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Expectations, attitudes, and preferences regarding support and purchase of eco-friendly fuel vehicles

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ABSTRACT

This study analyses public expectations, attitudes, and preferences to support and purchase eco-friendly fuel vehicles. The study used a telephone survey of a sample of residents in Greater Stavanger, Norway. Two cluster analyses were conducted to group the individuals based on expectations and attitudes toward eco-friendly fuel vehicles. In addition, two multivariate analyses were performed to explore the determinants of support and willingness to purchase eco-friendly fuel vehicles. The study found three components of expectation to support eco-friendly fuel vehicles, namely cost, comfort, and safety. The analysis further found four components to explain attitudes to support eco-friendly fuel vehicles: personal norm, pro-technology, awareness of priority, and environmental degradation. Multivariate analyses confirmed that age, gender, and the number of cars in the household are likely to influence public preferences to support and purchase eco-friendly fuel vehicles. The results reveal that individuals tend to support the eco-friendly vehicles when the technologies meet their expectations towards cost and safety, but the cost expectation is the significant factor that results in the decision to purchase the eco-friendly vehicles. The study also found that the pro-technology attitude has influenced the propensity to support and purchase the eco-friendly fuel vehicles.

1. Introduction

Policymakers, scholars, and civil societies in many countries including Norway have demonstrated a strong interest to improve everyday mobility among residents, to be more relying on green technologies (Dincer, 2000; European Renewable Energy Council/EREC, 2011). As pioneered by Gro Harlem Brundtland, private and public institutions in Norway are strongly supportive to the energy transition that is in line with the idea of "Cleaner Production". This is important as a response of the ongoing climate change and air pollution, as well as the fact that the current resources of fossil fuel in the globe have gradually declined (European Renewable Energy Council/EREC, 2011; Li and Loo, 2014).

The adoption of eco-friendly fuel vehicles for both individual and household levels is considered as an essential solution to reduce carbon emissions. An eco-friendly fuel vehicle basically utilises a non-fossil fuel to power the engine, thereby the air pollution produced is considerably low or zero. Presently, several forms of eco-friendly fuel vehicle exist in the global market, such as electric (Figenbaum et al., 2015; Langbroek et al., 2016), biogas (Cavicchi et al., 2014), biofuel (Collantes, 2010; Savvanidou et al., 2010), and hydrogen vehicles (O'Garra et al., 2005; Tarigan et al., 2012; Tarigan and Bayer, 2012).

Past studies have revealed socio-psychological factors as important components to determine eco-friendly fuel vehicles' acceptance (Ohta et al., 2013; Bakker and Trip, 2013). Intangible and psychological factors such as awareness, concerns, moral obligation, and fears of people about environmental problems may influence the support and their willingness to purchase for eco-friendly fuel vehicles (Sangroya and Nayak, 2017; Wang et al., 2017). Such information is essential as inputs for the governments when creating credible policy schemes. This information is also fundamental for market assessment of the future design of the technology as well as how the technology should be communicated and promoted to different segments of the population (e.g., Huijts et al., 2012; Bögel et al., 2018).

Understanding public feedback about green energy technology is beneficial to automotive producers and related industries—because they steer the industry during the transition from non-renewable to renewable energy. Naturally, the industry needs to forecast whether the economic value of the products is in

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line with consumers' willingness and ability to pay for the vehicles. If it is not profitable, the authorities might need to subsidise the business, partly or fully, during the transition period (Sangroya and Nayak, 2017; Wang et al., 2017).

In the Netherlands for example, studies about possible factors that drive the adoption of eco-friendly fuel vehicles have been extensively investigated. Several challenges were reported about the existing infrastructures, including charging station (Huijts et al., 2012; Bakker et al., 2014; Huijts and van Wee, 2015), as well as the technologies (Rasouli and Timmermans, 2013). Huijts and van Wee (2015) report that people are unsure if there is the sufficient number of charging station along their commuting journey. For the case of electric vehicles, people wonder about the durability of the battery and its impact to the vehicle speed (Rasouli and Timmermans, 2013). Furthermore, Molin (2005) revealed direct and indirect evidence regarding safety and environmental risks that have caused negative experiences among the Dutch respondents. For example, the accident of the Zeppelin Hindenburg or knowledge that hydrogen can be used as the resource for bombs is strongly remembered by some people, partly implying to negative attitudes and lack of support for hydrogen vehicles. Some other people are unsure about the economic value of green fuels and the price of the vehicle itself, including the future availability of refuelling facilities; thereby, such resistance could delay the adoption of sustainable energy. According to Anderson and Stradling (2004), people can be reluctant to switch to eco-friendly fuel vehicles because of strong negative feelings, expectations, and doubts associated with the new technology.

In Norway, the policymakers aim to decrease carbon emissions by 40% in 2030 through several approaches, including clean technology creation, mode shift, and car use reduction (Karlstrom and Ryghaug, 2014; Skjølsvold et al., 2015; Figenbaum, 2017). Related stakeholders from both private and public sectors have made joint efforts to create technological improvements for renewable energy. For example, more than 200 biogas buses and taxis operate in the Oslo region, and this effort might decrease by about 25,000 tons of CO2 emissions over the course of one year. In 2015, more than 7,000 electric cars, or about 18% of the global market, were purchased in Norway alone. This number represented a 300% increase over the sales in 2013 (AID/Industry sources, 2013; OFV, 2013; Figenbaum, 2017). Bjerkan et al. (2016) note that the Norwegian government encourages the public to use electric vehicles through 1) tax discount incentives for purchasing a vehicle, 2) exemptions for road pricing, 3) free charging facilities, 4) exclusive parking spaces, and 5) dedicated road lanes in some areas. As reported by Figenbaum (2017), Norwegian purchase incentives are able to create an attractive price for potential customers to purchase electric vehicles. In addition, there are benefits in terms of the selection of models and brands, technology, and extensive campaign.

To promote renewable energy technologies and increase public awareness regarding sustainable environments, it is necessary to understand how people think and react to the introduction and adoption of eco-friendly fuel technology (e.g. EREC, 2011; Karytsas and Theodoropoulou, 2014; Keramitsoglou, 2016; Bögel et al., 2018). The primary questions discussed in this study are that: 1) *How are public expectations and attitudes towards the introduction of eco-friendly fuel vehicles?* 2) *What factors do influence the likelihood to* support *and purchase the eco-friendly fuel vehicles?* This study utilises the 2009 survey that targeted the respondents from Greater Stavanger (Norway). The survey contain a set of information about public expectations and attitudes about eco-friendly fuel vehicles. This study aims at examining survey responses from residents of Greater Stavanger about support for and purchase of eco-friendly fuel vehicles. This study further uses two types of statistical analysis: 1) Segmentation analysis of expectations and attitudes towards eco-friendly fuel vehicles, and 2) multivariate analysis of the determinants of public support for eco-friendly fuel vehicles.

To the best of author's knowledge, little evidence has been reported about public attitudes, expectations, and support about various forms of eco-friendly fuel vehicle in Norway. Using the same source of data utilised in this study, Tarigan et al. (2012) and Tarigan and Bayer (2012) have demonstrated how people have reacted to the introduction of hydrogen vehicles. However, the two studies have no information concerning public expectations and attitudes to electric, biogas and other forms of an eco-friendly fuel vehicle. In fact, the use of electric vehicles has been increasing in Greater Stavanger over the past few years. This city was recently considered as one of five cities in Norway with the highest number of electric vehicle ownership.[1] In parallel, biogas vehicles have been adopted by several local companies in Greater Stavanger, like *Kolumbus* (the public transportation administration) and *Posten Norge* (the Norwegian postal service), for supporting transport activities. Hence, this study is substantial to explain the factors that drive the public acceptance to different types of eco-friendly fuel vehicles in Greater Stavanger.

The study may be globally relevant due to the lessons it provides about public expectations and preferences to eco-friendly fuel vehicles from developed countries, like Norway. Walker et al. (2010) suggest that although people could have similar expectations about global issues of sustainable environment, their expectations, attitudes, and beliefs about green vehicles could vary across individuals, regions, and countries. The next section will discuss the process of data collection, methodology, results, discussion, and conclusion.

2. Data collection and methodology

The study used a dataset from a random telephone survey over 1,279 people whose phone numbers were listed in Greater Stavanger, Norway, in spring 2009. After screening the non-useable samples, 1,000 respondents were included in this study. Information recorded in the survey consists of multi-dimensional variables including socio-demographics, expectations, attitudes, and preferences for different types of eco-friendly fuel vehicles. This study assumed that a large proportion of respondents were familiar with the issues discussed during the survey process—because electric vehicles have been widely used among residents in Greater Stavanger. Also, biogas vehicles have been used for taxi and public transport vehicles in the area. Hydrogen vehicles are probably the least popular type, as this type of technology for public buses and private cars is still a pilot project, and refuelling stations are not yet widely available. Since biofuel and electric cars and buses have operated in major cities in Norway, individuals in urban areas have a common understanding of eco-friendly fuel vehicles.

The survey questionnaire in this study was based on a similar format conducted by O'Garra et al. (2005), dealing about public expectations to the adoption of hydrogen energy vehicles and their refuelling stations. Two earlier studies by Tarigan et al. (2012) and Tarigan and Bayer (2012) were carried out using this dataset, but the focus of the analysis was limited to public opinions and consumer behaviours to the hydrogen energy vehicles. The previous studies did segment the potential market of other eco-friendly fuel vehicles. The past studies did not also consider all important information related to public expectations and attitudes reported in the dataset. Instead, the studies only depict few variables of expectation and attitude, to explain the determinants of consumer

[1] *Elbil-boom i Rogaland* (Electric car booming in Rogaland). https://www.dagsavisen.no/rogalandsavis/elbil-boom-i-rogaland-1.624708.

behaviours to hydrogen vehicles. As the next stage, this research expands the horizon of analysis, by linking the analyses of support and preference to purchase different eco-friendly fuel vehicles with public expectations, attitudes, and socio-demographic factors. This research examines what the most preferable modes in the market are and why, as well as whether there is a consistency between supporting eco-friendly fuel vehicles and preference to purchase eco-friendly fuel vehicles.

The procedure of analysis consisted of two stages (see Fig. 1). First, this study did two principal component analyses on expectation and attitude components. Since the survey included a number of questions about respondents' expectations and attitudes, it was difficult to include all variables in one model system. Thus, this study first performed a principal component analysis (factor analysis) on the two sets of information (expectations and attitudes) and then included the factor loadings as independent variables in the multivariate models.

Next, this study applied a binary logit model to explain factors that influence the likelihood of individuals to support eco-friendly fuel vehicles for the next three years. In addition, this study used a multinomial logit (MNL) model to explain public mode choice towards eco-friendly fuel vehicles. According to McFadden (1978), a multinomial logit model should be independent of the irrelevant alternatives (IIA) requirement. In the preliminary analysis of all models, this study omitted certain independent variables with high multicollinearity by checking the variance inflation factor (VIF) values. Although no formal 'cut-off' value exists for use with VIF to determine whether multicollinearity exists, values in excess of 2.5 are often suggested as indicating multicollinearity in logistic regression analysis studies.

The results in Table 5 indicate that all independent variables used in the model systems had a VIF value lower than 2.5, meaning that our MLR models have a goodness of fit in relation to the independent variables.

3. Descriptive results

3.1. Sample profiles

Analysis of the study was based on an approximately equal sample size across gender (male 48%; n = 1000). The simple *t*-test showed a significant difference ($p < 0.01$) between the percentages of males and females in the sample. The average age of the respondents was about 47 years old, with the lowest being 17 years old. There is also a significant difference between the percentages of individuals below 35 years old and those 35 years old or older ($p < 0.01$). The average education duration of the respondents was about three years, reflecting a normal period of higher education in Norway. About 74% of the respondents have an occupation, and about 48% reported that they work in the energy (oil and gas) sector. This information is very plausible, as Greater Stavanger is known as the oil capital of Norway. The survey also found that the group of individuals who regularly drive a car is dominant in the survey. More than 50% of the respondents expressed '*very often*' for car use and '*often*' for bicycle use. The majority of the respondents also expressed 'rare' for public transport use.

3.2. Expectations

An expectation refers to a belief about something that an individual prefers to actualise in the future (e.g. see: Bakker et al., 2014; Frantál, 2015; Lo and Jim, 2015; Morton et al., 2017; Taylor et al., 2017). An expectation is often based on a personal view or judgment, which may or may not be realistic. An expectation may be drawn from an accumulation of facts, knowledge, and principles, in which can lead to a solid argument (Morton et al., 2017; Taylor et al., 2017). Thus, the outcome of the expectation should be in line with the expectation reported by the consensus of experts (Frantál, 2015; Lo and Jim, 2015). A number of studies have revealed that public expectations among potential and the existing users of eco-friendly fuel vehicles are essential to influence the decision making in supporting and using the technologies (O'Garra et al., 2005; Molin, 2005; Savvanidou et al., 2010; Walker et al., 2010; Bakker et al., 2014; Li and Loo, 2014). In this study, the survey asked for respondents' expectations of different components of eco-friendly fuel vehicles. The statements were: a) "I think the vehicle maintenance cost should be low"; b) "I think the fuel cost should be low"; c) "I think the vehicle price should be low"; d) "I think the vehicles should be safe"; e) "I think the vehicle should be environmentally friendly"; 6) "I think the technology should be in-front/advanced"; 7) "I think, it should be easy to drive the vehicle"; and 8) "I think, it should be comfortable when driving the vehicle".

Each statement allowed Likert scale responses (1 = '*strongly disagree*'; 2 = '*disagree*'; 3 = '*neutral or neither*'; 4 = '*agree*'; 5 = '*strongly agree*'). The results were tabulated based on respondents' preferences to eco-friendly fuel vehicles (Fig. 2).

The results show that 'the vehicle should be safe' seems to be most critical, as more than 90% of the respondents stated '*agree*' and '*strongly agree*' about this aspect of the technology. This percentage is consistent across different supporters of eco-friendly fuel vehicles. The expectations of 'easy to drive' and 'comfortable to drive' have shown similar results: more than 80% of the respondents in each group suggested '*agree*' and '*strongly agree*' to the statements. Meanwhile, the expectation that the technology should

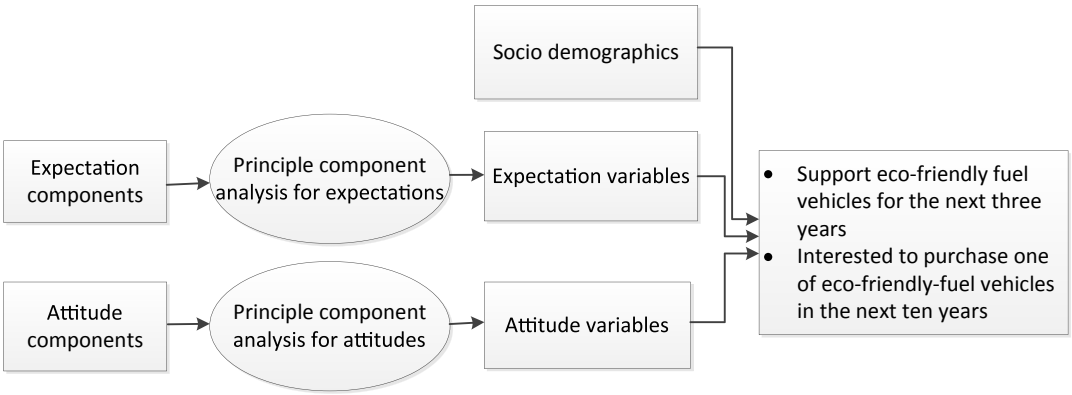

Fig. 1. The proposed model.

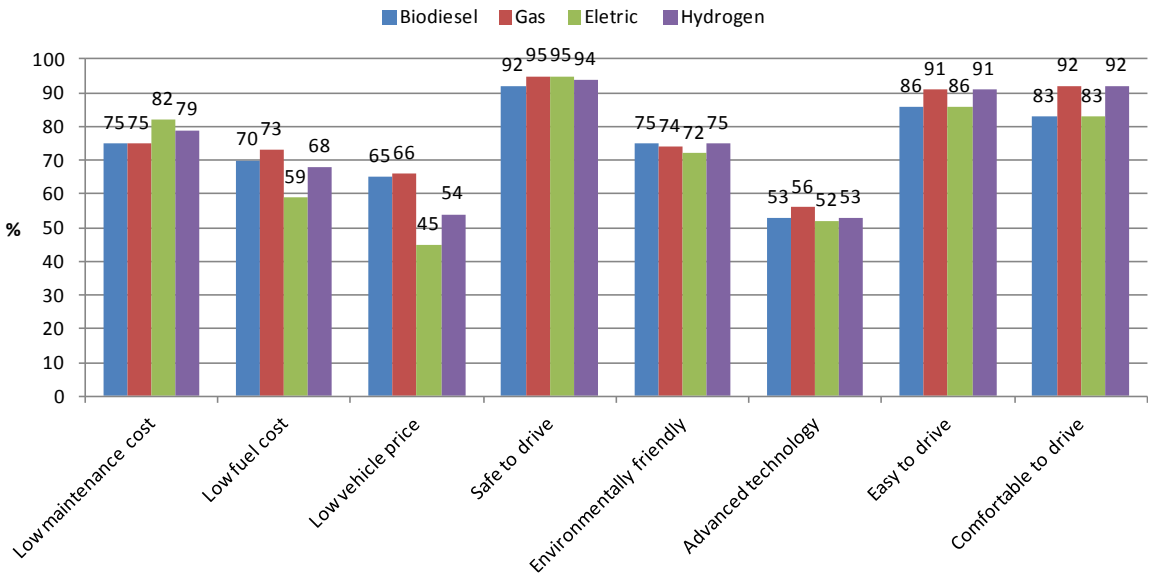

Fig. 2. Expectations regarding different aspects of the technology expressed by eco-friendly fuel vehicle supporters.

be in-front/advanced seems not to be critical for the respondents. The survey found that only about 52%–56% of the respondents in each supporter group responded with '*agree*' and '*strongly agree*' to these two statements. The percentages of this expectation statement are the lowest ones compared to other statements of expectation. Interestingly, vehicle price is also not a significant constraint for supporting the technology, especially among the electric vehicle supporters. The survey found that between 45% and 66% of the respondents expressed '*agree*' and '*strongly agree*' to the expectation of low vehicle price.

Using IBM SPSS Statistics version 20, a principal component analysis was conducted to cluster the statements about expectations of eco-friendly fuel vehicles. The results grouped the statements into three distinct components: cost, comfort, and safety (Table 1). Statistically, the three components are related to each other (Table 2). The first component (cost) pertains to expectations of low vehicle cost, good maintenance cost, and low fuel cost; and this explains 38% of the variance. This segment is mainly dominated by men (75%), individuals aged 18–29 years old (34%), work individuals (24%), and people with have a basic education only. This component also consists of the individuals who have no vehicle and who were willing to support eco-friendly fuel vehicles. The second component (comfort) explains 33% of the variance. This component is dominated by women (45%), individuals with children (25%), people with a higher education training (10%), and older people (8%) and/or retired individuals (5%). The third component (safety) explains 21% of the variance. It consists of older individuals (23%), individuals with more than one car (20%), people with an occupation (17%), and those who regularly use a car. The factor loadings were used in the logistic regression models, and their averages are presented in Table 1.

3.3. Attitudes

Attitude is a fundamental concept in social and environmental psychology research. It refers to a personal tendency expressed by individuals to favour or not favour a particular entity or phenomenon in society and nature (Anderson and Stradling, 2004; Kaldellis et al., 2011; Kalstrøm and Ryghaug, 2014; Bögel et al., 2018). This study asked about respondents' attitudes toward 10 different issues of environmental sustainability. The statements include 1) "It is necessary for everyone including me and my family to engage in certain activities to protect the environment", 2) "In environmental issues, it is sometimes necessary to understand illegal actions (such as civil disobedience) in order to get attention", 3) "Nature and animals have no value in themselves beyond simply making the people's interests"; 4) "Future energy should be based on renewable energy sources, not on oil, gas, and coal", 5) "Science and technology is the key that can solve environmental problems in Norway", 6) "Development of renewable energy sources like wind power and hydropower should be restricted because it involves significant infrastructure developments", 7) "Environmental protection should be given priority, even if it may cost the economic growth", 8) "Solving environmental problems should be one of the three highest task, prioritised by government budgets", 9) "If the existing trend continues, future generations will have major challenge to tackle human-made environmental problems", and 10) "Environmental problems such as global warning and air pollution have been exaggerated".

All statements of attitude were adopted from a study by O'Garra et al. (2005). Each item was measured by a Likert scale (1 = *accepted*; 2 = *neural or neither*; 3 = *rejected*). The results were tabulated based on preferences for eco-friendly fuel vehicles

Table 1
Results about expectations from the principle component analysis.

Component	Question	Loading
Expectation with cost	The maintenance cost of the vehicle should be low	0.721
	The fuel cost of the vehicle should be low	0.709
	The vehicle price should be low	0.682
Expectation with comfort	The vehicle should be easy to drive	0.542
	It should be comfortable to drive the vehicle	0.537
Expectation with safety	Expectation with vehicle safety	0.633
	Expectation about environmentally friendly	0.423

Table 2
Pearson correlation for expectation constructs.

	Expectation with cost	Expectation with comfort	Expectation with safety
Expectation with cost	1		
Expectation with comfort	0.634***	1	
Expectation with safety	0.453***	0.551***	1

*** $p < 0.001$.

(Fig. 3). The results demonstrate that the respondents have positive attitudes toward a sustainable environment. In most cases, the share of respondents that expressed '*accepted*' towards the statement is greater than 50%.

The principal component analysis was carried out to segment the statements of attitude, resulting in four distinct components: 1) personal norm (explaining 31% of the variance), 2) pro-technology (22%), 3) awareness of priority (14%), and 4) environmental degradation (11%). Personal norm refers to the group of individuals that considers individual values for being active in protecting the environment, through or beyond legal forms. Their attitudes are driven by personal and subjective perspectives regarding environmental challenges. This component was dominated by males (31%), young individuals (22%), people with no higher education training (16%), and non-worker individuals (9%).

The second component is namely pro-technology. It represents the population with the attitudes that are supportive to the creation of renewable energy fuels, by using the adoption of technology and science. Nonetheless, there is a clear point that people from this segment tend to restrict the use of heavy infrastructures when developing such renewable fuels, like the cases of wind power and hydropower energy. Individuals from this segment were dominated by younger people (aged 18–29), educated people, and workers.

The third component is namely awareness of priority. It refers to the attitudes that concern about the priority of public policies that can help protect the environment. It is obvious that individuals in this segment strongly relied on government-related policies for improving the environment. This component was dominated by women, older people (greater than 40 years old), and individuals with children.

The last component is namely environmental degradation. It consists of the segment of the population that worries with the overcoming challenges related to environmental degradation that exists globally. The individuals represented in this component also concern about the lack of attention shown by the society. Individuals from this segment were mainly those with children, no car ownership, and older people. The factor loadings of the components were used in the logistic regression models, and their averages are presented in Table 3. Statistically, the four components are related to each other (Table 4).

4. The results of multivariate analysis

The identification of factors that explain public support for eco-friendly fuel vehicles over the next three years was conducted through binary logit estimation. As discussed earlier, the analysis was carried out using the full-information maximum likelihood procedure. All independent variables contain values of VIF less than 2.5, indicating no multicollinearity existed in the estimation model.

Several socio-demographic variables in the model system were significant for explaining the determinants of support for eco-friendly fuel vehicles (see Table 5). The results reveal that the greater the education duration, the higher the support for eco-friendly fuel vehicles (0.06; $p = 0.05$). This may explain why people with a greater level of education may be knowledgeable of the technologies as well as the general challenges of the natural environment, inclining them to support eco-friendly fuel vehicles. However, the studies found no statistical influence of age in the support of eco-friendly fuel vehicles (−0.09; $p = 0.55$). This evidence probably explains that the tendency to support eco-friendly fuel vehicles is equally distributed across all age groups. The estimated results further demonstrate no significant impacts of being a worker (−0.02; $p = 0.95$), the presence of children (0.23; $p = 0.32$), or being a car user (−0.11; $p = 035$) on the propensity to support eco-friendly fuel vehicles. Interestingly, the study found that individuals who own more cars at home are less likely to support eco-friendly fuel vehicles as opposed to those who own fewer cars (−0.04; $p = 0.08$). This result suggests that people are less likely to switch to eco-friendly fuel vehicles the more they have invested in purchasing conventional fuel vehicles. Thus, this result implies that an effective campaign for the support and purchase of eco-friendly fuel vehicles should address and prioritize non-car owners as well as those who consider purchasing the first vehicle like young people (see Table 6).

Based on the expectation components, the study found that expectations about the low cost of fuel and vehicle price positively related to the support of eco-friendly fuel vehicles (0.32; $p = 0.09$). This means that people tend to support eco-friendly fuel vehicles when they expect the cost is low. Similarly, the component of safety positively and significantly implies a likelihood to support eco-friendly fuel vehicles (0.45; $p = 0.06$). However, the estimated model does not find a significant impact of the component of comfort on purchasing eco-friendly fuel vehicles.

The study found that three of the four components of attitudes (pro-technology, the priority of awareness, and environmental degradation) were statistically related to the support of eco-friendly fuel vehicles. The three attitudinal components that significantly influenced support for eco-friendly fuel vehicles were: the pro-technology component (0.07; $p = 0.07$); the awareness of the priority for performing sustainable environment activities component (0.10; $p = 0.01$), and the environmental degradation component of (0.20; $p = 0.02$). The analysis did not show support for eco-friendly fuel vehicles from the fourth component, the personal norm.

The next analysis seeks to explain factors that influence the likelihood to purchase different types of eco-friendly fuel vehicles over the next 10 years. Consequently, this analysis employed Multinomial Logistic Regression (MLR), due to the nominal (unordered) nature of the dependent variables (bioenergy, electric, hydrogen, and others). The analysis used hydrogen and others as the reference. The preliminary analysis was tested by making biodiesel and biogas different categories. However, goodness-of-fit for the model was very poor. This study then recoded biodiesel and biogas variables as one category to improve the model's performance and conducted the analysis through the full-information maximum-likelihood procedure. All independent variables had a VIF value lower than 2.5, which indicates the goodness of fit between the estimated model and the independent variables.

The estimation results indicate that male individuals are less likely to purchase bio-fuel (−0.54; $p < 0.1$) and electric vehicles (−0.43; $p < 0.1$) rather than are female counterparts. Interestingly, a

Fig. 3. Attitudes expressed by eco-friendly fuel vehicle supporters.

lower coefficient for electric vehicles than bio-fuel vehicles seems to indicate that across male individuals, the preference for purchasing bio-fuel vehicles is much lower than for purchasing electric vehicles. As expected, education positively influenced the propensity to purchase electric vehicles (0.30; $p < 0.05$). Consistent with the binary logit model discussed above, the MLR model shows that the more cars people own, the smaller the preference to purchase electric vehicles (−0.009; $p < 0.1$). The study also found that older individuals are less likely to purchase bio-fuel vehicles than are younger individuals (−0.59; $p < 0.05$).

Two components of expectation significantly influenced decision making in purchasing eco-friendly fuel vehicles. The component of cost had a positive relationship to the likelihood of purchasing biofuel vehicles (0.23; $p < 0.1$) and electric vehicles (0.30; $p < 0.05$). This result may show that people with more concern about technology cost are more likely to purchase biofuel and electric vehicles than are those with less concern about technology cost. Moreover, higher ratings for the comfort component may be linked to a trend for increased purchases of electric vehicles in the future (0.33; $p < 0.05$). Thus, those with more concern about vehicle comfort may induce people to purchase electric vehicles more so than will those with less concern about vehicle comfort.

The proposed model tested whether the four attitudinal components (personal norm, pro-technology, awareness of priority, and environmental degradation) were statistically related to the choice to purchase eco-friendly fuel vehicles. The results revealed that individuals with a higher attitudinal component of pro-technology are less likely to purchase biofuel vehicles (−0.33; $p < 0.01$). In addition, such individuals are more likely to purchase electric vehicles than are those with a lower pro-technology component (0.31; $p < 0.05$). Therefore, those with more support for pro-technology are much more willing to purchase electric vehicles than are those with less support for the technology. Lastly, the estimated model shows that individuals with a higher priority of awareness toward the sustainable environment are more likely to purchase electric vehicles than are individuals with a lower priority of awareness toward sustainable environment (0.29; $p < 0.05$).

5. Discussions

The important results of this study are related to three distinct components of expectation: cost, comfort, and safety. The cost component represents those who think that the low-cost factor for purchasing fuel and the vehicle, as well as its maintenance, is critical. The individuals from this component mainly consist of young individuals and males. The second component is the comfort. This group was dominated by women, individuals with children, those with higher education, and older and/or retired individuals. This segment represents people who consider the comfort of vehicles with renewable energy as a critical factor in their support of eco-friendly fuel vehicles. The third component is safety. This component was dominated by older people and those who have more than one car. This segment shows that safety is critical when supporting and purchasing eco-friendly fuel vehicles. Recent studies using latest samples (e.g. Fetanat et al., 2019; Liebe and Dobers, 2019; Schumacher et al., 2019) have indicated several segregated factors that link to the public expectations to the eco-friendly vehicles. Based on this analysis, cost, comfort, and safety are three integrated factors that are essential to the success rate of eco-friendly vehicles' introduction.

The principal component analysis further distinguished four clusters of attitudes: personal norm, pro-technology, awareness of priority, and environmental degradation. The personal norm segment refers to individuals who have attitudes toward being active in protecting the environment, within or beyond legal forms. The pro-technology segment represents individuals who have attitudes toward being supportive towards any technologies that can help contribute to the development and improvement of eco-friendly fuel vehicles. Awareness of priority represents individuals who have attitudes to take any relevant actions that can help protect the environment. Finally, the environmental degradation segment represents individuals' attitude to support different forms of environmental activities and overcoming challenges related to environmental problems.

The results reveal that education has a significant role in increasing support for, and willingness to purchase, eco-friendly fuel vehicles. As the level of education increases, the probability of supporting eco-friendly fuel vehicles also increases among the public in Greater Stavanger. This finding confirms the results of previous studies that show a strong contribution of formal education to openness toward renewable. Moreover, our study reveals that increased education improves the likelihood of purchasing electric vehicles.

Gender seems to have no influence on decisions to support eco-friendly fuel vehicles. However, this is not the case for the decision to purchase eco-friendly fuel vehicles. This study's results show that males are significantly less likely to purchase biofuel and electric vehicles. These facts support the strong preference on the part of male individuals to use conventional vehicles. Therefore, policymakers and the automotive industry need to improve the willingness of males to purchase eco-friendly fuel vehicles.

Interestingly, this study found that the more cars people owned, the less likely they were to support or purchase eco-friendly fuel vehicles. This result probably demonstrates that people are less likely to switch to vehicles that use renewable energy sources when they already have invested in conventional vehicles. Nonetheless, it is surprising since this study assumes that people tend to buy eco-friendly fuel vehicles as their second or third cars, instead of as the first car. A separate analysis in the future should be conducted to clarify this issue.

The study found age to be an insignificant factor regarding support of eco-friendly fuel vehicles. However, the estimated model indicates that older individuals are less likely to purchase biofuel vehicles. As biofuel is quite new among people in Greater Stavanger, compared to the adoption of electric cars, older people seem less familiar with biofuel vehicle technologies than younger people are. This may explain why they are less likely to purchase biofuel vehicles.

This study found significant impacts of the expectation components on the propensity to support and purchase eco-friendly fuel vehicles. The study revealed that, while the components of cost and safety strongly influence individuals' support for eco-friendly fuel vehicles, cost and comfort influence decision making to purchase biofuel and electric vehicles. The results further indicate that the expectation toward cost is the only component that consistently explains the likelihood to influence individuals' support and purchase of eco-friendly fuel vehicles. Interestingly, the safety expectation is likely to determine the likelihood to support eco-friendly fuel vehicles. However, the safety factor seems to be less important at the point of deciding whether to purchase eco-friendly fuel vehicles. By contrast, comfort does not influence whether individuals merely support the idea of eco-friendly fuel vehicles, but it is a significant factor in considering whether to purchase biofuel and electric vehicles. Thus, individuals are influenced by different sets of factors regarding their general support of eco-friendly fuel vehicles (cost and safety) than they are for specific decisions about purchasing such vehicles (cost and comfort).

As reported earlier, the study found four attitudinal components. The components of pro-technology and awareness of priority suggest a propensity to support and purchase eco-friendly fuel

Table 3
Results about attitudes from the principle component analysis.

Component	Statement	Loading
Personal norm	It is necessary for everyone including me and my family to engage in certain activities to protect the environment	0.743
	In environmental issues, it is sometimes necessary to understand illegal actions (such as civil disobedience) in order to get attention.	0.677
	Nature and animals have no value in themselves beyond simply making the people's interests.	0.633
Pro-technology	Future energy should be based on renewable energy sources, not on oil, gas and coal	0.773
	Science and technology is the key that can solve environmental problems in Norway	0.701
	Development of renewable energy sources like wind power and hydropower should be restricted because it involves significant infrastructure developments.	0.681
Awareness of priority	Environmental protection should be given priority, even if it may cost the economic growth.	0.781
	Solving environmental problems should be one of the three highest task, prioritised bu government budgets.	0.611
Environmental degradation	If the existing trend continues, future generations will have major challenge to tackle human-made environmental problems.	0.622
	Environmental problems such as global warning and air pollution have been exaggerated.	0.466

Table 4
Pearson correlation for attitude constructs.

	Personal norms	Pro-technology	Awareness of priority	Environmental degradation
Personal norms	1			
Pro-technology	.342**	1		
Awareness of priority	.872**	.421**	1	
Environmental degradation	.231**	.204**	.471**	1

** $p < 0.01$.

Table 5
Binary logit model: the support toward eco-friendly fuel vehicles.

Variable	B	S.E.	Wald	Sig.	Exp(B)
Socio-demographics					
Education duration	0.06	0.14	0.21	0.05	1.06
Male [D]	0.20	0.23	0.70	0.40	1.22
Number of cars at home	−0.04	0.16	0.08	0.08	0.96
Age	−0.09	0.14	0.36	0.55	0.92
Car user [D]	−0.11	0.12	0.87	0.35	0.90
Worker [D]	−0.02	0.27	0.00	0.95	0.98
Child [D]	0.23	0.24	0.98	0.32	1.26
Factor loading for expectation					
Cost	0.32	0.19	2.96	0.09	0.73
Comfort	0.12	0.20	0.39	0.53	1.13
Safety	0.45	0.24	3.43	0.06	1.56
Factor loading for attitude					
Personal norm	0.28	0.28	0.96	0.33	1.32
Pro technology	0.07	0.13	0.31	0.07	1.08
Awareness of priority	0.10	0.12	0.53	0.07	1.10
Environmental degradation	0.20	0.13	2.41	0.02	1.23
Constant	−2.32	1.18	3.91	0.05	0.10
2 Log likelihood	514.14				
Cox & Snell R Square	0.04				
Nagelkerke R Square	0.06				

vehicles. Interestingly, these results demonstrate that people with environmental degradation attitudes may support eco-friendly fuel vehicles, but this does not mean they automatically tend to purchase the vehicles. On the other hand, individuals with a pro-technology attitude were more likely to purchase eco-friendly fuel vehicles. This segment of people should be the main target for future marketing campaigns by renewable energy and automotive industries. Certain forms of subsidies from policymakers may be effective in encouraging such individuals to move beyond merely supporting to purchasing eco-friendly fuel vehicles.

6. Conclusions

This study has found a positive trend regarding public support for eco-friendly fuel vehicles in Greater Stavanger. This evidence is crucial to shaping policy activities, by showing, although the local economy in Greater Stavanger is much influenced by the natural resource business and industry, people are still aware of the urgency of eco-friendly fuel vehicle usage. As one may argue that urban residents who have significant benefit from the petroleum economy may be less supportive to the energy transition vision (Tarigan et al., 2017), this study can confirm that this is not the case of Greater Stavanger. Several factors such as the high level of education among residents, industrial activity diversification, and monetary incentive schemes to utilise eco-friendly fuel vehicles may contribute to this findings, but further studies should be carried out to confirm these assumptions.

The study further shows that people have consistent expectations and attitudes regardless of the types of eco-friendly fuel vehicle that they have supported. Evidence from this study indicates that eco-friendly fuel vehicle supporters report a quite similar tendency of perceptions to different aspects of the technology as well as the attitudes towards the environment. This is a clear message for the business operators that the existing vehicle types might have the same chance to compete in the market—because people have expressed similar hopes and desires for all eco-friendly fuel vehicle technologies. This result is supportive for the new players of eco-friendly vehicles as no dominant preference to certain features of the technology.

The results further reported three forms of expectation: cost, comfort, and safety. However, the cost and safety expectations may influence the possibility to support eco-friendly fuel vehicles, while the comfort expectation has no significant influence on the support of eco-friendly fuel vehicles. On the other hand, the cost expectation influences public decision to purchase electric and biogas vehicles. Thus, this research clearly indicates a significant attention from the potential customers about the low-cost expectation toward the fuel and the vehicle price, and this aspect is central to encourage them in not only supporting but also purchasing eco-friendly fuel vehicles. In fact, studies based on cases from the Netherlands have demonstrated that comfort regarding the charging station, as well as the technology readiness (Rasouli and Timmermans, 2013), may contribute to the support to the eco-friendly fuel vehicles. Nonetheless, this study further adds our understanding that the low-cost expectation is the significant factor that drives people's willingness to purchase the eco-friendly fuel vehicles.

Table 6
Multinomial Logistic Regression: Preference to purchase an eco-friendly fuel vehicle (Reference: hydrogen-fuelled vehicle).

	Biodiesel and gas				Electric			
	B	S.E.	Wald	Exp(B)	B	S.E.	Wald	Exp(B)
Socio-demographics								
Education duration	−0.10	0.14	0.56	0.90	0.30**	0.14	5.04	1.36
Male [D]	−0.54*	0.25	4.49	0.58	−0.43*	0.24	3.11	0.65
Number of car at home	0.40	0.15	6.97	1.49	−0.09*	0.16	0.35	0.91
Age	−0.59**	0.24	5.99	0.56	−0.23	0.23	1.01	0.79
Worker [D]	−0.16	0.20	0.65	0.85	0.13	0.18	0.50	1.14
Car user [D]	0.32	0.21	2.26	1.37	−0.27	0.18	2.24	0.76
Children [D]	−0.06	0.24	0.05	0.95	−0.1	0.24	0.18	0.91
Loading factor for expectation								
Cost	0.23*	0.12	3.54	1.26	0.30**	0.11	7.01	0.74
Comfort	−0.18	0.15	1.41	0.83	0.33**	0.15	4.96	1.39
Safety	0.16	0.14	1.37	1.17	−0.18	0.12	2.36	0.83
Loading factor for attitude								
Personal norm	0.02	0.12	0.04	1.03	0.10	0.12	0.71	1.00
Pro-technology	−0.33***	0.11	8.98	0.72	0.31**	0.13	5.76	1.37
Priority awareness	−0.03	0.12	0.05	0.97	0.29**	0.12	5.83	0.75
Environmental degradation	−0.16	0.31	0.27	0.85	0.03	0.29	0.01	1.03
Constant	−1.53	1.20	1.63	0.22	−1.2	1.13	1.11	0.30

It is further important to note that the attitudinal component of pro-technology influences the propensity to support and purchase eco-friendly fuel vehicles. Individuals with positive attitudes to science, technology, and renewable energy sources are likely to both supporting and then purchasing electric vehicles. Langbroek et al. (2016) have noticed that price is sensitive to influence electric vehicle adoption in Sweden. But people with certain attitudes about the environment are more likely to adopt or reject electric vehicles. In the UK, Bunce et al. (2014) have shown the public response to electric vehicle usage were substantially triggered by the attitudes in promoting green environment as well as the expectations that the recharging procedures of the vehicle are easy and convenient. In parallel, Bergman et al. (2017) note the critical role of pro-environmental lifestyles that determine the likelihood to purchase electric vehicles.

The estimated models indicated that education does matter to encourage individuals to support and purchase eco-friendly fuel vehicles. In particular, individuals with a greater duration of higher education are likely to support and purchase electric vehicles. A study by Daziano et al. (2017) has revealed that increasing the influence of carbon emissions information on car purchase may encourage people in Canada to utilise green vehicles. Bergman et al. (2017) also note that knowledge has a significant influence on technology acceptance, but the degree of support may be not similar between the early and the later stage of technology diffusion. Thus, it is likely that educated individuals are quite accessible with information regarding various aspects of eco-friendly fuel vehicles and how such technologies could contribute to overcoming climate change. This means that educated individuals with a strong attitude towards pro-technology should be the main target for marketing eco-friendly fuel vehicles, as they are likely to support and purchase eco-friendly fuel vehicles in the future.

Overall, the results presented in this study found that individuals may support the eco-friendly vehicles when they are confident that the technologies meet their ‘cost’ and ‘safety’ expectations. Interestingly, when considering to purchase the vehicles, individuals may mainly think that ‘cost’ is the primary factor, thereby ‘cost’ should meet their expectation first. The study further demonstrates that the pro-technology attitude is likely to influence individuals' support and purchase to the eco-friendly fuel vehicles.

7. Theoretical and practical implications

This study has demonstrated the essential approach of cluster analysis to segment the public based on their expectation and attitudinal factors. This method is effective to identify the multi-dimensional characteristics of the potential users of eco-friendly fuel vehicles. As there are many socio-psychological factors that can relate to public preferences to support and purchase eco-friendly fuel vehicles, this study recommends the application of cluster analysis to transform such complex factors into fewer variables. Furthermore, the use of multivariate analysis is also relevant to explain who the supporters of eco-friendly fuel vehicles are and why they tend to support and purchase the vehicles. Our results also give insights about the critical factors of low-cost expectation and pro-technology attitude to explain public preferences to support and purchase the technologies. The future quantitative analysis that tends to develop a model of public acceptance to eco-friendly fuel vehicles may need to include the two factors in the theoretical model of public acceptance of eco-friendly fuel vehicles.

Our findings are relevant for policymakers and industries that aim to improve the delivery of renewable energy technologies to the public. This research offers substantial clues to help innovative energy technologies in the automotive industry compete successfully with petroleum-based energy sources. This study not only provides insight into ways to map public expectations and attitudes toward various types of vehicles, but also reveals perspectives regarding public support for, and willingness to purchase, the technologies. Moreover, these results can be used to improve planning and marketing for this emerging industry.

As this study mostly demonstrates how expectations and attitudes are likely to influence the decisions to support and purchase eco-friendly fuel vehicles, policymakers and scholars need to consider actions that could change public expectations and attitudes, in order to ensure a greater support and willingness to purchase eco-friendly fuel vehicles. For example, with respect to the expectation of low cost towards green vehicles, this aspect can be quite problematic because it can be quite expensive at the current stage to produce certain features of eco-friendly fuel vehicles. Again, by sharing substantial information about carbon emissions calculator for each individual, people may be much more aware of the impacts they could contribute to tackling climate change, by

switching their modes of transport to eco-friendly fuel vehicles, rather than they focus on economic aspects of eco-friendly fuel vehicles.

Nonetheless, based on the boundary found in this study, few further studies are suggested to improve better understandings about public support and awareness of certain aspects of renewable energy development and technology. First, it may be fruitful to explore the variability of public expectations, attitudes, and preferences regarding different forms of eco-friendly fuel vehicles over a span of time. Consequently, longitudinal data should be employed to identify temporal changes of expectations, attitudes, and preferences for eco-friendly fuel vehicles. Thereby, a new data collection using the same format of questionnaire and sample object will be crucial to be carried out. Such dataset should be tested again with the same model proposed in this study. Secondly, the next study may need to examine the degree of willingness to pay for eco-friendly fuel vehicles. This may help the industries and the policymakers to set competitive prices for the products. Lastly, comparative studies across cities in Norway as well as across countries can be also conducted in the future.

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