Developing a Human Factors Integration Guideline for Road Transport Systems

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SUMMARY

Road transport systems worldwide continue to create unacceptable levels of trauma. Currently, there are no widely adopted Human Factors Integration (HFI) guidelines specifically developed for road transport systems. This project outlines the development of a guideline to support the application of Ergonomics and Human Factors (EHF) knowledge, principles, and methods in the design and operation of road transport systems. Existing guidelines were reviewed, and a model for an optimal HFI guideline was developed using Work Domain Analysis with stakeholder input.

KEYWORDS

Human Factors Integration, Work Domain Analysis, Road transport safety

Introduction

Road transport systems present persistent and complex safety challenges, with serious injuries and fatalities remaining a major concern internationally. Approximately 1.19 million people die annually as a result of road traffic crashes, with between 20 and 50 million more sustaining non-fatal injuries that often result in long-term disabilities (WHO 2023). These outcomes emerge from multiple interacting factors across the wider transport system, including infrastructure design, policy and regulatory settings, industry practices, technological development, and road user behaviour (Salmon et al 2012, Read et al 2017).

Rapid advances in vehicle technologies, digital systems, and user-facing interfaces have further increased system complexity and introduced new challenges for ensuring safe design and operation (Abedi et al 2024). There is a critical need for proactive system-wide strategies that integrate Ergonomics and Human Factors (EHF) principles across the transport system lifecycle. Although HF guidance exists, including mandated HFI processes in the UK Ministry of Defence (MOD, 2024), there are currently no widely adopted HFI guidelines for road transport systems. Therefore, this study aimed to develop a HFI guideline to support translation of core EHF principles and methods in the design, regulation, and management of the Australian road transport system.

Method

This project involved 2 stages:

Review of HFI Guidelines and Methods: HFI standards and guidelines from transport and other safety-critical domains were reviewed. Both domain-wide and context-specific documents were appraised, examining structure, specified methods, lifecycle coverage, evaluation plans, strengths/weaknesses, and intended users. A complementary review identified EHF method categories suitable for application across the road transport system lifecycle. These findings informed the required components of the road transport system HFI guideline (HFI-RT).

Application of Work Domain Analysis (WDA): WDA (Naikar, 2013) was used to develop an optimal model of the HFI-RT. The draft model, developed by the research team and informed by the reviews, was refined during an online workshop with 12 subject-matter-expert (SME). Using Naikar's (2013) prompts, SMEs assessed each level, confirming and adding nodes. The research team then refined the model until consensus was reached. The final model defined the guideline's functional purpose, values, required functions, object-related processes, and physical/cognitive objects.

Results

Sixteen HFI standards and guidelines were reviewed. The review identified following requirements for the HFI-RT guideline: it should have a clear purpose, be written in accessible language, and specify its intended users. It should define the importance of HFI, outline relevant methods and processes, and signpost to detailed resources. The guideline should provide templates to support application, be structured around the system design lifecycle, and include an evaluation plan with performance-monitoring guidance. A practical case study should also be included.

The draft WDA model was reviewed and refined through an online workshop. In the abstraction hierarchy, the functional purpose of the proposed guideline was to promote and support HFI in road transport system design and operation. Twelve core values and priority measures were identified, including those relating to stakeholder's ability to use the guideline (e.g. awareness of the guideline), stakeholder use of the guideline (e.g. uptake of the guideline), the desired impacts of the guideline (e.g. stakeholder knowledge and competence in HFI), and the content of the guideline itself (e.g. maximising quality). Fifteen purpose-related functions were identified, covering support for end-users understanding of the guideline (e.g. relevance, scope and purpose), the role of HF and HFI across the transport lifecycle; and the specification of HFI requirements and methods across each lifecycle phase. At the bottom level of the abstraction hierarchy, 21 physical objects were identified along with 18 associated object-related processes.

The draft HFI-RT was developed by the research team using insights from the guideline review, EHF methods review, and the WDA abstraction hierarchy model. The WDA model informed the structure and core components of the guideline, including a proposed table of contents and the key processes required for effective HFI. A road transport system lifecycle was then defined, and relevant HF principles and HFI methods were mapped to each phase. The HFI-RT guideline is structured around five phases of lifecycle phases: (1) Planning and needs assessment, (2) Requirements analysis and risk assessment, (3) Concept design, evaluation and iteration, (4) Construction/Acquisition, and (5) Operation, maintenance and disposal.

Key takeaways

The HFI-RT guideline provides a lifecycle-based framework to support the consistent and effective integration of Human Factors into road transport system design. Its principles are intended to help policymakers, designers, and technology developers strengthen system-wide decision-making and proactively address safety risks across the transport system.

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