

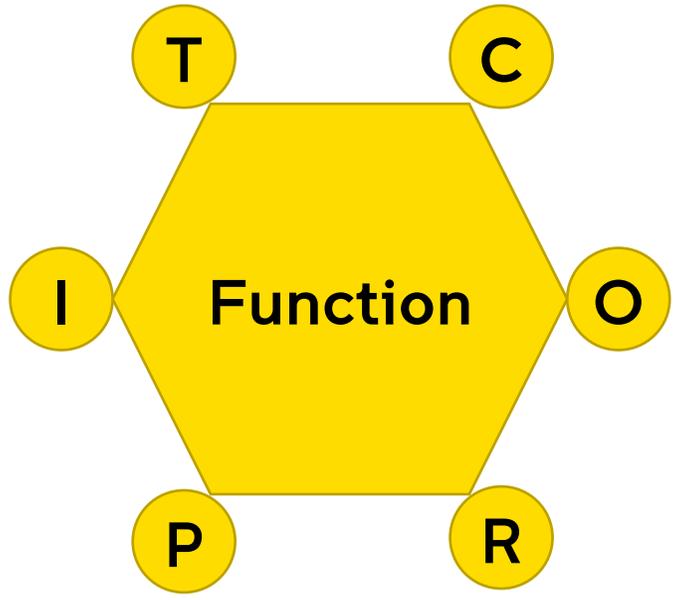
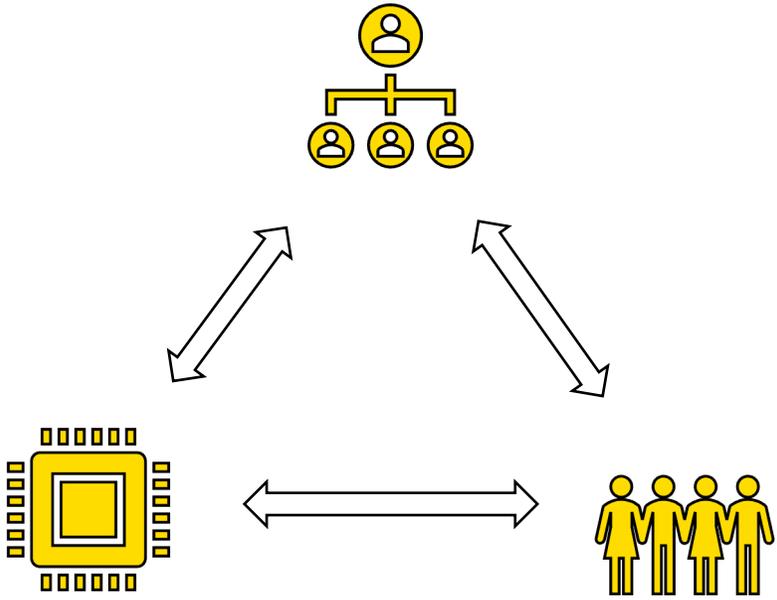
Understanding human factors variabilities through the lens of FRAM: a FRAM-based human factors taxonomy

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What is FRAM?



SKIP

Prospective



Work as imagined
VS
Work as done

Retrospective



FRAM analysis steps:

Step 0: Define the purpose and scope of proposed analysis

Step 1: Identify and describe the functions

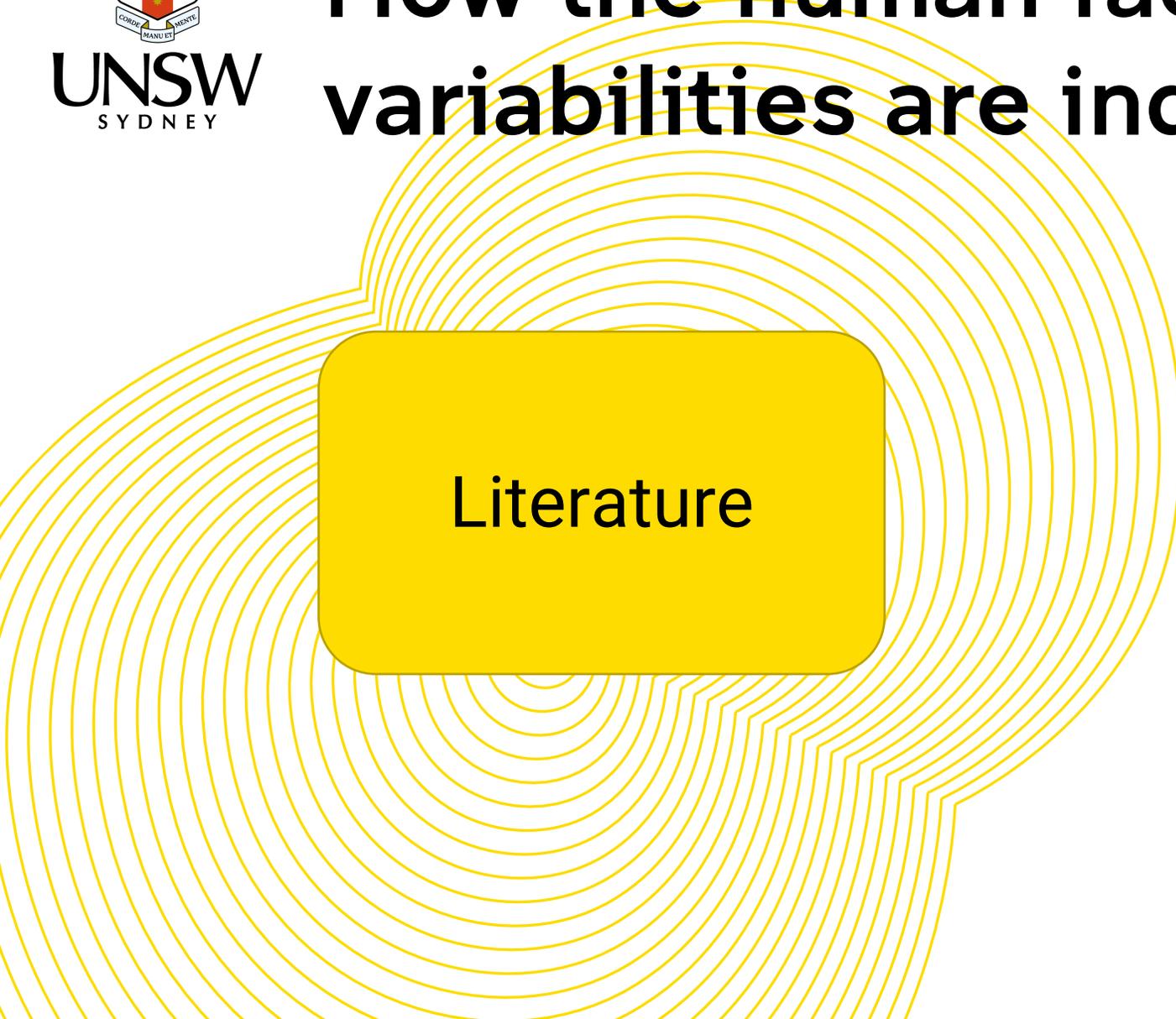
Step 2: The identification of variability

Step 3: The aggregation of variability

Step 4: Propose ways to manage variability

More information about FRAM: <https://www.youtube.com/watch?v=udGL6MHea94>

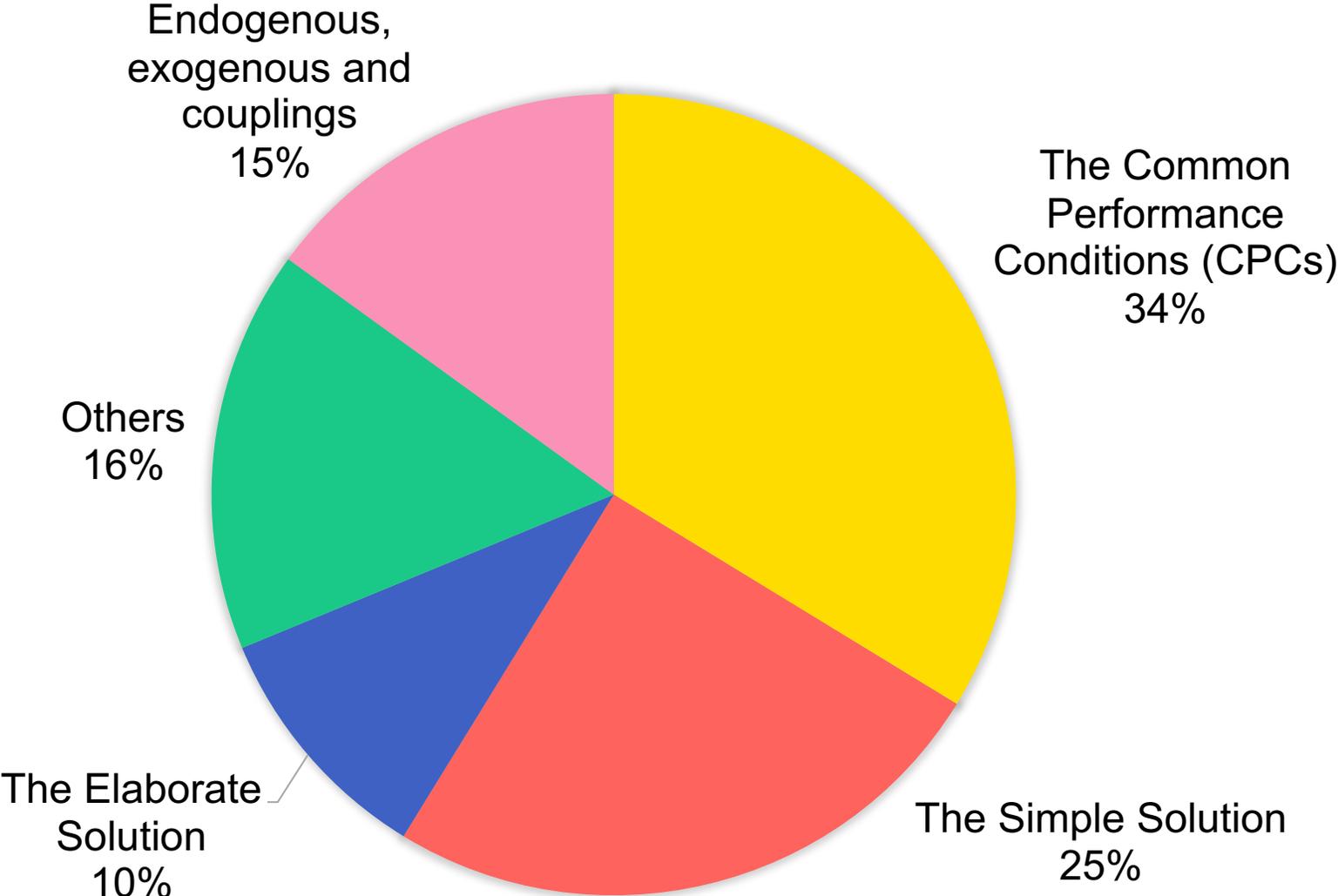
How the human factors related variabilities are indexed in FRAM?



Literature

Practice

Methods for identifying variability



The Common Performance Conditions (CPCs)

- 1) Availability of personnel and equipment
- 2) Training, preparation, competence
- 3) Communication quality
- 4) Human-machine interaction, operational support
- 5) Availability of procedures
- 6) Work conditions
- 7) Goals, number of conflicts
- 8) Available time
- 9) Circadian rhythm, stress
- 10) Team collaboration
- 11) Organizational quality

Each CPC can be examined as one of the following:

Stable or variable but adequate

Stable or variable but inadequate

Unpredictable

Not applicable

The Simple Solution

Timing	Precision
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The output of a function can be assessed as the following:

Too early	Precise
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On time	Acceptable
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Too late	Imprecise
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Not at all	Wrong
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Method

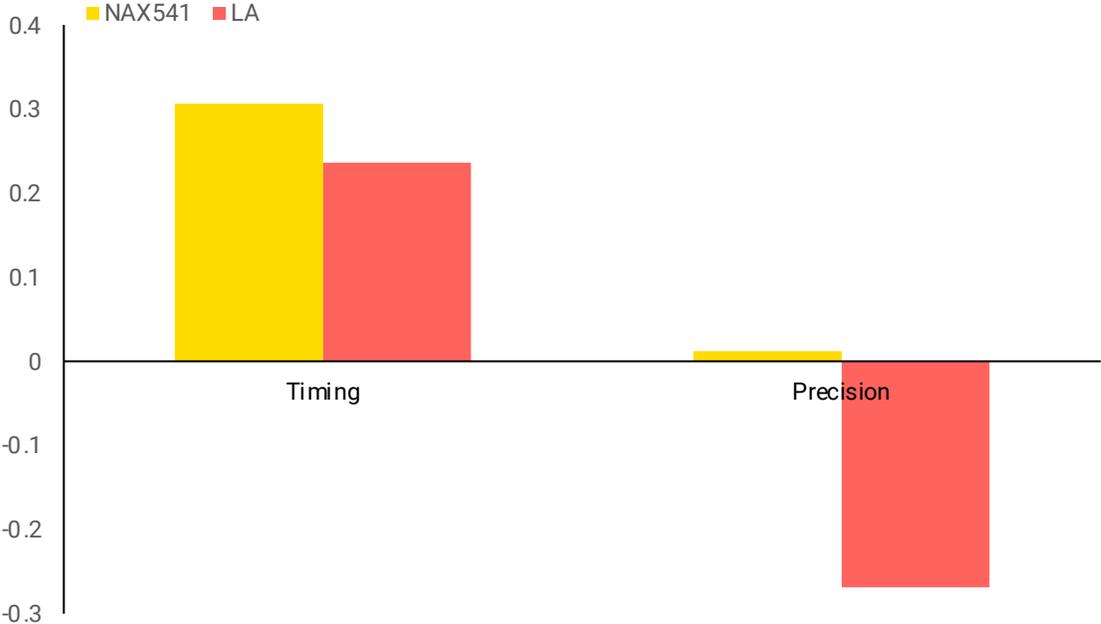
- Three Human Factors Ph.D. students were asked to use both the simple solution and the CPCs to analyse two aviation incidents. The re-analysis were conducted independently.

The Norwegian Air Shuttle Flight
NAX541 incident
(Herrera & Woltjer, 2009)

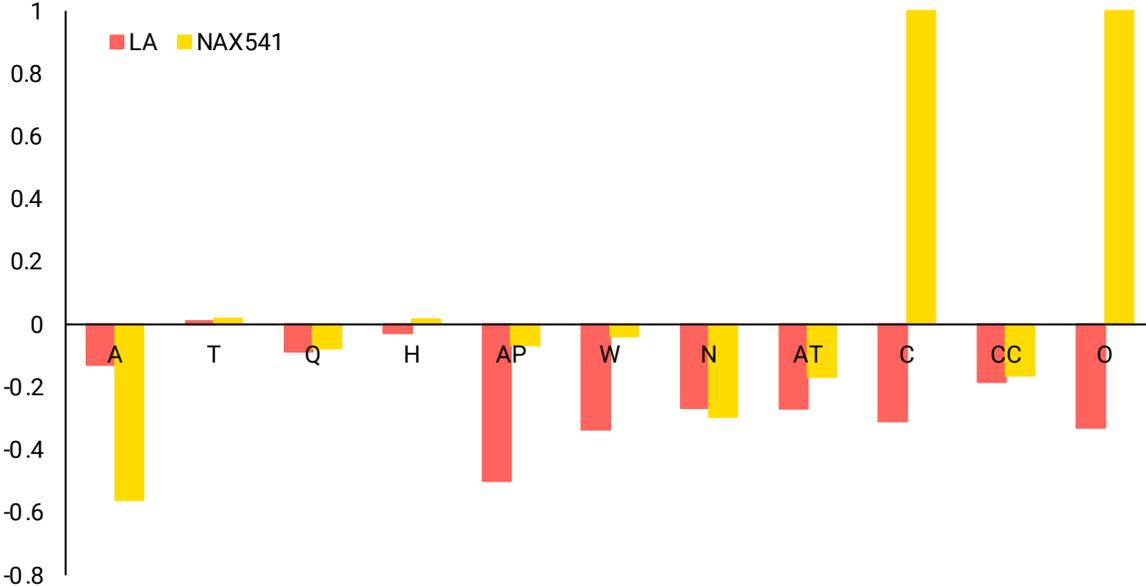
LA Runway Disaster
(Riccardo et al., 2018)

- The inter-rater reliabilities of using the CPCs and the simple solution
- User experience feedback

The inter-rater reliabilities of using the CPCs and the simple solution



The Fleiss's Kappa values of the simple solution



The Fleiss's kappa values across the 11 CPCs

Overall, the reliabilities of using the CPCs or the simple solution are very poor.

User experience feedback

	The simple solution	The CPCs
Advantages	Efficient to use, easy to understand	Structured and comprehensive
	Timing and precision are general terms and can be applied to any domain	Consider variabilities from different dimensions
Disadvantages	May fail to reflect human factors related variabilities	Examining all 11 CPCs for each function is time-consuming and might be not necessary
		Cannot reflect some observable indicators
	Distinctions between rating categories are blur	
	Analysts from different backgrounds may have different interpretations	
	Needs intensive information	

User experience feedback

- FRAM net and function labels do not suit the re-analysis
- It would be great if the functions were labelled with a verb phrase and could indicate the operator
- A clear time-line can be helpful to navigate the analysis

The pre-analysis checklist

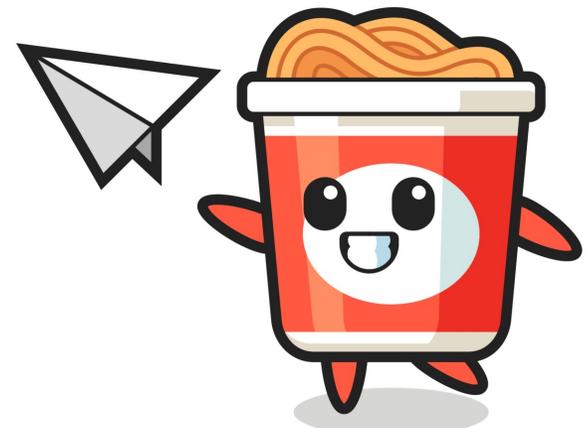
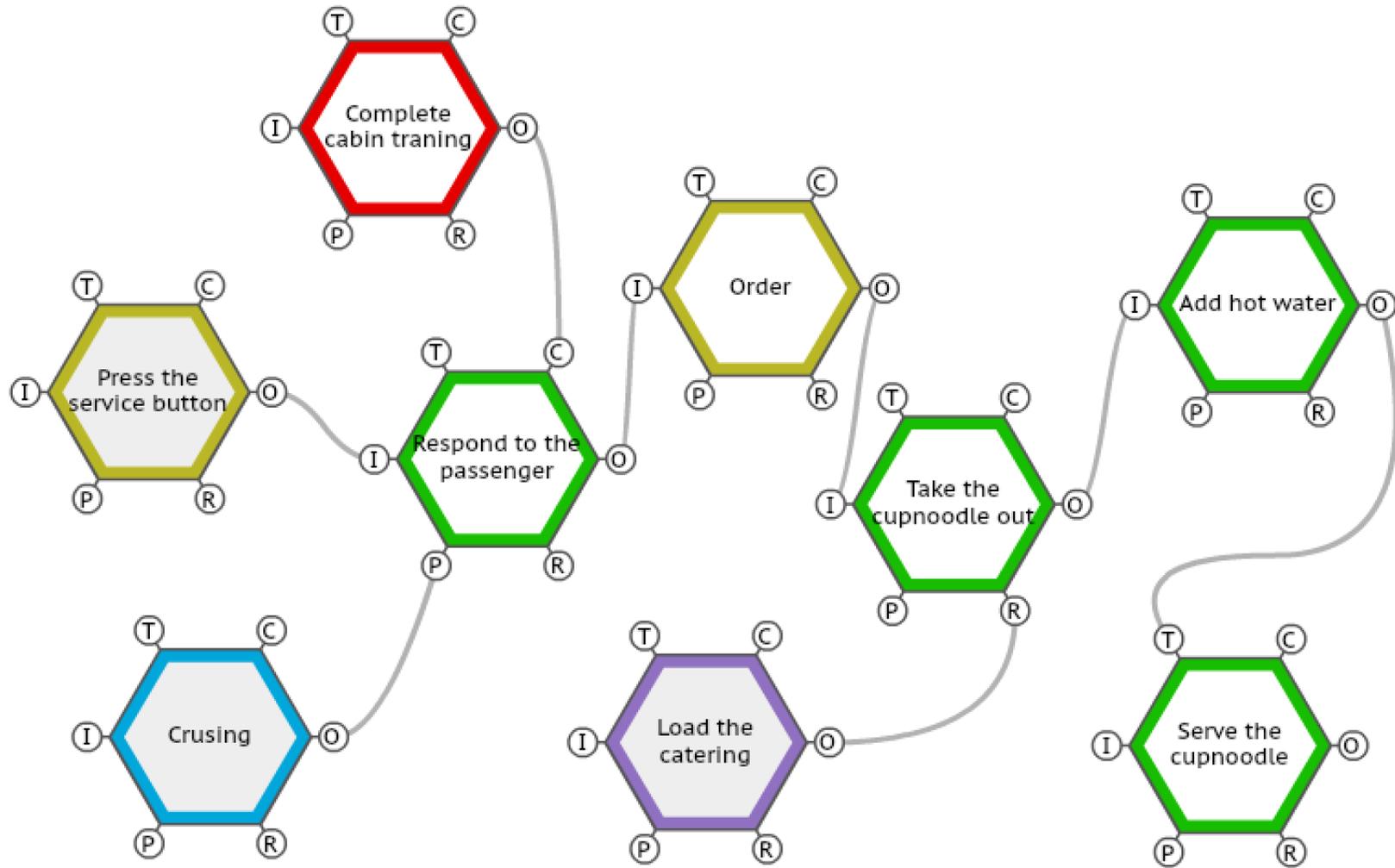
Pre-analysis checklist

The label of a function should be operator centered

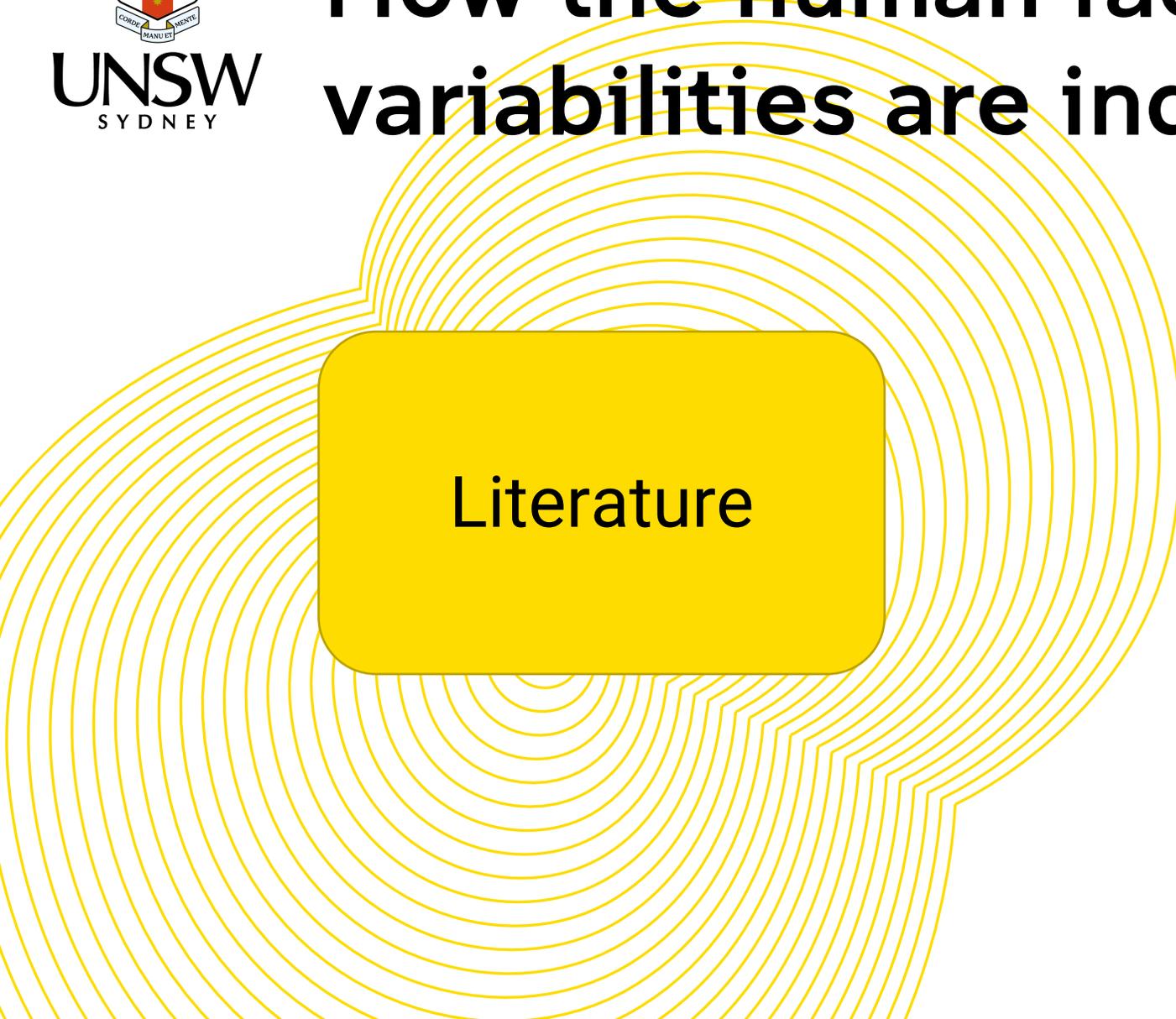
The label of a function should be a verb phrase

With clear time points (only when use FRAM retrospectively)

The description of the six aspects should be clear and distinct



How the human factors related variabilities are indexed in FRAM?



Literature

Practice

Aims:

To understand how FRAM users (researchers/practitioners) indexed human factors related variabilities in their FRAM analyses.

Interview Study

Corresponding authors of reviewed FRAM publications (journal articles, FRAMily conference presentations)

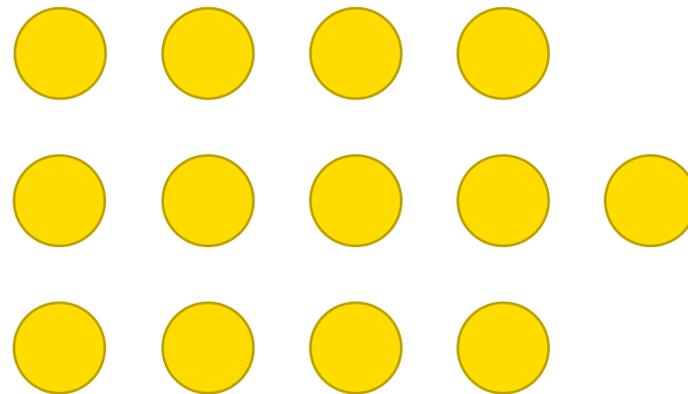
Tian, W., & Caponecchia, C. (2020). Using the functional resonance analysis method (FRAM) in aviation safety: A systematic review. *Journal of advanced transportation*, 2020.

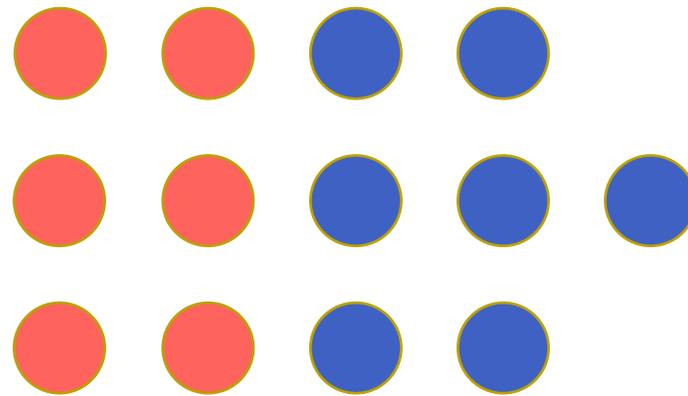


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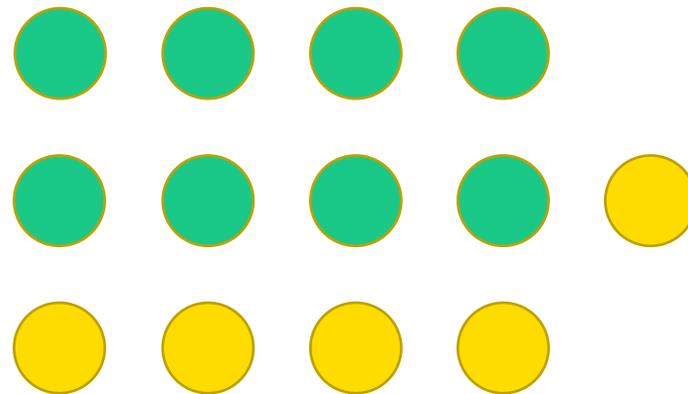
Semi-structured interview

- Background information (discipline, pros&cons of FRAM, etc)
- How do they identify the variabilities in FRAM?
- How do they identify the human factors related variabilities in FRAM?
- How to improve/further develop the current approach to capture the human factors-related variabilities using FRAM?



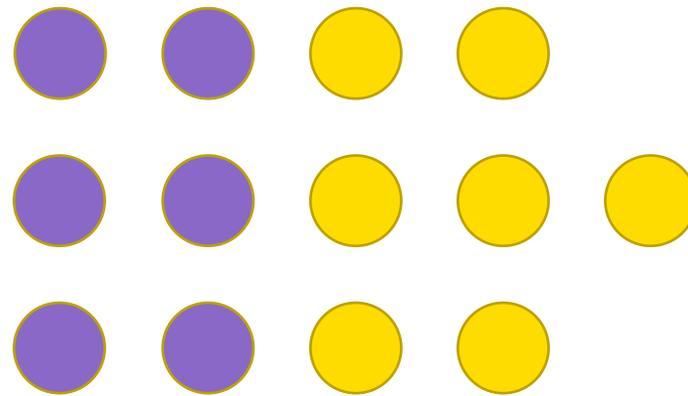


Female: n=6, 46.15%
Male: n=7, 53.85%



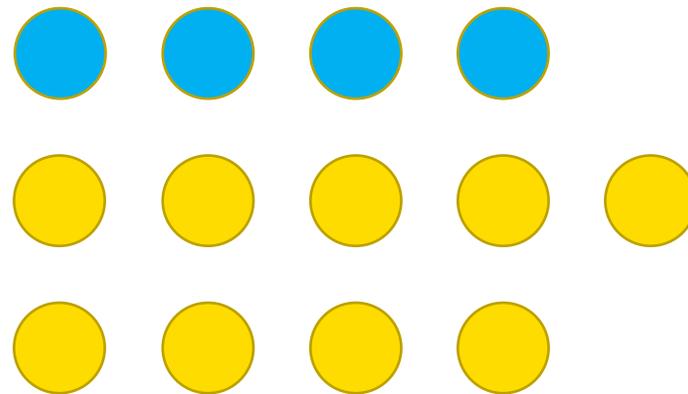
Ergonomists and human factors specialists

n=8, 61.54%



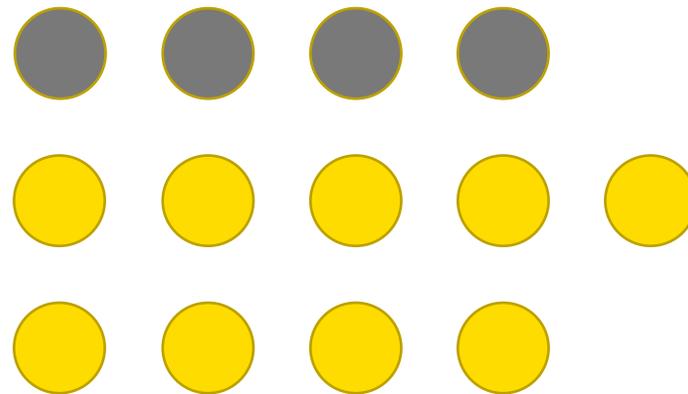
Healthcare experience

n=6, 46.15%



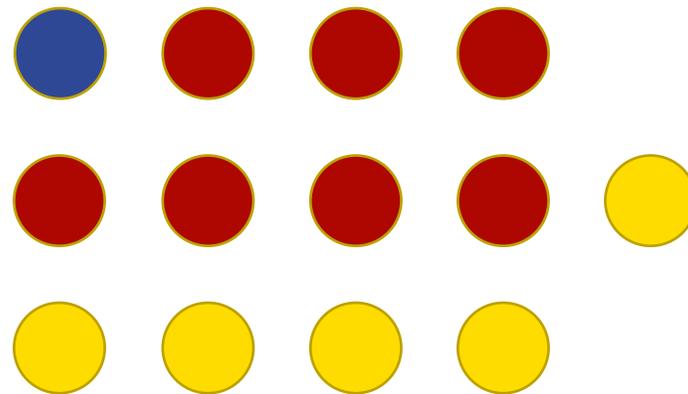
Aviation

n=4, 30.77%



Engineering

n=4, 30.77%



Pursing a degree

Master: $n=1$

Ph.D.: $n=7$

Advantages of FRAM:

- **FRAM is a good tool for describing the complex systems.**

“It actually goes to the heart of how do all the elements or – sorry, all the components of that system, how do they interface and work together, which is I think the powerful piece out of FRAM that a lot of other methods don’t do”

- Interviewee 4

- **Can be used to capture the non-linear nature of the complex systems.**

“It gives you a method to grapple with the non-linearity of sociotechnical systems, the non-linear nature, and in a way complexity”

- Interviewee 3

- **FRAM analysis process can be very flexible, the breadth of its results could be useful to collect more information and generate various solutions consequently.**

“Once you have a model, you can do a lot of things with the model”

- Interviewee 12

- **FRAM adopted the Safety-II perspective, which enables its users to learn from what goes well in daily operations.**
- **FRAM is easy to understand. Analysts can learn and use FRAM easily.**



Disadvantages of FRAM:

- **FRAM is a resource-intensive approach**

“So on top of it, taking time to develop the model, you also need to have continuous expert access to be able to refine the connections, ensure that the functions you identified are correct and so on”

- Interviewee 12

- **FRAM analysis is subjective and unreliable.**

“One of the FRAM one of the problems I see with the FRAM is how time is used ‘cause it’s not consistent, but sometimes the time aspect can indicate the degree of variability as well”

- Interviewee 11

- **FRAM is not easy to understand or learn to use. Its results is difficult to communicate.**

“So, it's kind of fun to play with, but it is a bit esoteric and academic”

- Interviewee 8

- **The absence of quantification methods to measure the variabilities.**

What methodologies are used for identifying variabilities?

- Interviews
- Focus group
- Observation

"I basically let the experts talk about their everyday work and then try to pick up what in the interview transcriptions indicated variability."

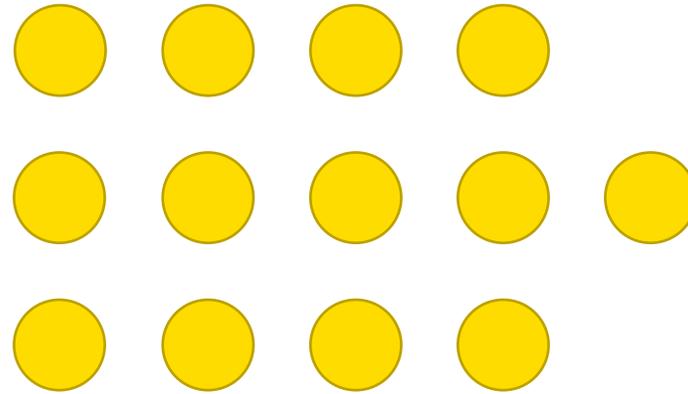
- Interviewee 12

- Function Signature
- Keywords & a summarised human error taxonomy

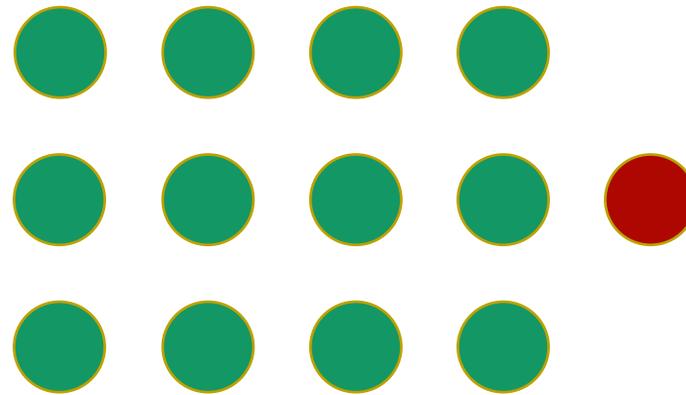
How human factors related variabilities are identified?

- Interview
- Documentary review
- Workshop
- Focus group
- FRAM is about learning throughout the developing process, during the discussion and interviews, the problem would come out.
- Examining the internal variability, output-input connections.
- Invite human factors colleagues to help, using existing human error taxonomy list

Do we need a FRAM based HF taxonomy?



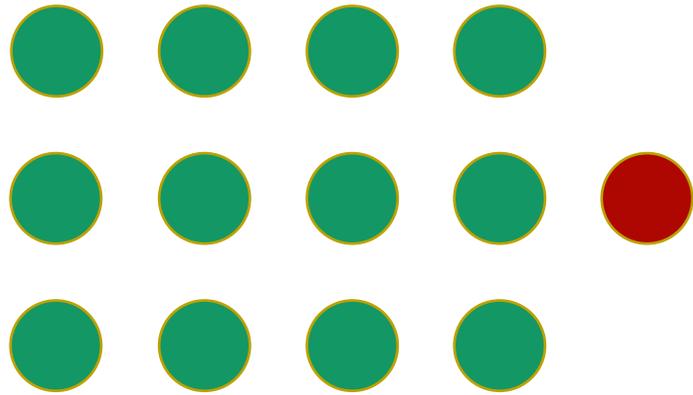
Do we need a FRAM based HF taxonomy?



 YES: n=12, 92.31%

 NO: n=1, 7.69%

Do we need a FRAM based HF taxonomy?



 YES: n=12, 92.31%

 NO: n=1, 7.69%

- More structured approach
- Make the analysis process be more consistent and easier
- Provide more robust evidence
- Avoid misuse of FRAM and prompt analysts to ask the right questions
- It would be good to develop a tool fit to FRAM rather than pick up an existing technique

Other changes to be made:

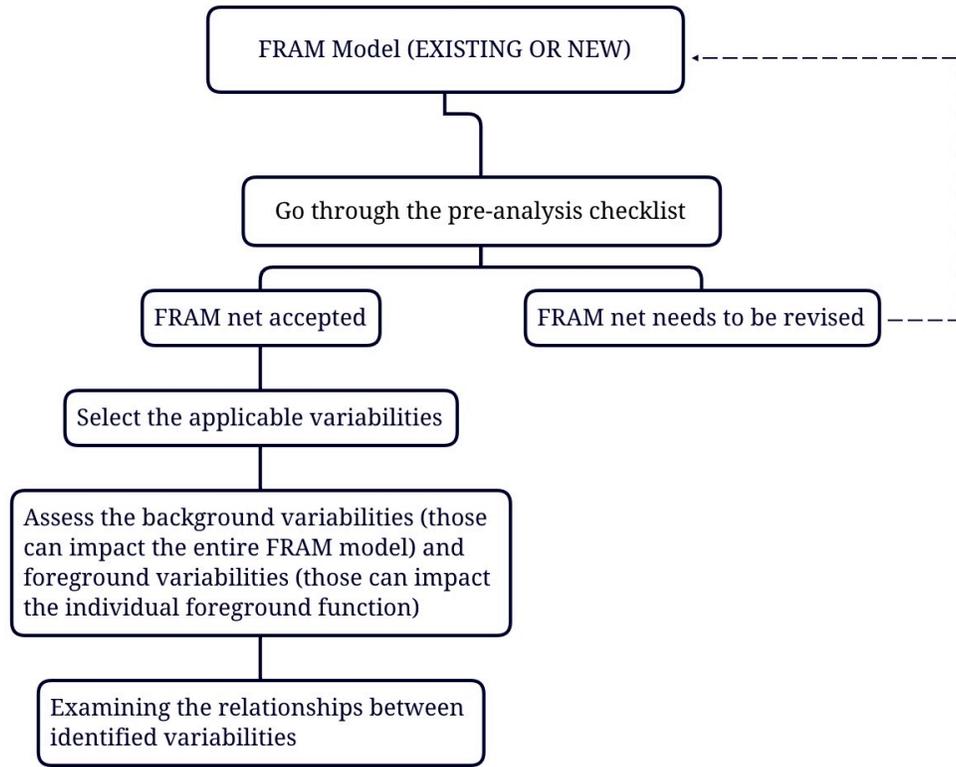
FRAM

- The process should be simplified
- More guidelines on FRAM learning and developing process
- More formalized approaches, such as a classification system to better index the variabilities.
- More quantitative elements need to be added.
- The presentation, visualization, and communication language need to be clearer and simpler.

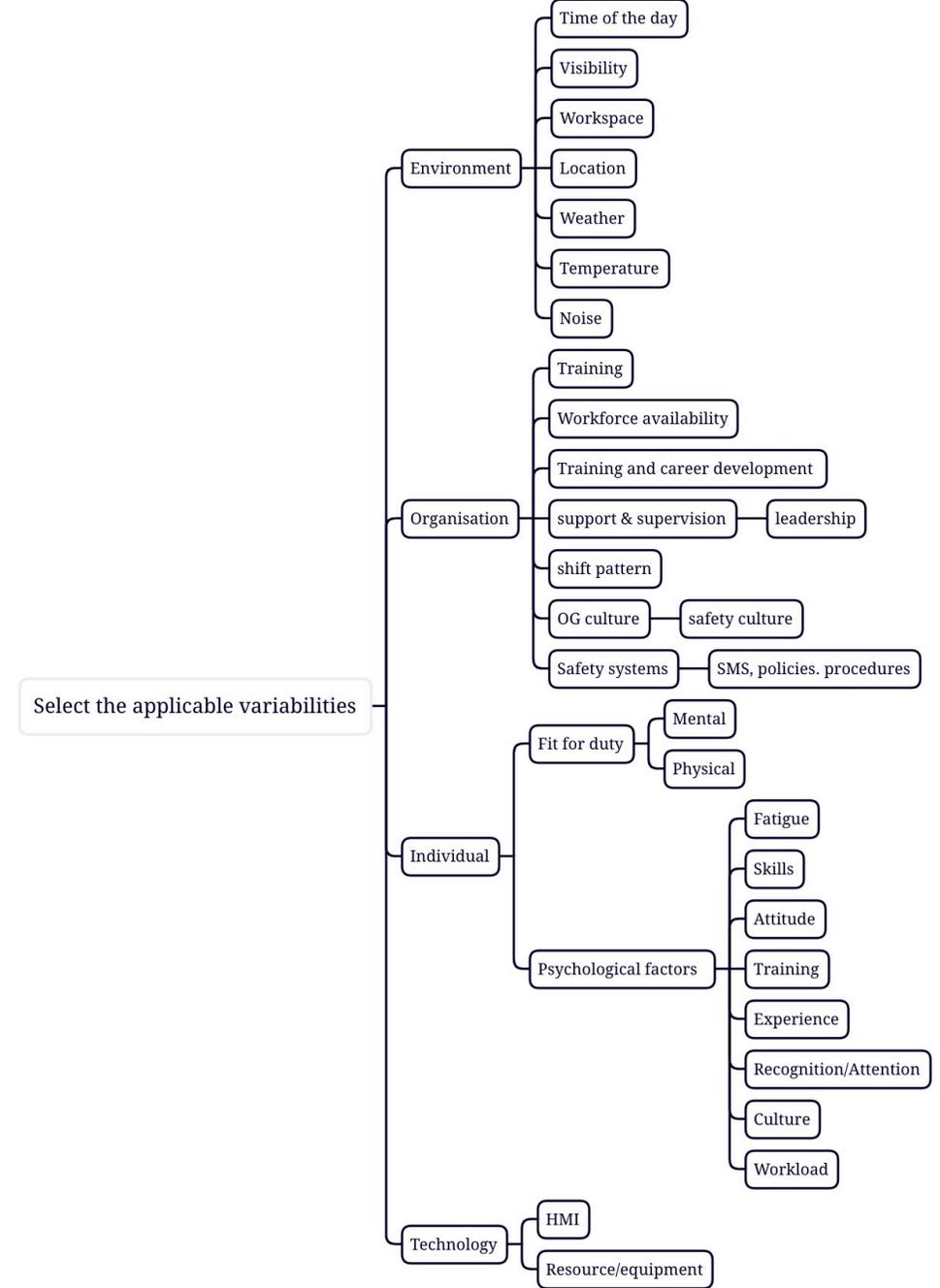
FRAM software:

- More flexible
- Automatically develop, analyse and compare FRAM nets

- To our best knowledge, this is the first study that interviewed FRAM SMEs to learn their experience of using FRAM.
- SMEs choose different tools to capture HF variabilities.
- A FRAM-based HF taxonomy is needed and could bring multiple benefits to current FRAM.
- SMEs' expected changes to be made to current FRAM, which provides various directions for future FRAM studies.



The process of FRAM-HFV analysis



*We considered communication and decision-making in the taxonomy, however, under FRAM, they should be described as functions rather than contributing factors

Thank you.

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