Development of Human Factors toolkit to inform behavioural research in the railway domain

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Europe's Rail

ProRail

Developing a Human Factors Toolkit

Aim: establish a comprehensive list of methods to evaluate operator performance in human-in-the-loop (HITL) railway simulation

Target audience: researchers and practitioners designing human-in-the-loop (HITL) railway simulations

Methods

First phase: Systematic literature review

Scoping review of topics in rail human factors, ergonomics, psychology, etc.

Searching across 6 databases: Web of Science, Scopus, IEEE, ACM, EBSCO (PsycInfo, BusinessSource)

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Charting the landscape of rail human factors and automation: A systematic scoping review

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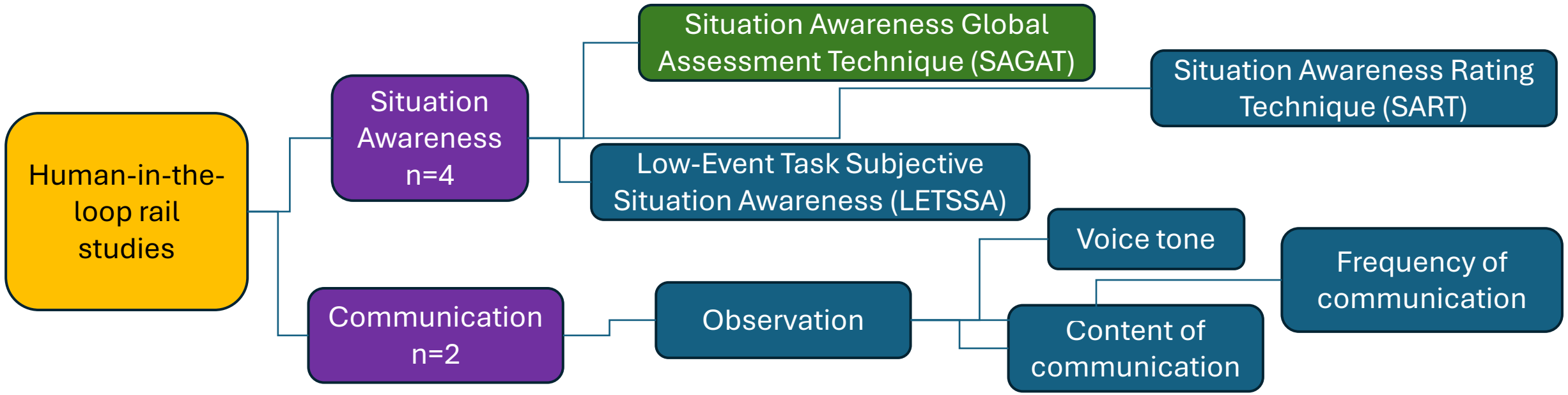
ABSTRACT

As railway systems in Europe move towards increased integration and automation, understanding the human factors implications is critical. This systematic scoping review examines research on human factors and automation in railways, with a focus on studies involving railway operators such as train drivers and traffic controllers. Following PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines, we explored six databases and solicited expert recommendations, identifying 65 relevant studies published since 2000. Studies were categorized based on methodology and analysed to identify key themes, measures, and research priorities. The review revealed five main types of studies: empirical simu-

Data extraction for toolkit

- Select studies involving HITL rail simulation and compile the measured aspects:
  - Measured constructs and definitions
  - Methods of measurement
    - Validation of methods



Second phase: Expert review

The initial version of the toolkit distributed to human factors and/or railway experts for further review

Part 1: Workshop

Part 2: Survey

Part 1: Workshop

Workshop conducted with 8 rail human factors experts from Europe's Rail project

Initial validation of toolkit structure and organization

Followed up with survey with the experts to provide more in-depth feedback

Part 2: Survey

Experts are then asked for agreement for each human factors constructs based on aspects outlined below:

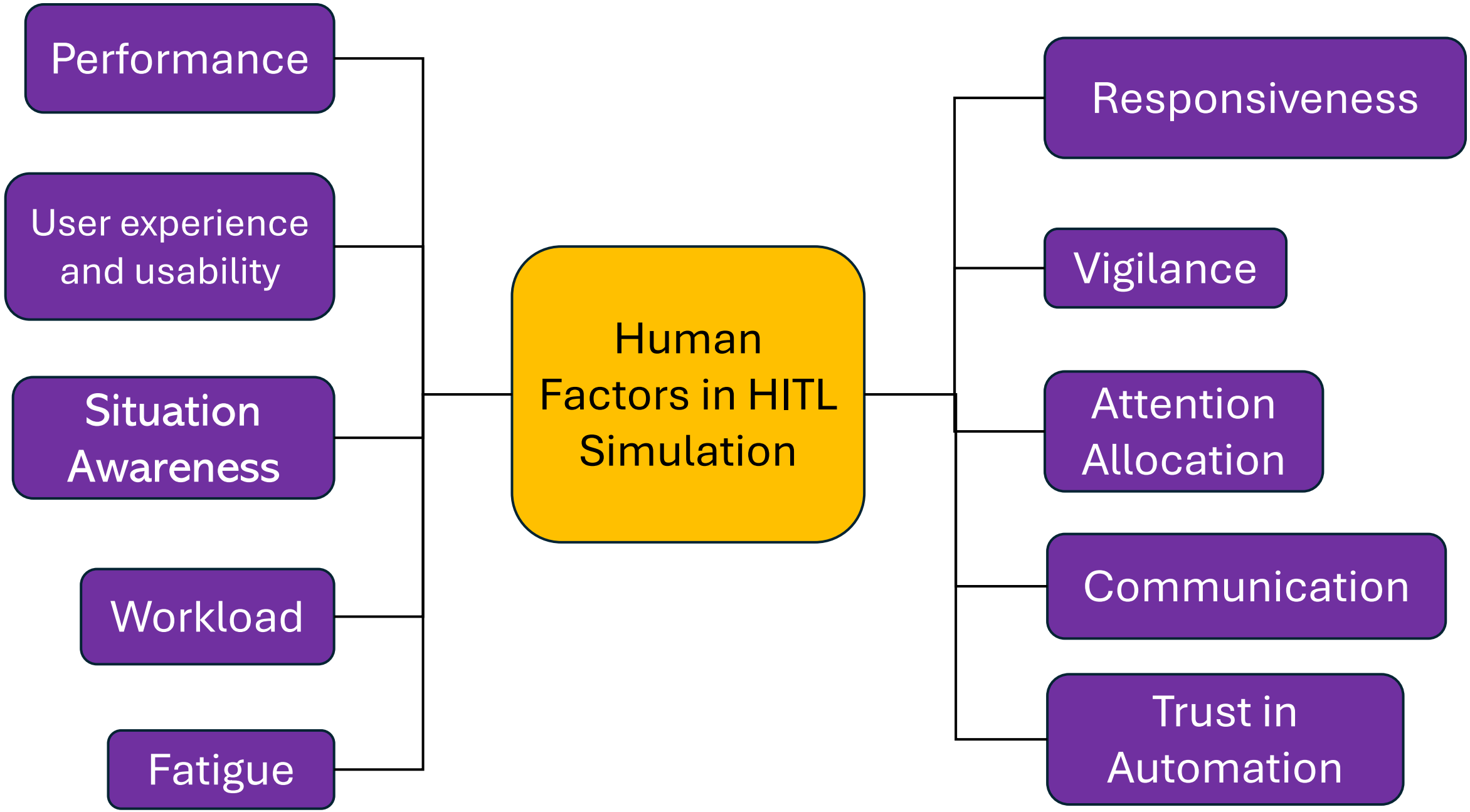
- **Relevance of construct**
- **Usefulness of information presented**
- **Sufficiency of methods included**
- **Other suggestions**

Seven human factors experts provide responses

Results

Human Factors Toolkit v.1

Results of literature review


Performance
User experience and usability
Situation Awareness
Workload
Fatigue
Human Factors in HITL Simulation
Responsiveness
Vigilance
Attention Allocation
Communication
Trust in Automation

Excerpt of toolkit document

Full toolkit document:
https://osf.io/cywka

Or scan below

Human Factors toolkit to inform the design of human-in-the-loop (HITL) simulation studies.

1. Performance aspects

Performance as a construct generally refers to how well an operator executes a specific task or duty in a simulation. Measuring performance serves the purpose of identifying the direct impact of certain experimental scenarios and conditions in the simulation. The way performance is measured is very dependent on the goals, specifications, and the capability of the simulation, but in general it should be as close as possible to how the performance would be measured in practice. Note that performance in this case refers to the performance of the operators instead of the performance of the system or interface.

Since there are differences in tasks and job duties for drivers and traffic controllers, we divide the list of methods for measuring performance by operator role (see Table 1).

Table 1. Summary of the subjective and objective measures commonly used in HITL research to assess performance aspects.

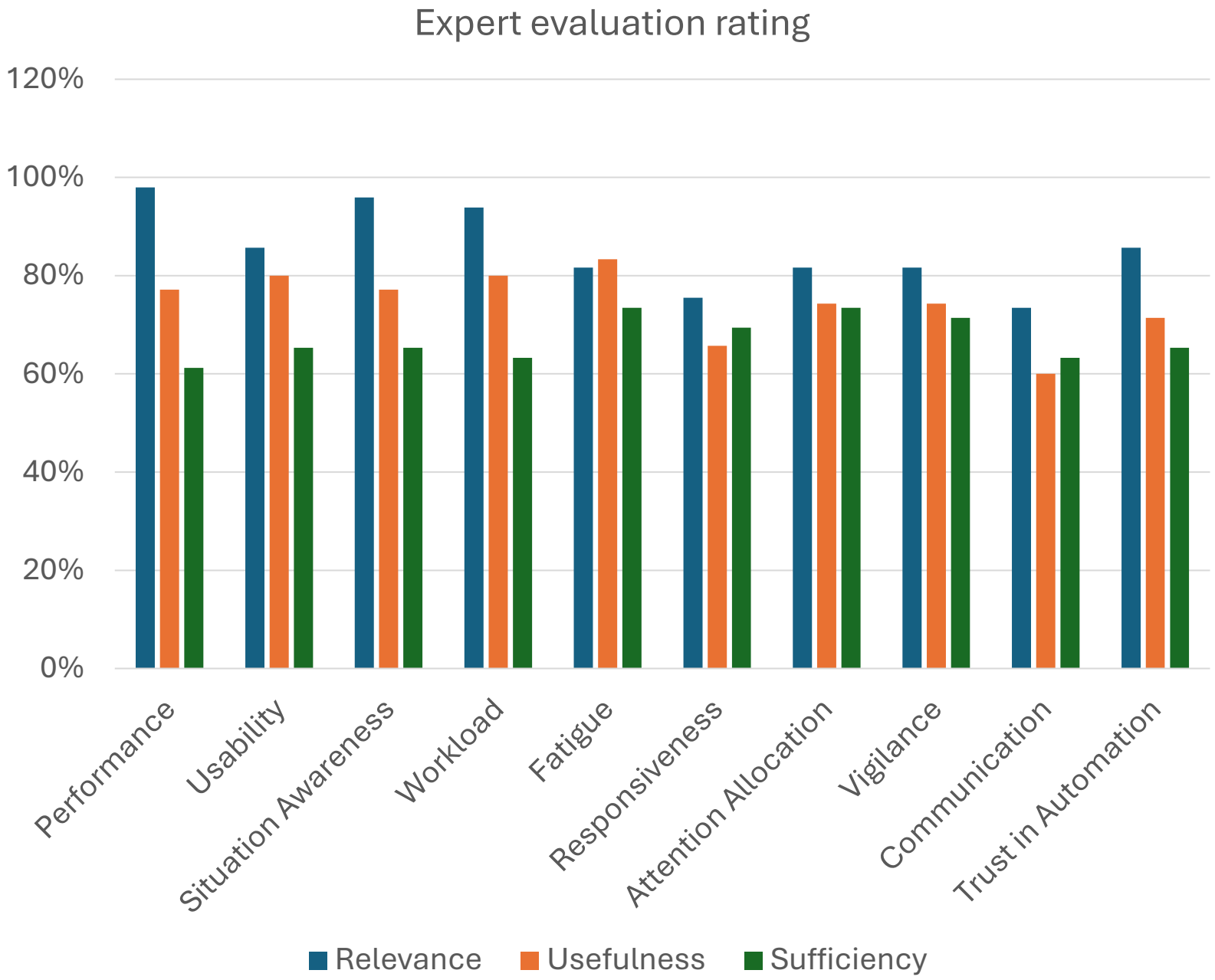
Aspect		Subjective Measure	Objective Measure
Performance	Train Driver		• Takeover time • Speed maintenance • Acceleration variability • Braking errors
	Traffic Controller	• Observational scoring system	• Response Latency • Punctuality, Arrival/Depart Delay

Train Driver

- **Takeover time (Objective):** Takeover refers to the transition between automated and human operated driving. The takeover from automated to human operated driving requires a level of cognitive and physical engagement from the driver. This can be measured by the overall time or speed it takes for the driver to take over or the quality of the transition (number of errors committed during transition). Takeover time was found to be measured in studies [2, 8, 29]
- **Speed maintenance (Objective):** Speed maintenance refers to the ability to maintain operational speed close to the advisory speed. This can be obtained by recording the speed of the the train during the simulation. Speed maintenance was found to be measured in studies [29, 34, 43]
- **Acceleration variability (Objective):** The standard deviation of train acceleration. Low variability is generally desired. This can be done simply by recording train speed and acceleration in the simulation. Acceleration variability was found to be measured in study [29]
- **Braking errors (Objective):** The ability to identify and diagnose brake demands, as well as determining the correct timing. It may also include aspects such as the ability to correctly utilize visual cues. This can be measured by incorporating braking scenarios in the simulation and recoding driver reactions. Braking errors was found to be measured in studies [1, 13]

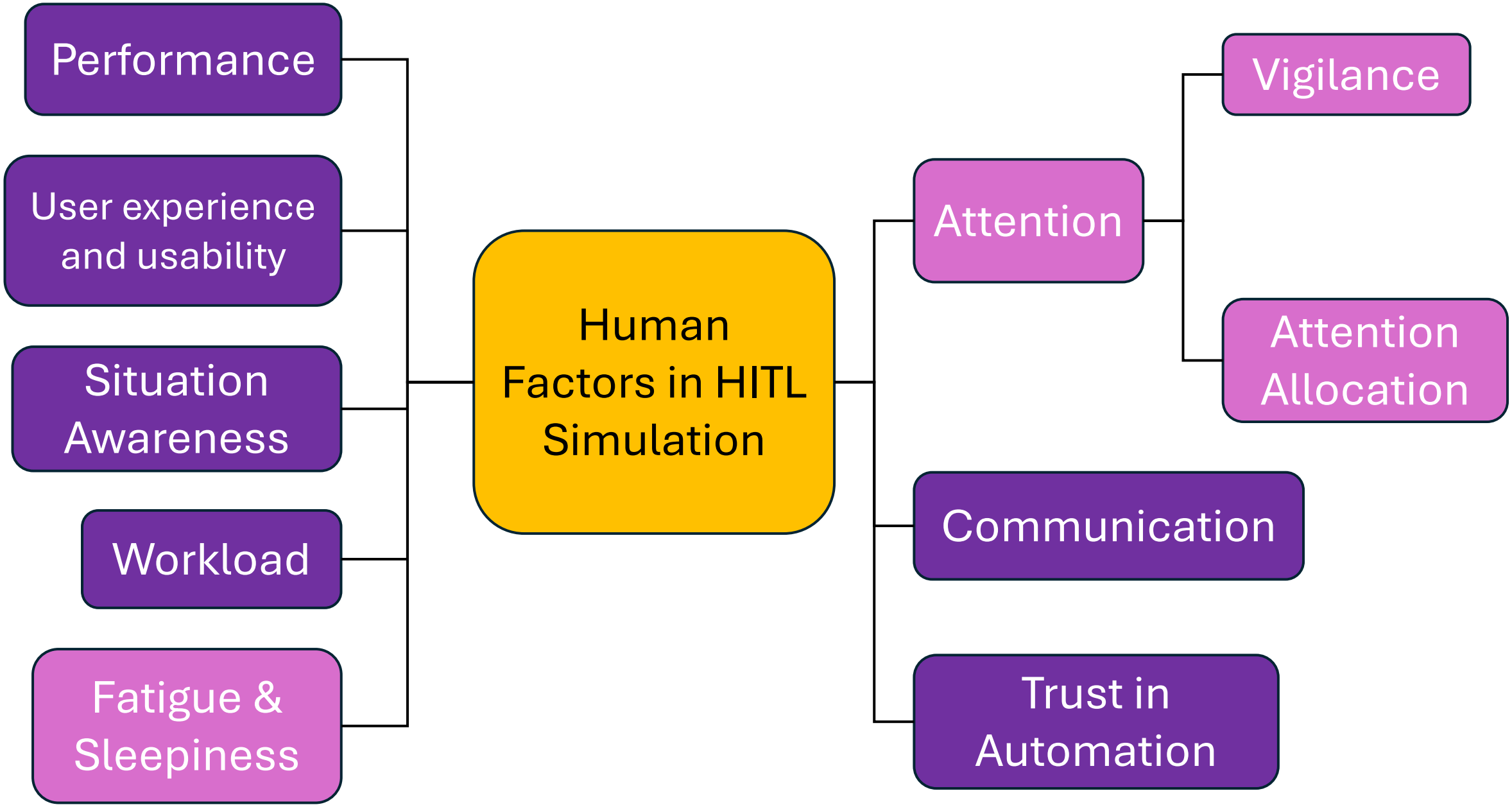
Expert feedback

Relevance, Usefulness & Sufficiency



Human Factors Toolkit v.2

After expert feedback


Performance
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Next steps

Additional review – we need experts!

End goal of providing a public document that can be utilized by researchers and practitioners in designing HITL rail simulations

Tell us what you think about the toolkit

Fill out our survey!