The demand for clean-fuel vehicles by Dutch local authorities: A stated choice analysis.

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Abstract

Previous research has showed that the era of cheap fossil fuels is over. Also, 23% of the worldwide emission of CO2 is produced by road transport. These problems demand a change in the propulsion of vehicles. Because the diffusion of clean-fuel vehicles is not happening at this moment, something has to change Rogers' diffusion of innovation theory is used to state that a critical mass of vehicles is needed to stimulate the diffusion of these vehicles. Due to public procurement Dutch local authorities (DLA's) can help stimulating this diffusion. Unfortunately these DLA's are not purchasing clean-fuel vehicles yet. To gain insight in what is hampering the diffusion of these vehicles by DLA's, a discrete choice experiment was created about the preferences by these DLA's. Six vehicle attribute were used to describe each vehicle. The results showed that the initial purchase price and the amount of local emission were experienced as the most important attributes by DLA's, where initial purchase price has a negative influence and local emission a positive influence in the choice for a new vehicle. Next, fuel price, range and availability of the fuel were found evenly important. Fuel price had a negative influence and both range and availability of fuel had a positive influence on the choice for a new vehicle. Finally time to refuel/recharge was found least important and also negatively influencing the choice.

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1. Introduction

Recent studies claimed that the era of cheap fossil fuels will soon be over. They agree that the production of crude-oil based fuels will start to decline somewhere between 2010 and 2015 (Alekket, 2007; de Almeida & Silva, 2009; Owen et al, 2010). With an increasing demand for these fuels in especially China and India (Tsoskounoglou et al, 2008; Schippers et al, 2009) scarcity is inevitable.

Further studies showed that the increasing emission of greenhouse gases causes global climate change and more and more natural disasters (Obersteiner et al, 2001; van Aalst, 2006). One of the most important causes for these changes is the emission of carbon dioxide (CO_2). A recent study has showed that road transport contributes for about 23% of the worldwide emission of CO_2 (IEA, 2007). Within road transport, 60% is accounted for by automobiles and light duty vehicles (Schippers et al, 2009).

Upcoming shortage and climate change demand a change in the propulsion of cars in the near future. Consequently, different clean car propulsion technologies that do not rely on fossil fuels have been developed over time, but until now none of them has been able to dethrone the Internal Combustion Engine (ICE) (MacLean & Lave, 2003; Thomas, 2009).

The diffusion of clean-fuel vehicles will not happen spontaneously (Struben & Sterman, 2008). A critical mass of vehicles is needed in order for the new technology to become successful. This critical mass is usually gained by what Rogers (1995) calls "early adopters". Early adopters are the first consumers that jump in technologies when the advantages are starting to appear. They expect certain benefits to appear or are influenced by environmental reasons such as social pressure (Midgley & Dowling, 1978; Robinson, 2009). Early adopters play an important role in the diffusion of new technologies. These early adopters set an example to the rest of the world. They are the first that test a new technology (Midgley & Dowling, 1978; Rogers, 1995), and they contribute to new product development and improvement of the new product (van Rijnsoever & Oppewal, 2012). However, early adopters are still reluctant to enter the clean-fuel vehicle market (Struben & Sterman, 2008). A new party that can step into this gap is the government. Governmental organizations purchase all sorts of products every day including vehicles used by the government itself to conduct its tasks. Acquisition by governments is called public procurement. Public procurement can have a positive effect on the diffusion of a new technology (Rothwell, 1984; Edler & Georghiou, 2007). In this way, the government will start adopting a new technology and helps making the new technology more attractive for other parties to start adopting. In order to gain insights in how governments can be influenced to start adopting clean-fuel vehicles, preferences of these governmental parties for clean-fuel vehicle technologies should be researched.

Previous studies have already tried to encompass the preferences of consumers for clean-fuel vehicle attributes by using a discrete choice analysis. Some of these studies mainly focused on one technology, like hydrogen fuel cells or battery powered electric vehicles (Calfee, 1987; Chéron & Zins, 1997; Gracia et al, 2009). Other studies addressed only the cost factor as vehicle attribute to study (Potoglou & Kanaroglou, 2007; Hensher & Layton, 2010). Older studies have already discussed the demand for several alternatives of clean-fuel vehicles for consumers (Bunch et al, 1993; Ewing & Sarigöllü, 1998). Due to new technological breakthroughs, these studies are not up to date anymore. One recent study has focused on the influence of individual characteristics on the choice for different alternatives of clean cars (Ziegler, 2010).

All of these studies focus on individual consumers. Due to technological constraints the adoption of clean-fuel vehicles is still not happening by these consumers. Therefore, this study will focus on the key group of governments. The focus will be aimed at Dutch Local Authorities (DLA's). By starting to adopt clean-fuel vehicles, DLA's can help making the new technologies more attractive. In order to gain insight in the demand for clean-fuel vehicle by DLA's, a clear distinction should be made between the different technologies used in this study.

The focus of this research will be on the following clean-fuel vehicle alternatives: Battery Electric Vehicle (BEV), Fuel Cell Vehicle (FCV) and Biogas Internal Combustion Vehicle (BICV). Although the production of Hydrogen Gas for FCV's, Electricity for BEV's and Biogas for BICV's are not yet 100% CO_2 neutral nowadays, the fuels can be produced 100% CO_2 neutral in the future. These technologies will not be used directly in this research. Service attributes and the values of these attributes belonging to the above stated alternatives will be used to gain insights in what hampers DLA's to acquire clean-fuel vehicles. While most vehicles sold on the market now are Internal Combustion Engine vehicles (ICE), the attributes for this technology will also be used in this study.

Therefore the research question of this thesis is:
What is the influence of service attributes of different types of clean-fuel vehicle alternatives on the demand of these vehicles by Dutch Local Authorities?

No previous studies have tried to encompass the preferences of local governments. Therefore, the theoretical contribution of this study is aimed at adding knowledge of these preferences. In addition, this study tries to apply the analysis of preferences to local authorities, instead of to consumers.

The results of this study can be used by the Dutch central government to increase the adoption by its local governments to help stimulating towards a critical mass of clean-fuel vehicles. Eventually this critical mass can help starting the diffusion among the general population. If for example the purchase price is the only bottleneck, then a fiscal measurement can help. When technological characteristics of the vehicles hamper the diffusion, subsidies for research in these fields will help clearing these restraints.

The next chapter will discuss the theoretical background of this study. Chapter 3 will discuss the used methods. Chapter 4 contains the analysis and results. This is followed by the conclusion and a discussion.

2. Theory

This chapter will start with Rogers' (1995) Diffusion of Innovation Theory and the term critical mass. Next, the difference between stated and revealed preference will be explained. This will lead to Random Utility Theory. The theory section will end with the used vehicle attributes and DLA characteristics. When the term attribute is mentioned, it refers to the vehicle attributes. When the term characteristic is mentioned, it refers to the DLA characteristics. This theory section is mainly based on a thorough literature study. The explanation of the vehicle attributes and DLA characteristics is based on both a literature review and exploring interviews with experts of the Dutch governmental organization NL Agency. Focusing on sustainability, innovation, international business and cooperation, NL Agency is the number one contact point for businesses, knowledge institutions and government bodies[1]. The explanation of the vehicle attributes and DLA characteristics directly tends towards the method section. Therefore the theory section with partly consist of the method for measuring the attributes and characteristics.

2.1 Diffusion of Innovation and Critical Mass

Rogers' diffusion of innovation theory (1995) describes five different groups with their propensity to adopt a technology. These five groups are: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards. Each of these groups has its own characteristics.

In the clean-fuel vehicle industry, the innovators are already present. Some innovators are already purchasing clean-fuel vehicles for several years. Some small firms are changing traditional cars into clean-fuel vehicles, but only in very small numbers.

The second group consists of the early adopters. This group is more likely to hold a leadership role in the diffusion of the technology; they are used by the other groups to gain information and advice about a new technology. Their opinion towards a new technology is crucial for the diffusion (Sahin, 2006). In fact, "early adopters put their stamp of approval on a new idea by adopting it" (Rogers, 1995:283). This group has to be convinced that a new technology is better than the traditional technology (Rogers, 1995). In the clean-fuel vehicle market, this is the focus group of this research. The early adopters do not yet exist within the normal consumer market. NL Agency (2011) assumes that DLA's can partly take over the role of early adopters by making use of public procurement. When DLA's adopt clean-fuel vehicles, technological restraints can be find out and information is uncovered about what clean-fuel vehicle manufacturers should improve to make the vehicle better suited for its needs. In this way, the different clean-fuel technologies can be improved. In addition, users will get more familiar with the new technologies and normal consumers will see these vehicles drive around. This can eventually improve the adoption of early adopters within the population of normal consumers. For example, by adoption the BEV massively the initial purchase price will go down due to mass production. In this way, public procurement by local governments will possibly help improving one or more of the attributes of the new technology and therefore improves the possibility of a wider adoption. Therefore, public procurement can stimulate the early adoption of normal consumers (Faucher & Fitzgibbons, 1993; Edquist & Hommen, 1998).

When a certain number of early adopters are using the new technology, the technology can get self-sustaining (Rogers, 1995). This number is called the 'critical mass' (Oliver et al., 1985; Rogers, 1995; Mitsufuji, 2003). Oliver et al. (1985) define a critical mass as "a small segment of the population that chooses to make big contributions to the collective action while the majority does little or nothing" (Oliver et al., 1985:524). This assumption creates the gap between the early adopters and the rest (Moore, 2002). "The critical mass occurs at the point at which enough individuals have adopted an innovation so that becomes self-sustaining" (Rogers, 1995:313).

As stated before the adoption of clean-fuel vehicles is still not in the early adopters phase. In order to gain insight in what is hampering the diffusion of clean-fuel vehicle

[1] http://www.agentschapnl.nl/en/about-us

technologies among DLA's, a better understanding must be achieved about the preferences of DLA's for these technologies.

2.2 Random Utility theory

In order to gain insight in the preferences of DLA's for clean-fuel vehicle attributes, two different types of choice data can be used. These are revealed preferences (RP) and stated preferences (SP). "RP data refer to situations where the choice is actually made in real market situations" (Hensher et al., 2005:5). RP data cannot be used when the behavior is not observable (Adamowicz et al., 1998). The problem with RP data in analyzing the market demand for clean-fuel vehicles is that there is no real market situation, because these vehicles are hardly for sale and are not bought in great numbers by DLA's.

"SP data refer to situations where a choice is made by considering hypothetical situations" (Hensher et al., 2005:5,6). SP data is thus used when behavior is not observable. In this study, SP data refers to the preferences DLA's have for the vehicle attributes.

To model the preferences of DLA's, this study relies on random utility theory (Thurstone, 1927; Block & Marschak, 1960; Manski, 1977; Cascetta, 2009). This theory is based upon decision makers, deriving their utility for each choice they make in a certain context. The main assumptions for this theory are:

- The decision maker considers every alternative that is available for his choice. The set of alternatives may differ for every decision maker. For example, a car model that is not for sale anymore is removed from the choice set.
- Next, the decision maker will set his perceived utility for every alternative. This utility will be based upon attributes of the alternatives and of the decision maker's characteristics. The decision maker will give a score and weight to every attribute.
- The goal of this consideration is the maximization of the utility for his choice. The alternative with the highest score will eventually be the 'winner'.
- For an analyst it is impossible to gain insights in every characteristic and attribute that is seen as important by the decision maker. Therefore, it is impossible to explain the entire choice. This results in an error in the evaluation of the choice (Manski, 1977; Cascetta, 2009). This error term contains all the characteristics and attributes that are not asked for by the analyst. A part of the error term is determined by the context of the decision maker.

This leads to the next formula:

(1) $U_a = V_a + \varepsilon_a$

Where U_a is the overall utility given for alternative a, V_a is the systematic value that is represented by the vehicle attributes DLA characteristics and ε_a is the random residual that cannot be explained by any of the observed attributes or respondent characteristics (Hensher et al., 2005; Cascetta, 2009). The systematic value V_a is influenced by the score and weight for each of the attributes. This leads to formula 2:

(2) $V_a = \beta_1 X_1 + \beta_2 X_2 \ldots + \beta_n X_n + B_1 Z_1 + B_2 Z_2 \ldots + B_n Z_n$

The β's are the parameters for the vehicle attributes and the X's are the values for these attributes. The B's are the parameters for the DLA characteristics and the Z's are the values for these characteristics (Bliemer & Rose, 2009).

2.3 Model

In this study, a discrete choice experiment (DCE) was used. A DCE is based on the assumption that any good or service is described by its attributes and that the utility experienced by this good or service is based on the value of these attributes (Louviere et al., 2000; Ryan et al., 2001). In a DCE, respondents are asked to make a selection of one alternative among a set of mutually exclusive alternative with different scores for the different attributes (Hensher et al., 2005). Over the different choice tasks the respondent had to make, the values for each attribute of each alternative was changed systematically.

The computer program Ngene was used to generate an orthogonal design where all attributes are statistically independent of another. A fractional factorial design was generated where the main effect display zero correlations. The design consists of 72 choice tasks, each containing four alternatives. These 72 tasks were divided over eight different versions, each having nine different choice tasks.

2.4 Vehicle attributes

In SP experiments attributes have to be defined which are related to all alternatives that are analyzed. An unlimited number of attributes can be introduced in the analysis in order to interpret the influence on choice behavior. However, the problem with large quantities of attributes is that each of them must be clearly explained for the respondents so that no misinterpretations will occur (Hensher et al., 2005, Ewing & Sarigöllü, 1998). Furthermore, a large number of attributes will only make it more difficult for respondents to make their choice. Therefore, the number of attributes should be large enough to explain the utility of the alternatives, but small enough to be clear for the respondents. Unfortunately, there are no agreements about how many attributes is the perfect. For this thesis, six vehicle attributes were chosen. The attributes should not only be in economic sense, but also in real-world choice such as time to refuel and pollution. Product attributes can be divided into two sets: technical and service (Saviotti & Metcalfe, 1984). The technical attributes can be seen as supplier driven (Frenken et al., 1999). The supplier determines the technical attributes of the technology. These attributes tell something about parts of the vehicle itself. For example the engine size, haw many cylinders the engine has and how many doors the car has. Service attributes are seen as the attributes that are experienced by the users. To keep it with the same example as in the technical attributes, service attributes are the top speed of the vehicle, the mileage and how easy it is to get in the car. While this study is focusing on the demand side of the technology, service attributes will be used (Lancaster, 1966; Castaldi et al., 2009).

Based upon literature (e.g. Ewing & Sarigöllü, 1998; Brownstone et al., 200; Ziegler, 2010) a list of common used attributes for clean-fuel vehicles has been generated. Each of these characteristics was verified by interviewing experts in the field of alternative fuel vehicles. For each of the attributes the present value is determined using a thorough internet research and through the expert interviews. For each attribute, a hypothesis is stated to show the expected influence of that attribute. Next to the description of the attribute and the hypothesis, the values for that attribute used in this thesis are explained. A summary of the vehicle attributes with its values can be found in table 1.

- The first attribute is *initial purchase price* (IPP). Previous studies have already shown that the initial purchase price has a negative influence on the adoption of clean-fuel vehicles (Bunch et al., 1993; Ewing & Sarigöllü, 1998; Potoglou & Kanaroglou, 2007; Ziegler, 2010). Therefore hypothesis 1 is:
    - *H1: A higher initial purchase price will have a negative influence on the chance a certain vehicle is chosen as the best option.*

  The attribute initial purchase price is measured as a percentage of the purchase price of an ICE. Monetary values are harder to use in this type of survey, because of the great difference in car prices between cars used for different purposes. By using percentages, it is clear for every respondent what the difference is between the alternatives in the survey. This is common in SP experiments (Bunch et al., 1993; Ewing & Sarigöllü, 1998; Potoglou & Kanaroglou, 2007; Ziegler, 2010). In this research, the following values were used: 100% as the benchmark for regular ICE vehicles. Studies by Hsu et al. (2011) and Kragha (2010) showed that the average price of green gas vehicles would be in a range of 110% to 134%. One green gas model is already directly for sale by the auto manufacturer Opel, the Zafira CNG. The average price of this car is 10% higher than a normal ICE Zafira with about the same specifications[2]. Therefore the price of 125% is used for BICV's. The prices for BEV's are not easy to calculate. BEV's that are easily comparable with ICE vehicles are not on the market yet. Studies by Hsu et al. (2011) and Thiel et al. (2010) have calculated that prices are in a range between 143% and 175% of an ICE. The already available Nissan Leaf is also priced about 150% of a comparable Volkswagen Golf (NL Agency, 2010). Therefore, for these vehicles 150% is chosen. For FCV's it is even much harder to set a price. These vehicles are not for sale yet. In an interview with an expert in the field of hydrogen and FCV's in the Netherlands, the initial purchase price of FCV's came out as a point of discussion. While FCV's are not at all for sale on the market, no market prices can be used to determine the initial purchase price of these vehicles. Previous studies showed prices ranging from 450% (van Vliet et al., 2010) to even 2000% (Hsu et al., 2011). The expert added that German vehicle manufacturers stated to put FCV's on the market in the year 2013. Prices are expected to lie even higher than BEV's. Therefore, in order to remove unrealistic values, the price was set on 200%.

- The second attribute that is used in this thesis is also economic: *fuel price*. Vehicles with a higher fuel price will less likely be sold than vehicles with a lower fuel price. Therefore, the fuel price is of importance in the decision of purchasing a new vehicle (Mohammadian & Miller, 2003; Ahn et al., 2008).
    - *H2: A higher fuel price will have a negative influence on the chance a certain vehicle is chosen as the best option.*

  Fuel price will not be measured in price per liter, because the amount of liters used to drive are different between the alternatives and some of the alternatives use other units, like kWh for BEV and kilo for FCV. While people find it harder to imagine what a price per kilometer means for the costs of driving a car, a larger distance is taken. In this research, the price per 100 kilometer is used to define the

[2] car configurator can be found on http://www.opel.nl/Configurator/Zafira_Tourer/Start.aspx

fuel costs (Calfee, 1995; Bunch et al., 1993). For ICE vehicles, this study uses an average fuel price of €1,80 per liter (price of normal fuel around the time of study) with an average efficiency of 15 kilometers per liter fuel. This gives a price of €12,- per 100 kilometer. For BEV's studies have showed that the average price per kilometer is around €0,04 (Bakker, 2010; Hsu et al., 2011; van Vliet et al., 2011), while Vliet et al. (2010) calculated an average price of €0,049 per kilometer. These studies do not take account of possible taxes that can be introduced in the future. Therefore in this study €5,- per 100 kilometer is used. For both FCV's and BICV's studies have showed that the average price per kilometer are between €0,067[3] and €0,08 per kilometer (Hsu et al., 2011; Kragha, 2010; van Vliet et al., 2010). Again, because of possible tax regulations a price of €8,- per 100 kilometer is used in this study.

- Next, the *range* of the vehicles after refueling/recharging can be of great importance on the choice for clean-fuel vehicles (Chéron & Zins, 1997; Dagsvik et al., 2002). Recent studies have shown that range is an important bottleneck for BEV's (Grünig et al., 2011; Meerkerk et al., 2011). A lower range can have a negative effect on the chance a vehicle is chosen.
  - *H3: A larger range will have a positive influence on the chance that a certain vehicle is chosen as the best option.*

  The range is determined as kilometers that can be driven between two refuel/recharge stops (Chéron, 1998; Dragsvik et al., 2002). As a benchmark, the ICE is used with a fuel tank of 40 liters. Combined with an average fuel efficiency of 15 liters per kilometer, this gives an average range of 600 kilometers. For BEV's the range that is found in literature lies between 100km and 200km (ING, 2011; Lee & Lovellette, 2011). Interviews with several experts within NL Agency that have driving experience with BEV's showed that the real time range is more likely to be 100 km. Therefore, this value is used for BEV's. A study on BICV's and FCV's has showed some comparisons. For both technologies, a range of about 350 to 400 kilometers is given (Hsu et al., 2011). For these two technologies, 400 kilometer is used for the range.

- In addition to the range, the *refueling/recharging time* is also used in this research. Especially BEV's are said to have problems with recharging time. Previous studies have shown that this is an important constraint for the adoption of BEV's (Chéron & Zins, 1997; Ewing & Sarigöllü, 1998). A longer refuel/recharge time will counteract the adoption of certain vehicles.
  - *H4: A longer refuel/recharge time will have a negative influence on the chance a certain vehicle is chosen as the best option.*

  The attribute of refuel/recharge time will be measured as the time it will take to fully refuel or recharge the vehicle. For the BEV both the times for slow and fast recharging will be taken into account. This attribute is measured in hours and

[3] Fuel costs calculated by dividing average price of €1,- per liter by 15 kilometers per liter gives a price of €0,067 per kilometer. Link: http://www.groengasmobiel.nl/tanken/prijs-van-groengas/

minutes. The average time to refuel an ICE vehicle takes about 5 minutes. While fueling green gas works in the same way as fueling natural gas, the time is also about the same. Fueling green gas takes about the same time as normal fuel, so 5 minutes is used too (Hsu et al., 2011). For FCV's again 5 minutes is used. Studies have showed that refueling a FCV takes about 2 minutes extra (ECN, 2011; Mckinsey, 2010), but this can be neglected compared to the time to recharge a BEV. There is a difference between fast charging and slow charging of BEV's. By using high power fast charging a battery of a BEV can be recharge within 20 to 30 minutes towards 80% of the capacity. Slow charging takes about 6-8 hours to recharge the batteries completely. Therefore, the values of 30 minutes and 8 hours are used in this study.

- The fifth attribute that is also in connection with the two previous is the *availability of the fuel*. This is the traditional chicken and egg problem. For example there are no FCV's sold now, because there are no fueling stations. On the other hand, there are no fueling stations for FCV's because those vehicles are not driving around yet (Romm, 2006; Achtnicht et al., 2008; Struben & Sterman, 2008).
    - *H5: A higher availability of the fuel will have a positive influence on the chance a certain vehicle is chosen as the best option.*

For fuel availability, presenting exact amounts of fueling or charging stations is not clear enough for the respondents. In addition, a clustering of these stations in one part of the country can make it seem there are enough stations, but in fact, in a large part of the country this is not the case. Therefore, this characteristic is stated as a percentage of the availability of traditional fuels and the assumption is made that these stations are divided evenly over the country (Achtnicht et al., 2008). As a benchmark, the availability of normal fuel is set on 100%. Hydrogen is not yet available in the Netherlands. Therefore, this technology is set at 0%. In this way, the respondents are asked to imagine that they themselves have to set up the fueling infrastructure in their own DLA. More and more green gas fueling station and electric charging stations are being built in the Netherlands. At this moment there are over 80 green gas-fueling stations[4] and more than 3000 charging stations, 28 of them are fast chargers[5]. To make it clearer for the respondents, this study used both 25% and 50% as values for the BEV and BICV.

- *Local Emission* can be of great importance too on the decision of car acquisition by DLA's (Brownstone et al., 2000). By the emission of greenhouse gases (GHG) the environment is harmed. Local emission is defined as the emission of both GHG and particular matter.
    - *H6: A higher local emission will have a negative influence on the chance a certain vehicle is chosen as the best option.*

Local emissions will be measured compared to ICE. Both BEV's and FCV's are zero emission vehicles. They do not emit any GHG's where they drive. When their fuels are produced with sustainable sources, they are even entirely emission free in the future. BICV's do emit some GHG's where they drive. On the other hand, the

[4] Groengasmobiel: http://www.groengasmobiel.nl/no_cache/tanken/tanklocaties-in-nederland/
[5] Oplaadpalen.nl: http://www.oplaadpalen.nl/

fuel for BICV's is made entirely out of sustainable sources. Therefore the total chain emits no GHG's. While this attribute is about local emission, the value for BICV's is set right in between, at 50% less than ICE.

Next to these direct effects, some interaction effects were used in this analysis. First, there is the interaction between initial purchase price and fuel price. A higher initial purchase price can be compensated by a lower fuel price. In this way, the higher initial costs can be recovered by the lower fuel price during the vehicle's lifetime.

- *H7: There is a negative interaction between initial purchase price and fuel price.*

The second interaction that is analysed in this study is between the range and the time to refuel/recharge. This problem occurs mainly by BEV's. BEV's do have a short range. When this can be compensated by a short recharge time, the problem should be solved.

- *H8: There is a negative interaction between range and recharge time.*

The last interaction is between range and availability. This is similar to the previous interaction. A short range can be compensated by a better availability of fuel. In this way, drivers can refuel their vehicles in more places and thus the short range is no longer a problem.

- *H9: There is a negative interaction between range and availability of fuel.*

2.5 DLA characteristics

DLA's differ from each other. Therefore, next to the influence of the vehicle attributes on the choice for clean-fuel vehicles, this study will also try to analyze the influence of different DLA characteristics on the adoption of clean-fuel vehicles. Three different types of DLA's will be used in this study. These are: Municipalities, provinces and Regional Water Authorities (RWA). This study will try to find any differences between these DLA's in preferences for the vehicle attributes. All DLA's have signed the Climate Agenda 2011-2014 in which they stated to work together towards a sustainable future (Min. I&M, 2011). For the acquisition of new vehicles, this means that only vehicles with a low CO_2 emission may be purchased by DLA's. The next step will be the acquisition of 100% CO_2 neutral vehicles. Therefore, this study is aiming at the next step for DLA's. First, the characteristics, which are applicable for all three types of DLA's are, explained. Secondly, two characteristics, which are only applicable for municipalities will be discussed. Again, hypotheses concerning the influence of these characteristics will be stated. The characteristics are summarized in table 2 of the method section.

First, the average distance that is driven per car per day is used. Vehicles that are driven over very large distances will have to need a great driving range or should be able to refuel/recharge very fast. DLA's that drive their vehicles over larger distances every day, will be more reluctant to choose vehicles with a shorter range, longer refuel/recharge time and a smaller availability of fuel.

- *H10: DLA's with a larger daily distance will have a lower chance of choosing vehicles with a lower range, higher refuel/recharge time and lower availability of fuel.*

The second characteristic is if the acquisition of the fleet of cars is managed by a person within the DLA or if the car fleet management is outsourced to a leasing corporation. In this way the influence of the leasing corporation on the purchase of clean-fuel vehicles is examined. An expert interview showed that leasing corporations have great influence on the acquisition of cars by local governments. Most local governments use leasing corporations for their fleet management. While there is no clear view of a business model for clean-fuel vehicles, leasing corporation often are reluctant towards offering these vehicles. Therefore, they often choose not to offer these vehicles or to offer these vehicles for higher prices. In this way, the leasing corporations lower their risk of losing money. This characteristic is divided in a four-point scale: Completely outsourced, partly outsourced, partly in own hands, completely in own hands.

- *H11: The higher the influence of the leasing corporation is, the lower the chance is that the combination vehicle attributes is moving towards clean-fuel vehicles.*

Municipalities differ from each other (Metatopos, 2012). Some of these differences can influence the choice for clean-fuel vehicles. For municipalities, two characteristics were used in this study. The first characteristic is the size of the population of the municipality. Municipalities with more inhabitants will have larger car fleets. Therefore, it is easier to start adopting a few clean-air vehicles to start with. The size of the population will be divided over three categories: 0-25.000 inhabitants, 25.000-50.000 inhabitants and over 50.000 inhabitants. In this way, there is a distinction between small, medium and large municipalities. There are respectively 204, 140 and 71 municipalities in the categories.

- *H12: The higher the number of inhabitants is, the higher the chance is that the combination vehicle attributes is moving towards clean-fuel vehicles.*

The second characteristic is the area size of the municipality. Larger municipalities will possibly be more reluctant to vehicles with short ranges. The area size is divided over three categories: 0-60 km2, 60-120 km2 and over 120 km2. In this way the categories are almost the same size as the categories of the population size: 202, 131 and 82 municipalities.

- *H13: The bigger the area size is, the lower the chance is that vehicles with a lower range, higher refuel/recharge time and lower availability of fuel is chosen as best option*

The final two questions concern air or noise problems due to traffic that are encountered by municipalities. In order to reduce these problems municipality will adopt clean-fuel vehicles quicker. Both characteristics can have a score of yes or no. It is expected that municipalities with air problems tend towards vehicles with lower local emission, because a lower emission can partly solve these problems. Municipalities with noise problems would tend more in the direction of BEV's and FCV's, because these vehicles produce less sound than ICE vehicles and BICV's.

- *H14: Municipalities with air problems will have a higher chance on choosing for vehicles with lower local emission.*
- *H15: Municipalities with noise problems have a higher chance on choosing attribute combinations that tend towards BEV's and FCV's.*

Finally, all DLA's were asked to rank their own DLA in the three ways described by Egmond (2006). To determine the adoption category, Egmond describes three different items for housing corporations that can be combined to one single score for each DLA. These items were transcribed towards DLA's. DLA's that rank themselves higher than others are more likely to adopt clean-fuel vehicles.

- *H16: DLA's with a higher ranking have a higher chance of choosing combination of vehicle attributes that tend towards clean-fuel vehicles.*

The first item is about the attitude that DLA's have towards purchasing clean-fuel vehicles comparing to other DLA's. The possible answers for this question are: (0) other DLA's are more positive than the own DLA, (1) other DLA's have an equal attitude towards purchasing clean-fuel vehicles compared to the own DLA, (2) other DLA's are more negative than the own DLA.

The second item is about the speed with which decisions about purchasing clean-fuel vehicles are made. DLA's were asked if they see themselves as: (0) a laggard, (1) a trend follower, (2) a trendsetter.

Finally, DLA's were asked if the DLA thinks they have a higher ambition level towards purchasing clean-fuel vehicles. Possible answers are (0) lower than others, (1) higher than others (table 1).

The scores for these three attributes are added to give an overall score of how the DLA rate itself concerning clean-fuel vehicles. This will give a categorization that follows Rogers's adoption of innovation model. A total score of 0 or 1 shows that the DLA sees itself having a low adoption speed or being a laggard. A score of 2 shows that the DLA thinks it has an average adoption rate and can be placed in the late majority. A score of 3 point shows that the DLA sees itself having an adoption rate that is higher than average. These DLA's can be placed in the early majority. A score of 4 or 5 shows that the DLA has a very fast adoption rate and therefore the DLA sees itself as an innovator or early adopter (Egmond, 2006). DLA's that score higher on this scale would more likely tend towards purchasing clean-fuel vehicles. Therefore, their choices would tend more towards combinations of vehicle attributes that represent clean-fuel vehicles.

Item	**Possible outcomes**
Attitude towards purchasing clean-fuel vehicles	0. less positive than others 1. equal to others 2. more positive than others
Decision speed	0. laggard 1. trend follower 2. trendsetter
Ambition level	0. lower than others 1. higher than others

Table 1: Own ranking

To determine the reliability of this ranking, a Cronbach's α test is performed. The Cronbach's α for this ranking is 0,784. A minimum score of 0,7 is needed in order to have a reliable ranking. Therefore, this ranking will be used in this thesis.

3. Method

3.1 Sample and data collection

A survey was constructed based upon the attributes and values for these attributes. The first part of the survey started with a short introduction. The respondent was asked to imagine that the DLA has to acquire a new vehicle in the next few years. The exterior and interior will be the same for every vehicle. There is even no difference in brands. This is in order to remove the influence of image of a certain brand. The differences exist only in drive train and these differences were defined by the attributes in the choice. The survey consisted of nine choice sets. Each choice set consisted of four alternatives. These alternatives were not labeled, to make sure that there would be no influence because of the label itself (Huybers, 2004). The different attributes were explained clearly with an example. This example can be found in appendix 1. The respondent had to choose the vehicle that the DLA would acquire most likely based on the attributes. In other words, the DLA had to choose the best option for them. The respondent also had to choose the vehicle that the DLA would acquire least likely, or in other words the worst alternative. This gives extra insights in the influence of the attributes and the demand of the DLA's (Finn & Louviere, 1992; Marley & Louviere, 2005).
Besides these choice tasks, each DLA was given one special task. In this task, the four alternatives did have a label and the scores for the attributes were given by the actual scores for each alternative in nowadays market. In this way, insights are gained into what DLA's would choose for in present market.

The second part of the survey consisted of questions about the DLA characteristics. These characteristics are explained in chapter 2.5. As an addition questions were asked if the DLA already drives one or more of the clean-air vehicles, how many of these vehicles they drive, what technology the car uses and how they experience driving these vehicles. A summary of the vehicle attributes and DLA characteristics can be found in table 2. Table 3 shows the municipality characteristics used in this study.

Attribute	**Units**	**Used Values**
Initial purchase price	% of an ICE	100%, 125%, 150%, 200%
Fuel price	Price per 100 km	€5,-, €8,-, €12,-
Range	Km	100km, 400km, 600km
Time to refuel/recharge	Hours +Minutes	5 minutes, 30 minutes, 8 hours
Availability of fuel	% of ICE	0%, 25%, 50%, 100%
Local Emission	Amount of local emission compared to ICE	Zero Emission, 50% less than ICE, Same as ICE
Average distance driven per day	Km driven per day	km
Fleet management	Level of outsourcing	Completely outsourced, Partly outsourced, Partly in own hands, Completely in own hands.

Table 2: Attribute and characteristics for all DLA's.

Characteristic	Units
Population size	0-25.000; 25.000-50.000; 50.000+ inhabitants
Area size	0-60; 60-120; 120+ km2
Noise problems	Yes/no
Air problems	Yes/no

Table 3: Municipality characteristics

The characteristics population size and area size were not included in the survey itself. Instead, the municipalities will be asked to name their own municipality in the survey. Using public data of the Statistics Netherlands Bureau the values for each municipality will be determined.

The survey was conducted by using the online survey software 'Qualtrics'[6]. In order to collect the contact details of the different DLA's an extensive search was held using both contact databases of NL Agency and official websites of the DLA's. On the official DLA websites, contact details were collected of policy makers in the field of sustainability, environmental issues, traffic and transport. Where these details were not available, the general contact details of the DLA were collected. When multiple contact details were found for the same DLA, all of these details were collected. In this way, a survey could be send to the same DLA more than one time, possibly increasing the overall response. The invitation for the survey was send to 657 e-mail addresses; 598 municipalities, 34 provinces and 25 RWA's. The link to the survey was used 128 times, which results in a response rate of 19,5%. Of these 128 responses, 82 were partly or completely filled in. The other 46 respondent did not fill in the survey at all. This gives a valid response rate of 12,5%. None of the DLA's filled in the survey more than once. Therefore, no double DLA's were used.

54 of the 82 responses were made by municipalities, 5 were made by provinces, 6 were made by RWA's and the other 17 were only filled in partly or did not answer the question about the type of DLA. The survey was not filled in evenly over the municipalities. When looking at population size, medium municipalities were overrepresented by 23 versus 10 and 13 responses for small and large municipalities. Looking at area size, the small municipalities were represented correctly but the large municipalities were overrepresented.
When looking at the air and noise problems due to road traffic, 13 municipalities answered that they do encounter air problems and 28 municipalities encounter noise problems.
Analyzing the results for the own ranking showed that 7 DLA's rank themselves as laggards, 5 DLA's as late majority, 12 as early majority and 31 DLA's think that they are early adopters.

3.2 Analysis

For the analysis IBM SPSS Statistics 20 was used. The data is analyzed using an Ordinal Logistic Model. Ordinal Logistic is a normal logistic model, where the dependent variable is ordinal (Cramer, 2003). While this study focuses on both the best as the worst choice, the outcome can be -1 (worst), 0 (not chosen) and 1 (best). While a 0 is better than a -1 and a 1 is even better, the outcomes of the dependent variable are in an order. Therefore the

[6] www.qualtrics.com

dependent variable is the choice the respondent makes. As independent variables or covariates, the vehicle attributes and the DLA characteristics are used. In this way, the preferences for the vehicle attributes and the differences between the DLA's are found. The independent variables of vehicle attributes were standardized. In this way, it is clear which attributes have the most influence on the choice.

4. Results

This chapter will discuss the results of this study. First the results of the analysis of the vehicle attributes will be given. Next, the results of the analysis of the DLA characteristics will be explained.

4.1 Main effects vehicle attributes

Table 4 shows the standardized results for the direct effects and for the direct effects combined with the interaction effects.

Table 4: Standardized results for direct and interaction effects.

	Direct Effects	Direct Effects + Interaction effects
IPP	-0,589***	-,0587***
Fuel price	-0,325***	-0,324***
Range	0,346***	0,350***
Time	-0,229***	-0,229***
Availability	0,330***	0,330***
Local Emission	-0,517***	-0,513***
IPP * Fuel Price		0,036
Range * Time		-0,008
Range * Availability		0,083
R^2	0,231	0,233
	DF=24, N=2252, Chi^2=1030,866	DF=27, N=2252, Chi^2=1030,072

* P<0,05
**p<0,01
***p<0,0001

As can be seen in table 4, all six vehicle attributes appear to be significant (p<0,001). Initial purchase price, fuel price, time to refuel/recharge and local emission all have a negative influence on the choice for a new vehicle. The attributes range and availability of fuel both have a positive effect on the choice for a new vehicle. These results confirm hypothesis H1 to H6.

The estimates for the standardized attributes show that initial purchase price is the most important attribute experienced by DLA's, with a parameter of -0,589. Local emission is set second with a parameter of -0,517. The next three attributes, range, fuel price and availability of fuel, all lie close to each other. Their parameters are respectively 0,346, -0,325 and 0,330. The time to refuel/recharge is experienced as the least important, with a parameter of -0,229.

Table 4 also shows that the Nagelkerke pseudo R-square of this model has a score of 0,231. This means that the used model performs well.

Furthermore, the results showed that the place of the car in the survey is of influence on the choice. Car one is chosen most, car two comes in second place, car three in third place and car four in fourth place. On the other hand, adding the variable car only adds 0,01 to the Nagelkerke pseudo R-Square. Therefore, this influence is negligible and controlled for.

Adding the three expected interaction effects showed that these effects did not have a significant influence on the choice for a new vehicle. Therefore, hypotheses H7 to H9 can not be confirmed and are rejected.

4.2 DLA characteristics

In this part, the results of the analysis of each of the DLA characteristics will be explained. First, the DLA-wide characteristics will be showed. Next, the differences between municipalities will be explained.

4.2.1 Differences between different types of DLA

Table 5 shows the results of adding the type of DLA to the analysis. The attributes for municipality and province are compared with RWA's. Therefore, these results show what the differences are between municipalities, provinces and RWA's.

Table 5: Standardized results for direct effects for differences between DLA types.

	Direct effects + DLA types
IPP	-,0576***
Fuel Price	-0,159
Range	0,704***
Time	-0,399*
Availability	0,099
Local emission	-0,148
IPP for municipality	-0,059
IPP for province	0,085
Fuel price for municipality	-0,227
Fuel price for province	-0,076
Range for municipality	-0,384*
Range for province	-0,237
Time for municipality	0,112
Time for province	0,230
Availability for municipality	0,247
Availability for province	0,298
Local emission for municipality	-0,427**
Local emission for province	-0,543*
R^2	0,255
	DF=36, n=2252, Chi^2=1528,215

* P<0,05
**p<0,01
***p<0,0001

As can be seen in the table, the attributes range for municipalities and Local Emission for both municipalities and provinces were found significant. The results show that municipalities are less influenced by the range of a vehicle than RWA's, because the parameter is -0,384. This is logical, while municipalities are smaller than RWA's and therefore the range of vehicles is less of a problem.

The attribute local emission is stated as more important by municipalities and provinces. Provinces are even more influenced by local emission than municipalities. These results are again logical. Municipalities and provinces have the task to take care of air quality in their own region.

The vehicle attributes fuel price, availability of fuel and local emission are not found significant after adding the characteristic of DLA type.

Table 6 shows the results for the DLA characteristics of daily distance and fleet management.

Table 6: Standardized results for direct effects for daily distance and Fleet management

	Direct effects for daily distance		Direct effects for Fleet management
IPP	-0,593***	IPP	-,0582***
Fuel price	-0,373***	Fuel price	-0,380***
Range	0,329***	Range	0,341***
Time	-0,181***	Time	-0,096
Availability	0,367***	Availability	0,366***
Local emission	-0,565***	Local emission	-0,546***
IPP * distance	0,0002	IPP * Fleet Management	-0,018
Fuel price * distance	0,002	Fuel price * Fleet management	0,018
Range * distance	0,001	Range * Fleet management	0,006
Time * distance	-0,002	Time * Fleet management	-0,086
Availability * distance	-0,001	Availability * Fleet management	-0,021
Local emission * distance	0,002	Local emission * Fleet management	0,002
R^2	0,237	R^2	0,249
	DF=30, N=2252, Chi^2=2319,180		DF=30, N=2252, Chi^2=1943,622

* P<0,05
**p<0,01
***p<0,0001

Analyzing the results for the DLA characteristic daily distance shows that no interaction between the attributes and the daily distance is significant (table 6). Therefore, H10 is rejected.

Adding the influence of leasing corporations resulted in no significant relationships. Therefore, H11 can be rejected. There is no proof of any influence of leasing corporations on the choice for certain vehicles.

4.2.2 Differences between Municipalities

Table 7 shows the results for both the population size and the area size.

Table 7: Standardized results for direct effects for population and area size.

	Direct effects + population		Direct effects + area
IPP	-0,598***	IPP	-0,848***
Fuel Price	-0,349***	Fuel Price	-0,373***
Range	0,360***	Range	0,202*
Time	-0,255**	Time	-0,241**
Availability	0,333***	Availability	0,286**
Local emission	-0,975***	Local emission	-0,599***
IPP for small	-0,046	IPP for small	0,193
IPP for medium	-0,149	IPP for medium	0,245
Fuel price for small	-0,050	Fuel price for small	-0,119
Fuel price for medium	-0,158	Fuel price for medium	-0,127
Range for small	-0,030	Range for small	0,204
Range for medium	-0,109	Range for medium	-0,021
Time for small	0,123	Time for small	0,037
Time for medium	0,042	Time for medium	0,054
Availability for small	0,285*	Availability for small	0,063
Availability for medium	-0,040	Availability for medium	0,312*
Local emission for small	0,399**	Local emission for small	0,086
Local emission for medium	0,578***	Local emission for medium	-0,166
R^2	0,295	R^2	0,294
	DF=36, N=2252, Chi^2=1667,496		DF=36, N=2252, Chi^2=1793,480

* P<0,05
**p<0,01
***p<0,0001

A population score of small is for municipalities with a maximum of 25.000 inhabitants, a medium score stands for municipalities with 25.000 to 50.000 inhabitants. The interactions are compared to municipalities with more than 50.000 inhabitants. As can be seen in the table, municipalities with a low amount of inhabitants are influenced more by the availability of fuel than municipalities with more inhabitants. The other significant relationship is between local emission and population size. Municipalities with medium amount of inhabitants are less influenced by local emission than large municipalities. Small municipalities are placed in between medium and large municipalities. The direct effect is even increased, compared to the direct effect only model. These results are again logical. Municipalities with a higher number of inhabitants tend more towards vehicles with lower emission. They are able to acquire vehicles with lower local emission. These results show that

H12 can partly be confirmed. Municipalities with a high number of inhabitants are more influenced by the local emission of vehicles.

Table 7 also shows the results for the analysis of municipality area size. Again, a score of small reflects small municipalities, a medium relates to medium sized municipalities. The interactions are again compared to large municipalities in area size. As can be seen in the table, only one significant relationship is found. Medium sized municipalities are more influenced by the availability of fuel than large municipalities. This is in contrast with H13. This hypothesis stated that larger the municipality is, the more they are influenced by availability of fuel. The other expected results were not found significant. Therefore, H13 can be rejected.

Table 8 shows the results for both the air and the noise problems of municipalities.

Table 8: Standardized results for direct effects for air and noise problems.

	Direct Effects + air problems		Direct Effects + noise problems
IPP	-0,625***	IPP	-0,649***
Fuel price	-0,390***	Fuel price	-0,532***
Range	0,293***	Range	0,112
Time	-0,216***	Time	-0,259**
Availability	0,317***	Availability	0,337***
Local Emission	-0,590***	Local Emission	-0,451***
Local emission for air	-0,030	IPP for noise	0,034
		Fuel price for noise	0,230*
		Range for noise	0,294**
		Time for noise	0,074
		Availability for noise	-0,024
		Local emission for noise	-0,241*
R^2	0,256	R^2	0,267
	DF=25, N=2252, Chi^2=1713,844		DF=30, N=2252, Chi^2=1678,191

* P<0,05
**p<0,01
***p<0,0001

Analyzing the results for the DLA characteristic of air pollution experienced by municipalities showed that no significant relationship is found between air pollution and local emission of vehicles. Therefore, H14 can be rejected.

Analyzing the results for the noise pollution in municipalities shows some other results. As can be seen in table 8, municipalities with noise problems are less influenced by fuel price and more influenced by range and local emission than municipalities without these problems. DLA's with noise problems are influenced less by fuel price. Lower fuel prices are distinctive for BEV's and FCV's, compared to ICE. On the other hand, DLA's with noise problems are more reluctant towards choosing for vehicles with shorter range and higher local emission. Because of the higher influence of range, these municipalities are more reluctant towards choosing BEV’s. While FCV’s have a higher score for range, the DLA’s would tend more towards this technology. On the other hand, local emission is more of a problem for these municipalities. These results show that municipalities with noise problems are less reluctant towards choosing FCV’s. Therefore, H15 can partly be confirmed.

4.2.3 Own Ranking

Table 9 shows the results for the analysis of the influence of the own ranking on the choice.

Table 9: Standardized results for direct effects for own ranking.

	Direct effects + own ranking
IPP	-0,739***
Fuel price	-0,044
Range	0,245*
Time	-0,294**
Availability	0,390***
Local Emission	-0,329**
IPP for own ranking	0,054
Range for own ranking	-0,141***
Time for own ranking	0,023
Availability for own ranking	-0,033
Local emission for own ranking	-0,113**
R^2	0,259
	DF=30, N=2252, Chi^2=2228,906

* P<0,05
**p<0,01
***p<0,0001

As can be seen in the table, there is a significant relationship between the own ranking and the attributes range and local emission. The results show that range is less of a problem for DLA’s that rank themselves as early adopter. Also, it shows that local emission is more of a problem for DLA’s with a high own ranking. In other words, DLA’s that rank themselves lower will choose vehicles with higher scores for range and lower scores for local emission. These results are according to H16. Therefore, H16 can be confirmed.

4.2.4 Present market

The analysis for the present market only shows how often each of the alternatives is chosen for by the different DLA’s. As the best choice, 11 DLA’s chose for ICE, 22 DLA chose for BEV and 33 DLA’s chose for BICV. FCV were not once chosen as the best alternative by any of the DLA’s.

When analyzing the data for the worst choice in present technology, The FCV was most often chosen, 43 times. The ICE was second with 18 choices and the BEV was chosen 5 times. The BICV was not chosen by any of the DLA’s as the worst alternative.

Combining these results show that there actually is an order in alternatives chosen by DLA’s. The best vehicle according to the DLA’s is the BICV, second place is for the BEV, third place is for ICE and finally last place is for FCV. When looking at the actual owned vehicles, some differences are found. The most owned fuel technology is still the ICE. The respondent DLA's together own 1957 ICE vehicles. On the second place, the BEV comes with a total of 226. The DLA's own 189 BICV's. Finally the province of Arnhem own one FCV vehicle. As can be seen with these numbers, DLA's still own a large number of traditional ICE vehicles. On the other hand, some numbers of clean-fuel vehicles are already purchased by these DLA's.

Unfortunately, due to differences in values between the nine unlabeled choice tasks and the single labeled choice task, the differences between labeled and unlabeled choices can not be analyzed.

5. Conclusion and discussion

First, an answer on the research question will be given. Next, the limitations of this study will be discussed. Finally, the theoretical implications and policy recommendations will be given based upon the results

5.1 Conclusion

The research question of this thesis was: *What is the influence of service attributes of different types of clean-fuel vehicle alternatives on the demand of these vehicles by Dutch Local Authorities?*

The results showed that the six proposed hypotheses about the vehicle attributes were all found significant. The choice for clean fuel vehicles by DLA's is positively influenced by range and availability of the fuel. The other four attributes, initial purchase price, fuel price, time to refuel/recharge and local emission were found negatively significant.

The attributes initial purchase price and local emission were found most influencing the choice for a new vehicle. Time to refuel/recharge was found least influencing. This result is possible, because DLA's can plan their trips much better. When they would choose for BEV's they can plan the charging outside office hours. The other three attributes lie close to each other.

These results show that DLA's are still reluctant to adopt clean-fuel vehicles. On the other hand, the results showed that choosing between the different clean-fuel options, BICV is a serious candidate.

Next to vehicle attributes, differences between the DLA's were tried to be found. Some of these characteristics were found significant. First, a higher influence of local emission was found for provinces and municipalities than for RWA's. This is an expected result, while RWA's are not responsible for air quality within their working region and municipalities and provinces are.

Next, municipalities with noise problems due to road traffic are influenced less by fuel price but more by local emission and range than municipalities without these problems. These results are partly in accordance with the stated hypothesis and partly in contrast with the hypothesis that municipalities with noise problems focus more on BEV's and FCV's. Due to the higher influence of local emission and range and the lower influence of fuel price, DLA's with noise problems tend more towards FCV's.

5.2 Limitations

The first limitation of this study is the number of respondents, especially in the groups of provinces and RWA's. Therefore, no real differences can be explained between the different types of DLA's. Another problem with these types of surveys is that DLA's that are interested in the topic of clean-fuel vehicles are more attracted by surveys concerning this topic. Therefore, DLA's that are no interested in clean-fuel vehicles would probably not fill in the survey at all. This can give a biased result.

Next, the used attributes may not be the main point of influence for DLA's. Attributes like image, brand and connection with brands in previous acquisitions are likely to have influence on the acquisition of new vehicles. In addition, this research did not focus on the way DLA's decide about vehicle acquisitions. Also, decision makers can be focused more on the total cost of ownership instead of initial purchase price and fuel price. Further research could be aimed at investigating the way DLA's decide about acquisition and how this affects the decision for clean-fuel vehicles.

An assumption that can not be neglected in the clean-fuel vehicle market is the availability of these vehicles. At this moment, only a few car manufacturers offer BEV's and BICV's and FCV's are even not available at all. Therefore, DLA's would keep these vehicles in mind when making the choice tasks. Especially the labeled tasks can be influenced by the present availability of vehicles.

5.3 Theoretical implications and policy recommendations

This research showed that a DCE can be used to research the preferences for local governments. Even though these institutions are different than normal customers, the results showed that DLA's are influenced by vehicle attributes that previous studies have showed to be of influence on the choice for clean-fuel vehicles by normal costumers.

The results showed that initial purchase price and local emission were the most influencing attribute. Therefore, policy based upon these attributes could have the best results on improving the adoption of clean fuel vehicles by DLA's. In order to improve the adoption of clean fuel vehicles by these DLA's the initial purchase price of clean-fuel vehicles could be improved. While the attribute score for local emission for clean-fuel vehicles is already lower than for ICE, clean-fuel vehicles are already in advantage above ICE.

Next, the most influencing attributes are range, fuel price and availability of fuel. Therefore, research on increasing the range of vehicles could be stimulated by the Dutch central government in order to improve the adoption by DLA's. Policy could also be aimed at knowledge transfer. Next, policy could also be aimed at lowering fuel prices for clean-fuel vehicles. In this way, these vehicles can get more attractive for DLA's. Policy on improving the availability of these fuels can help creating a network of filling/charging station. While refuel/recharge time was also found significant, the focus for implementing BEV's could also be at the charging infrastructure. Especially for the adoption of BEV's this could help. DLA's are more reluctant towards slow charging of BEV's. Therefore, a network of fast chargers could stimulate the adoption of BEV's by DLA's.

The last few years, focus has been mainly on the introduction of BEV's. Policy has also been aimed at this technology. The results of this study show that BICV's appear to be chosen more by DLA's. Therefore, this technology can not be forgotten.

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Appendix 1: Example question

Choose from the next 4 alternatives the vehicle that your authority would purchase most likely and choose the vehicle that your authority would purchase least likely.

	Car 1	Car 2	Car 3	Car 4
Initial purchase price	100%	100%	125%	200%
Fuel price per 100 kilometer	€ 8,-	€ 5,-	€ 8,-	€ 5,-
Range	400 km	400 km	400 km	400 km
Refuel/recharge time	5 minutes	5 minutes	8 hours	30 minutes
Availability of the fuel	0%	100%	0%	25%
Local emission	Zero	50% less than ICE	Zero	Same as ICE

Most Likely	☐	☐	☐	☐
Least Likely	☐	☐	☐	☐