. The time factor is quite big really. You know you can't always get ambulance straight to somebody." (ECP 12)

Patients themselves may take the geographical considerations for consenting to be transported to the hospital by ambulance. Geographical factor, coupled with the time of day and availability of other transport options may make travel by ambulance a

less desirable option. Those with their own transport can go to the hospital on their own. Those without transport may decide to follow other care pathways:

> *"It is not necessarily for [the hospital] to decide how you get home. A taxi journey at 3 o'clock in the morning is very expensive. That is off-putting for [the patients]." (ECP 16)*

6.3.2.3 Staffing issue

The deployment of ECP does not adhere strictly to the roles for which they were designed. Fluctuations in the demand for pre-hospital care influence the decisions for sending an ECP to patients. For example, when there are not enough role-specific cases to be assigned to the ECPs, then they may be asked to respond to other cases:

> *"There is performance times [target] that the ambulance service has to work to, and due to that, it has an impact on the way the ECPs actually used." (ECP 3)*

On the other hand, they may be the nearest resource available that can arrive fastest to the patient. Therefore, there is not enough time for the ECPs to get updates from Control Room:

> *"The job could be other side of the road. I might not even know what the problem was. It is just a call." (ECP 16)*

The implication of these staffing issues is that ECPs are responding to patients who needed to be transported to hospital (such as those assigned as Category A callers). Therefore, the staffing issue produces a bias for the ECPs in favour of patient conveyance.

6.3.2.4 Technical Factor

The system used to process 999 calls is found to be inaccurate at times resulting in a mismatch between the actual presenting problem and the problem as conveyed to the ECPs:

> *"The AMPDS system can be a little misleading sometimes. The calls seem to be falling into the wrong category." (ECP 10)*

The system does not allow in-depth information gathering by the call takers. The threshold for categorising some medical complaints is low, thus forcing the call takers to make a decision quickly:

> *"The computer system, we use is very strict in the sense that it does not allow a non-clinical person to elaborate on certain calls So, when a [patient with] chest pain [call], that would be automatically responded to in an 8 minute a response time. A chest pain could be anything from serious MI* [myocardiac infarction] *to minor indigestion, muscular skeletal. [The system] need to allow that elaboration." (ECP 15)*

The inaccuracy leads to problem such as the following:

"Somebody may [be reported as having] a chest pain, but when you get there, it is not actually chest pain at all. It is something else." (ECP 16)

Technical problems could also present itself in the form of access of language line. Translation service may not be available when the ECPs need it. The time it would take to secure a language service via the control room would make transport to the hospital a better choice for patients:

"In some circumstances, for example, if there is a particular language barrier, patients may go to the hospital anyway because you might not have the resource there to sort the problem out." (ECP 13)

6.3.2.5 Connectivity to Other Care Pathway

Related to the technical problem, other care pathways are not universally accessible to the ECPs. The best care pathway as decided by the ECPs may not be available. For example, the external resources to help ECPs make decision are limited by the opening hours. Speaking about a problem that the patient cannot answer, an ECP demonstrate the limitations of connectivity to other care pathways:

"There are problems. It can be overcame because we talk to the [patient's] doctor. But that's ideal within working hours, when doctors work. [At] 2 o'clock in the morning, you can't get the information." (ECP 3)

Hospital admission may be used as a bridging pathway due to limited direct connectivity. The limitations could be due to the lack of professional recognition of ECPs by the receiving institution:

> *"I have sent patient to hospital purely based on the social aspects of their home life and the condition of the home in order to facilitate a follow-up with social services." (ECP 9)*

On the other hand, patient's needs may be distorted as their information is passed through different care providers. In the example below, the control room sent an ECP to a patient even though the patient did not require ambulance transport:

> *"[The patient] may be given [an ambulance service resource] indirectly not because they have asked for the ambulance. [They] speak to another primary care may be a GP, the out-of-hours, the NHS Direct [and they] had referred them to the ambulance service unknowingly. I turned up on scene they weren't expecting an ambulance they want us stand down." (ECP 16)*

6.3.2.6 Information Factor

The information factor represents an interaction of factors already identified. For example, patient's characteristics interact with the limitations of the technical systems at the control room and leads to inadequate information gathering:

"Sometimes the call maker doesn't give the control [the information]. Sometimes controllers themselves get limited information." (ECP 17)

"The patient can't tell them [the control room staff] for any reason or I suppose over the telephone misunderstanding about what people are saying." (ECP 10)

This problem is compounded by the individual variations of the control room staff. The information gathered, and subsequently transferred to the ECPs, depends on the thoroughness of the control room staff:

"Some [controllers] are more thorough than others." (ECP 17)

The lack of information leads may impede the ability of the ECPs to make decisions. The cases assigned to them, based on the limited information, may not be cases that they can deal with. Therefore, a safer decision would be to arrange for a hospital admission for the patients.

6.4 Discussion

If we take at face value that the ECP role was designed to cater for urgent care demand, then the AMPDS and call categories demonstrate limitations in terms of assigning ECPs to patients. The limitations are partly due to factors outside of the ambulance services' control. Hoax calls represent one such factor, albeit only a small percentage of all calls. In terms of time factors, one study showed that the number of calls for London Ambulance Services fluctuated by day with the highest number of calls on Saturday and the lowest on Wednesday (Victor, Peacock, Chazot, Walsh, &

Holmes, 1999). However, in the present study, the day of the week was shown to have little effect on the number of calls assigned to each call categories and the corresponding rate of patient transports.

In terms of factors not directly under the control of the Ambulance Services, patients' characteristics appear to be more important in determining the outcomes of ECP intervention. For example, the patient's social needs are not captured by the AMPDS categorisation but influence the decisions for patient conveyance. The patient's ability to cope without social support is one such factor. Patient's rights in making decision regarding medical care may also contribute to distort the number of hospital admittance. The number of patients who refused treatment and the account of the ECPs from the interviews suggest a significant number of patients do not behave in expected ways. In other words, the predictive value of the AMPDS and call categories is weakened by the decisions that the patients make. Therefore, the AMPDS data needs to be seen in the light of patient as one of the active participant within the large system of pre-hospital care.

Some of the predictive values of the computerised dispatch system are within the ambulance services' control. The percentage of patients transported to the hospital after being seen by an ECP is much lower than reported elsewhere. At Yorkshire Ambulance Services, the percentages of patients attended Emergency Department after being seen by ECPs are 52.6% (Category A), 41.2% (Category B), and 52.1% (Category C) (Gray and Walker, 2008). These numbers are similar to those from another study that reported the actual proportion of cases being dealt with by ECPs without the need for referral is 54% (Mason, O'Keeffe, Coleman, Edlin, & J Nicholl, 2007). These differences also occur within the Ambulance Services and point to a set of wider systemic factors that influences decisions to deploy ECPs. These systemic

factors include local implementation and interpretation of the ECP role, and patient-specific factors.

As mentioned by participants in the interview, staffing levels are an example of an organisational decision that eventually influences the type of jobs being assigned to the ECPs. The placement of ECPs at appropriate locality may increase the proper utilisation of their skills. Whether the ECPs – primarily designed to cater to urgent (i.e. non-emergency) demand – should be subjected to time-based target also need to be reconsidered.

With regards to the wider healthcare structure, it seems there are varying degrees of support available to the ECPs. If the ECPs are expected to channel the demand on hospital resources, then there must be access to other care pathways. Apart from building and developing new supporting health and social care services, existing services should be made more accessible to the ECPs. The promotion and integration of the role within the wider healthcare system is desirable. This is in line with the aim of the role which is complementing existing practitioners/clinical within the NHS (DOH, 2004).

Viewing the ECPs as actors within a wider system helps to describe and explain the relative success of the role. As mentioned in another study, the larger strategic vision contributes to a successful operational framework (Cooper et al., 2004). The ability of the ECPs to achieve their role's objective should be evaluated against the level of other resources, and targets – which may not directly be applicable to the ECPs (i.e., put forward or set by the Ambulance Services, Strategic Health Authorities, and Department of Health). In this light, this study provides further support for the plan to

change the assessment of the ECP from a time-based to an outcome-based performance measure (Gray & Walker, 2008).

The factors identified by this study are relevant to highlight the importance of the shared SA for making the best decision for the patients. Shared SA refer to the degree to which team members' SA are similar (Bolstad & Cuevas, 2005). Beyond the similarity, team members unique SA can be complementary. The uniqueness of members' SA, and its complementary nature give rise to the conceptualisation of team SA as the sum of individual member's SA (Hauland, 2002). Shared or team SA can overcome some of the issues identified through the factors that influence the decision making.

In describing the ECPs performance, team SA concept is more appropriate. The Control Room staff, the ECPs and other relevant Ambulance Services staff (e.g. Ambulance Technician who are on duty) may hold relevant information: not just about the patient, but also about the wider task environment. In treating a patient, the directly and indirectly collaborating individuals may have similar information (e.g. the location of patient is shared between Control Room staff and ECP) or unique information (e.g. Control Room staff know there is another ambulance nearby but not necessarily tell the ECP). An example of the indirectly collaborating team member is the Ambulance Technician on duty who has information about the traffic condition that affects route planning. Factors like these are the contextual factors (Bolstad & Cuevas, 2005) that may be important for the ECPs.

Problem may arise when information are not shared on time amongst the ECPs and other staff. For example, an Ambulance crew may have information about the

availability of bed at Respite care. If this information is not shared, the ECPs may require a longer time to make a decision whether to send the patient to the hospital or social care. The connectivity to other care pathway has been identified as a factor that influence decision making. Thus, the sharing of information about this factor can help the ECPs to make better decision. Similarly, the Control Room staff and other Ambulance crew, over the course of their work shift, may gain information about crowding at the hospital. The turnaround time for the ambulances will be long when the hospital is delayed in receiving the patient. The limited availability of the hospital-based resource may biased the ECPs' decision for finding other more accessible care. Again, the sharing of contextual information have the potential to avoid problems when ECPs want to make a decision.

A limitation to this study is the time period used in the analysis. Compared with the data set reported for Yorkshire Ambulance Services (Gray & Walker, 2008) , the data presented here only covers a period of six months instead of twelve. However, this study has a larger number of calls (12,722 compared to 3955). Another limitation is the number of participants in the interviews. The data reported here, however, suggests that these are worthwhile issues and should be investigated further.

Another practical limitation with studies like this is the frequent changes that happen in the Ambulance Services. These changes are hard to pin down. Changes like re-assignment of ECPs to different ambulance stations are not discernible from the data set. Future studies should try to identify major changes that occur and then compare the data from before and after the change had occurred. Comparison with other Ambulance Services would also be beneficial in order to provide a better picture of pre-hospital care for the whole of England.

6.5 Summary

The findings reported in this chapter show a wide range of influences on ECPs job assignment and the resulting patient outcomes. Highlights from this study are summarised as following.

1 The deployment of ECPs is steadily increasing, but there are variations among PCTs in terms of the care pathways for the patients after being seen by ECPs. This provides a quantitative evidence for the findings in the Chapter 4 regarding the wider system influence on the ECP role.

2 Based on the interviews, the fit of the ECP role within the larger healthcare and social care systems needs to be improved. Their ability to decide the best care pathways to patients are constrained by the limitations existing in the interfaces between the different care providers.

3 While patients may want their clinical needs met, ECPs' decisions are based on a larger set of concerns. The ECPs have to make holistic inquiry before they are able to decide the best decisions for patients.

4 Information need for the ECPs can be further supported by having technical system designed for the role, improvement in the number and training of staff, and information system that can provide timely and accurate information especially about patient and other care pathways.

Chapter 7 present a study that investigates the ECP role using observation and questionnaires. The ECPs are studied in the field to provide further extend the findings reported in this and previous chapters.

CHAPTER 7: TESTING THE SOCIO-TECHNICAL FRAMEWORK

7.1 Introduction

The findings reported in the previous Chapters provide insights into the role of ECPs. The main findings concern the factors influencing ECPs' decision-making process and the information requirements to support ECPs' SA. This Chapter presents a set of studies that aim to evaluate and validate the framework presented in Chapter 4. An ethnographic approach was used whereby the researcher observed and interviewed ECPs during their regular working hours. More specifically, the study is intended to achieve the following objectives.

1. To assess the relevance of factors influencing ECPs' decision regarding patients' care pathway that were previously identified (Chapter 6).
2. To assess the sources of information used by ECPs.
3. To examine system-related influences on decision-making and SA

In the previous studies, factors influencing the ECPs' decision on patient care had been identified using retrospective interviews. The limitations of the retrospective account are accuracy and bias of the information recalled. The validity of the factors can be tested by measuring the extent to which they are applicable to actual cases. In other words, can the factors be reliably measured for actual cases?

Another question posed for this Chapter relates to the information source used by the ECPs. By using actual cases, it would be possible to assess the type and source of information used by the ECPs. The studies reported in this chapter seek to answer the following questions: Can the actual information used by the ECPs be mapped to system levels? Are the decision-making process influenced by system elements?

Chapter 7 presents a set of two interrelated studies. The next section provides an overview of the method used for the two studies (observations and questionnaires). More detailed information of each study, alongside their results and discussion, are provided in separate sections. The last part of the Chapter summarises the findings and the issues identified in the discussion sections of each studies.

7.2 Overview of the Study

The ethnographic study involved data collection using two methods namely field observations, and self-administered questionnaire. Ride-out sessions were organised by agreement with the ECPs. Suitable dates and times were provided by the ECPs. On the day of the observations, ambulance stations' protocols regarding visitors were followed as required. The protocols involved signing a visitor's form, and observing safety measures such as wearing a high-visibility jacket and hard helmet when on the road. To balance the need for rich data, and minimise intrusion into the ECPs' work-time (a concern of the NHS ethical committee), the observations were done with a target of getting five calls for each ECP. The target was negotiated with the ECPs based on the number of jobs they expect to get during their shift. Further details of each method are described in separate sections in order to illustrate the findings.

7.3 Observations

Observations were structured along ride-out sessions. The researcher followed and interacted (e.g. asking for clarifications, helping carrying medical equipment) with the ECPs when they are working. The aims of the observations were:

1. to characterise the jobs assigned to the ECPs
2. to identify sources of information used by ECPs

These aims are related to the findings regarding influences on ECPs decision-making and SA requirements. The findings were identified using interviews and thus the observations of ECPs in the field were capable of providing data to validate the findings.

7.3.1 Methods

7.3.1.1 Procedure

To achieve the aims stated above, the field notes involved taking information regarding the following:

1. ECPs' demographic information (age, years of ECP experience, clinical background)
2. Work equipment (vehicle, communication devices)
3. Jobs assigned (call category, patient's characteristics, location, decisions, materials used)
4. Work environment (ambulance station's notice board, weather)

Field notes were taken with respect to safety, patient confidentiality, and time. Notes were not taken in the presence of patients in accordance with procedures set out in the application for ethical approval. The nature of the study (i.e. emergency care) made it impractical to obtain consent in advance from patients. However, as it is regularly practiced within the ambulance service, consent for allowing the presence of observers is initiated by the ECPs. They would introduce the observers to the patients and explaining that the observers are present to observe the ECPs, and not the patients.

The notes were to be written immediately after the conclusion of each job or at the earliest possible considering that there is no guarantee of a time gap between successive jobs. The immediacy of note taking is to facilitate recall of details that should be noted. Where possible, the ECPs were asked to provide clarifications on the observations.

7.3.1.2 Data analysis

The demographic information on the ECPs was analysed using SPSS 11.01 to obtain descriptive statistics such as means and standard deviation. Descriptive statistics (frequency and percentages) were also obtained for the job characteristics (call categories and outcomes). The descriptive statistics were obtained to characterise the participants and the jobs that they received.

To examine the information used by ECPs to support their SA, sources of information are identified from the notes. These information sources are organised in a summary table based on the goals and SA requirements of the ECPs. The organisation

facilitates the comparison of the information needs against the actual information used. In addition, the information can be further analysed to identify its source. To achieve this, the summary table incorporates system levels framework (Chapter 5). The framework identifies system levels namely work environment, staff, management, company, regulators, and government. However, to reduce the complexity of the table, the system levels were reduced to three major levels. Thus, the table has columns for 'environment', 'staff' and 'macro' which comprises the management, company, regulators, and government.

7.3.2 Results

The observations were conducted between 5th July 2010 and 30th October 2010. The characteristics of the ECPs are as reported in section 4.3 (page 62). Eight of the 13 ECPs were observed in more than one shift: five ECPs were observed twice, and another ECP was observed three times. The observations were done for shifts in the day (18) and at night (2) shifts. The total duration of observations was 206.5 hours, with an average of 15.9 hours (SD=2.93) spent with each ECP.

Table 16. Number and percentage of job by call category and outcomes

Outcomes	A	B	C	n.a.	Total	%
treated & discharged	16	3	5	3	27	35.5%
requested crew	13	6	5	5	29	38.2%
crew handled	5	1	0	3	9	11.8%
patient dead	2	0	0	0	2	2.6%
Total	36	10	10	11	67	
%	53.7%	14.9%	14.9%	16.4%		100%

Notes: (1) Total completed job = 67 (2) n.a.= call category not available

The ECPs received 84 jobs, out of which 17 (20.2%) were stood down (i.e. cancelled) and these were excluded from further analysis. Only jobs where patients were seen by the ECPs are included in the table. As shown in Table 16, the number

of jobs requiring the ECPs to call for transport crew is higher than for the jobs that were treated and discharged on scene. However, of those treated, one patient refused transport to the hospital, three were sent to hospital with the ECPs' own vehicle, and one patient was sent on an ambulance accompanied by the ECPs. Furthermore, two patients were seen and left on scene because they did not ring for ambulance services: it was the police and a bystander (of a road accident) that called 999.

The observations revealed different ways by which call categories are named. Apart from using the alphabet (A, B, C), colour coding is used on the ECPs' mobile data terminal: red (A), yellow (B), and green (C). In addition, the ECPs themselves used a different set of code when requesting ambulance crews. For serious cases, they would request a 'hot response', while for the less serious a 'normal response' is required.

The observations also reveal the sources of information used by the ECPs. A goal-directed task analysis was conducted to identify the goals for the ECPs as well as the relevant information requirements. The information for the task analysis was collected during the ride-out sessions described in Chapter 5. The overall goal that the ECPs want to achieve is delivering the right treatment at the right time at the right place. The task analysis results in 3 sub-goals.

By combining the ECPs' goals and SA requirements with the system hierarchy, it was possible to analyse system-level influences on ECPs' SA. Summaries of the information sources for the sub-goals are presented in Table 17 (responding to a call within a time target), 18 (provide timely clinical care within scope of practice), and 19

(conclude episode of care). To summarise the data presentation, only first and second level goals and the associated SA requirements are presented. Additionally, the levels of systems are grouped under three major categories: macro (the government, the strategic health authority, and the Ambulance Service management), staff (the ECPs themselves) and environment (patients and their surroundings).

Table 17. Source of information for the goal 'responding to a call within a time target'

Goals and SA requirements	Macro	Staff	Environment
1.1 Ensure vehicle is ready to be mobile Fuel Tyre pressure Front lights Signal lights Blue lights Siren Horn Brakes Overall cleanliness Medical equipment Drugs supply	Vehicle dashboard Drugs record Co-worker	Pre-shift visual checks	By-stander
1.2 Ensure Control is aware of current status Call details Status updates Confirmation from Control Shift time Break time	Radio MDT display Shift schedule		
1.3 Select best route to destination Location Estimated arrival time Road closure Alternative routes	Satellite Navigation system Map book Notice board MDT notices Control staff Co-worker	Personal knowledge	Road signs
1.4 Drive progressively and safely to destination Weather condition Road surface condition Local speed limit Other vehicles on road Changes in patient status	Control staff MDT updates	Personal knowledge	Road signs By-standers

Notes: (1) MDT = Mobile data terminal
(2) Toughbook = portable computer

Table 18. Information source for the goal 'provide timely clinical care within scope of practice'

Goals and SA requirements	Macro	Staff	Environment
2.1 Obtain consent for consultation Patient's age Physical disability Patient's state of mind Patient's mental disability	MDT display	Glasgow comma scale score	Patient By-stander Family member Friend Neighbour Carer Cleanliness Smell
2.2Evaluate patient's clinical and social needs Patient's name Reason for calling Existing medical issues Medical list Existing care plan Patient's physical appearance Temperature Skin colour Breathing pattern Physical disability Wider environment Immediate surrounding Evidence of care Patient's attitude	Thermometer ECG Oximeter GP Patient's record form Care Plan Nursing home residence record Care home residence record Toughbook Drug prescription print-out MDT Discharge notes	Glasgow comma scale score Watch	Patient By-stander Family member Friend Neighbour Carer Drug List of drugs
2.3 Administer suitable treatment Distance to hospital Equipments needed Drugs needed Drug allergies Drug dosage Contraindication Drugs taken before PGD recommendations	Equipment bags Ambulance crew GP PGD folder Drugs labels Discharge notes	Personal knowledge	Patient By-stander Family member Friend Neighbour Carer Drug List of drugs

Table 19 . Information source for the goal 'Conclude episode of care'

Goals and SA requirements	Macro	Staff	Environment
3.1 Ensure patient understand the decision (same as 2.2)	MDT display	Glasgow comma scale score	Patient By-stander Family member Friend Neighbour Carer Cleanliness Smell
3.2 Provide safety net for patient Available health care services Patient's mobility Patient's access for help	Toughbook GP District Nurse Social Services	Personal knowledge Mobile phone	Patient Family member Friend Neighbour Carer
3.3 Leave scene Equipment cleanliness Consumables Waste Clearance status	MDT updates Radio Control staff	Visual checks Mobile phone	

7.3.3 Discussion

Consistent with the findings reported in Chapter 6, the ECPs attended to emergency cases more than urgent cases (i.e. ECP-type jobs). The percentage of Cat A calls is even higher than that found in the AMPDS data (Chapter 6). This reflects the concern voiced by the ECPs that they are increasingly being used to meet performance targets when they can arrive at the patients the fastest. The high percentage of category A calls, however, does not lead to a high rate of patients being transported to hospital. The number of patients send to hospital is only slightly higher than those treated and discharged on scene. However, the overall percentage of patient transports is higher than the rates reported in Chapter 6.

A wide variety of information resources are available to the ECPs. These sources can be roughly categorised into existing external records (prescription list, care plan,

patient record form), acquired record (ECG strips, thermometer reading), and personal report (patient, carer, relatives). The existing external records are generally more preferred by the ECPs as they tend to be more reliable and less prone to error compared to personal report. For example, a patient may not be able to state correctly the drug that they are taking, and the purpose of taking those drugs. The macro level of the system is instrumental in providing these external records. ECP's job performance should be supported further by providing them with correct, accurate, reliable and timely information.

The Ambulance Service is making a good deal of efforts to provide better support for the ECPs. The use of "Toughbook" by some ECPs has advantages in getting accurate information for filling in patient's report. The Toughbook system is designed with access to databases of drugs, healthcare providers, and medical symptoms. For example, limited information from the patient regarding the name of their GP's practice may be augmented by the list available in Toughbook. The same is true for medication. In other words, the Toughbook system is a useful memory aid for both patients and ECPs. The drawbacks of using the Toughbook include the lengthy process of data entry and the lack of hard copy of the patient record generated. The hard copy would be useful for follow ups as indicated in Table 12 – patient record form left by ambulance crew was referred to by the ECPs during patient consultation.

7.4 Decision-Making Questionnaire

In this study, a qualitative method of data collection was used. This is part of the mixed-method approach used in the thesis. As can be seen in Figure 19, the influences on ECP job in general (Chapter 4 and 5) and on decision for patients' care pathway (Chapter 6) were identified using qualitative method. The questionnaire was

used to complement the method used in Chapter 5 and 6 for addressing similar issue but with more specificity. The triangulation of the method allows for a richer set of data to be collected, thus providing different perspectives that can either reinforce or contradict the findings reported earlier.

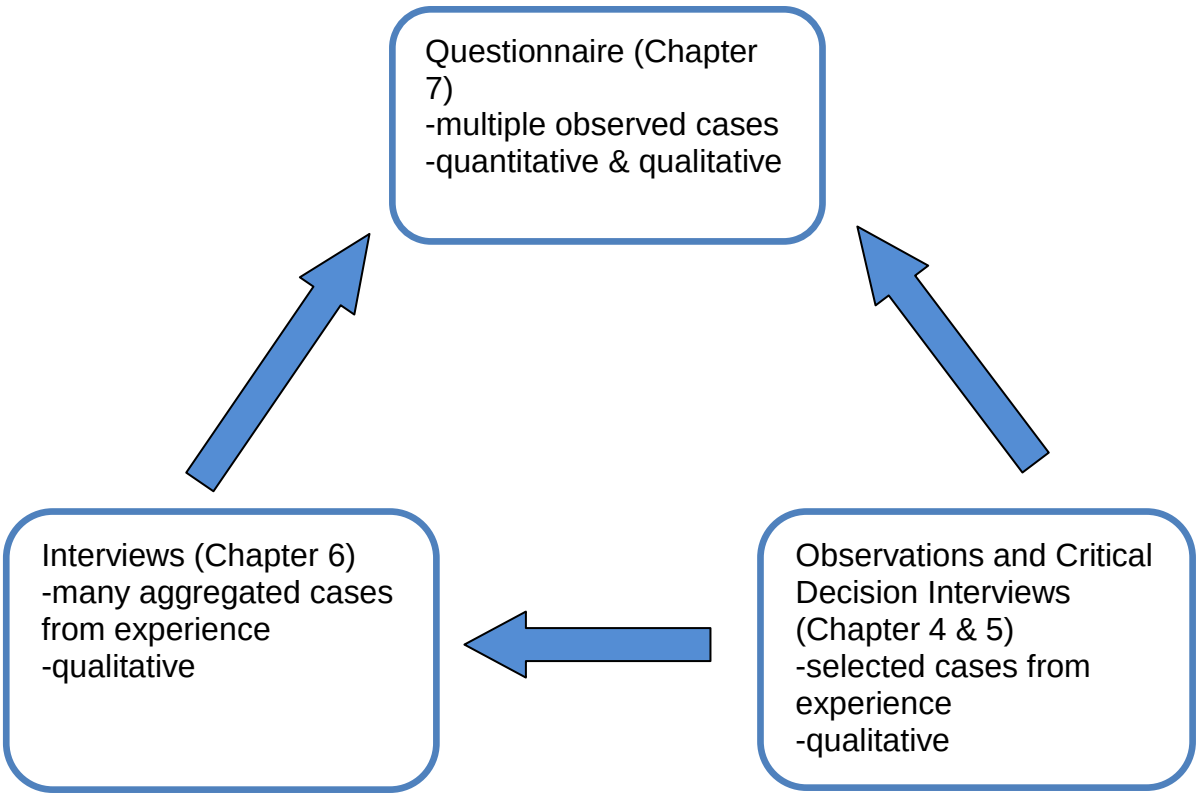

Figure 17. Triangulation used to examine factors influencing decision making

7.4.1 Methods

The items for the questionnaires were derived from the influencing factors reported in Chapter 6. ECPs were asked how each item influences their decisions on the patients' care pathway (Figure 20). The ratings are made on a five-point Likert scale ranging from 5 ('highly relevant') to 1 ('highly irrelevant'). Thus, the higher the score, the more influences the items has on the ECPs' decision.

Which of these factors did you consider in making a decision about the care pathway for the patient?

Factors	**Relevance**				
	Highly relevant	Somewhat Relevant	Neutral	Somewhat not relevant	Highly irrelevant
Social Needs					
Availability of social support					
External risks to the patient					
Suitability of home environment					
Patient's ability to cope at home					
Patient having the means to get help					
Ability to communicate clearly					
Patient's age					
Patient's level of vulnerability					
Patient's own preference					
Geographical factor					
Distance to hospital					
Time to reach hospital					
Other transport options for patient					
Staffing					
ECP meeting the Ambulance Service's targets					
ECP being nearest to patient					
ECP as back up to ambulance crew					
Technical factor					
Limitations of computerised triage system					
Inaccurate triage by Control room staff					
Overestimation of patient's need through using the AMPDS					
Connectivity to other care pathways (CP)					
Existence of other suitable CP					
Temporal availability of other CP					
Professional recognition by the receiving CP of ECP referral					
Information factor					
Control room does not have sufficient information to triage accurately					
Case out of scope of practice					

Figure 18. Decision making questionnaire

The questionnaires were given at the end of each job (for each patient) or at a more suitable time depending on the ECPs preference and work pace. The ECPs were given the opportunity to ask for clarification on the questionnaire items. The questionnaires were collected immediately after completion.

The ratings were analysed using SPSS 11.01 to obtain descriptive statistics (mean and standard deviation). The central tendency score can reveal the relevance (or lack thereof) of each items on the ECPs' decision process. Cronbach's Alpha was obtained to assess the internal reliability of the questionnaire. In addition, inter-item Pearson correlations were obtained to extent to which the influencing factors can be identified. More specifically, items under the same factors should have positive correlations and items under different factors should not have significant correlations.

7.4.2 Results

The ECPs completed 67 jobs, as stated in Table 12. From the 67 jobs, 63 questionnaires were completed. The number of questionnaires completed by the ECPs were 2 (1 ECP), 4 (4 ECPs), 5 (5 ECPs), 6 (1 ECP), and 7 (2 ECPs). As can be deduced from table 20, 92.31% of the ECPs completed at least 4 questionnaires.

Table 20. Questionnaires completed by the ECPs

number of completed questionnaires	Number of ECPs	Percentage
2	1	7.69%
4	4	30.77%
5	5	38.46%
6	1	7.69%
7	2	15.38%
Total 63	13	100.00%

Table 21. Mean and SD for questionnaire items.

Factors	N	Mean	SD
Social Needs			
Availability of social support	63	3.37	1.406
External risks to the patient	63	3.33	1.295
Suitability of home/scene environment	63	3.48	1.413
Patient's ability to cope at home/scene	63	3.71	1.419
Patient having the means to get help	63	3.59	1.433
Ability to communicate clearly	63	3.92	1.383
Patient's age	63	3.33	1.308
Patient's level of vulnerability	61	3.39	1.406
Patient's own preference	62	3.42	1.386
Geographical Factor			
Distance to hospital	62	2.81	1.353
Time to reach hospital	62	2.82	1.373
Other transport options for patient	63	2.49	1.281
Staffing			
ECP meeting the Ambulance Service's targets	63	3.60	1.238
ECP being nearest to patient	62	3.53	1.251
ECP as back up to ambulance crew	61	2.21	1.266
Technical factor			
Limitations of computerised triage system	63	3.00	1.356
Inaccurate triage by Control room staff	63	2.83	1.326
Overestimation of patient's need through using the AMPDS	63	2.70	1.315
Connectivity to other care pathways (CP)			
Existence of other suitable CP	63	3.06	1.501
Temporal availability of other CP	63	2.98	1.408
Professional recognition by the receiving CP of ECP referral	63	3.11	1.515
Information factor			
Control room does not have sufficient information to triage accurately	63	2.75	1.459
Case out of scope of practice	63	2.44	1.37

The extent to which each item influences the ECPs' decision-making, as represented by their mean ratings, is presented in Table 21. Fourteen items have mean rating higher than 3, nine items have mean rating below 3, and one item with mean rating of exactly 3. All 'Social Needs' items were rated as relevant; the highest rating was given to the item 'ability to communicate clearly'. Items for 'Geographical Factor' and 'Information Factor' have mean ratings below 3, indicating these two groups of items are less relevant. Other factors have items with mixed level of relevance.

Overall, the questionnaire demonstrated high internal consistency (Cronbach's Alpha =.8632). To further show the internal consistency of the questionnaire, inter-item correlations analysis was obtained (Table 18). The results show that items within each factor tend to have significant positive correlation, except for staffing issues. This demonstrates the items are measuring the same factor. The range of inter-item correlation co-efficients for each factor are as follows: 'Social Needs' *r*=.506, p<.01 to *r*=.877, p<.01, 'Geographical Factor' *r*=.394, p <.05 to *r*=.996 p<.01 'Staffing'. *r*=.136, p>.05 to *r*=.623, p<.01, 'Technical Factor' *r*=.769 <.01 to . *r*=.906, <.01 'Connectivity to other Care Pathways' *r*=.472 <.01to *r*=.923, and 'Information Factor' *r*=.451, <.01

In addition, there is generally a lack of significant correlation between items across factors. Several significant correlations (marked in red in Table 22) are mostly weaker than those observed in within-factor correlations. Again, this suggests that the items within each factor are more strongly related to each other than to items across other factors. Several of these across-factor correlations are highlighted below.

1. The ability of the patients to communicate clearly (Social Needs) is related to distance and time to hospital (Geographical Factor).
2. Patients own preference (Social Needs) is also related to both distance and time to hospital (Geographical Factor).
3. Meeting ambulance service target (Staffing) is also related to both distance and time to hospital (Geographical Factor).
4. ECP being nearest to scene (Staffing) is related to accuracy of triage system (Technical Factor).
5. All items for information factor and technical factors are inter-correlated.

6. Items for connectivity factor correlate with items from the ‘Social Needs’: patients’ age, level of vulnerability, and patients’ own preferences.
7. Existence of other care pathway (Connectivity Factor) correlates with patient’s ability to cope at home (Social Needs).
8. Temporal availability of care pathway (Connectivity Factor) also correlated with social support (Social Needs)

Correlations 1, 2, and 3 above suggest that the access to hospital (in terms of distance and time) matters when high quality information from patients, patients own preference, and meeting work targets are also important. Correlation 4 reflects the fact that ECPs tend to be assigned jobs where they can be the fastest resource to arrive on scene. The fast response time also means sufficient information may not have been collected to perform accurate triage.

Correlations 5 suggest that the Information Factor is perhaps a subset or manifestation of the Technical Factor. For example, the fact that ‘control room does not have sufficient information to triage accurately’ (Information Factor) is related to the ‘limitations of computerised triage system’ (Technical Factor)

Correlations 6, 7, and 8 seem to suggest that connectivity to other care pathway is relevant to the ECPs’ decision when social needs of the patients were also considered. To choose the best option for the patients, the ECPs weighed the patients’ social need in relation to the care pathways that are available.

Table 22. Inter-item correlations for the decision-making questionnaire

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1																						
2	.738[a]	1																					
3	.812[a]	.749[a]	1																				
4	.724[a]	.763[a]	.745[a]	1																			
5	.780[a]	.788[a]	.720[a]	.877[a]	1																		
6	.621[a]	.681[a]	.589[a]	.720[a]	.822[a]	1																	
7	.617[a]	.619[a]	.620[a]	.582[a]	.695[a]	.773[a]	1																
8	.772[a]	.747[a]	.762[a]	.788[a]	.859[a]	.773[a]	.836[a]	1															
9	.542[a]	.605[a]	.506[a]	.617[a]	.630[a]	.714[a]	.648[a]	.668[a]	1														
10	.066	.084	.014	.064	.092	.287[b]	.202	.122	.286[b]	1													
11	.053	.089	.001	.048	.094	.292[b]	.205	.126	.287[b]	.996[a]	1												
12	.096	-.052	.082	.052	-.028	.031	-.013	.019	.128	.414[a]	.394[a]	1											
13	-.156	-.057	-.038	-.001	-.012	.066	.123	-.003	-.033	.314[b]	.313[b]	-.027	1										
14	-.044	.099	-.018	.019	.044	.077	.043	-.012	.075	.169	.181	-.152	.623[a]	1									
15	-.046	-.075	.053	.000	-.176	-.109	-.069	-.049	-.143	.198	.184	.154	.186	.136	1								
16	-.076	.028	-.067	-.092	.025	.172	.173	.109	.035	.185	.191	.019	.096	.263[b]	-.022	1							
17	-.112	.006	-.050	-.061	-.005	.133	.146	.093	.050	.153	.152	.061	.095	.277[b]	-.040	.906[a]	1						
18	-.044	-.044	-.078	-.030	-.024	.049	.013	.015	.000	.124	.107	.166	.034	.241	-.056	.769[a]	.866[a]	1					
19	.233	.138	.168	.251[b]	.170	.181	.268[b]	.299[b]	.362[a]	.030	.013	.202	-.108	-.066	.064	.182	.176	.165	1				
20	.264[b]	.180	.166	.240	.205	.206	.301[b]	.327[b]	.395[a]	-.002	-.018	.138	-.087	-.069	-.026	.169	.128	.137	.923[a]	1			
21	.132	.170	.028	.045	.155	.297[b]	.445[a]	.254[b]	.380[a]	.209	.221	-.012	.075	.145	.143	.188	.194	.114	.472[a]	.485[a]	1		
22	-.064	.020	.028	.011	.003	.062	.096	.055	.006	.073	.058	.249[b]	.068	.130	.099	.375[a]	.452[a]	.439[a]	.184	.171	-.024	1	
23	-.102	.006	-.053	.033	-.077	-.125	-.057	-.086	.023	-.024	-.036	.221	.048	.177	-.085	.251[b]	.299[b]	.387[a]	.111	.145	-.148	.451[a]	1

[a]= Correlation is significant at the 0.01 level (2-tailed); [b]= Correlation is significant at the 0.05 level (2-tailed)

7.4.1 Discussion

The questionnaire used in part of this study helped to elicit distinct groups of factors influencing ECPs' decision making. Firstly, the overall internal reliability is high, demonstrating the overall reliability of the questionnaire. Secondly, all factors except 'staffing' have high inter-item correlations; showing that the items within the groups are measuring similar influences. Thirdly, there is also a disconfirming evidence in the low between-factor correlations. This shows that items in one group does not relate to items in other groups except for ('information factor' and 'connectivity factor'). In short, there is enough evidence to show that the questionnaire can reliably measure the influences on ECPs' decision making regarding patients' care pathway.

The correlations between information factor and technical factor suggest that their respective items can be combined into one factor. Every item was positively correlated to each other. This may mean the information factors' items address the same issue as the Technical Factor. Similarly, 'ECP being nearest to patient' could also belong to the Technical Factor instead. An argument can be made regarding the placement of the ECP during their shift is as much due to technical issues as to staffing issue. Shortage of staff requires the ECPs to be moved around based on the computer-aided system for keeping track of responders in the ambulance service.

The results from the questionnaire lend further support to the findings reported in Chapter 5. Firstly, there is evidence that each factor identified in Chapter 5 can be reliably measured as mentioned above. The factors identified in Chapter 5 were applicable for actual cases that were observed. Secondly, the items have standard

deviation values that suggest the items were not rated uniformly. The ratings were made with a consideration of how each item was applicable to each patient. If the ECPs had rated the items regardless of the patients seen, a low standard deviation value would be observed. Based on the findings in this Chapter, this is not the case. Moreover, inspection of the individual questionnaire sheet did not reveal obvious systematic bias in the ECPs' rating.

'Social Need' emerged as the most relevant factor based on the questionnaire. This shows that social needs are important in the ECPs' decision. The focus on the social need provides evidence for patient-centred care. The needs of the patients were considered to make the best decision. Nevertheless, factors that are outside of the ECPs' control can influence what they can and cannot do.

There is also evidence that ECPs weighed efficiency consideration in conjunction with thoroughness. For example, there is a correlation between 'time and distance to hospital' (how fast the patient can get hospital-based care) with 'clear communication with patient' (sufficient information elicited from patient). In this example, the positive correlation between the two may mean two things: (1) a decision to send patients to hospital when there is a lack of information and slower time to access hospital-based care, and (2) a decision to treat patient on scene when there is sufficient information and fast access to hospital-based care. These decisions further support the findings regarding geographical factor mentioned in Chapter 6 (section 5.3.2.2).

7.5 Conclusions

Three studies reported in this Chapter re-affirm findings from previous Chapters as well as provide further details into ECPs' decision-making and SA. The factors influencing the ECPs' decision for patients' care pathway were found to be in agreement with the previous findings reported in Chapter 6. Most notable, patients' social needs are important consideration for the ECPs.

The study was successful in getting a wide range of cases for observations. Different medical complaints, patient locations, and outcomes were observed. Thus, the observations and the questionnaire covered many types of situations that the ECPs may face. However, a strong claim cannot be made regarding the representativeness of the cases observed in this study.

Another limitation to the study is the fact that the decision making questionnaire can only validate factors that have already been identify. The questionnaire cannot add new factors. It is also based on a smaller number of observations compared to the retrospective accounts (range and variety of cases limitation). Meanwhile, the CDM interviews were restricted due to limited time available for the interviews. Unpredictable work pace meant the most suitable time for the interviews was during meal break.

CHAPTER 8: REVISITING THE SOCIO-TECHNICAL FRAMEWORK

8.1 Introduction

The studies reported in this thesis examined the cognitive work of ECPs in an Ambulance Service. This Chapter attempts to summarise the findings by presenting a revised socio-technical systems framework that describes SA and NDM among ECPs. Findings from Chapters 4, 5, 6, and 7 that had been discussed in each respective chapter are summarised here and related to the research questions stated in Chapter 1. Limitations of the studies are discussed with a view to provide context in drawing conclusions from the findings. To conclude the thesis, further questions and a set of issues for future research are presented.

8.2 Putting the pieces together

Two objectives were set for describing the cognitive aspects of ECP job. The description was achieved by conducting studies that put together a socio-technical systems framework. Then, the framework was evaluated using an ethnographic approach. A revised framework is proposed here as a means of summarising the findings.

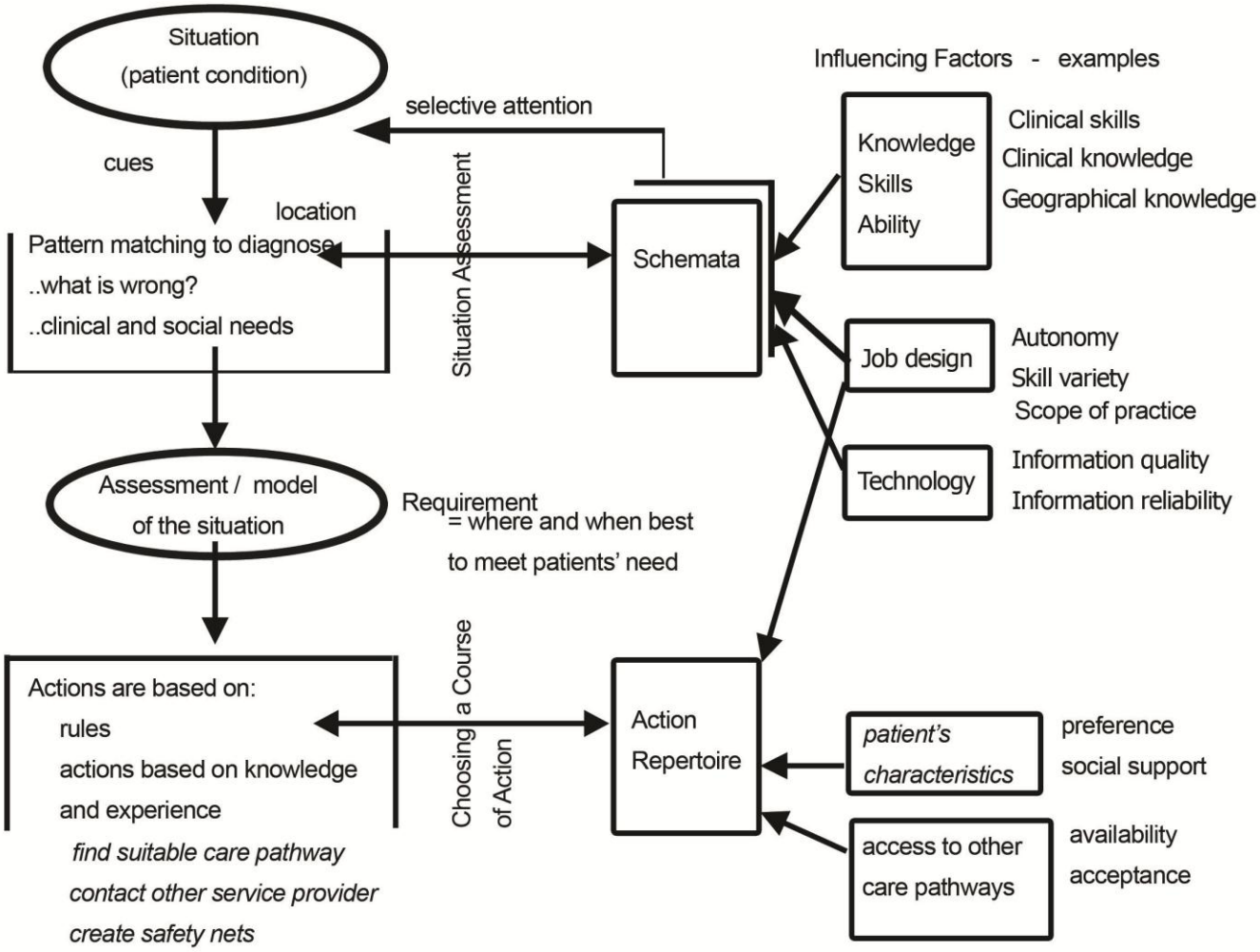

Figure 19. Revised IDM for ECPs

The decision making process can be fitted into the IDM model (Wong, 2000) with minor modifications. The revised model (figure 21) presents various aspects of ECPs' decision-making. Control Room, patients, and patients' surrounding provide the problem cues that the ECPs compare with their schemata of patients' condition. The cues are used to assess the clinical and social needs of the patients. An understanding of the needs lead the ECPs to know the appropriate care pathway for the patient. A successful assessment of situation depends on the ECPs' existing knowledge and skills, and the quality of information gained from the patient. If the patients' condition is understood or familiar, then the ECP can choose the relevant care pathway: treatment on scene, admission to A&E, or referral to other care pathway. If the situation was less clear or unfamiliar, the ECP choose the safest option, which is admission to A&E.

A revised socio-technical systems framework (Figure 22) is proposed to highlight the influence of different system levels on ECPs' SA and NDM. In this simplified framework (compared to figure 6), the government and regulatory agencies scope the context and system constraints (blue shading). In turn, trust governance and ambulance service NHS Trust set the context for the ECP job (green shading). Dispatch, patients, and the patients' environment have a more direct influence as shown by the solid arrows. Meanwhile, the trickle-down effect mentioned in Chapter 5 is visualised by the shaded areas in Figure 22. It can be concluded that the two macro-level systems elements have an indirect effect on the ECPs' SA and NDM. It has been mentioned in Chapter 4 that the macro policies set by the Department of

Health and adopted by the Ambulance Services may conflict with each other. The findings provide support for the assertion on the conflicting policies. The time-based performance target interferes into the original objectives of the ECP role which is to cater for urgent care (non-hospital based) demand.

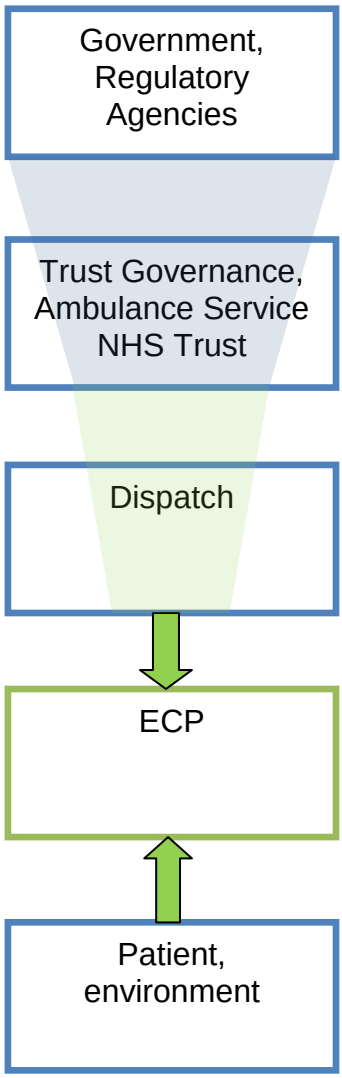

Figure 20. Revised socio-technical systems framework

The direct and indirect influences are demonstrated more explicitly by combining figure 21 and 22 (figure 23). The influences of the micro-level and macro-level systems elements are made clearer in figure 24 and 25. For example, it can be seen

that the Ambulance Trust influences decision making through its scoping of the ECPs' job design (red dotted arrow – figure 24). This example is particularly interesting because job design can influence both the schema for assessment of situation and the selection of action. A more direct influence can be seen for patient's characteristic on selection of action (solid red arrow- figure 25).

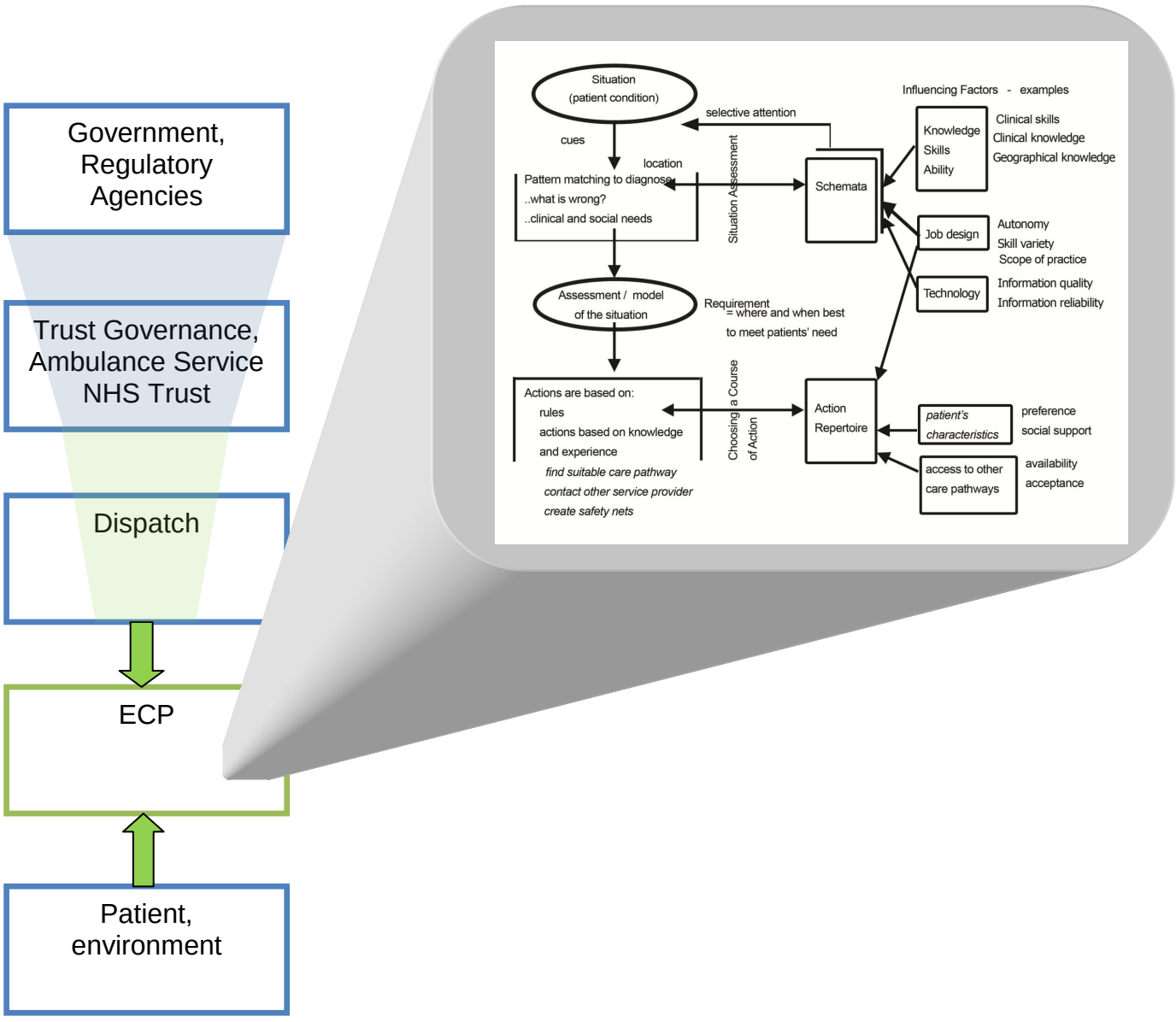

Figure 21. Revised socio-technical systems framework showing system levels influences on ECP decision making.

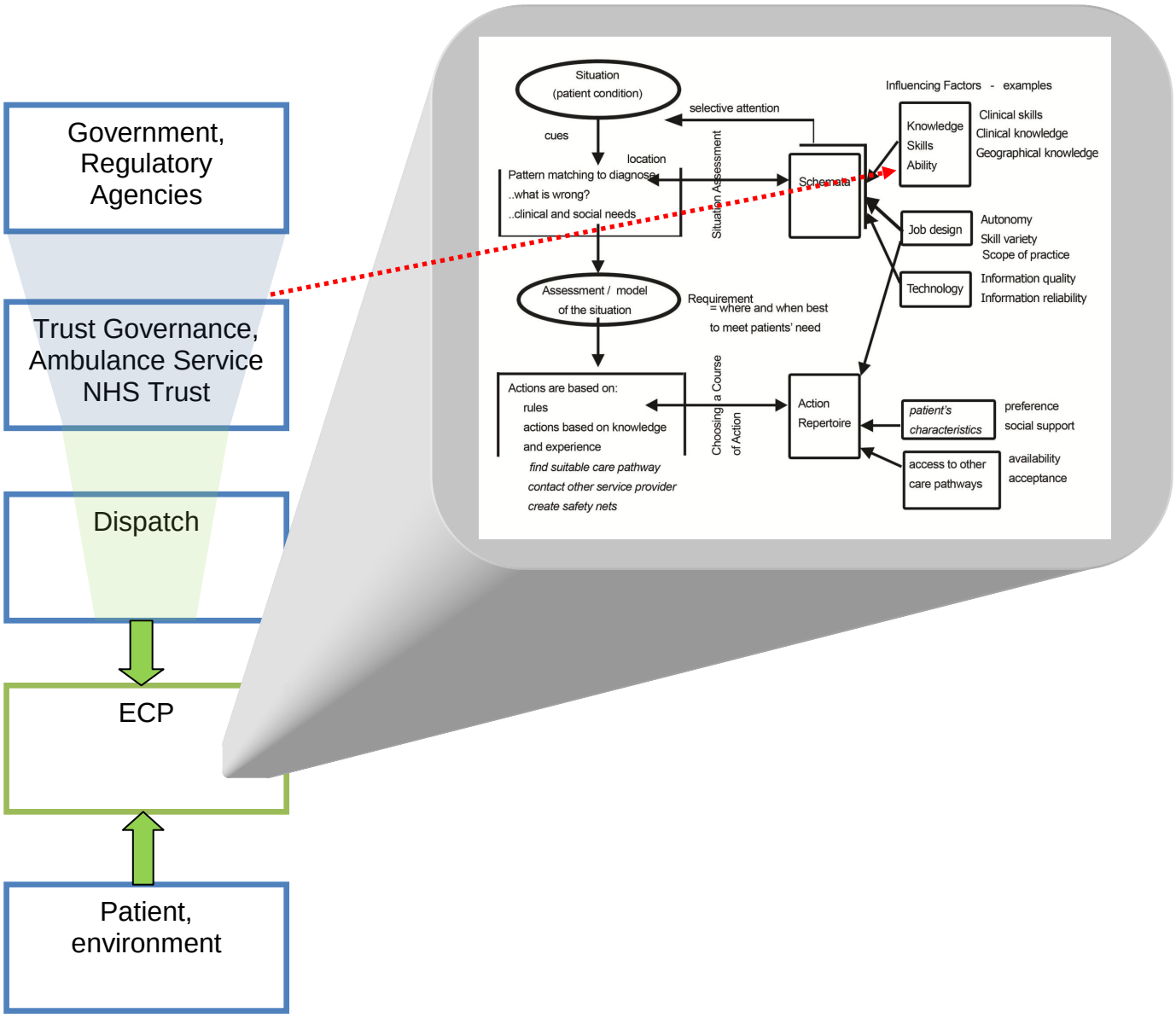

Figure 22. Revised socio-technical systems framework showing indirect influences of macro-level element on decision making

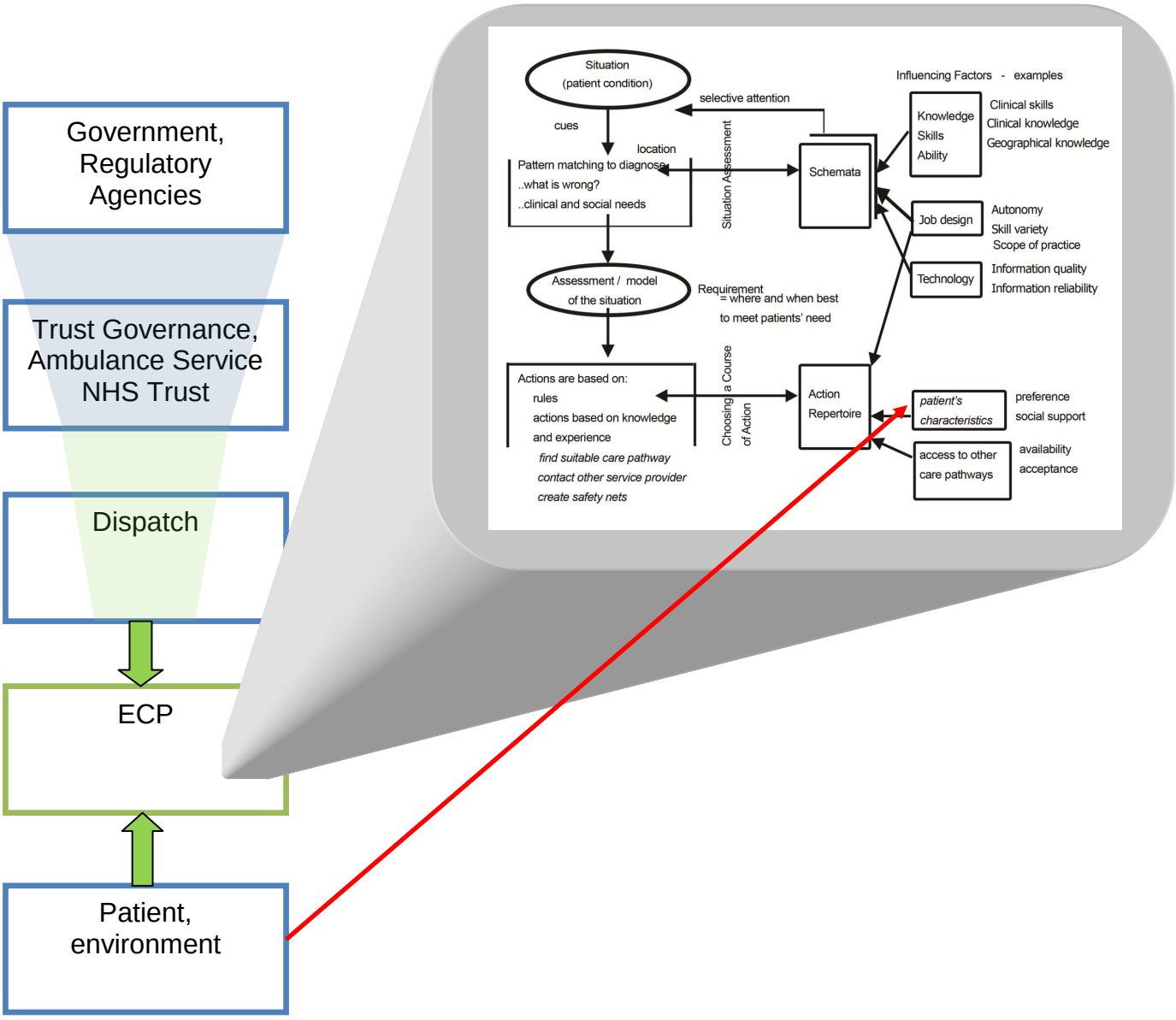

Figure 23. Revised socio-technical systems framework showing direct influence of patient and environment elements on decision making

The framework serves as a basis with which to put forward a number of future research questions cutting across a range of system levels, these include: (a) focusing on the suitability of the organisational structure (in light of the linkages between macro/micro elements) to support sound clinical decisions and treatments by the ECPs; and, (b) how the performance of the ECPs contribute to the overall performance of the emergency care pathway as a whole (figure 11). Therefore, it is also relevant to examine the ways in which the deployment of ECPs contributes towards systems resilience. From the point of view of the UK Ambulance Services, it is hoped that this helps the Ambulance Services develop a more holistic systems-based approach to understanding and further designing the role of the ECP.

8.3 Addressing the original research aims and questions

Two main objectives were set in relation to the aim of the thesis as mentioned in Chapter 1. The first objective is to construct a socio-technical systems framework for investigating the SA and NDM among ECPs. This had been achieved through an examination and selection of relevant framework. The framework was further supported by initial data obtained from a small sample of ECPs and Control Room staff.

The second objective of the thesis is to evaluate the socio-technical systems framework. By conducting a mixed-method research using an ethnographic approach, the initial data was compared against a large set of qualitative and

quantitative data. The later data reaffirms the initial findings and provide further details into SA and the decision making process.

The construction and testing of the framework were the main ways for describing the cognitive aspect of ECP job. The framework allows for a description of SA and decision making by taking into consideration the influences of different systems elements. Moreover, the information requirements to support SA were also identified. Based on the interviews, observations, and analysis of AMPDS data, it was possible to draw the following conclusions.

8.3.1 Patients' characteristics

Patient characteristics are important as a source of cues and information in the assessment of situation stage of decision making. The use of patient-related information was a strong theme coming from the various studies. Patient's characteristics, including their immediate surroundings, are important for the ECPs to make a holistic assessment of the patients' clinical and social needs. The evidence suggests that patients' characteristics have direct influences on SA and decision making. It can be argued that not much can be done to change patients' characteristics to support SA and decision making. However, the efforts could be focused on gathering and presenting relevant information to the ECPs in a timely manner. Pre-arrival information should ideally provide the ECPs with a medical history that are relevant to the presenting medical complaints. Patients could also be educated to make sure they keep a good record of their medical history. The availability of reliable information would help the ECPs to avoid bias in their decision

(e.g. bias towards admission to hospital due to uncertainty about recent medical concerns).

8.3.2 Personal characteristics

Individual characteristics have already been identified as an important factor for SA development and maintenance (Endsley, 1995). The findings from these studies outline the individual characteristics that are pertinent to the ECP role. Practical experiences of treating patients at walk-in unit, A&E department, and minor injury unit were important for the formation of schemata. Additionally, access to and reviews by more qualified clinicians are also important to reinforce the schemata. This suggests the training of ECPs should emphasise the practical experiences to develop better decision making ability. The importance of training towards decision making ability and confidence had already been reported (Cooper et al., 2004). The findings in this thesis provide an explicit mechanism on the effect of training. Practical experience helps in the formation of schemata that are activated in the first stages of decision making (assessment of situation).

8.3.3 Tools and technology

Information relayed to the ECP via existing communication technology was not found to be as important compared to information obtained directly from the patients. The quality and reliability of the information need to be improved to assist the ECPs. Suitable hardware (e.g. data screen) and information system (e.g. electronic patient records) can be designed to suit the ECP role. The current system (AMPDS) to select jobs for ECPs is not tailored towards what the ECPs should do. According to

the AMPDS, ECPs are no different from other emergency responders. To a certain extent, other healthcare workers also treat like regular emergency responder as mentioned in section 8.3.6.

The tools and technology for clinical assessment and tests also face reliability problems. The ECPs use the information derived from the devices like the ECG and thermometer with caution. Triangulation of information, by finding both confirming and disconfirming evidence, was used by the ECPs to arrive at a diagnosis. Again, this highlights the importance of having access to reliable patient records like medical history and medication mentioned in section 8.3.1. The design of tools and technology provided to the ECPs should be reviewed as their role is different from other emergency responders in the Ambulance Service.

8.3.4 Performance targets

Performance target has an indirect effect on SA and decision making. The indirect effect is manifested in the role of the government, regulating agencies and the ambulance trust in setting performance target. Time-based targets are used to measure the quality of job performance. There is a strong reason to move to a clinical-based measure instead (Gray & Walker, 2008). However, the emphasis on response time, couple with limited resources available to meet increasing demands, means ECPs are at times deployed like other emergency responder. Therefore, the ECPs would go to scenes without much information prior to arrival. In some cases, the ECPs were sent to a patient because they were there nearest resource available even though another (further) resource had already been mobilised to the same patient. This was done to ensure the response time falls within the time target. In

these cases, the decision about patient care had already been determined (i.e. patient had to go on the ambulance). So, the role of the ECP is reduced to emergency paramedics while waiting for the arrival of ambulance crew.

8.3.5 Job-design

As mentioned in section 8.2, job design can influence assessment of situation and selection of action. This is another macro-level influence on SA and NDM. Skill variety, as encouraged or discouraged by the management of ambulance service (i.e. via the practice of placement rotation and jobs assignment) can have an impact of schemata. ECPs from different background (e.g. nursing, paramedics) reported having different awareness and skills in assessing situations. The diversity of experience amongst ECPs is certainly an asset to the ambulance service. However, there remains the problem of matching the skills to the patients' need.

Enlarging the scope of practice, for example via providing advanced prescribing course, would give a wider options for the ECPs. This is equivalent to adding to the ECPs' action repertoire. Employing alternative way to assign jobs to ECPs, other than via 999 calls, could also be beneficial. Some ECPs expressed their concern that their skills are deteriorating due to a lack of variety in the cases assigned to them. Allowing ECPs to choose their own cases would allow the ECPs to sharpen specific skills that they think are lacking or starting to deteriorate. The willingness to enlarge their job (i.e. job crafting) was evident among some ECPs. The role of the management is to define the job-design and implement it accordingly. In the absence of clear leadership for the ECPs, which was a concern raised by some ECPs, the role may suffer from a lack of direction. A clear direction is needed if the role is to be

developed further with considerations for the influence of job-design on SA and decision-making.

8.3.6 Professional boundaries

The ECP role was designed to provide better linkages for the different parts of the healthcare systems. The autonomy designed into the role means ECPs can theoretically make decisions regarding the best care pathways for patients. However, the ability to make decision is not yet matched with the ability to implement the decision. This represents an issue concerning systems beyond pre-hospital care. Barriers to other care pathway still exist. ECPs still have to negotiate professional boundaries in making referrals. Better recognition of the ECP role by other healthcare providers is desirable. If other health and social care services know what the ECPs can do, not only access to suitable resources can be facilitated, but also the ECPs can potentially get jobs that otherwise not covered by the ambulance services. For example, staff at nursing homes can make specific request for ECPs to assess their residence instead of letting the dispatchers making the decision for them. The other issue about professional boundary is the time required to access the external services. ECPs may be aware of the resources that are available for patients, but if the time required to access those resources are lengthy, then a less time consuming resource (e.g. A&E department) could be selected instead. The ECPs have to weigh different options with a limited knowledge of the status of the other resources. The lack of visibility of available resources put extra workload for the ECPs.

8.3.7 Resilience

A highly potential benefit of the ECP role to the wider healthcare systems is in improving resilience: the ability to cope with high demands to the systems. In light of the increasing demands for the Ambulance Services and the hospital-based emergency services, the ECP role could act as a buffer in redirecting patients to other care providers. Their skills of evaluating patients' needs can be used to filter out patients who need not be treated at hospitals' Emergency Department.

The findings show that there are evidence for resilience strategy used by the ECPs and the Control Room staff. These little 'r' resilience strategies – the reuse of existing strategies to cope with demands – are applied for routine events. Strategies for big 'R' resilience – the creation of novel strategy – was not observed due to the absence of non-routine event during the observations. However, the novel effort of putting the ECPs into the Ambulance Services pool of staff can be seen as a big R strategy. The implementation of these strategy does not necessarily lead to greater resilience of the systems. The potential for resilience conflicts with the focus on performance target. Deployment of the ECPs may be due to them being able to achieve the time target rather than providing the right treatment in the right time as reported in Chapter 6. Similarly, ambulance crew may be deployed when ECPs would be the better responder for some patients. Additionally, job-design and professional boundary issues also reduce the likelihood of the ECPs from fulfilling their full potential to improve resilience. For example, job crafting among the ECPs suggests there are improvements to the role that the management had yet to accept into common practice. Meanwhile, the acceptance of the ECPs' referral is still an issue with some care providers as mentioned in Chapter 6.

Therefore, it can be said the ECPs contribute towards resilience for routine events. To realise the full potential of the ECP role to improve resilience requires further development of the role.

8.4 Limitations

Several limitations were recognised and discussed in the following sections. The limitations concern the restrictions in the data collection procedure which is related to the researcher's background. Additionally, the study did not control for the changes within the Ambulance Service. Finally, the scope of the study excluded the measurement of job performance.

8.4.1 Data collection procedure

The main constraint was the conditions set in the ethical application. Access to staff of the Ambulance Service was not as flexible and generous as first proposed. Conducting interviews during the ECPs' shift has to take into account the variable nature of their work pace. The time that can be spared for the interviews was highly dependent on the ECPs themselves and the amount of work assigned to them during the shift.

Another constraint is the timeliness of note taking during observations. The issue of patient consent and privacy were raised by the ethics committee. A solution that was acceptable was for the researcher to not take any notes in the presence of the

patient. This restriction reduced the amount of details that can be recalled accurately afterwards, especially for high-paced and high-intensity cases.

8.4.2 Changing nature of the job

Changes occurring in the Ambulance Service are beyond the scope and control of the researcher. During the course of the study, ECPs were reassigned to different ambulance stations, seconded to other position. Some ECPs left the ambulance service to hold other jobs in the primary care. The impact of the differences in the composition of the ECPs across the whole of EMAS cannot be accounted for. Therefore, the findings like those in Chapter 5 (analysis of the AMPDS data) should be interpreted with an awareness of the on-going changes occurring in the background.

8.4.3 Researcher's Background

The researcher was not trained in clinical domain. The learning curve was steep especially in appreciating the breadth and depth of the overall healthcare systems. A comprehensive view of the systems is important for interpreting underlying tones like the tension or the quality of relationship between different healthcare providers. While the research findings show the professional recognition of the ECP role is far from universal, the full impact of this situation is not fully understood. Another issue related to the clinical background is the time scale of events (Wears, Woloshynowych, Brown, & Vincent, 2010) in emergency cases. Given the nature of medical emergencies, it was difficult for the researcher to notice events that were important to understand.

The researcher's cultural background also played a role in the data collection process. The ethnographic nature of the study required high level of interactions with people whose cultural background was significantly different. Personal approach, for example the level of assertiveness and persuasiveness, played a role in getting participants to complete the data collection process (e.g. interviews and questionnaire). The non-English background may have induced reactive responses from patients that influenced the nature of their interaction with the ECPs. In most cases, the patients and family members were highly co-operative. What was more of a concern was the language barriers (accent, idiomatic expressions, slangs, and non-verbal communication) that limited the understanding of nuances in ECP interactions with patients.

8.4.4 Scope of study

The studies reported in this thesis are descriptive studies. They only described the cognitive aspects of the ECP role and the support for them. In this sense, this is the delimitation of the thesis: it does not look at the influence of the processes and support on job outcomes and patients outcome. In other words, the scope of the thesis does not go beyond showing how SA and NDM affect the quality of clinical interventions and the clinical outcomes among patients.

8.5 Further questions and future work

The assessment of emergency health services in England is being reviewed and changes are being proposed (Triggle, 2010). The ambulance response-time targets

will be revised and other performance indicators more directly related to quality and patient safety will be introduced. The focus on patient outcomes is a welcome change. The changes are part of the on-going changes affecting the whole stages of the emergency care system. Hospitals will face financial penalties if patients are readmitted as an emergency within 30 days of being discharged (Roberts, 2010). These changes necessitate further works to be conducted to shape the development of the role. The followings are strands of further work that can be carried out.

Further study is suggested to examine issue beyond the scope of this thesis. One strand of research that should be looked into is the effect of SA and NDM on job performance. The need to find performance measure other than response time has been recognised (Snooks et al., 2008). Measures of job performance can include the patients' clinical outcomes, and indices of patient safety like errors, and risks. Clinical outcomes that can be used as indices of patient safety are patients' re-admission to A&E, and subsequent calls by patients after being seen by ECPs. The nature of these investigations requires a longitudinal approach, and can use the examination of information from initial contact with ECP and hospital record at a later time (Gray & Walker, 2008). Investigations into the job performance can provide a more direct link between the aspects of cognition to safety outcomes in the emergency care domain.

Another issue which was made obvious from the studies is the divergence of the designed-role and the actual-role as it is presently applied across the Ambulance Services. The skills and knowledge of the ECPs are perhaps not well matched to patients' need in the community. This is evident by the high percentage of patients who were eventually transported to hospitals after being seen by the ECPs. The

methods to assign jobs to ECP should be reassessed and redesigned. The computerised system and the dispatchers' role have to be reconfigured to take into account the ECP role. Additionally, the wider context of the ECP operational framework needs to be re-examined. Currently, ECPs are part of the reactive responders of the Ambulance Services. Other ways of delivering the ECP skill and knowledge could be explored to meet the need for urgent care in the community.

Another aspect of the operational framework for the ECP role is leadership and management. As found in Chapter 4, the way the ECP role is implemented can be improved with more support from the management. For example, a clinical lead could be created for the role as a way to ensure ECPs get appropriate guidance. The lead would also be useful for providing feedback on their performance. Furthermore, proper guidance and vision for the role in general are needed. These kinds of support from the management are expected to refine, or even redefine, the role and focus its pre-hospital care delivery. Studies should be made into the influence of management in setting the operational framework of the role and its subsequent effect on emergency care quality.

Another step forward from the present set of studies is an examination into the devices and tools to support decision-making. Electronic patient records (via the use of Toughbooks) had been implemented gradually. The extent to which the Toughbooks actually support the cognitive work of the ECP needs to be evaluated. Initial observations suggest there is a trade off between completeness of the records against the time taken to enter the information. Furthermore, features can be added to the Toughbook to ensure ECPs get more information about the patients to aid the

development of their SA and their decision making. The development of the features can be guided by the information requirements reported in Chapter 6.

As mentioned earlier, ECPs had mentioned the need for a clinical lead or an external evaluator to improve their confidence in what they are doing. Observations of ECPs at the ambulance stations reveal a way by which ECPs share their concerns, observations, and issues with colleagues. During stand-by times at the stations, ECPs were observed to hold informal conversations with colleagues about previous jobs that they had completed. This can be interpreted as a way for the ECPs gaining feedback on what they were doing. In the absence of formal clinical lead, ECPs took part in informal clinical review with colleagues. This particular behaviour can be seen as an attempt to expand their job boundary; a behaviour that can be called job-crafting (Wrzesniewski & Dutton, 2001). Efforts to change the operational framework of the ECP role can benefit from an examination of job-crafting behaviour amongst the ECPs. Their creative ways of redefining and rethinking about their job can provide insights into how the role can be redesigned to improve the delivery of pre-hospital care.

8.6 Conclusions

There has been increasing attention paid to cognitive aspect of emergency responder's work. New technologies are developing to integrate the management of chest pain in ambulances like dysrhythmia software that can aid understanding of changes in patient's ECG readings (Erich, 2010). Technologies like this can greatly enhance SA and decision. However, technology should not impede or create hazards like. Although there are no published data, there had been cases reported where

ambulance crashed because the driver were looking at GPS screen (Richtel, 2010). Therefore, assistive technology need to be designed and evaluated to achieve desired impacts. In the context of evidence-based medicine, research into cognitive aspects of clinical job can provide the evidence needed for the fit between the technological and social systems.

This thesis presented a set of studies that aims to describe the cognitive aspect of a role in pre-hospital care setting. It identifies macro and micro level influences on ECPs' SA and decision making. There need to be a wider systems consideration for assessing how the ECP role can be supported to deliver pre-hospital care. This will enable the role to be developed and applied optimally to meet the need for urgent care in the community.

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Appendix B: Research Ethics Protocol and Approval

Table of Contents

Study Summary

Title	Situation awareness among Emergency Care Practitioners
Short Title	SA among ECPs
Protocol Version Number and Date	Version 1.0, September 2008
Methodology	Type of study: Mixed method (field studies: participative observation, interview, survey)
Study Duration	12 months
Study Centres	Single Centre
Objectives	1) To describe SA issues related to ECPs' job performance 2) To draw a map of communication of ECP within EMAS 3) To delineate SA requirements among ECPs 4) To evaluate a system model of SA: 1) testing the system model, 2) comparing between pre and post-EPR utilisation
Number of Subjects/Patients	50 - 59 ECPs, 8 Control room staff
Main Inclusion Criteria	Currently working full time in EMAS
Statistical Methodology and Analysis	Goal Directed Task Analysis, Thematic Analysis, Content Analysis Correlation Chi-square

1. Introduction

This document is a research protocol and the described study will be conducted in compliance with the protocol, The Research Governance Framework, International Conference on Harmonisation Good Clinical Practice Guideline ICH/GCP, and all applicable NHS Foundation Trust Research Office requirements.

1.1 Background

Studies on situation awareness (SA) in complex systems show its value for system evaluation, especially in relation to safety. SA is defined as "…the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley, 1988). SA is usually studied at the individual, level. Amidst the current debates and criticisms, the progress on SA continues. Among other reasons, the measurement of SA can be used to evaluate system design, evaluating training techniques, and understanding human cognition (Endsley and Robertson, 2000).

In healthcare, SA is not as widely studied as in other domains. Changing demands for the way health care is delivered led to the creation of a new role in emergency medical services namely Emergency Care Practitioner (ECP). A national evaluation of ECP schemes concludes that the "ECP schemes are moving forward in line with original objectives and could be having a significant impact on the emergency services workload" (Mason et al., 2006: p 435). However, many of the studies on ECP examined post-task aggregated data. Studies that examine ECPs in action would complement the existing literature. A study is thus proposed to examine the relationship between SA and performance among ECP. Preliminary analysis of ECP communication at the macro level yielded research questions that will be followed up. The proposed study is expected to reveal the applicability of SA in emergency medical services and assist in understanding the ECP's role.

2 Study Objectives

1) To describe SA issues related to ECPs' job performance
2) To draw a map of communication of ECP within EMAS
3) To delineate SA requirements among ECPs
4) To evaluate a system model of SA:
    4.1) testing the system model,
    4.2) comparing between pre and post-EPR utilization

There are no secondary objectives.

3 Study Design

3.1 General Design

This study is divided into two consecutive phases. The first phase is designed to describe the work system as relevant to ECPs and their SA. The second phase is designed to measure SA and evaluate a socio-technical framework for the ECPs. It The data collection process is expected to be between 6 months to 12 months.

3.2 Primary Study Endpoints

There are two primary endpoint to be analysed in the study. One endpoint is the data that describes how SA is applicable for ECPs. These data are used to develop a model of SA among ECPs in EMAS. The model will then be tested. The data from a test of the model constitutes the second primary endpoint.

3.3 Secondary Study Endpoints

There are no secondary endpoints to be analysed in the study.

4 Methods

4.1 Subject Selection and Withdrawal

Inclusion Criteria

Participants that will be recruited in this study are ECPs and Control Room staff. The only criterion for inclusion is being currently employed by EMAS on a full-time basis.

Exclusion Criteria

1. Currently not working with EMAS (e.g. temporary leave).
2. Working on a part-time basis.

4.2 Subject Recruitment and Screening

The ECPs and other Ambulance Services staff to be involved in this project will be identified through the Director of Operations (DO), EMAS. Contact provided by the DO will be used to individually contact the participants. Information will be given by arrangement with the participants. The preferred arrangement is face-to-face meeting.

Informed consent will be obtained in a face-to-face meeting or via email attachment.

The participants have one week to reply. If no answer is obtained after one week, the researcher will follow up via phone or email. If no answer is obtained after two weeks, it will be assumed that the potential participant is not interested to participate.

There are no laboratory or diagnostic testing necessary to be imposed on the participants.

A Unique Subject Identification (USI) numbers will be allocated based on the contact information provided by the DO. The USI comprises a combination of three alphabets (denoting the ambulance station), the digit 0 (for male) and 1 (for female), and followed by a two digit ordinal number assigned on the basis of the name's appearance in the contact information obtained. So, for example, MIC-1-01 refers to the first male participant from Mickleover. The soft-copy of this Recruitment Log will be stored on a

PC with password access at the researcher's laboratory. A hard copy will be stored in a folder at the same facility.

Participation in this study will not be recorded in the staff records.

4.3 Withdrawal of Subjects

4.3.1 When and How to Withdraw Subjects

A subject may be withdrawn from the study if the subject meets the exclusion criteria stated earlier. There are no foreseeable safety precaution that may necessitate early withdrawal. None the less, subjects can withdraw without having to provide an explanation. An abrupt withdrawal from the study does not affect subject's safety.

4.3.2 Data Collection and Follow-up for Withdrawn Subjects

Survival data is not applicable for this study. However, follow-up for the purpose of data clarifications may be conducted with the agreement of the subjects.

4.4 Prior and Concomitant Therapy

(not applicable)

5 Laboratory Assays

(not applicable)

6 Randomisation

There are no intervention imposed by the researchers. Therefore, there is no need to randomly assign participant to different treatment groups.

Selection of ECP will follow stratified random sampling. The sampling method would consider ambulance station as a variable so that all ambulance station would be represented. The ECP will be assigned to case study, observation, and/or interview based on agreement with the researcher. If there are more volunteers with than

required, then simple randomisation will be used to assign the ECP to the different data collection procedures.

7 Study Procedures

This research is cross sectional and is divided into two phases. The first phase is aimed at describing SA within the ECP's work domain. The second phase attempts to examine the role of SA in ECP's job performance via a pre-and-post evaluation.

1) Describing SA issues related to job performance Method: Literature search, analysis of AMPDS data, EMAS references.

Data will be examined to show the types of 999 calls to which ECPs were assigned, the dispatch code, the ECPs decision for each case (transport or not), and any follow up, if applicable. The data will be examined for all relevant ambulance stations within EMAS. Other information relevant for the understanding of the work context of the ECPs will be obtained by literature search and references at EMAS.

2) Creating a communication map of ECP within EMAS Methods: Interview, subject matter experts' validation.

Based on a preliminary communication map, the researcher will interview an ECP, and three Ambulance Control Room Staff (Triage Nurse, Call Taker, and Dispatcher) to add details to the map. In addition, the Ambulance Control Room Manager would be consulted as an expert to verify the map that will be produced. The interview and consultation will be repeated as necessary until at least 3 persons (different from the ones interviewed and consulted) agree that the map is satisfactory (i.e. correct and have sufficient details)

3) Identifying SA requirements among ECPs Method: Goal-Directed Task Analysis

Goal-Directed Task Analysis (GDTA) involves participative observation, interview, and validation from subject matter experts. It involves several iterations as necessary to describe the ECP tasks in detail. The researcher will observe the ECPs while they are performing their job (i.e. during a ride-out session). The ECP will also be interviewed

about their job. For this, at least two ECPs are required. Then, a GDTA diagram will be produced and shared with at least two other ECPs for validation. These processes (observation & validation) will be performed at least twice. Other sources of information (e.g. job manual, guidelines, ECP documentations) relevant to understanding the ECP job will be examined. The interview will be audio-taped and transcribed for analysis. Photographs of the ECPs and their work environment, excluding the patients – will be taken to supplement the analysis. These photos will be taken when the ECPs are not responding to a call.

4) Linking SA and performance

Method: (1) Case study. A measure of SA will be developed and tested among the ECP. Case studies will be used to test a model of SA that links SA and performance. At least 5 ECPs, selected randomly, will be observed and interviewed after they attended to a patient. They will be observed during the shift except when they are attending to patients. The interview will be audio-taped and transcribed for analysis. A 28-days follow up on the patient will be done by checking their data. The patient will not be contacted personally. There will be at least 5 Category C cases for each ECP.

Method: (2) Questionnaire and Interview. Depending on the final version of the SA measure, a self-administered questionnaire will be distributed to be filled up and collected during the interview. 50 ECPs will be interviewed before and after the introduction of EPR. It will be a semi-structured interview on SA and performance issues identified previously. The interview will be audio-taped and transcribed for analysis.

8 Statistical Plan

A statistician has not been consulted. The planned statistical analyses are basic descriptive and inferential analysis within the expertise of the research team.

8.1 Sample Size Determination

Sample size is determined by feasibility and availability of the relatively small population. At the latest count, EMAS employs 73 ECPs. All ambulance stations under EMAS will be included. At least 50% of all ECPs will be included with the maximum of 68% (50 ECPs).

8.2 Statistical Methods

Descriptive and inferential statistics will be used to analyse ECPs call responses data. Pearson correlation and chi-square tests will be run on the data.

8.3 Subject Population(s) for Analysis

This study examines ECPs within EMAS. Therefore, the population is all of the ECPs within EMAS. A contingency plan involves ECPs working with PCT in the same geographical area as EMAS. Therefore, they may be included in the population.

9 Safety and Adverse Events

9.1 Recording of Adverse Events

No adverse events are anticipated in this non-invasive study.

9.2 When Adverse Events are Recorded

No adverse events are anticipated in this non-invasive study.

10 Data Handling and Record Keeping

10.1 Confidentiality

Information about study subjects will be kept confidential and managed according to the requirements of the Data Protection Act, NHS Calldicott Guardian, The Research Governance Framework for Health and Social Care, Ethics Committee Approval and Trust IM&T Policy.

Details

- Identifiable details to be collected from subjects in this study include sex, age, and the ambulance station where the ECP work.
- The information will be available to all three researchers for data analysis purposes.
- The information will be used by the three researchers. The Chief Investigator (Harris Shah Abd Hamid) will be the primary person handling the data. The two co-researchers handle the data in supervisory role. The Principal Investigator does not handle the data directly.
- The data will be anonymised using a Unique Subject Identifier.
- The Trust has a comprehensive registration with the Information Commissioner with research being registered under **Purpose 4** of the Register; The Trust Data Protection Officer will be notified of all research studies in order to comply with the Trust IM&T Security Policy.
- The Principal Investigator is the “Custodian” of the data.
- Patient identifiable details will not be taken out of the UK and EU. Any information related to the patient will be completely anonymised for research presentations and teaching.
- A research subject has the rights of to revoke their authorisation for use of their PHI.
- Subjects will not be identifiable from any future publications.
- Audio recording from the interviews would be stored on a password-protected personal computer. Transcripts of the interviews will not contain identifiable details of the participants.

10.2 Source Documents

Source data for this study includes:

- tabulated AMPDS data – to be obtained from EMAS. The data to analyse are the number of Cat A, B and C calls attended to by the ECPs and whether the calls resulted in hospitalisation or not. The despatch code for each call would also be analysed.
- annotated observation sheet – observation sheets (see Attachment) will be used during ride out session, sit-in session.
- audio recording of interviews – semi-structured interviews will be conducted to capture the SA requirements as well as SA measurement for the ECP. An interview schedule (see Attachment: Interview Proforma: Emergency Care Practitioner) will be used.
- digital photos – to capture the physical aspects of the work system, photos will be taken of the ECPs and their work environment. These photos are meant to support and supplement the observations and interviews. These photos will be taken when the ECPs are not responding to a call.
- questionnaire forms – a questionnaire will be develop to assess self-reported SA, and related indices (mental work load, job satisfaction, and stress) among the ECP. The SA questionnaire will be drafted as enough information are collected in phase one of the study.

10.3 Records Retention

Data generated by this study will be stored and accessed for at least five years. This is to allow the Chief Investigator to complete his PhD programme. The data will be stored in a laboratory with a controlled access. Digital data is stored on a password-protected personal computer. Copies of the digital data will be made on CDs or other suitable electronic storage devices.

Upon the completion of the PhD, the raw data (questionnaire, annotated observation sheet, and audio records) will be destroyed. Digital materials like photographs and transcripts of interviews will be kept further for another ten years. These digital materials

will only be used for re-analysis of data and teaching purposes. Any personally identifiable information will be deleted or masked.

11 Study Monitoring, Auditing, and Inspecting

11.1 Study Monitoring Plan

The investigator will permit study-related monitoring, audits and inspections by the Ethics Committee, the Sponsor and the Research Governance Manager. This study will be monitored by the Research Governance Manager according to the Research & Development Office procedure for monitoring all non-commercial research carried out at the EMAS NHS Trust. In line with the responsibilities set out in the Research Governance Framework, the Investigator will ensure that the research governance manager or other regulatory monitoring authority is given access to all study-related documents and study related facilities.

Participation as an investigator in this study implies adherence to the principles and responsibilities of the Research Governance Framework, ICH/GCP and Directive 2000/20/EC.

In addition, the study is monitored by two academic supervisors and a Director of Research appointed by Loughborough University. The academic supervisor is Patrick Waterson (listed as research team member). The Director of Research is Paula Griffiths.

12 Ethical Considerations

This study will be conducted according to the standards of International Conference on Harmonization, Good Clinical Practice Guideline, Research Ethics Committee regulations, any applicable government regulations, Trust and Research Office policies and procedures.

This protocol and any amendments will be submitted to a properly constituted Research Ethics Committee (REC) for approval of the study conduct.

The decision of the REC concerning the conduct of the study will be made in writing to the investigator. The Investigator must then submit the approval letter to the R&D Office in order for Trust and / or R&D approval to be issued.

No research studies can commence until the principal investigator has received a letter of approval from the Trust issued by the Research and Development Office and a letter of approval from the Research Ethics Committee.

Undertaking a research study without the written approval of the Trust, as detailed above, and a REC or if carried out in breach of the Research Governance Framework will lead to disciplinary action.

All subjects for this study will be provided with an information sheet describing the elements of this study and sufficient information for subjects to make an informed decision about their participation in this study. See Attachment '*Participation Information Sheet: Interviews and Observations*' for a copy of the Information Sheet. The subject will complete and sign a consent form to indicate that they are giving a valid consent to participate.

The formal consent of a subject, using the UK National REC approved consent form, must be obtained before that subject is submitted to any study procedure. The subject or legally acceptable surrogate must sign this consent form, and the designated research professional obtaining the consent must countersign this consent indicating that all available information has been given to the subject.

With regard to obtaining informed consent, the researcher has prior experience. The researcher had taught an undergraduate course on 'Ethics in the Helping Profession' that included topics on informed consent. The researcher had also attended a course on 'Ethics in Healthcare' where the focus was research within NHS. On the practical side, the researcher had designed and conducted research where informed consent was obtained from the participants. The researcher also supervised undergraduate research project that included obtaining inform consent. Additionally, the researcher has had 36 hours of ride-out sessions with ECPs. These ride-out sessions exposed the researcher to the actual work of an ECP.

The most vulnerable situation for the researcher would be the ride-out session with an ECP. Firstly, the vehicle is driven very fast especially in responding to a CAT A calls. Thus, the researchers need to wear seatbelt all the time. Secondly, the researcher cannot control the environment of the ECP's job. The ECP would go to patient's houses or an open area such as in a traffic accident. Patients, their relatives and members of the public may be hostile towards the ECP. To manage this risk, the researcher will seek the ECP's advice whether it is safe to join him/her at the treatment scene or stay in the car. The researcher will also request and wear a safety jacket labelled 'observer' to identify himself as part of the RRV crew. The control room also has procedures to reduce the risks to the ECPs. They are usually alerted, via the MIS, of a patient's/caller's history of hostility where available. Moreover, they are assigned in conjunction with another crew, or in the knowledge of police presence, for cases that may involve alcohol-related violence.

Potential Harms to ECPs

There is no intervention or treatment in this research. The ECPs are not asked to perform tasks that they don't usually do. The main issue here is the privacy of data. Observations and case studies may use audio tape recording. As such, the data will be anonymised so that it will not be identifiable to a particular ECP. Additionally, access to

the audio recording will be restricted to the researcher and the research supervisors only.

Potential Harms to Patients

Patients' privacy is also very important. However, the research does not involve direct observation of patients. The researcher will look at medical data that does not have identifiable information. The ECP might give examples about specific patients. However, the transcription will not include identifiable data. Therefore, there is a very minimal foreseeable potential harms to the patients.

Study Contingency

As it stand, the research depends on the roll out of the Electronic Patient Record in EMAS which is scheduled in the first half of 2009. If the roll out is delayed, then a different study is proposed for the research. The alternative study is a comparison between ECPs in Ambulance Services and in PCT. This comparison would achieve the objective of testing an SA model. Instead of a pre-post comparison, there would be a comparison across two work settings.

13 Study Finances

13.1 Funding Source

This main researcher (Harris Shah Abd Hamid) receives a scholarship from the Ministry of Higher Education Malaysia. The scholarship covers the PhD programme that includes the proposed study.

13.2 Indemnity for the performance of the study

Indemnity arrangements are made by Loughborough University (see attached indemnity certificates)

14 Sponsorship:

The research is sponsored by East Midlands Ambulance Services. The Director of Operations had agreed to support the study.

15 Publication Plan

Publications planned for this study includes conference papers (Naturalistic Decision Makin, Ergonomics Society Annual Conference), journal articles (Ergonomics, Emergency Medical Journal), and PhD thesis (Loughborough University). The Director of Operation, EMAS, will be acknowledged in the journal articles. The DO will check that the publications meet the requirements of publication policies of EMAS, as the Sponsor.

16 References

1. Endsley, M.R. 1988, Design and evaluation for situation awareness enhancement. *Proceedings of the Human Factors Society 32nd Annual Meeting*. 97-101. (Santa Monica, CA: Human Factors Society).
2. Endsley, M.R. Robertson, M.M. 2000, Training for Situation Awareness in Individuals and Teams. In MR Endsley, DJ Garland (Eds.) *Situation Awareness Analysis and Measurement*. (London: Erlbaum). 349 – 365.
3. Mason, S., Coleman, P., O'Keefe, C., Ratclife, J., Nicholl, J. 2006. The evolution of the emergency care practitioner role in England: Experiences and impact. *Emergency Medical Journal. 23*, 435 – 439.

17 Attachments

The following is a list of attachments.

- Participation Consent Form – Staff
- Participation Information Sheet – Staff
- Layman's Summary
- Scientific Review – Internal
- Scientific Review – External
- Indemnity cover – Professional Indemnity
- Indemnity cover – Employer and Public Liability

- ECP Observation Sheet
- Interview Proforma – Goal Directed Task Analysis
- Interview Proforma – Communication Map Analysis: Control Room Staff
- Interview Proforma – Communication Map Analysis: ECP
- Study Procedures Flowchart

Healthcare Ergonomics and Patient Safety Unit
Dept. of Human Sciences
Loughborough University
Loughborough
Leics. LE11 3TU
UK

Director: Dr Sue Hignett
Ph.D. M.Sc. M.Erg.S. M.C.S.P. Eur.Erg.
Tel: +44 (0)1509 223003
Fax: +44 (0)1509 223940
Email: S.M.Hignett@lboro.ac.uk

Consent Form: Interviews and Observations

Title: Situation awareness among ECPs

Investigators: *Harris Shah Abd Hamid, Patrick Waterson,*
Site: *East Midlands Ambulance Service NHS Trust*

	Please initial box
I confirm that I have read and understood the Participation Information Sheet dated 22nd June 2009 (version 2.1). I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without my professional or legal rights being affected.	
I understand that the interview will be audio-taped, transcribed anonymously and that verbatim quotations may be used in publications and presentations.	
I understand that the field notes, sketches, and photographs will be recorded from the observations	
I understand that the interview will be confidential.	
I understand that the data (including audio-recordings) will not be available to me after the study	
I understand that relevant sections of my research notes and data collected during the study, may be looked at by individuals	

from Loughborough University, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.

I agree to take part in the above study

Signature (Participant)……

Date……..…

NAME (BLOCK CAPITALS)……

I have explained the study to the above participant and they have indicated their willingness to take part

Signature (Researcher)……

Date……..…

NAME (BLOCK CAPITALS)……

Healthcare Ergonomics and Patient Safety Unit
Dept. of Human Sciences
Loughborough University
Loughborough
Leics. LE11 3TU
UK

Director: Dr Sue Hignett
Ph.D. M.Sc. M.Erg.S. M.C.S.P. Eur.Erg.
Tel: +44 (0)1509 223003
Fax: +44 (0)1509 223940
Email: S.M.Hignett@lboro.ac.uk

Participant Information Sheet: Interviews and Observations

Situation Awareness among ECPs

Emergency Care Practitioners is a role designed to deliver urgent healthcare. To further develop the role, evaluation should be performed with regards to the original objectives. The evaluation would contribute to refinements of the role.

This project is looking at the thinking processes of the ECPs and the organisational factors affecting them. The ability of the ECPs to notice, understand and predict the elements in their job environment is important to make the right decisions and take correct actions. These thinking processes are known collectively as situation awareness. Creating and maintaining situation awareness helps the ECPs to be in the loop with regard to each patient that they see.

Invitation to participate

You are being invited to take part in the study as stated in the Invitation Letter. There are five different procedures in which you may participate.

Communication map analysis	This analysis involves interviews and looks at your reflection of the ECP as a role within EMAS. The interview is to be conducted during work time, or at a different time at your convenience. It should last a maximum of an hour. Photographs may be taken and anonymous drawings on paper will be used to supplement the interviews. The interview will be audio-taped for analysis, the tapes will be anonymously transcribed (with each participant given a number) and the tapes will be destroyed/erased 5 years after the findings have been reported as a thesis.
Task Analysis	These ride-out sessions looks at performance of clinical tasks carried out normally during work time. Observations and interviews should last a maximum of four hours. There will be

	one session arranged with your agreement. Observations notes will be written on paper. Photographs of you and your work environment, excluding the patients, will be taken. The interviews are to be conducted during the ride-out session, or at a later time at your convenience. They should last a maximum of 1 hour. They will be audio-taped for analysis, the tapes will be anonymously transcribed (with each participant given a number) and the tapes will be destroyed/erased 5 years after the findings have been reported as a thesis.
Case Study – SA measurement during ride-out sessions and interviews	These ride-out sessions looks at performance of clinical tasks carried out normally during work time. Observations and interviews should last a maximum of six hours. There will be two sessions arranged with your agreement. Observations notes will be written on paper. Photographs of you and your work environment, excluding the patients, will be taken. The interviews are to be conducted during the ride-out session, or at a later time at your convenience. They should last a maximum of 1 hour. They will be audio-taped for analysis, the tapes will be anonymously transcribed (with each participant given a number) and the tapes will be destroyed/erased 5 years after the findings have been reported as a thesis.
Questionnaire	The questionnaire will be mailed to you to be completed at your own time. It consists of questions about your job as an ECP. The estimated time to complete the questionnaire is 15 minutes. The questionnaire is to be returned using an envelope supplied. Alternatively, the questionnaire can be completed and returned through the internet.
Interview	This interview looks at your reflection of the thinking processes involved at work. The interview is to be conducted during work time, or at a different time at your convenience. They should last a maximum of a half of an hour. They will be audio-taped for analysis, the tapes will be anonymously transcribed (with each participant given a number) and the tapes will be destroyed/erased 5 years after the findings have been reported as a thesis.

Each of the five procedures can be completed outside of work time, except for ride-out sessions. If you want to complete the procedure during work time, management permission will be sought on your behalf.

Before you decide whether to participate it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Purpose of study

This research is looking at the role of situation awareness in ECP's job performance. The study is conducted to assist the Ambulance Services to understand, and consequently improve healthcare delivery provided by the ECPs. The interviews and observations will give detailed

information about the tasks themselves, and factors that affect them. These data will be used to highlight issues and design recommendations to support the ECP role.

Who is doing this research?

The researchers are Mr Harris Shah Abd Hamid (Chief Investigator), and Dr Patrick Waterson, from the Healthcare Ergonomics and Patient Safety research Unit (HEPSU) at Loughborough University.

Why have I been chosen?

Because you are a key stakeholder who has knowledge and in-sight about the ECP role.

Do I have to take part?

No. Once you have read this information sheet, you will have at least 7 days to decide if you want to take part. If you decide to take part you will be asked to sign a consent form, but you can still change your mind later, without giving a reason. You may withdraw from the observations and interviews at any time.

Sensitive personal data

We will not be asking you any personal or sensitive questions about yourself.

What will happen to me if I agree to take part?

You will be asked to assist in data collection in your organisation.

What will happen if I decide to withdraw from the project?

There will be no effect on your professional status. The data already collected will be used for analysis unless you specifically request it to be withdrawn and destroyed.

What do I have to do?

There are three activities which we may ask you to be involved with.

1) We will watch your normal work activities so that we can look at how you perform the clinical tasks.

2) We will ask you to meet with the researcher at an agreed venue for an interview where you will be asked questions about performing the clinical tasks or the ECP job in general, which you may answer with as much detail as you feel happy to give. We will audio-tape your replies for analysis at a later date.

3) We will give you a questionnaire to complete at your own time, estimated to take 15 minutes.

What are the possible advantages/disadvantages of taking part?

The advantage of taking part will include the generation of information about urgent and emergency care in the UK. Specifically, it will contribute to a greater understanding of the ECP role. There are no foreseeable disadvantages of taking part.

What happens if something goes wrong?

We will follow the incident reporting procedure at Loughborough University and your organisation concurrently. If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain about any aspect of the way you have been approached or treated during the course of this project the normal National Health Service mechanisms may be available to you. Alternatively, you can contact Peter Townsend at Research Office, Loughborough University, LE11 3TU Loughborough, Leicestershire. His office telephone number is 01509222450 and his email address is P.A.Townsend@lboro.ac.uk.

Will my taking part in this study be kept confidential?

If you take part in the research all information collected from you and your organisation during the course of the research will be kept strictly confidential. All references to participants in the report and any subsequent publications/presentations will be anonymous. The information will be kept in a secure location, accessible only to the researchers. All of the raw data (audio-tape, documents etc.) will remain the property of Loughborough University and will be destroyed/erased 5 years after the findings have been reported as a thesis.

What will happen to the results of the research study?

The results will be coded (for anonymity) and analysed by the research team before being reported as a thesis (scheduled to be completed in September 2010). The results may also be presented in appropriate scientific journals and at conferences The availability of these publications depend on the date of acceptance from the journal editors or conference organisers. If you take part in this research, you can obtain copies of these publications from the research team. Please contact the Chief Investigator (Harris Shah Abd Hamid) by email (H.S.Abd-Hamid@lboro.ac.uk) or by phone (01509 228157).

The data will be stored by the Chief Investigator (data controller) at Loughborough University under conditions specified by the Departmental Data Protection Advisor.

Who is funding this research?

This research is funded via a scholarship held by the Chief Investigator (Harris Shah Abd Hamid) from the Ministry of Higher Education Malaysia.

Who do I contact for more information?

You can ask: Mr Harris Shah Abd Hamid (H.S.Abd-Hamid@lboro.ac.uk)– Tel. 01509 228157, Dr Patrick Waterson (P.Waterson@lboro.ac.uk) – Tel. 01509 228478.

What if I have any concerns?

If you have any concerns about this study or the way it has been carried out you should contact the investigators (Harris Shah Abd Hamid, Patrick Waterson). Alternatively, you can contact Peter Townsend at Research Office, Loughborough University, LE11 3TU Loughborough, Leicestershire. His office telephone number is 01509222450 and his email address is P.A.Townsend@lboro.ac.uk.

Thank you for reading this information sheet.

Layman's Summary

Situation Awareness among Emergency Care Practitioners

Situation awareness (SA) is a term that is used to describe a range of mental processes. It refers to an awareness for any given time in a particular surrounding. Awareness arise from noticing, understanding, and predicting the behaviours of objects in the surrounding. Research on SA show that it is useful for evaluating complex work organisations, especially in relation to safety. In healthcare, SA is not as widely studied as in other areas like the military and commercial aviation. Healthcare in the UK is a complex system that changes regularly. One such change is the creation of a new role in emergency medical services namely Emergency Care Practitioner (ECP). A study is proposed to examine the relationship between SA and work performance among ECP. An initial study looked at ECP communication. From the initial study, a number of research questions were identified. The proposed study is expected to answer whether SA is useful to evaluate an emergency medical system within an ambulance services. Another question to answer is whether SA is improved by the introduction of electronic patient records. This study is expected to help in understanding and developing the ECP work role.

Scientific Review

Harris is approaching the end of the first year of his MPhil / PhD. He provided his 10,000 word report in September and this was examined on 25th September by myself with Dr Griffiths in attendance as DoR.

The report provides a review of Situation Awareness from a theoretical perspective and proceeds to describe its application in healthcare. The student identifies that Emergency Medical Services are an under-studied part of Situation Awareness and that this is suitable for PhD study. Emergency Medical Services are then described.

Harris has already completed some orientation studies, observing in some healthcare settings but is waiting for ethical clearance to start on his main data collection phase of the PhD.

The student's performance in the viva was excellent, where he demonstrated a comprehensive understanding of the relevant topic areas, well beyond what was written in the report. The main criticism of the report was that it is too long, by at least 40%; although the examiners agreed that it would not be good use of time to re-write, the student was strongly advised to ensure that he meets the requirements and needs of his audience in future dissemination.

In summary, Harris performed beyond what is expected and it is therefore recommended that his status be upgraded to PhD.

Dr Neil J Mansfield, September 2008

ECP Observation sheet: Ride-out with ECP

Date:_____ Time:_____ Location: _____

Machine & Equipments
Task / Work Procedure / Processes
Related Systems / Organisations
Environment
Outcomes (Projected & Actual)
Issues
SA issues

Interview Proforma: Goal Directed Task Analysis

Date:	Time:	Venue:
USI number:	Age:	Work Experience:

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1. When did you start working as an ECP?
    a. Were you a nurse or paramedics ECP?

2. What are the goals of an Emergency Care Practitioner?

3. What information are necessary for each job that you are assigned to?

4. When you arrive at the patient, what information do you normally look for?

5. How do you decide whether to send a patient to the hospital or not?
    a. How quickly do you make the decision?
    b. How confident are you with the decision that you make?
    c. What would influence your decision to transport the patient?

6. What would be an example of a job done badly?

Thank you.

Interview Proforma – Communication Map Analysis: Control Room Staff

Date: Time:
SUI: Age: Sex:

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1. Can you please describe your work?
2. How long have you been working in the Control Room?
3. How does an ECP differ from other emergency responders?
4. How do you decide whether a job is for an ECP?
5. What are the considerations for assigning a job to an ECP?
6. Can you please outline the process of assigning a job to an ECP?
7. What are the ways available for you to communicate with the ECP?

Thank you for your time.

Interview Proforma – Communication Map Analysis: ECP

Date: Time:
SUI: Age: Sex:

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8. Can you please describe your work?
9. How long have you been working as an ECP?
10. How does an ECP differ from other emergency responder?
11. How do you think the control room decide whether a job is for an ECP?
12. What do you think are the considerations for assigning a job to an ECP?
13. Can you please outline the process of assigning a job to an ECP?
14. What are the ways available for you to communicate with the Control Room?

Thank you for your time.

Situation Awareness among ECPs
Project Stages