A proposed model of factors influencing hydrogen fuel cell vehicle acceptance

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Abstract. Issues such as environmental problem and energy insecurity keep worsening as a result of energy use from household to huge industries including automotive industry. Recently, a new type of zero emission vehicle, hydrogen fuel cell vehicle (HFCV) has received attention. Although there are argues on the feasibility of hydrogen as the future fuel, there is another important issue, which is the acceptance of HFCV. The study of technology acceptance in the early stage is a vital key for a successful introduction and penetration of a technology. This paper proposes a model of factors influencing green vehicle acceptance, specifically HFCV. This model is built base on two technology acceptance theories and other empirical studies of vehicle acceptance. It aims to provide a base for finding the key factors influencing new sustainable energy fuelled vehicle, HFCV acceptance which is achieved by explaining intention to accept HFCV. Intention is influenced by attitude, subjective norm and perceived behavioural control from Theory of Planned Behaviour and personal norm from Norm Activation Theory. In the framework, attitude is influenced by perceptions of benefits and risks, and social trust. Perceived behavioural control is influenced by government interventions. Personal norm is influenced by outcome efficacy and problem awareness.

1. Introduction
Hydrogen fuel cell vehicle (HFCV) is the new era in automotive industry. HFCV uses hydrogen as the fuel which combines with oxygen in the air to produce electricity for the propulsion and emits only water and heat. Although there are issues on the carbon emission during the production of hydrogen fuel, there is no doubt that HFCV has a zero tailpipe carbon emission [1].

Recently, Honda has launched its third generation of fuel cell sedan, the Honda Clarity in Japan which is expected to be on sale in the first quarter of 2016. In Malaysia, Datuk Seri Idris Jusoh, the Education Minister launched the first Malaysian-made HFCV, a golf buggy at the National University of Malaysia (UKM) in December 2014. UKM was given RM7 million by the Education Ministry to lead the project to develop a zero emission vehicle using indigenous fuel cells.

Since HFCV is still new and probably unknown to Malaysian, it is important to understand to what extent public will accept this new sustainable technology and what are the predictors of such intention. This is to give an insight on how the technology should be introduced and implemented and to give the
idea to design communication about the technology to the public later [2]. To the authors’ knowledge, there is still no published study on the acceptance model of HFCV in Malaysia.

2. Literature review
The proposed model is developed based on two psychological theories of acceptance/behaviour and factors from other empirical studies.

2.1. Acceptance
There are three types of acceptance distinguished, that are, socio-political acceptance (public reaction to national or international policy-making), citizen acceptance (public responses towards the adoption of a technology in one’s living areas as a result of others) and consumer acceptance (public’s reaction to the availability of innovations on the market) [3]. The authors also proposed the term ‘acceptance’ for “actual behaviour in reaction to the technology”. In this study, the acceptance is limited to consumer acceptance and we defined acceptance as behaviour towards HFCV. However, HFCV is still undergoing technical developments and is still not available in the automotive market in Malaysia. Therefore, we could not measure the actual behaviour such as actual acceptance. Instead, we proposed to measure the intention to accept (intention to support, purchase or using) which is a direct predictor of the acceptance [2] of HFCV and study the determinants of such intention.

2.2. Theory of planned behaviour (TPB). TPB stated that intention influences behaviour via three determinants, namely, attitude, subjective norm and perceived behavioural control [4]. Attitude towards behaviour is defined as the extent to which an individual has a good or bad evaluation of the behaviour [4][5]. Subjective norm refers to perceived social pressure to perform or not perform the behaviour while perceived behavioural control refers to the perceived ease or difficulty of performing the behaviour [4].

2.3. Norm activation theory (NAT). Pro-social and pro-environmental behaviours, both involve giving up own self-interest for the sake of others [6]. According to [7], altruistic behaviour, that is behaviour that benefits others than oneself, is induced by personal norms. Personal norms reflects “feelings of moral obligation to perform or refrain from specific actions” [8]. These personal norms are influenced by two main factors: the problem awareness and outcome efficacy [9]. The problem awareness refers to the awareness that not performing a specific behaviour has certain negative consequences [9][10]. Outcome efficacy can be defined as the extent to which a person feels in control over the problem [10] or whether one thinks that the new technology/relevant behaviour will actually reduce energy problems [5]. Many studies include this norm activation model in predicting pro-environmental behaviours [2][11][12][13].

2.4. Perceptions of benefits and risk. Attitude is influenced by perceived benefits and risks of the technology/behaviour [5]. Studies showed that perceptions towards the technology significantly influence usage intention [14][15] and acceptance [16][17]. Therefore, we proposed that these perceptions of benefits and risks influence acceptance through attitude in the model. These perceptions are then influenced by social trust [18][19].

2.5. Social trust. As HFCV is still not in the Malaysia’s automotive market, we assume that the public have little or no knowledge about HFCV. The technology and innovation of alternative energy is a complex topic that only fully known by experts and actors responsible in the area [20]. People will base their attitudes toward new technology through social trust when there is insufficient knowledge or resources [19]. Social trust refers to “willingness to rely on those who have the responsibility for making decisions and taking actions related to the management of technology, the environment, medicine, or other realms of public health and safety” [19]. Through trust, public would not need to fully understand the details of the benefits and risks and rely on the information provided by the
trusted parties to make decision [21]. Several studies showed that trust in those responsible for the technology influences perceived benefit positively and perceived risk negatively [2][18][19].

2.6. Government interventions. The availability of resources and opportunity which results in less perceived impediment will cause a higher PBC in an individual [4]. This resources and opportunity refers to ‘facilitating condition’ as used by [22]. Government intervention has become a facilitating condition to the adoption of new technology and has a significant influence in several studies related to vehicle acceptance [14][23]. Therefore, we proposed government interventions such as tax exemption and subsidies as the facilitating resources to be the antecedent of perceived behavioural control.

3. The proposed model of acceptance

Figure 1. The proposed model of factors influencing HFCV acceptance.

Table 1. Factors and their definitions.

| Factor                        | Definition                                                                                                                                 |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Intention to accept           | Intention to support, purchase or use HFCV.                                                                                               |
| Attitude                      | The degree to which a person has a favorable or unfavorable evaluation of accepting HFCV.                                                   |
| Perceptions of benefits and risks | The extent to which a person thinks that HFCV has certain advantages and disadvantages.                                           |
| Social trust                  | Willingness to rely on those who have the responsibility for making decisions and taking actions related to HFCV.                      |
| Subjective norm               | The extent to which a person thinks that important people to him/her believes he/she should support, purchase or use HFCV.          |
| Perceived behavioral control  | The perceived ease or difficulty to support, purchase or using HFCV.                                                                       |
| Government interventions      | The extent to which a person thinks the government will intervent in the penetration of HFCV especially in financial help.          |
| Personal norm                 | A feeling of moral obligation to accept HFCV.                                                                                               |
| Outcome efficacy              | The perceived effectiveness of supporting, purchasing or using HFCV in reducing energy problems.                                         |
| Problem awareness             | Awareness (having realization) that not accepting HFCV has a certain negative consequences.                                                |

Figure 1 depicts the proposed model. There are ten latent variables to be measured with exception on acceptance. The reason is explained in 2.1. The lines with arrows show the directions of the
relationships between the factors and the dashed line shows the relationship that will not be tested. The detailed definition of each factor is shown in Table 1.

4. Conclusion
This study will be a significant effort in the implementation of HFCV in Malaysia. Malaysia’s government will be able to have an insight about the public acceptance of this new type of transport, HFCV, which will help in the decision-making and policy-making of the implementation. From the significant factors, the government could organize and plan better for the introduction and implementation of HFCV. In return, this will enhance the mitigation of the local environmental problems and energy insecurity caused by transport industry. The automotive industry will also benefit from this study. The results of this research will be helpful for automotive manufacturers in Malaysia in their decision-making to produce and sell HFCV and would also convey the public concerns regarding HFCV such as the costs, risks and benefits.

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