

# Train operation in the future: Optimal design of human-machine systems in train driver's cab

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## ► Background: Automation and its consequences

Increasing digitization and automation of train control at the Swiss Federal Railways (SBB) change work processes radically. Core questions of a prospective work organization (e.g. *How can skill and competence losses be avoided? How to avoid monotonous work?*) have to be discussed now in order not to be surprised by the technical developments in the future.

## ► Aim: Optimal design of human-machine systems

The aim of the project was to develop a catalogue of requirements, theoretically founded by work psychology, which would allow developers to design automated systems such that human-machine interaction will not lead to loss of operators' situation awareness, competences and skills.



Figure 1: View from a driver's cab (separate photo).

## ► Theoretical background

When designing work tasks in automated work systems, the human-machine allocation of functions, the individual work task and the work system into which human and technology are embedded must be taken into account<sup>1</sup>. If an appropriate functional allocation fails, negative consequences may occur such as loss of situational awareness, competence and skill<sup>2</sup>. The KOMPASS method<sup>3</sup> defines criteria, like *process transparency* or *information authority*, that are relevant for a human-centered design in automated work systems.

## ► Methods: Operationalization of the KOMPASS criteria

On the basis of previously conducted work analyses of the human-machine systems of train drivers, we conducted expert workshops to operationalize the KOMPASS criteria.

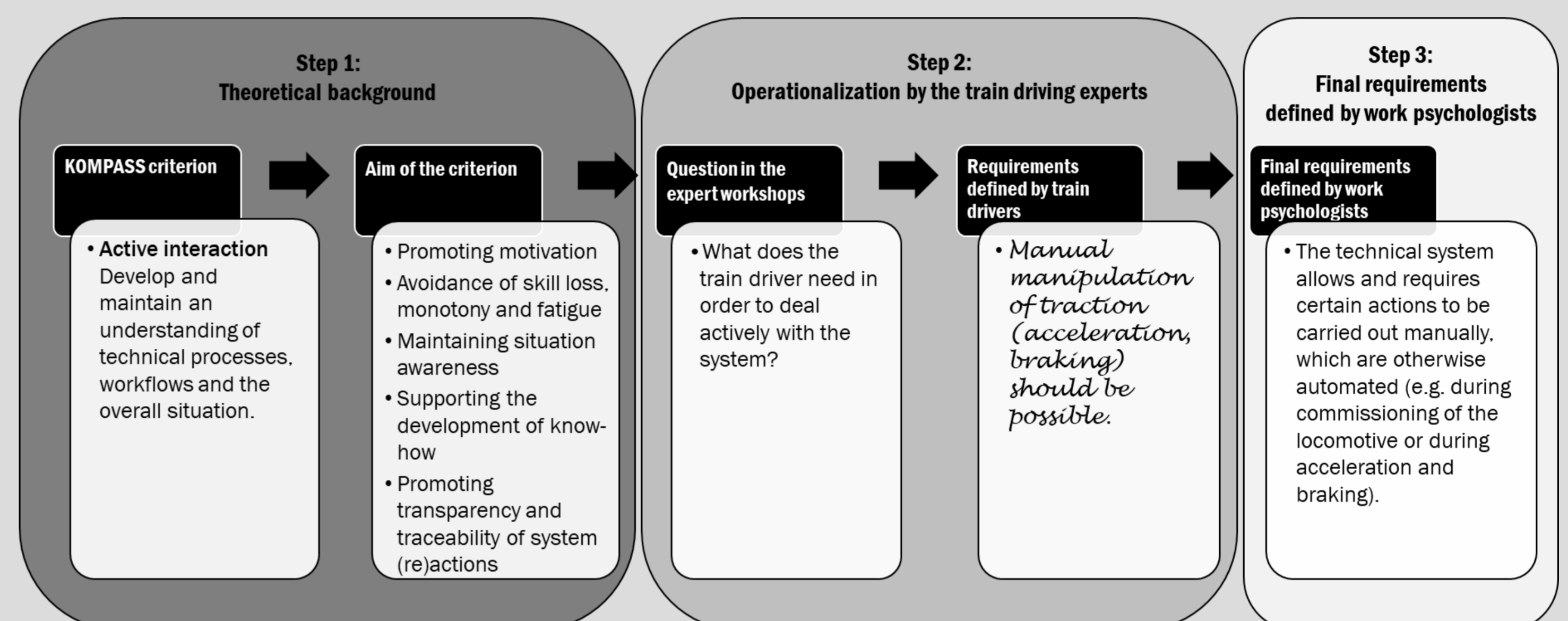


Figure 2: Procedure for the operationalization of the KOMPASS criteria.

## ► Resulting requirements: Work psychological instrument

The result is a catalogue with 88 requirements, defined regarding to technology (64), education and training (14) and organizational processes (10). The requirements are implemented into an electronic tool, based on Excel and completed with macros.

Table 1: Example of requirements for a human-machine system regarding to technology, education and training as well as regarding to organizational processes based on the KOMPASS criteria.

KOMPASS criterion	Requirement	Aim of the requirement
Active interaction. Develop and maintain an understanding of technical processes, workflows and the overall situation.	The technical system makes it possible and requires certain actions to be carried out manually, which are otherwise automated (e.g. during commissioning of the locomotive or during acceleration and braking).	<ul style="list-style-type: none"> <li>Promoting motivation</li> <li>Avoidance of skill loss, monotony and fatigue</li> <li>Maintaining situation awareness</li> <li>Supporting the development of railway know-how</li> <li>Promoting transparency and traceability of system (re)actions</li> </ul>
	The training imparts system-specific knowledge of procedures and processes used during incidents.	<ul style="list-style-type: none"> <li>Adequate response to disruptions</li> <li>Promoting competence development</li> <li>Supporting knowledge building</li> <li>Promoting and understanding of the work processes</li> </ul>

## ► Outlook and acknowledgement

In order to use the developed instrument in other socio-technical contexts, e.g. for aviation, the requirements must be adapted to the specific area. Many thanks to SBB for the constructive cooperation and support of the research project.

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