# BEYOND LIKELIHOOD AND CONSEQUENCE: DEVELOPING A SYSTEMS APPROACH TO RISK ASSESSMENT IN THE LED OUTDOOR ACTIVITY CONTEXT

Clare Dallat

THE CORONER'S VERDICT…

- "It was clear upon the evidence that the **risk assessment** process applied [to the Bells Parade excursion] by Mr Mc Kenzie and his staff was **informal, ad hoc and seriously inadequate**". (Coroner Rod Chandler, 2011 Tasmania).

- "There had been **no substantive analysis undertaken by the school** concerning swimming at this site, and **little or no current advice had been passed on** to the Year 7 homeroom teachers as a group". (Coroner Peter White, 2014 Victoria)

- "The failure to earlier undertake an **appropriate, comprehensive risk assessment**, proved critical". (Worksafe Victoria, 2011)
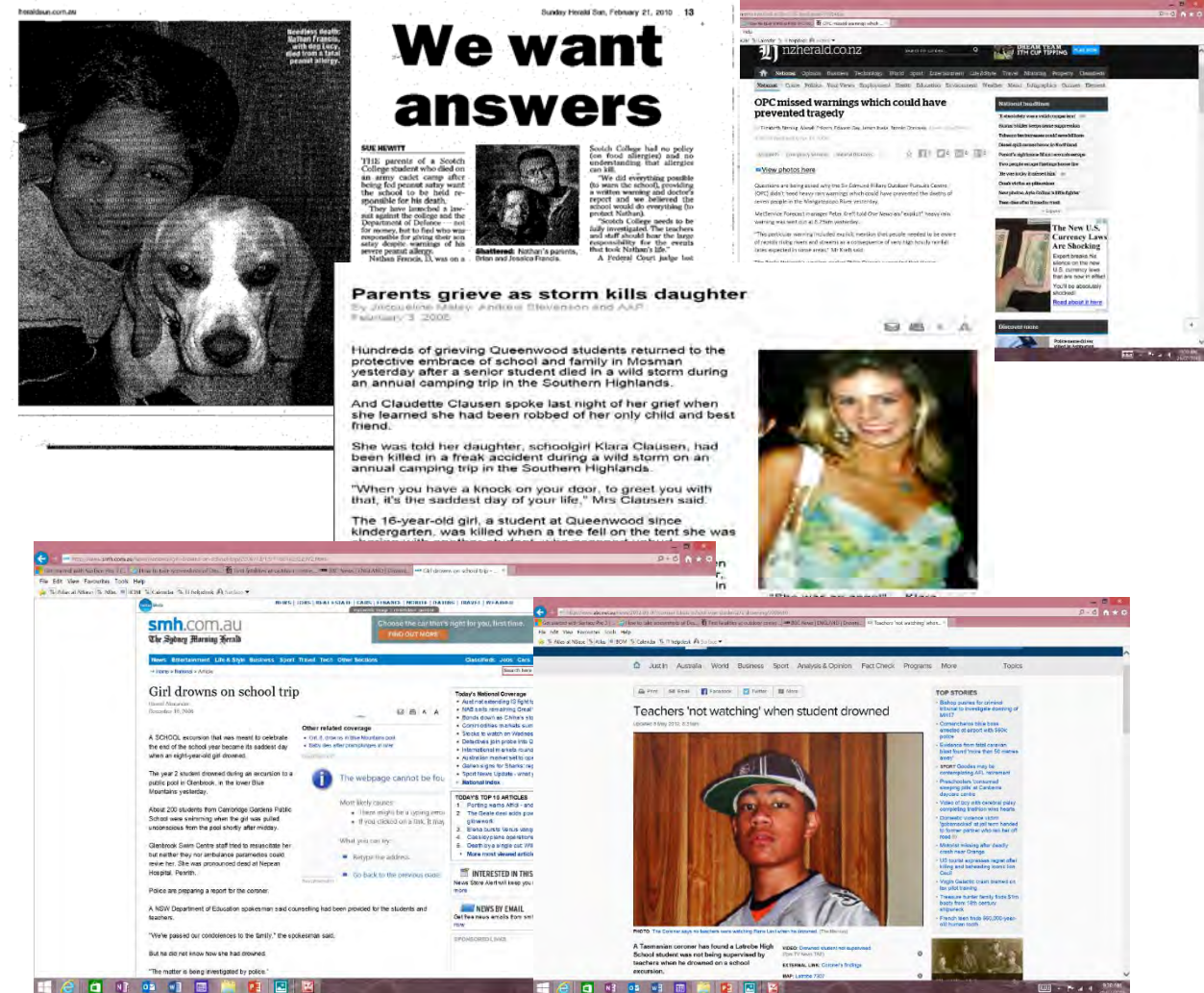
THE RESEARCH PROBLEM

- Inadequate risk assessment frequently highlighted as a contributing factor in deaths and injuries of participants on led outdoor activities (LOA)

- The completion of a risk assessment is a formal requirement in planning LOA's

- The systems-thinking approach to accident causation in LOA domain (and safety critical domains generally) is now prevalent

- The extent to which schools/organisations consider and apply the systems approach to LOA's when conducting risk assessments is not clear.

RESEARCH QUESTIONS

1. To what extent are risk assessment methods in both the LOA sector and other safety-critical domains, underpinned by systems theory?

2. What challenges and barriers exist for LOA practitioners in relation to risk assessments?

3. Can we integrate a systems thinking –based approach to risk assessment design and development?

4. Does a systems thinking-based risk assessment method achieve acceptable levels of reliability and validity?

Public opinion →

Government

Changing political climate and public awareness

Laws

Regulators, Associations

Regulations

Company

Changing market conditions and financial pressure

Company Policy

Management

Changing competency levels and education

Plans

Staff

Action

Work

Hazardous process

Fast pace of technological change
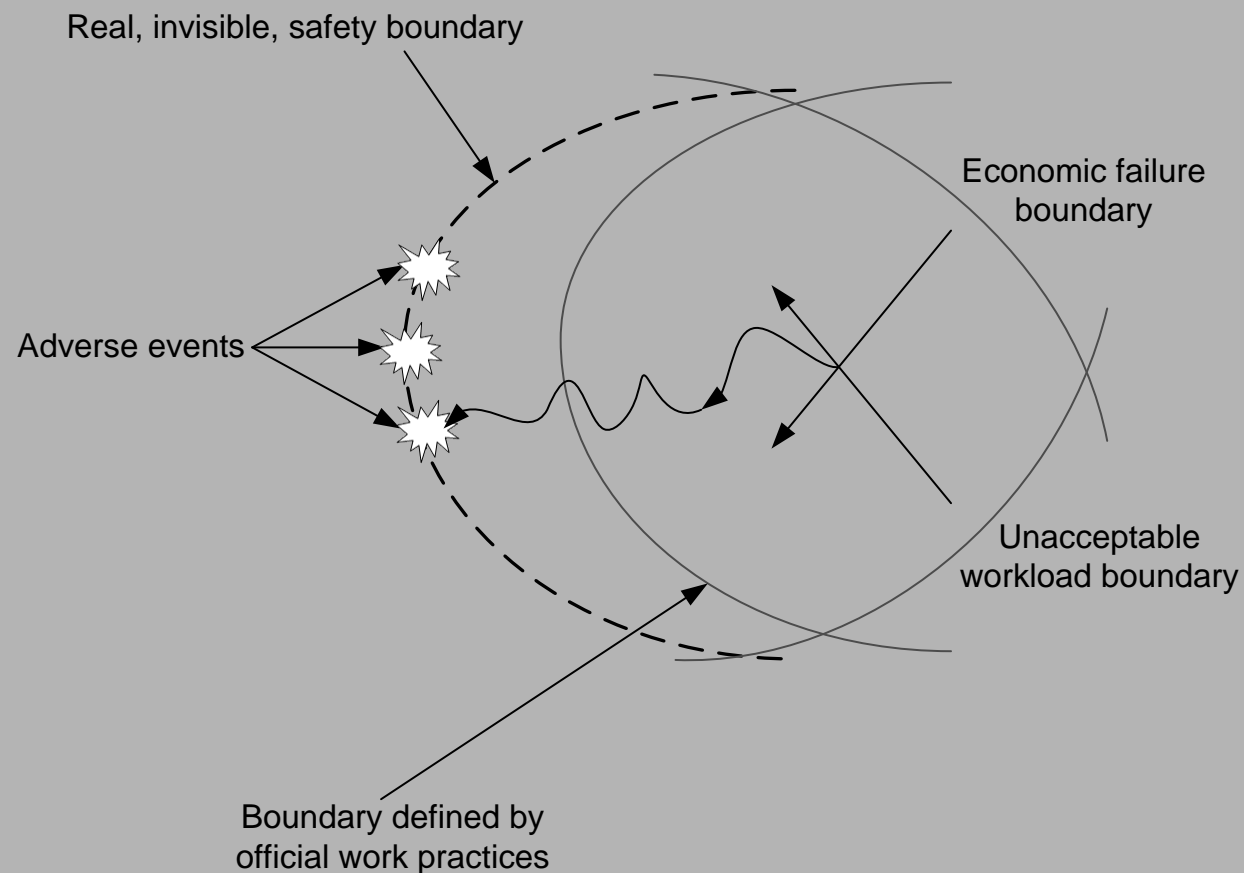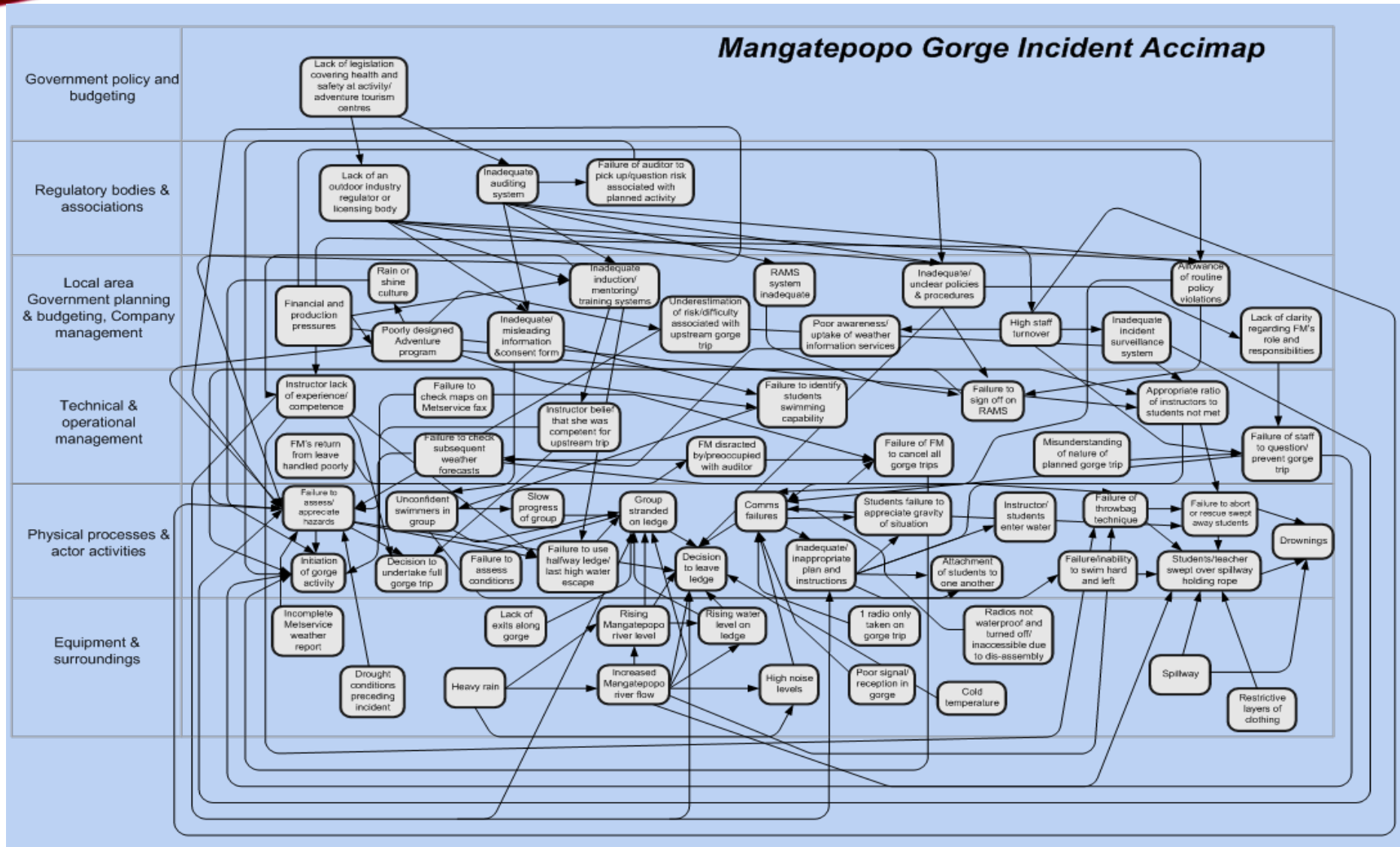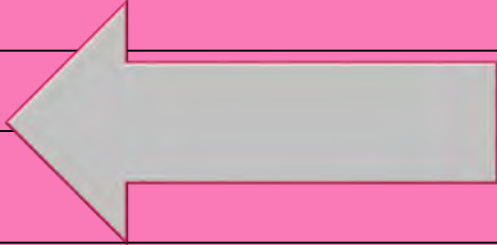
Real, invisible, safety boundary

Economic failure boundary

Adverse events

Unacceptable workload boundary

Boundary defined by official work practices

Mangatepopo Gorge Incident Accimap

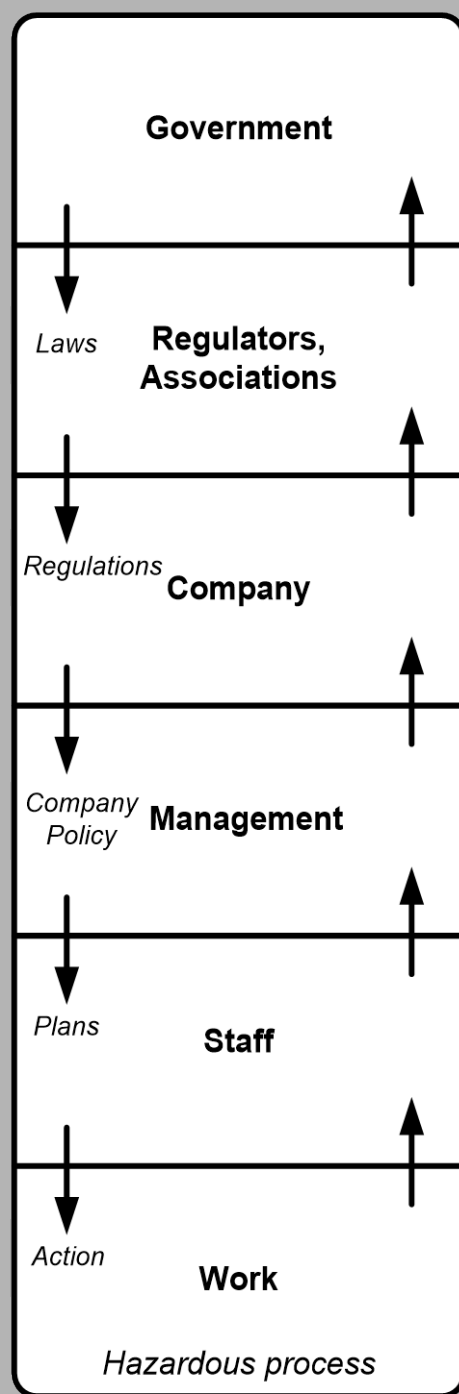*RQ1: To what extent are risk assessment methods in both the LOA sector and other safety-critical domains, underpinned by a systems approach?*

- 4 LOA RA's analysed to assess the extent to which they were underpinned by contemporary systems thinking.

- The 'PEE' approach

Government department decisions and actions							
Regulatory bodies and associations							
Local area government, schools and parents Activity centre management planning and budgeting							
Supervisory and management decisions and actions	Student numbers						
Decisions and actions of leaders, participants and other actors at the scene of the incident	Limited skill (1)	Medical conditions (3)	Exhaustion (1)	Special needs group (1)	Abrasions (1)	Lost student (1)	
	Dehydration (1)	Burns (3)	Fatigue (1)	High risk behaviour (1)	Fractures (3)	Infection (1)	
	Chafing (1)	Slips and trips (1)	Strains and sprains (2)	Abduction (1)	Injury from arrow (1)	Negative impact with another group (1)	
	Trailer reversing (1)	Jumping (1)	Diving (1)	Falls (3)	Allergic reaction (3)		
Equipment, environment and meteorological conditions	Steep terrain (1)	Sloping ground (1)	Tree fall (1)	Temperature hot/cold (3)	Falling objects (1)	Sharks (1)	Bike failure (1)	Vehicles (1)
	Unknown site (1)	Environment being harmed by human (1)	Road hazards (1)	Weather conditions (2)	Heights (1)	Exposure (1)	Communication device failure (1)	Jewellery (1)
	Treed campsite (1)	Wild animals (1)	Lightning (2)	Water visibility (1)	Drowning (3)	Fire (1)	Clothing entangled in bike (1)	Arts and crafts material (allergic reaction to) (1)
	Exposed ridges/hollows (1)	Cattle grids (1)	Animal bites/stings (3)	Rips (2)	Water quality (2)	Sunburn (1)	Trailer decoupling (1)	Equipment failure (1)

Findings:

- Systems thinking-based RA methods are not being used in LOA

- Brainstorming, prior experience & 'PEE' process driving RA process

- In general, a picture of <u>confusion and uncertainty</u> in relation to conducting risk assessments, as well as a <u>lack of policy guidance and formal training</u>, was observed.

- Only a small proportion of the potential risks around LOA **program development, planning and delivery** are currently being identified and assessed.

RQ1: To what extent are risk assessment methods in both the LOA sector and other safety-critical domains, underpinned by a systems approach?

RQ2: What methods, approaches, challenges and barriers exist for LOA practitioners in relation to risk assessments?

LOA RISK ASSESSMENT

Figure 5 Accimap representing the LOA system

Anglesea Kayaking Incident Accimap
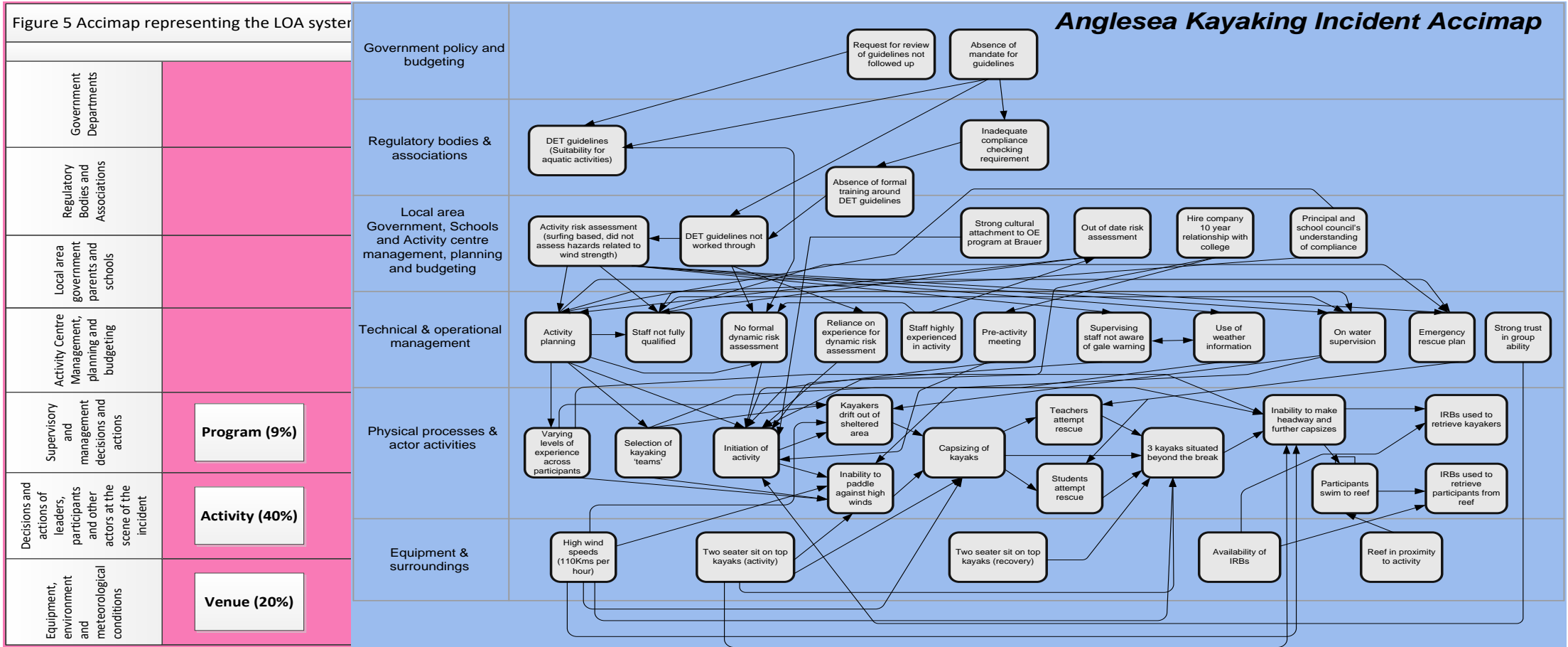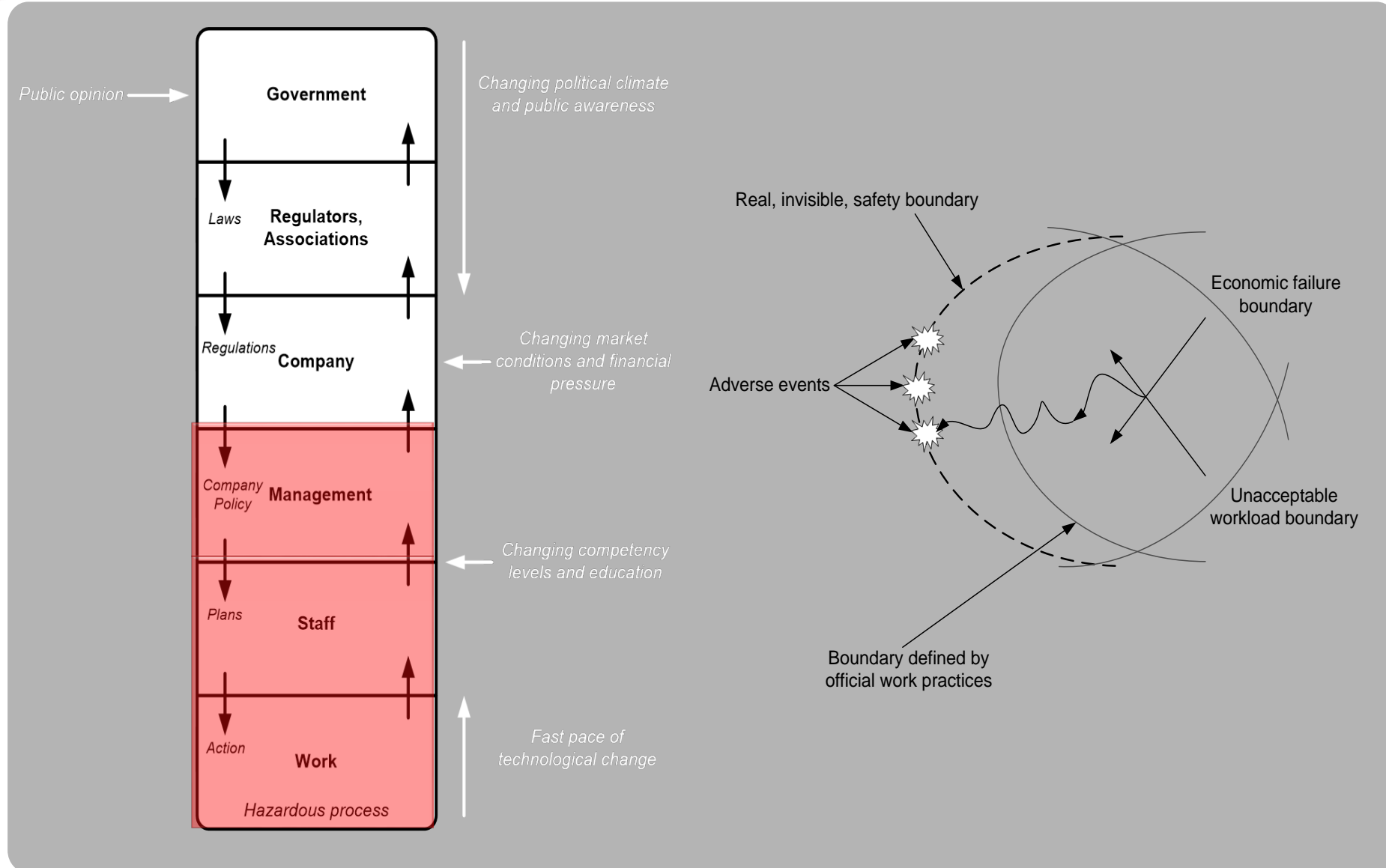
THE SYSTEMS APPROACH AND LOA RISK ASSESSMENT

RQ1: To what extent are risk assessment methods in both the LOA sector and other safety-critical domains, underpinned by a systems approach?
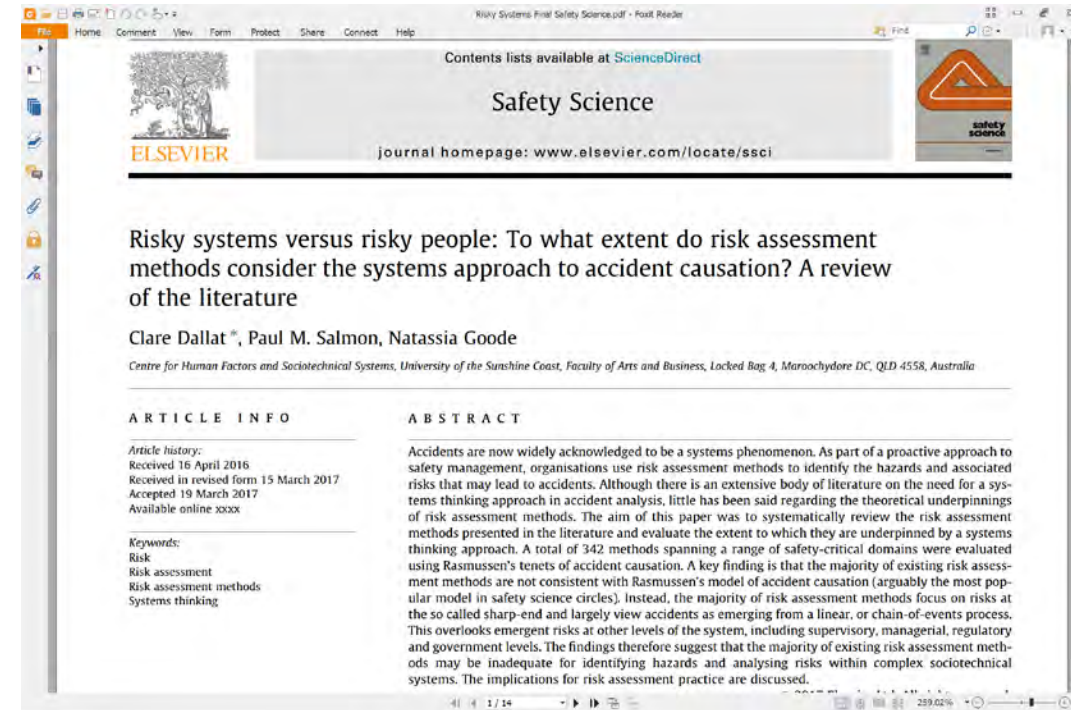
Method:

- N=342
- Rasmussen's (1997) seven tenets of accident causation used to evaluate extent to which methods were underpinned by systems approach

Findings:

- Most RA methods do not use systems thinking-based approach. Rather, they adopt linear, chain-of event perspective

- **Conclusion – majority of risk assessment methods are not aligned with current understanding of accident causation**

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Risky systems versus risky people: To what extent do risk assessment methods consider the systems approach to accident causation? A review of the literature

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ARTICLE INFO

ABSTRACT

Accidents are now widely acknowledged to be a systems phenomenon. As part of a proactive approach to safety management, organisations use risk assessment methods to identify the hazards and associated risks that may lead to accidents. Although there is an extensive body of literature on the need for a systems thinking approach in accident analysis, little has been said regarding the theoretical underpinnings of risk assessment methods. The aim of this paper was to systematically review the risk assessment methods presented in the literature and evaluate the extent to which they are underpinned by a systems thinking approach. A total of 342 methods spanning a range of safety-critical domains were evaluated using Rasmussen's tenets of accident causation. A key finding is that the majority of existing risk assessment methods are not consistent with Rasmussen's model of accident causation (arguably the most popular model in safety science circles). Instead, the majority of risk assessment methods focus on risks at the so called sharp-end and largely view accidents as emerging from a linear, or chain-of-events process. This overlooks emergent risks at other levels of the system, including supervisory, managerial, regulatory and government levels. The findings therefore suggest that the majority of existing risk assessment methods may be inadequate for identifying hazards and analysing risks within complex sociotechnical systems. The implications for risk assessment practice are discussed.

Dallat, C., Salmon, P.M., & Goode, N. (2017). Risky systems versus Risky people: To what extent do risk assessment methods consider the systems approach to accident causation? A review of the literature. *Safety Science.* http://dx.doi.org/10.1016/j.ssci.2017.03.012

RQ3: Can we integrate a systems thinking –based approach to risk assessment design and development?

- NET-HARMS was designed to support practitioners in identifying a) risks across overall work systems, and b) emergent risks that are created when risks across the system interact with one another.

- First RA method to specifically identify emergent risks

- Uses and/or adapts Hierarchical Task Analysis (Annett et al., 1971), SHERPA (Embrey, 1986) & Task Networks (Stanton et al., 2013).

- Findings show that NET-HARMS is capable of forecasting systemic and emergent risks, and that it could identify almost all contributory factors that featured in the accidents in a comparison dataset (Van Mulken et al., 2017).

Identifying risks and emergent risks across sociotechnical systems: the NETworked hazard analysis and risk management system (NET-HARMS)

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ABSTRACT
Accidents are a systems phenomenon and multiple methods are available to enable retrospective analysis of accidents through this lens. However, the same cannot be said for the methods available for forecasting risk and accidents. This paper describes a new systems-based risk assessment method, the NETworked hazard analysis and risk management system (NET-HARMS), that was designed to support practitioners in identifying (1) risks across overall work systems, and (2) emergent risks that are created when risks across the system interact with one another. An overview of NET-HARMS is provided and demonstrated through a case study application. An initial test of the method is provided by comparing case study outcomes (i.e. predicted risks) with accident data (i.e. actual risks) from the domain in question. Findings show that NET-HARMS is capable of forecasting systemic and emergent risks and that it could identify almost all risks that featured in the accidents in the comparison data-set.

Relevance to human factors/ergonomics theory

Methods which both support and enable application of a systems theoretical perspective to risk assessment are extremely limited. This paper outlines the development of a risk assessment method both underpinned by systems thinking and that was consciously designed to facilitate ease of use and application by the risk management practitioner.

Introduction

Dallat, C., Salmon, P. M., & Goode, N. (2017). The NETworked Hazard Analysis and Risk Management System (NET-HARMS). Theoretical Issues in Ergonomics Science, DOI:10.1080/1463922X.2017.1381197.

STEP 1 - HTA OF A 5 DAY LOA RAFTING AND CAMPING PROGRAM

0. Plan and deliver a five day led outdoor activity program

Plan 1: Do 1.1 then 1.2 to 1.6 in any order, then do 1.7 and 1.8, then EXIT

Plan O: Do 1, then do 2, then 3, then 4, then 5 then EXIT.

Plan 3: Do 3.1 and 3.2, then do 3.3, then 3.4 to 3.8 in any order. Then do 3.9 and 3.10. Then, if participant preparation activities are required, do 3.11. Then, do 3.12, then 3.13, then 3.14, then 3.15 and then EXIT.

Plan 2: Do 2.1 and 2.2. Then do 2.3 – 2.6 in any order, then do 2.7, then 2.8, then EXIT.

1. Initiate Program Design

2. Design Program

3. Program Planning & Preparation

4. Delivery

5. Post Program Review

1.1. Establish need

1.2 Select date and activity type

1.3 Determine resources

1.4 Determine program delivery model

1.5 Determine staffing model

1.6 Check Insurance

1.7 Determine external guidelines (e.g. DE&T, AAS)

1.8 Work within existing policy/ guideline framework

5.1 Review incident reports

5.2 Debrief & evaluation with participants and staff

5.3 Review and update risk assessment

5.4 Budget analysis and reconciliation

Plan 5: If incident occurred, do 5.1, then do 5.2, then 5.3, then 5.4, then EXIT. If no incident occurred, do 5.2, then do 5.3, then do 5.4, then EXIT.
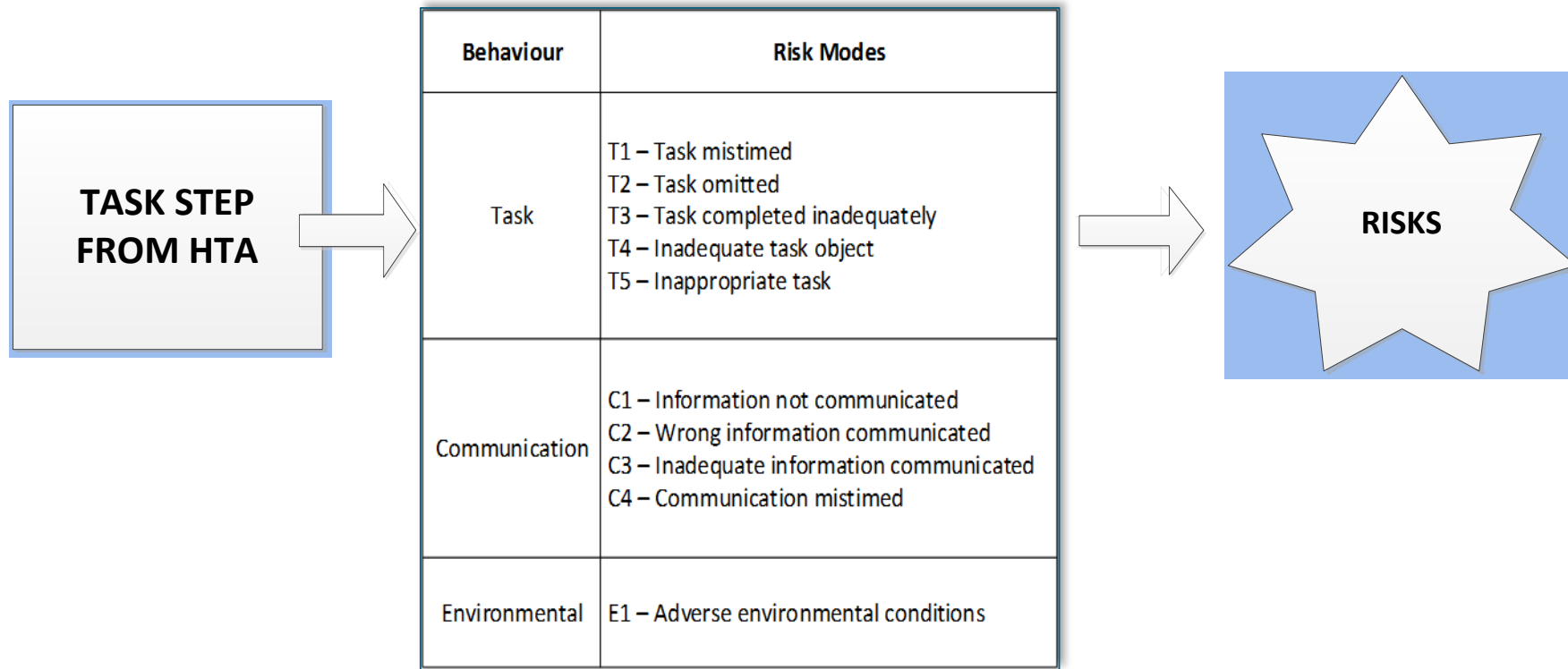
2.1 Determine desired outcomes

2.2 Consider/ determine participant characteristics

2.3 Choose activity(ies)

2.4 Choose location (s)

2.5 Determine resource and staffing requirements

2.6 Conduct compliance/ quality checks

2.7 Develop program outline

2.8 Conduct Organisational Risk Assessment

3.1 Provide/ exchange information w/ participants/parents (e.g. medical)

3.2 Provide info to participants/ parents (e.g. clothing, logistics)

3.3 Establish parent consent

3.4 Recruit staff

3.5 Plan resources

3.6 Establish venue specific information & familiarisation

3.7 Gain appropriate permits

3.8 Confirm venue/ accommodation / catering details

3.9 Prepare program information pack (for staff)

3.10 Staff Briefing

3.11 Participant preparation activities

3.12 Pre-Program Dynamic Risk Assessment

3.13 Determine contingencies

3.14 Plan crisis management

3.15 Plan on-program communications

4.1 Final staff attending program review and confirmation

4.2 Travel to program location

4.3 Unpack equipment and set-up

4.4 Meet & greet

4.5 Initial program briefing (program/ emergency information)

4.6 Equipment issue

4.7 Supervisory team discuss expectations & working relationship

4.8 Review pre-existing medical&dietary needs

4.9 Activity briefing & demo

4.10 Dynamic on-program risk assessment

Plan 4: Do 4.1, then 4.2, then 4.3, then 4.4, then 4.5. If equipment required, then do 4.6, then 4.7 and 4.8 and then do 4.9. Then do 4.10 to 4.14 continuously. If incident occurs, then do 4.15. When activity completed, then do 4.16, then do 4.17, then 4.18, then do 4.19, then EXIT.

4.11 Commence and complete activity

4.12 Food prep & management

4.13 Water management

4.14 Site management

4.15 Incident response

4.16 Pack up & equip de-issue

4.17 Participant transportation home

4.18 Staff transportation home

4.19 Unload equipment at home base

STEP 2 – NET-HARMS TAXONOMY

TASK STEP FROM HTA →

Behaviour	Risk Modes
Task	T1 – Task mistimed T2 – Task omitted T3 – Task completed inadequately T4 – Inadequate task object T5 – Inappropriate task
Communication	C1 – Information not communicated C2 – Wrong information communicated C3 – Inadequate information communicated C4 – Communication mistimed
Environmental	E1 – Adverse environmental conditions

→ **RISKS**

- Based on SHERPA (Embrey, 1986)

- The taxonomy is the consistent filter through which we identify and assess risks

PREDICTING LOA TASK RISKS – EXAMPLES

HTA Task	Risk mode	Risk description	Risk consequence
3.3 establish parent consent	E1	Room too noisy/ env unsuitable/ too much info/ parents busy/ distracted	Incomplete info. Not fully informed. Not understood. Not full consent.
3.10 Staff Briefing	T1	Staff briefing undertaken late (e.g. on the bus, immediately before program)	Staff member may miss important aspects of briefing relevant to management of risk Staff members do not have time to develop/evaluate appropriate risk controls
4.7. Supervisory team discuss expectations and working relationship	T2	Expectations and working relationship not discussed	Potential for key information not to be communicated prior to activity (e.g. how to use satellite phone, behavior expectations, group communication methods, where first aid kit is, epi pen locations) Mismatch in expectations e.g. between provider and school

Hierarchical Task Analysis: Plan and deliver a five day led outdoor activity program

0. Plan and deliver a five day led outdoor activity program

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4. Delivery

Plan 4: Do 4.1, then 4.2, then 4.3, then 4.4, then 4.5. If equipment required, then do 4.6, then 4.7 and 4.8 and then do 4.9. Then do 4.10 to 4.14 continuously. If incident occurs, then do 4.15. When activity completed, then do 4.16, then do 4.17, then do 4.18, then do 4.19, then EXIT.

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- 4.3 Unpack equipment and set-up
- 4.4 Meet & greet
- 4.5 Initial program briefing (program/ emergency information)
- 4.6 Equipment issue
- 4.7 Supervisory team discuss expectations & working relationship
- 4.8 Review pre-existing medical&dietary needs
- 4.9 Activity briefing & demo
- 4.10 Dynamic on-program risk assessment
- 4.11 Commence and complete activity
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- 4.16 Pack up & equip de-issue
- 4.17 Participant transportation home
- 4.18 Staff transportation home
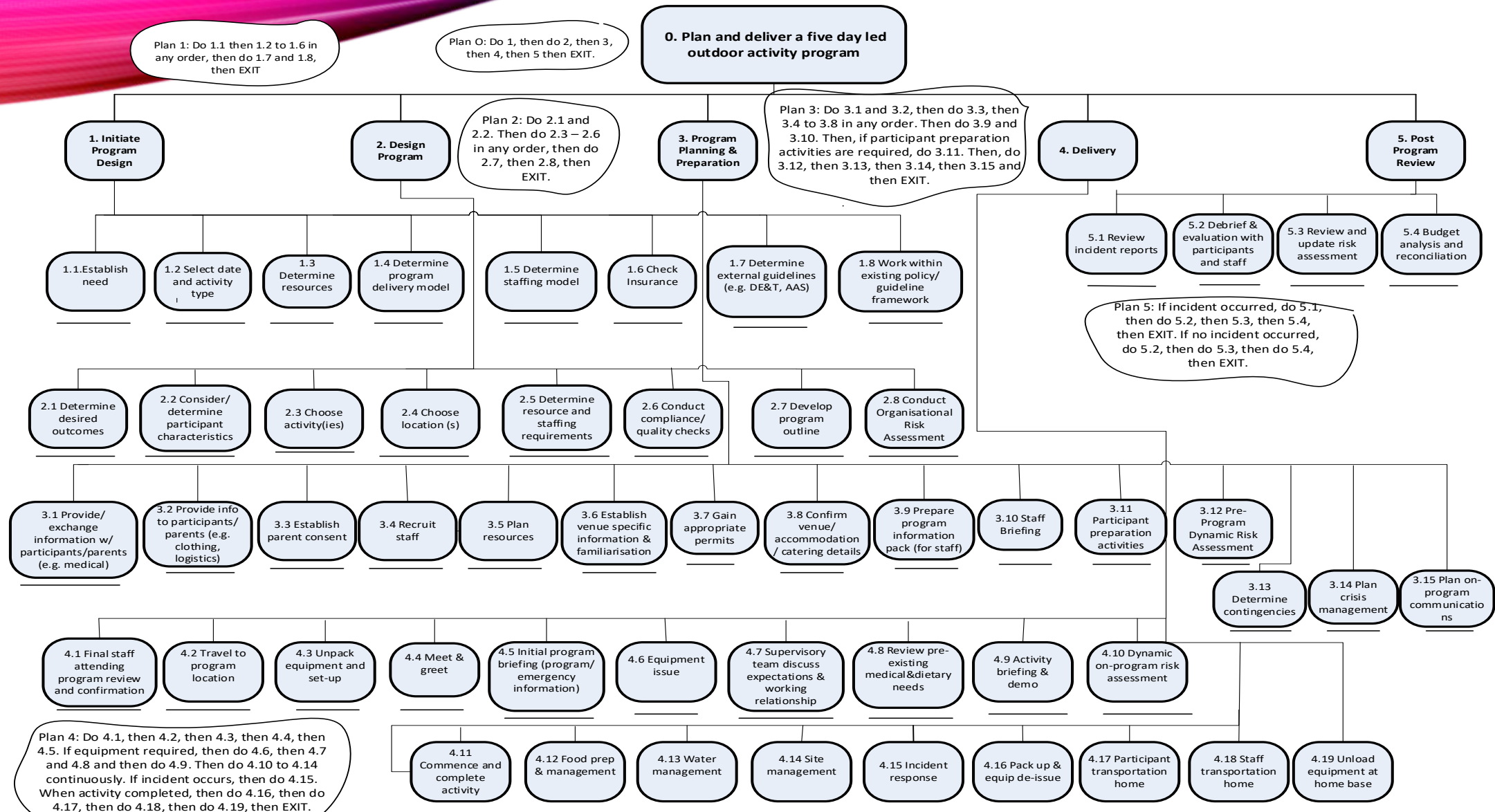- 4.19 Unload equipment at home base

5. Post Program Review

Plan 5: If incident occurred, do 5.1, then do 5.2, then 5.3, then 5.4, then EXIT. If no incident occurred, do 5.2, then do 5.3, then do 5.4, then EXIT.

- 5.1 Review incident reports
- 5.2 Debrief & evaluation with participants and staff
- 5.3 Review and update risk assessment
- 5.4 Budget analysis and reconciliation

TASK NETWORK

TASKS ARE RELATED WITH ONE ANOTHER IF THE CONDUCT OF ONE TASK INFLUENCES, IS UNDERTAKEN IN COMBINATION WITH, OR IS DEPENDENT ON, ANOTHER TASK
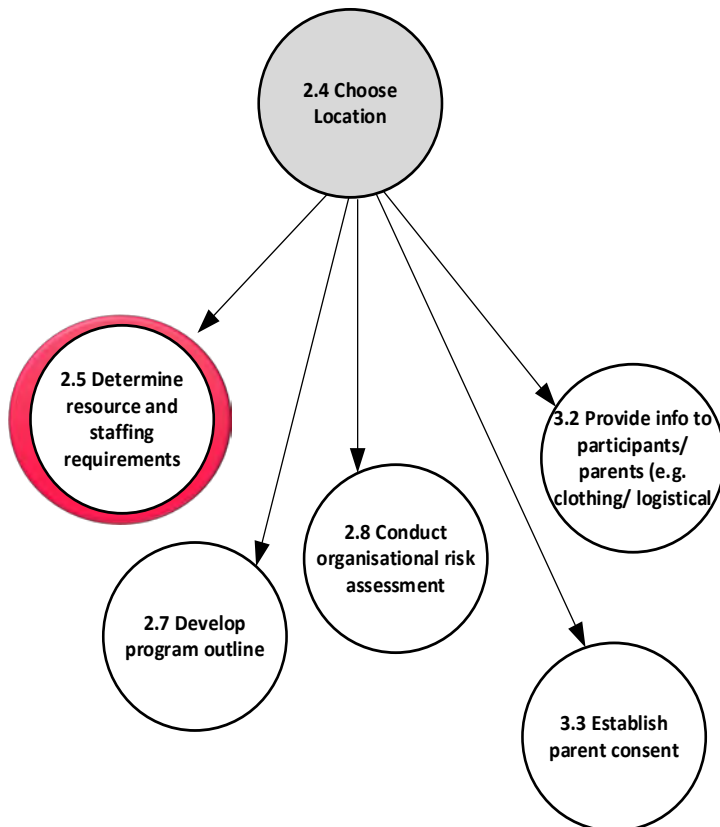
STEP 3 – EMERGENT RISK PREDICTION

Emergent risks are new risks created as a result of the interaction between task risks and other tasks
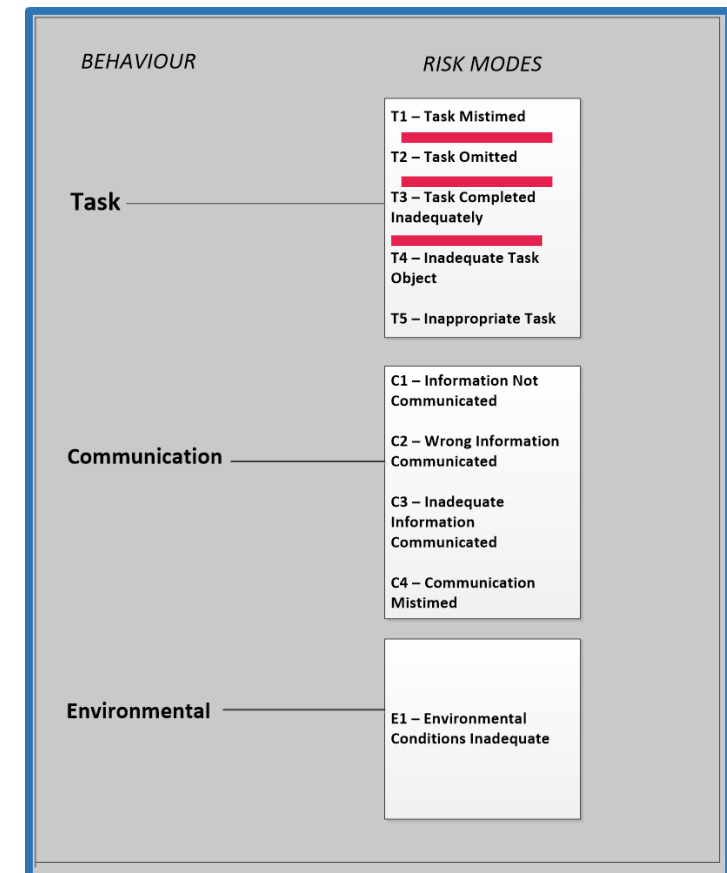
ALL ABOUT THE INTERACTIONS…

HTA Task	Risk mode	Risk description	Risk consequence
2.4 Choose Location	T2	Location choice is not considered in the design phase	Location choice may not be suitable for the program.

Because the 'location choice was not considered in the design phase', **is it possible that the task of:**

could be conducted…

EMERGENT RISK EXAMPLES

HTA Task	Task Risk Description	Linked Task	Risk Mode	Emergent Risk Description
3.5 Plan resources	Adequate resources are not planned for the whole program	4.15 Incident response	T3	Insufficient resource planning for inclement weather and therefore an inadequate ability to respond to incident in a timely fashion (e.g. no spare vehicles for quick response for whole group evacuation – buses are gone)
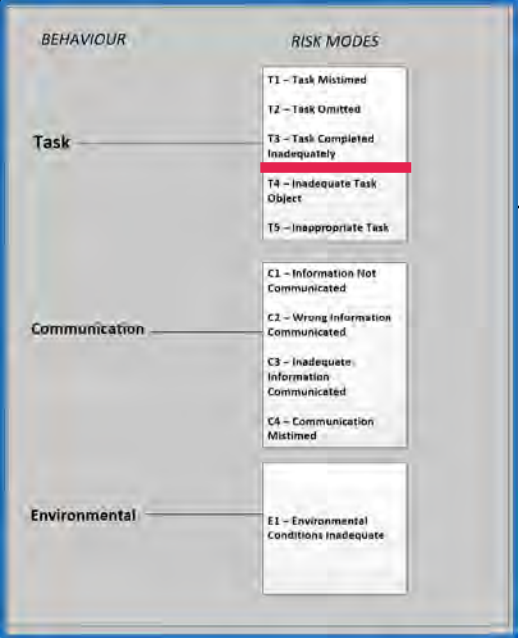
NET-HARMS CASE STUDY APPLICATION

NET-HARMS Case study application identified:

- Approximately 200 task risks
- Approximately 1400 emergent risks

  - 1200 associated with the design, planning and review tasks

  - 200 associated with delivery tasks

- Overall, Study 4 demonstrated the existence of 5.8 times more emergent risks in the system than task risks.

Dallat, C., Salmon, P. M., & Goode, N. (2017). The NETworked Hazard Analysis and Risk Management System (NET-HARMS). Theoretical Issues in Ergonomics Science, DOI:10.1080/1463922X.2017.1381197.

- The study involved comparing the risks identified by two groups of analysts (LOA and Human Factors researchers) with an expert risk assessment of the same work system

- LOA practitioners worked across the LOA system

- Study demonstrated that validity can be enhanced by analyst pooling process (vs. single analyst) (Stanton, 2009; Cornelissen et al, 2014)

- Findings suggest the need for significant rethink in terms of the methods and approaches currently used in RA

RQ4: Does a systems thinking-based risk assessment method achieve acceptable levels of reliability and validity?

Dallat, C., Salmon, P. M., & Goode, N. (Under review). Testing the validity of a new risk assessment method: the NET-worked Hazard Analysis and Risk Management System (NET-HARMS).

IMPORTANCE OF MULTIPLE ANALYSTS REPRESENTING THE WHOLE SYSTEM

Task
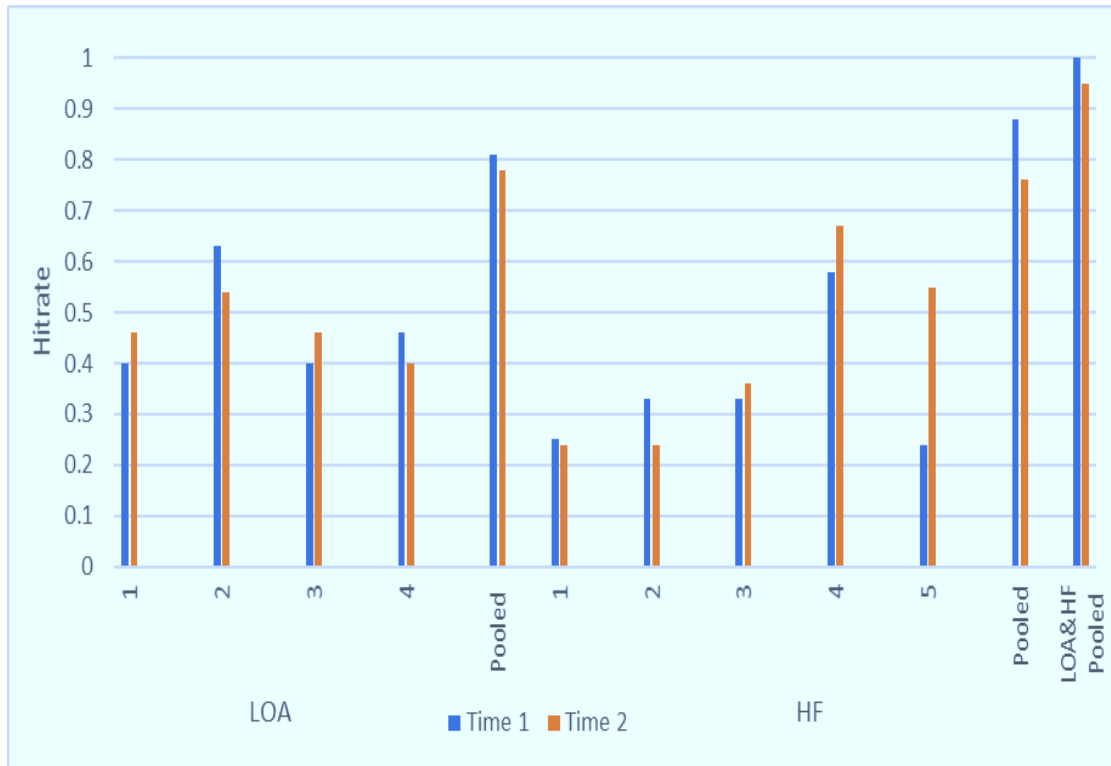
Emergent
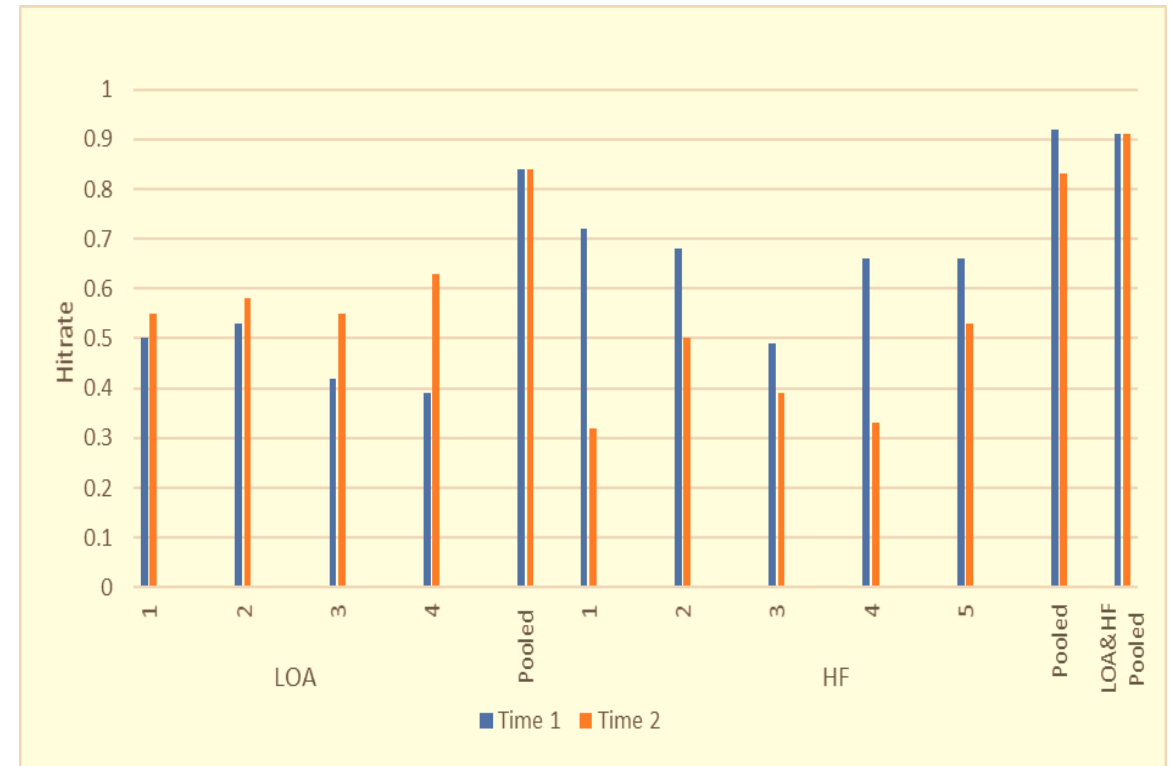
RESEARCH CONTRIBUTIONS

- **Theoretical**
  - Application and testing of systems theory in a risk assessment context. Results show that risks exist across a socio-technical system.

- **Methodological**
  - NET-HARMS
  - Pooling of analysts results (Study 2 vs. Study 5)
  - Appears that having both domain-specific and human factors expertise leads to more identified risks

- **Practical**
  - Practical, easy to use, benefits of HTA to organisation
  - Step by step guide available as to how to use NET-HARMS
  - Shouldn't be an individual conducting risk assessments
  - Importance of involvement from multiple people representing different perspectives from across the work system
  - Already being applied in practice

TRANSLATION INTO PRACTICE
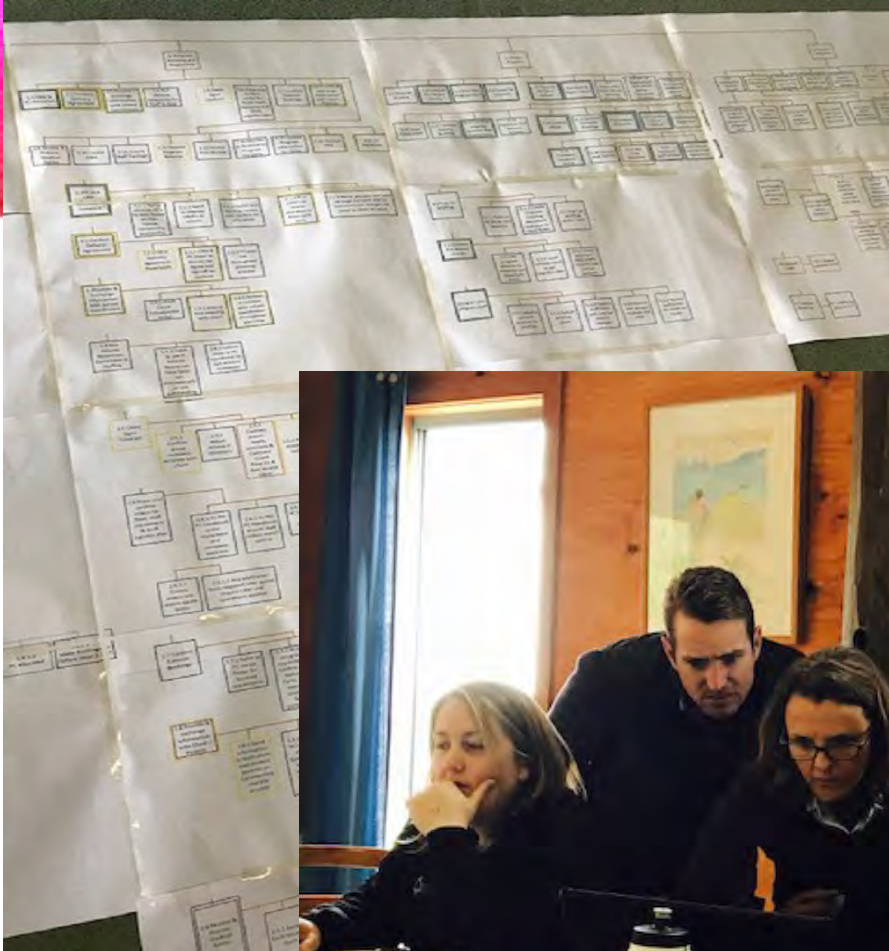
"NET-HARMS gave me a much broader and more structured format for the risk identification process, as opposed to the more common brainstorming hazard and risk identification approach. Clare's tool has made it much easier to identify the many areas of potential risks in the planning processes of outdoor learning programs and to help identify their many flow on effects and potential hazards during the actual delivery of program." (Katelyn Caldwell, Wodonga TAFE).

LIMITATIONS AND FUTURE RESEARCH

- NET-HARMS not yet tested against other systems RA methods (e.g. STPA, FRAM, EAST)
  - This is planned through upcoming Discovery project

- NET-HARMS case study completed on higher level LOA design, planning and conduct tasks (e.g. Commence and complete activity).

- ALARP
  - How organisation's can practically address risks identified

HUGE THANKS TO:

THE OUTDOOR EDUCATION GROUP ▲

- Professor Paul Salmon
- Dr. Natassia Goode
- The Outdoor Education Group
- The CHFSTS
- The LOA professionals who contributed time and expertise
- All participants in the studies

QUESTIONS/ COMMENTS

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