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Assessing technology acceptance for skills development and real-world decision-making in the context of train driving

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A B S T R A C T

Advances in technology have improved operator performance and efficiency in transport but it is not uncommon for end users to resist technology in spite of its benefits. Operators may resist technology from genuine and legitimate concerns though it is often seen as unjustified. While beneficial, such resistance can have detrimental effects on operations and safety, and can result in the withdrawal of a technology. Theories relating to technology acceptance include elements such as perceptions about the purpose and use of the technology, personal impact, individual characteristics, peer influence, perceived equity, and organizational factors. Although considerable research into technology acceptance and resistance has been conducted in other domains, very little has been conducted in transportation. Findings from two Australian studies are reported which examined train driver attitudes to two state-of-the-art technologies aimed at enhancing skills development and real-world decision-making. The technologies were implemented in the form of in-vehicle information support and simulated learning. Analysis of interviews defined three overarching themes relating to technology resistance: task dynamics related to ways of working and safety; redundancy regarding the utility of the technology and the impact on job security; and personal impact with respect to effects on status and the drivers' capacity to learn new skills. It is argued that domain-specific characteristics must be considered when designing and implementing new technologies to ensure that benefits of technologies are optimised. It is also argued that resistance should be seen as a positive element of the design and implementation process. This paper has high relevance for transport researchers, and practical application for rail organisations and policy makers.

1. Introduction

Technology has improved operational safety and efficiency in numerous industries. New technologies are continuing to emerge throughout the transportation industry, with much research being conducted on the benefits of those technologies in relation to safety and performance. The focus is on the technology itself and how effective it is likely to be or the impact it may have on a task. However one important element in which research is limited in transportation technologies in general is user acceptance of those technologies. No matter how effective and beneficial a technology may be, it can only provide its intended benefits if the end user embraces the technology and uses it to its full potential (Rose & Bearman, 2013).

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The research that has been conducted on technology acceptance in the transportation domain is almost entirely focussed on motor vehicle driving and drivers' attitudes to and acceptance of technologies such as driver assistance systems (Son, Park, & Park, 2015), intelligent transport systems (e.g. Larue, Rakotonirainy, Haworth, & Darvell, 2015), an active accelerator pedal (Adell & Várhelyi, 2008), a seatbelt reminder system (Young et al., 2008), and eco-driving support systems (e.g. Staubach, Schebitz, Köster, & Kuck, 2014). Research has mostly been focussed on general motorists with some research investigating the attitudes of drivers for whom driving is their main task in employment (e.g. truck drivers) (Huang, Roetting, McDevitt, Melton, & Smith, 2005). Other research on technology acceptance in transportation includes adoption of electronic toll collection services (e.g. Chen, Fan, & Farn, 2007; Holguín-Veras & Preziosi, 2011; Jou, Chiou, & Ke, 2011) and customer satisfaction relating to mobile ticketing (Cheng & Huang, 2013; Di Pietro, Guglielmetti mugion, Mattia, Renzi, & Toni, 2015) and website service (Cheng, 2011) in public transport. An area that is under-researched is technology acceptance by the operator in the working environment, e.g. pilots, truck drivers, train drivers. It is likely that there will be similarities between other domains and transportation with respect to the reasons and manifestations of resistance to technology but there may also be differences.

In all domains, including transport, it is not uncommon for new technologies to create unforeseen problems while addressing others which can create resistance. When introducing new technology, those who resist (i.e. resisters) may cite a number of legitimate concerns but their views are often interpreted as unjustified, deliberately obstructive, and something to be overcome (Courpasson, Dany, & Clegg, 2011). Resistance is invariably inherent to organisational life (Mumby, 2005) but the gladiatorial nature of this interaction could feasibly result in the prevention or subsequent withdrawal of technology that may actually be beneficial. Generally speaking, resistance may not necessarily harm the system (Ford, Ford, & D'Amelio, 2008), and more recent views have offered notions of "productive resistance," conceiving of it as an "authentic expression seeking positive solutions... rather than as underlings' reactive response to managerial power" (Courpasson et al., 2011, p. 801).

In the context of technology, resistance has been the focus of considerable study, particularly in areas of medicine (e.g. Prasad & Prasad, 2000) and education (e.g. Hu, Clark, & Ma, 2003). This body of research has revealed a variety of forms of resistance to technology, including complaints about potential flaws (e.g. Smith & Douglas, 1998), refusing to use the technology (e.g. Jian, 2007; Lapointe & Rivard, 2005), feigning compliance (e.g. Mahoney, 2011), and even sabotage (e.g. Prasad & Prasad, 2000).

There are many theories about the reasons for resisting technology. The Technology Acceptance Model (TAM) posits that system design features will influence users' perceptions of a technology's usefulness and ease-of-use and those perceptions will then influence the users' attitudes towards the technology which will in turn determine if and how well a technology is used (e.g. Davis, Bagozzi, & Warshaw, 1989). Other theories include: negative personal impact such as reducing the need for a worker's skills (e.g. Liker & Sindi, 1997); characteristics of the individual such as attributes and beliefs (e.g. Martinko, Zmud, & Henry, 1996); influence of peers (e.g. Hu et al., 2003); beliefs about equity and fairness (Joshi, 1991), and organisational factors (Greenberg, 2005). Each of these theories has received considerable support such that resistance to technology is likely to be attributable to more than a single factor. However, as noted above, few studies have explored or applied these in the context of transportation where advances in technology are a staple of the environment. In particular, the idiosyncrasies of rail systems may offer important substantive insights.

As a domain, rail is caught between two worlds. It is a mode of surface transport that has as much in common with aviation as it has with road (Bjørnskau & Longva, 2009), but the comparison with aviation often presents views of underdevelopment in rail transportation, both in terms of their reliability and culture (Uff & Cullen, 2001). Rail is also highly amenable to technology take-over; the need to sustain speed and manage networks optimally makes innovations in technology very attractive (Sussman & Raslear, 2007). These may manifest in the form of increased automation, additional decision-support tools, or new methods for training. Inadequate investment in rail can lead to deterioration of infrastructure and rolling stock, and have a huge impact upon the morale of employees. Consequently, there has been considerable investment in technology that provides the system with decision and communications support and makes available the abilities of people to interpret, prioritise, intervene and optimise (Wilson & Norris, 2005). However, while technology may address emerging demands and even offer substantial improvements, resisters may convey legitimate concerns when they are put into practice. While this does have its challenges, the issue is clearly complicated when a newly introduced technology happens to be useful but is nonetheless resisted.

Rail transport systems are connected by a number of functions that rely on technology. This is particularly the case with train driving, which relies on the signaller or controller function to manage signals, and where many aspects of the task have traditionally relied on non-technical skills (Branton, 1979). However, in the wake of advanced technology, the nature of train driving has changed and rail organizations are now routinely wrestling with a much broader range of dynamic performance goals; for the train driver (also known as locomotive engineer), there is now a need to draw on additional skillsets (Naweed, 2014). This evolution is likely to have met with many undocumented cases of resistance. In order to gain the benefits from new technologies, it is important to ensure that the process of introducing them is conducive to their acceptance, but also that it takes into consideration any concerns or comments raised by resisters. In this regard, resistance may indeed be better explained by what resisters do to achieve their ends than by seeing it as an adversarial confrontation (Courpasson et al., 2011). To achieve the goal of technology acceptance in the transport domain and interpret resistance as a proactive process for the design or usability of the technology, but also as an indication of the extant disposition of skilful workers, it is essential that the claims, opinions, and interests of resisters of technology be properly understood. As an industry that has many