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UNDERSTANDING THE PUBLIC ACCEPTANCE OF HYDROGEN TECHNOLOGIES IN TRANSPORT:
A CONCEPTUAL FRAMEWORK

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ABSTRACT

Public acceptance is recognized as an important factor determining the success of the implementation of hydrogen technologies in transport. This paper presents a framework for understanding citizen and consumer acceptance, focusing on psychological factors, by summarising psychological research. The relevance of each psychological factor for hydrogen technology acceptance will be explained and where possible supported by referring to empirical hydrogen technology acceptance studies. The paper concludes with a conceptual framework, which needs to be comprehensively tested for hydrogen technology acceptance and other technology acceptance instances.

KEYWORDS

Public acceptance, hydrogen technology, transport, conceptual framework, goal frame theory

Public acceptance is recognized as an important factor determining the success of the implementation of hydrogen technologies (e.g. Eames and McDowall, 2007). In the role of consumer, people may decide whether or not to purchase a hydrogen vehicle once they are introduced to the market. In the role of citizen, people may accept or protest against refuelling stations that are planned near their living area. Several studies have been conducted on hydrogen acceptance, many of which studied consumer acceptance of hydrogen buses (see for overviews Yetano Roche et al., 2009; Huijts et al., 2010). The studies are rather descriptive in nature and not well funded in theory (Huijts et al., 2010). In the few studies that are based on theory, only a single theoretical perspective has been chosen, with the result that other determinants suggested by competing theories are not taken into account. Hence, the insight in which factors affect hydrogen acceptance is still limited and a comprehensive

understanding of factors influencing consumer and citizen acceptance of hydrogen technologies in transport is missing. To the best of the authors' knowledge, also a more general comprehensive causal framework on citizen and consumer acceptance of new technologies that can be applied to this acceptance topic has not been developed yet.

In this paper we aim to fill this gap by developing a general framework for citizen and consumer acceptance of new technologies and apply that to hydrogen technology in transport. We do this based on theories from social and environmental psychology. The presented framework has several functions with respect to hydrogen technology research: it helps to understand a wide range of psychological factors that influence the acceptance of the transition to a hydrogen fuelled transportation system and how these are interrelated; it can support decision making and communication by policy makers and practitioners; it can provide starting points for acceptance research for new implementations; and finally, it will help to understand the value and limitations of currently available hydrogen acceptance studies.

As a start to understanding public acceptance, we recognize that people's acceptance behaviour may be motivated by different goals. Lindenberg and Steg (2007, p. 119) explain that goals are influencing decision making: "goals govern or 'frame' what people attend to, what knowledge and attitudes become cognitively most accessible, how people evaluate various aspects of the situation, and what alternatives are being considered." Three goals are distinguished: the gain goal, the hedonic goal and the normative goal.

The gain goal assumes that people base their decisions on costs-benefit analyses and choose options with the highest gains against the lowest costs. This aligns with the underlying thought of the theory of planned behaviour (TPB, Ajzen, 1991). The TPB postulates that attitudes, subjective norm and perceived behavioural control influence intentions to act, which in turn influences behaviour. Applied to technology acceptance, attitudes are evaluative judgements of the technology and behaviours in response to the technology that influence intention to perform technology related behaviours. The theory posits that attitudes result from a summed evaluation of perceived attributes or beliefs related to the technology and the behaviour (like the perceived costs, risks and benefits). Subjective norm reflects the perceived social pressure to perform or not perform the behaviour, or the expected social consequences of the technology related behaviour. Perceived behavioural control reflects the perceived ease or difficulty of performing the behaviour. So in the gain goal-frame, people can decide to buy a hydrogen vehicle based on their evaluations of the expected effects of buying and using the car (including other people's responses and expected effort). One hydrogen acceptance study (Molin et al., 2007) showed indeed that preferences for hydrogen vehicles are influenced by costs (fuel price and vehicle purchase cost) and convenience factors (detour and range). To the authors' knowledge, subjective norm has not been measured in hydrogen acceptance studies.

The hedonic goal-frame suggests that affect has the strongest impact on people's attitudes and behaviour; people will base their decision on what feels best. Dual-processing theories (e.g. Strack and Deutsch, 2004) discuss the role of affect next to cognitions in human thinking and decision making: they suggest that affect and cognition reflect two distinct systems in the human brain that have a separate but interactive role. For hydrogen technology acceptance, negative feelings such as fear can hamper acceptance, and positive feelings such as satisfaction can strengthen acceptance. Indeed, negative affect as a result of risk perceptions has been found to influence hydrogen technology acceptance (Montijn-Dorgelo and Midden,

2008), but to the authors' knowledge, positive affect has not been studied in the hydrogen technology context.

The normative goal-frame is active when people mainly base their opinion and behaviour on what is the most appropriate thing to do; on what they think "ought to be done" for the greater good (like the environment and other people). Schwartz (e.g. 1968) described a norm activation model (NAM), arguing that personal norms are feelings of personal obligation to perform or refrain from certain actions, based on the awareness of the adverse social consequences of not acting in the desirable way. Personal norm activation is influenced by whether people think that their behaviour influences the identified adverse consequences (outcome expectancy). Thus, intention to behave is influenced by personal norm, which is influenced by awareness of adverse consequences and outcome expectancy. In the case of hydrogen vehicles, people can have feelings of personal obligations to address environmental problems by purchasing a hydrogen vehicle, which can be strengthened by the belief that current fossil fuel use has a significant effect on the environment and the believe that their behaviour can influence the state of the environment. To the authors' knowledge, the NAM has not been tested in the context of hydrogen technology acceptance.

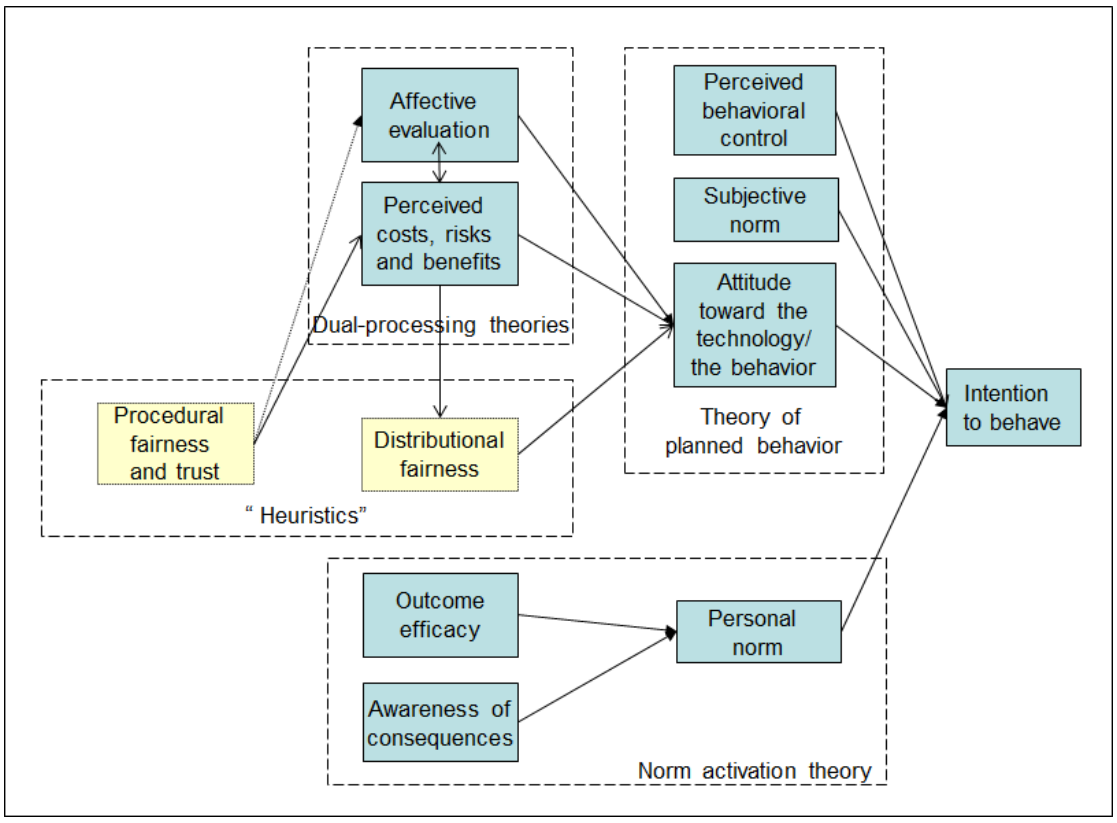

Figure 1: The technology acceptance framework

Next to these goal-frames, studies have also shown that the way the implementation of a technology is perceived and how the actors involved are perceived, influence the perceived costs, risks and benefits, and the attitude towards the technology. Two important factors in this respect are fairness and trust. Fairness can be distinguished into two types: procedural and distributional fairness. Procedural fairness concerns whether people find the way in which decisions were made fair. For example, decision making on the placing of a refuelling station can be found unfair because people's voice was not heard and acceptance can be low.

Distributional fairness concerns the perceived fairness of the distribution of personal and societal costs and benefits. For example, people living close to a refuelling station may feel that a location choice is unfair to them, because they are faced with the safety risks, while others enjoy the benefits of the refuelling station. Both types of fairness are likely to play a stronger role when others rather than you have taken the decision for the implementation of the technology. This has not been tested in hydrogen acceptance studies. Trust in actors involved with the technology and actors providing information about the technology are found to influence acceptability of technologies associated with risks, especially if people have know little about them. Trust has been to found to influence acceptability of hydrogen technologies in transport (Montijn-Dorgelo and Midden, 2008).

To conclude, we suggest that citizen and consumer acceptance are influenced by a wide range of variables, as depicted in figure one. The causal order is based on the causal order suggested in the original theories and measured in empirical studies. This conceptual model needs to be tested for several technology acceptance issues and specifically for hydrogen technology acceptance, to provide inside on the relative influence of each factor. We aim to test the model for the acceptance of hydrogen refuelling stations in the Netherlands.

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