July 2002 ECN-C--02-080

PERFORMANCE AND ACCEPTANCE OF ELECTRIC AND HYBRID VEHICLES

Determination of attitude shifts and energy consumption of electric and hybrid vehicles used in the ELCIDIS project

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Acknowledgement

This study has been carried out as part of the 'Electric Vehicle City Distribution'-project (ELCIDIS) (TR 0048/97). This project is co-ordinated by the Municipality of Rotterdam. The ECN project number was 7.7179.

Summary

The goal of the ELCIDIS project (*El*ectric Vehicle *Ci*ty *Dis*tribution Systems) is to demonstrate the suitability of clean and silent hybrid and electric vehicles in urban distribution activities. This is done by means of practical demonstrations in six European cities. These demonstration projects include setting up an electric vehicle based goods distribution system and assessment of the efficiency and environmental impact of the electric and hybrid vehicles. The contribution of the Energy Research Centre of the Netherlands (ECN) existed of two tasks:

1) Measurement and analyses of (shifts in) opinion about the use of and opportunities for electric and hybrid vehicles.
2) Analyses of energy consumption of the electric and hybrid vehicles used in the ELCIDIS project.

Two questionnaires have been developed. The first questionnaire had to be filled in before the vehicles were put into operation. The second questionnaire was repeated every couple of months during the period of operation of the vehicle, in order to be able to observe shifts in attitude and preferences. When comparing the expected performance (first questionnaire) with the actual performance (second questionnaire), it was found that for most aspects the actual performance is lower than the expected performance (so the vehicles are performing less well than expected). Largest differences (decrease) between expected performances and actual performance were found for 'energy use', 'suitable for our organisation', 'safety'. The most important drawbacks of electric and hybrid vehicles mentioned were 'radius of action' and 'power of the engine'.

During the project, some of the vehicles have covered large distances. The three electric vehicles in Stockholm drove over 13.000 km during the project. The maximum distance driven on one single day ranged from 39 to 84 km for these vehicles. The vehicles in Stockholm use more energy per km (0.55 ± 0.06) in comparison to comparable vehicles in Lombardia (0.35 ± 0.02) and Stavanger (0.31 ± 0.02). The differences in specific energy consumption cannot be explained by means of differences in average trip length of driving style.

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1. INTRODUCTION

The goal of the of the ELCIDIS project, *El*ectric Vehicle *Ci*ty *Dis*tribution Systems, is to prove the suitability of clean and silent hybrid and electric vehicles in urban distribution activities. This is done by means of practical demonstrations in six European cities. These demonstration projects include setting up an electric vehicle based goods distribution system and assessment of the efficiency and environmental impact of the electric and hybrid vehicles. The participants in ELCIDIS are, Rotterdam as project co-ordinator, Stockholm, La Rochelle, Erlangen, Regione Lombardia with the city of Milan, Stavanger and CITELEC, European Association of cities interested in electric vehicles.

The following objectives can be distinguished for the ELCIDIS project:

- To demonstrate the economic, technical and social viability of city distribution with electric vehicles.
- To analyse the environmental benefits of the deployment of electric vehicles for urban goods distribution.
- To gain insight in the technical specification of (hybrid) electric vehicles operating in urban distribution activities.
- To analyse the logistic efficiency of newly created urban distribution centres.
- To demonstrate the acceptance of urban distribution with (hybrid) electric vehicles by transport companies, shopkeepers, businesses, inhabitants and shoppers.

The contribution of ECN Policy Studies consists of the following two tasks:

1. analysis of energy effects of the vehicles used in ELCIDIS project,
2. analysis of aspects related to the social acceptance of the hybrid and electric vehicles.

In order to do so, the most part of the vehicles have been equipped with a so-called mobi-box system, an electronic data storage system. By means of these mobi-box systems, energy use, charging, number and length of trips, daily range, temperature of the battery as well as outdoor temperature is measured. ECN Policy Studies has developed questionnaires for drivers, mechanics, planners and fleet owners involved in the project. These questionnaires were supposed to be filled in before the electric vehicles are put into operation as well as during use.

In this report, the contribution of ECN Policy studies to the ELCIDIS project is described. In chapter two of this report, the results of the analysis of the questionnaires are given. In chapter three, the results of the analysis of the data as collected by means of the mobi-box system is shown.

2. VALUATION OF THE USE OF THE ELECTRIC AND HYBRID VEHICLES

2.1 Introduction

The succeeding of a transition from a conventional gasoline based urban transportation system towards a sustainable way of transportation, might depend on a quite number of critical factors. The substitution of conventional vehicles through electric and/or hybrid vehicles involves not only economical and environmental aspects, but aspects of social acceptance might be as relevant as i.e. the cost-effectiveness.

In order to determine possible barriers with respect to the valuation of electric and hybrid vehicles, two questionnaires have been developed. The questionnaires are supposed to be filled in by the critical actors, such as drivers, fleet owners and planners. The first questionnaire has to be filled in before the electric and hybrid vehicles are put into operation. The second questionnaire is supposed to be filled in every couple of months as soon as the vehicles are taken into service. By comparing the results of the first and the second questionnaire, a possible shift in the valuation of the vehicles as a result of the (first) experiences using the vehicles can be determined. The first questionnaire measures primary the expected judgement, which is in generally based on limited or even no relevant experience with electric or hybrid vehicles. The second questionnaire measures the appreciation at the time that the critical actors have had (at least) some actual experiences using the vehicles. This comparison might for instance indicate whether or not some of the critical actors are prejudiced (in either a positive of negative sense).

By comparing several samples of the second questionnaire filled in by the same respondent, shifts in time of the appreciation of the respondent during the actual use of the vehicles can be observed. I.e. in the first phase of the project, some initial technical problems could occur, which might influence the judgement negatively. However, when the system has overcome possible initial problems, one might expect a rise again in appreciation.

First, a short description of the contents is given (Section 2.2). Next, the score of questionnaire one (Section 2.3) and two are given (Section 2.4). Chapter 2 concludes with the general results that can be drawn from the comparison between the questionnaires.

2.2 The questionnaires

The first questionnaire, Q1, makes an inventory of expectations and experiences before the electric or hybrid vehicle is put in use. By means of questionnaire one, the following topics are addressed, see also Appendix A:

- The type of vehicle that is being used by the driver during working hours are asked (fuel type, opinion).
- The objectives of the ELCIDIS project (familiarity, importance).
- Past experiences with hybrid and electric vehicles.
- Expectation as well as the importance with respect to the performance of the electric or hybrid vehicle (i.e. reliability, energy consumption, noise, acceleration, etc.)
- General statements with respect to benefits and use of electric and hybrid vehicles. The respondent is asked to indicate whether or not they agree.

Part of the questions of questionnaire 1 are repeated in questionnaire 2 (Q2). In questionnaire 2, the following issues are addressed, see also Appendix A:

- Use of the electric and/or hybrid vehicle (duration, distance etc.).
- Valuation of the information received at the start of the ELCIDIS project.
- Valuation of the performance of the electric or hybrid vehicle (i.e. reliability, energy consumption, noise, acceleration, etc.) This question is almost identical to the question asked in Q1.
- General opinion about the ELCIDIS project.
- Technical issues (i.e. charging of batteries, reliability, comparison between vehicles, malfunctions).
- Comparison (benefit/drawback) of the electric or hybrid vehicle with a conventional vehicle.
- Possible improvements (technical, organisation).
- General statements with respect to benefits and use of electric and hybrid vehicles. This question is identical to the question asked in Q1.

As stated before, Q1 has to be filled in (only one time) before the electric or hybrid vehicle is put in use. Q2 has to be filled for the first time a couple of weeks after the electric or hybrid vehicle is put into use. From that time, Q2 is supposed to be filled in (about) every couple of months. Q2 is repeated a couple of times a year. Therefore, some of the drivers who make use of the electric or hybrid vehicle for a longer period (i.e. a year or more) have to fill in Q2 several times. In Table 2.1, the number of questionnaires received per city is given.

Table 2.1 *Number of questionnaires received per city*

City	Questionnaire 1	Questionnaire 2
Stavanger	17	25
Stockholm	20	28
La Rochelle	6	4
Region de Lombardia/Milan	8	20
Erlangen	18	22
Rotterdam	3	4
Total	72	103

2.3 Results of Questionnaire 1

When looking at the results of questionnaire 1, one should bear in mind that this questionnaire was filled before the electric and/or hybrid vehicle was put into use. Therefore, it deals with expectations rather than experiences.

2.3.1 Respondents

In Figure 2.1, the position at the job of the respondents of the first questionnaire is given. About 50% of the respondents were driver of the vehicle. About 20% of the questionnaires were filled in by fleet managers, 13% by ‘others’ and 11% by planners.

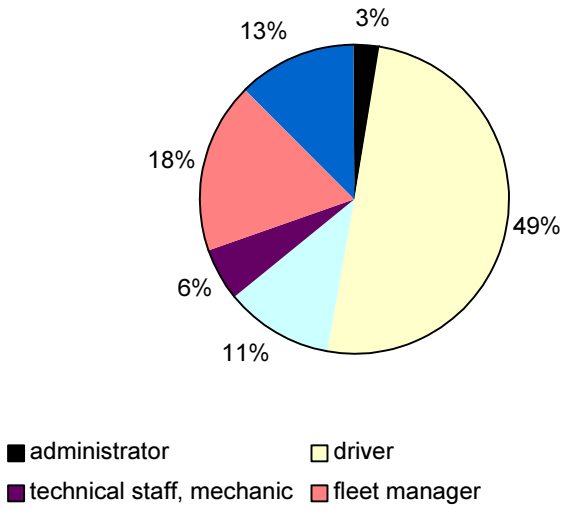

Figure 2.1 *Position at the job of the respondents of questionnaire 1 (n = 72)*

2.3.2 Objectives

In Figure 2.2, the average score for the relevance of the different objectives of the ELCIDIS project is given for the cities using electric vehicles. The objective 'more efficient distribution' has the lowest score for each city besides La Rochelle. This can be explained by the fact that in La Rochelle, as a result of the ELCIDIS project, a new distribution system was put into use. In the city of Milan, the objective 'environmental benefits' did score relatively high.

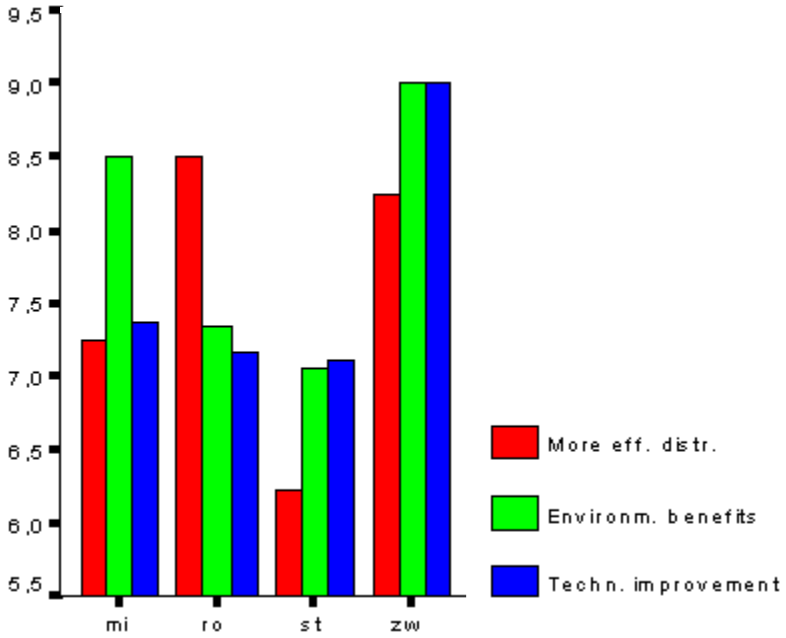

Figure 2.2 *Average value per city for three objectives of the ELCIDIS project for electric vehicles (mi = Region de Lombardia, Milan, ro = La Rochelle, st = Stavanger, zw = Stockholm)*

The average value for the objectives of the ELCIDIS project per participating company using electric vehicles is given in Figure B.1 of Appendix B.

The average score for the objectives of the ELCIDIS project for hybrid cars and trucks is shown in Figure 2.3. The objective 'more efficient distribution' was regarded to be the least important

objective. This can be explained by the fact that the basically the transportation system was unaltered for these cities. In comparison to the other objectives, 'environmental benefits' was considered more important for hybrid trucks than for hybrid cars.

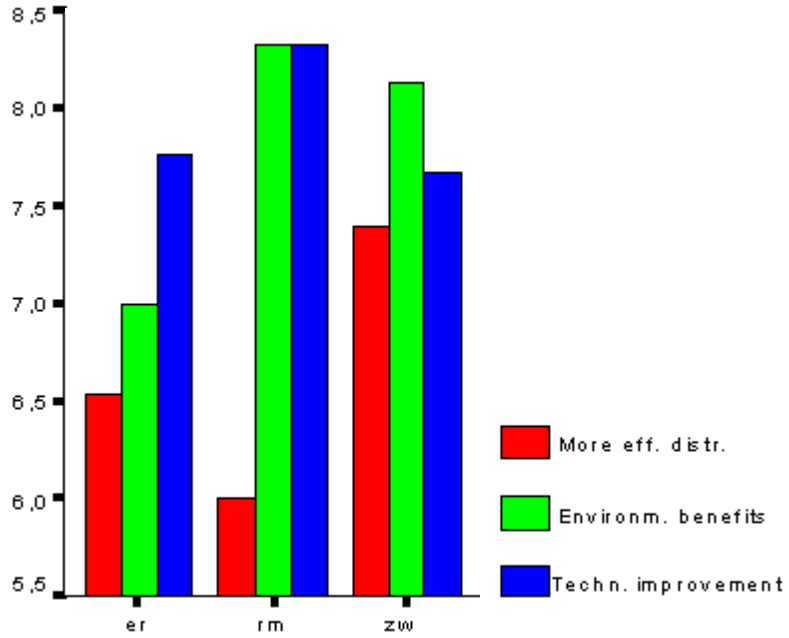

Figure 2.3 *Average value per city for three objectives of the ELCIDIS project for hybrid vehicles (er = Erlangen (hybrid vehicle), rm = Rotterdam (hybrid trucks), zw = Stockholm (hybrid trucks))*

2.3.3 Objectives of the project and expected performance

Next, it is investigated whether or not there exists a relationship between the average score for the objectives (relevancy) of the ELCIDIS report and the expected performance of the electric and hybrid vehicles, see Figure 2.4. The basic assumption is that a high score for the relevancy of the objectives goes together with high expectations with respect to the performance of the vehicles.

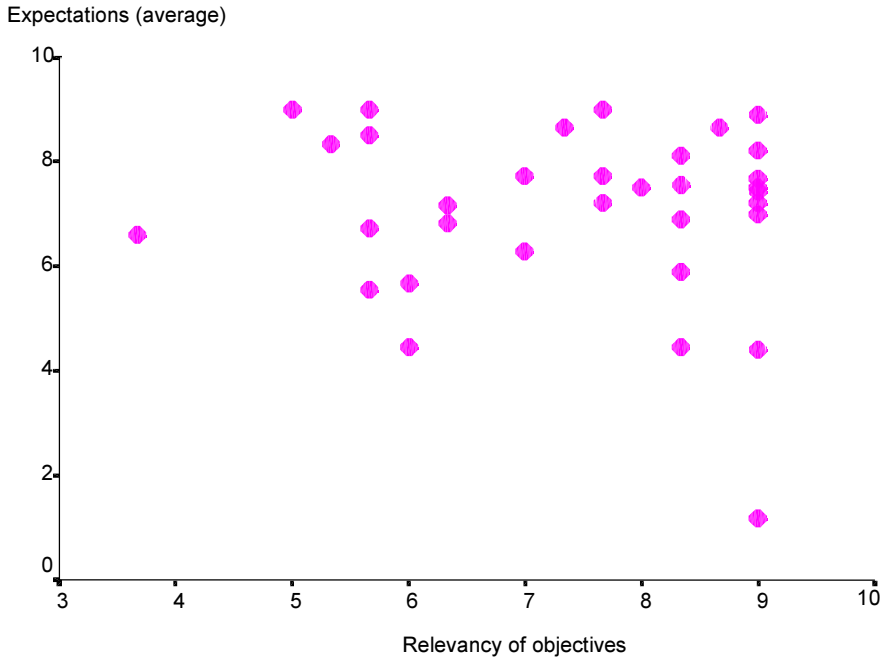

Figure 2.4 *Relevancy of the objectives of the ELCIDIS project vs. expected performance of electric vehicles*

When looking at Figure 2.4 - Figure 2.6, there is no statistical evidence for the existence of a relationship between the average score on the relevancy of the objectives of the ELCIDIS project and the expected performance of the electric and hybrid vehicles ($R^2 < 0.012$).

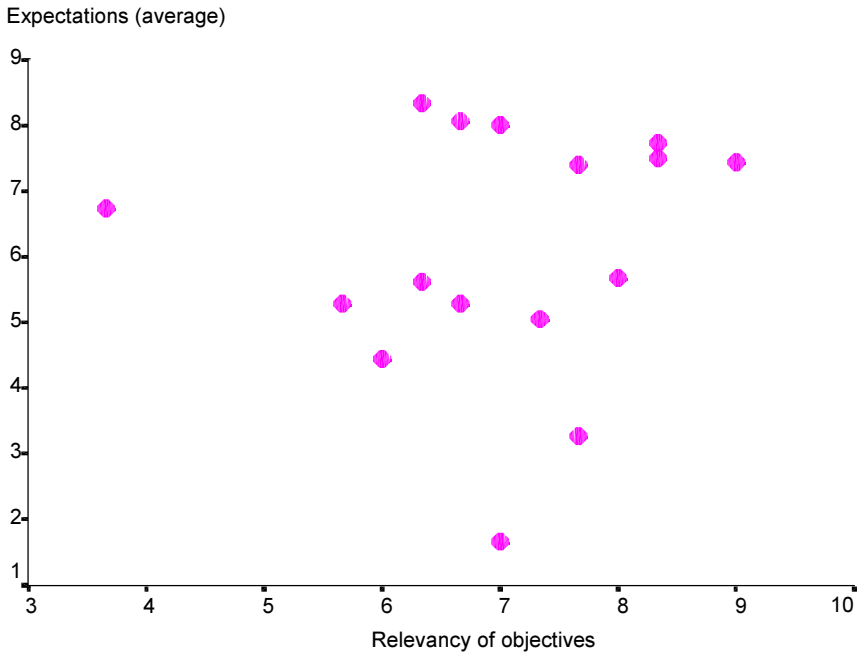

Figure 2.5 *Relevancy of the objectives of the ELCIDIS study vs. expected performance of hybrid cars*

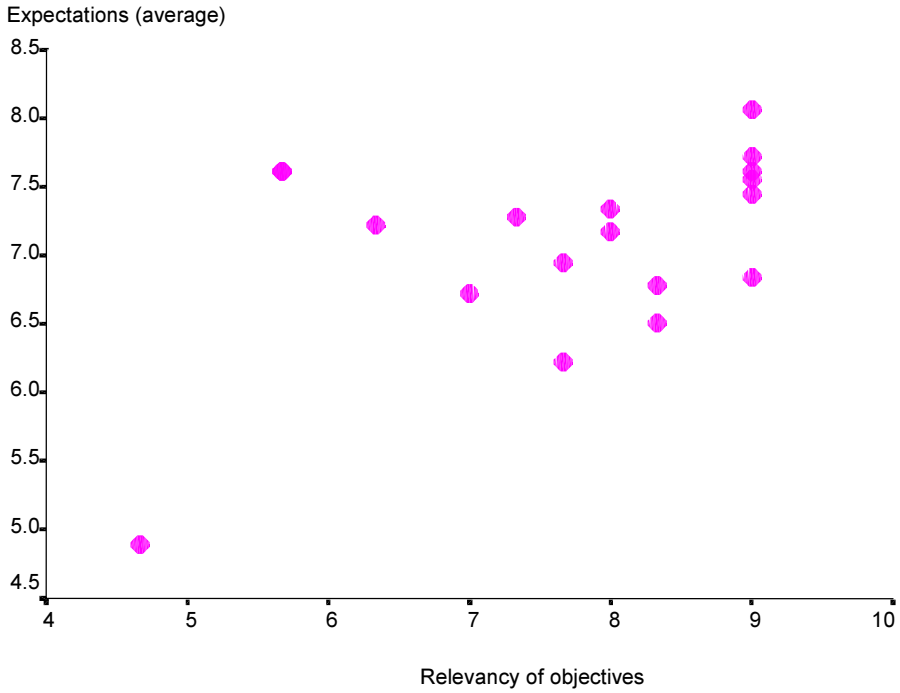

Figure 2.6 *Relevancy of the objectives of the ELCIDIS study vs. expected performance of hybrid trucks*

2.3.4 Importance and expectations of several aspects related to the use of the vehicles

In the first questionnaire, the respondents are asked to score several aspects related to the use of electric and hybrid vehicles on relevance and expectations. In Figure 2.7, the score for the importance as well as expectation for the different aspects is given for electric vehicles.

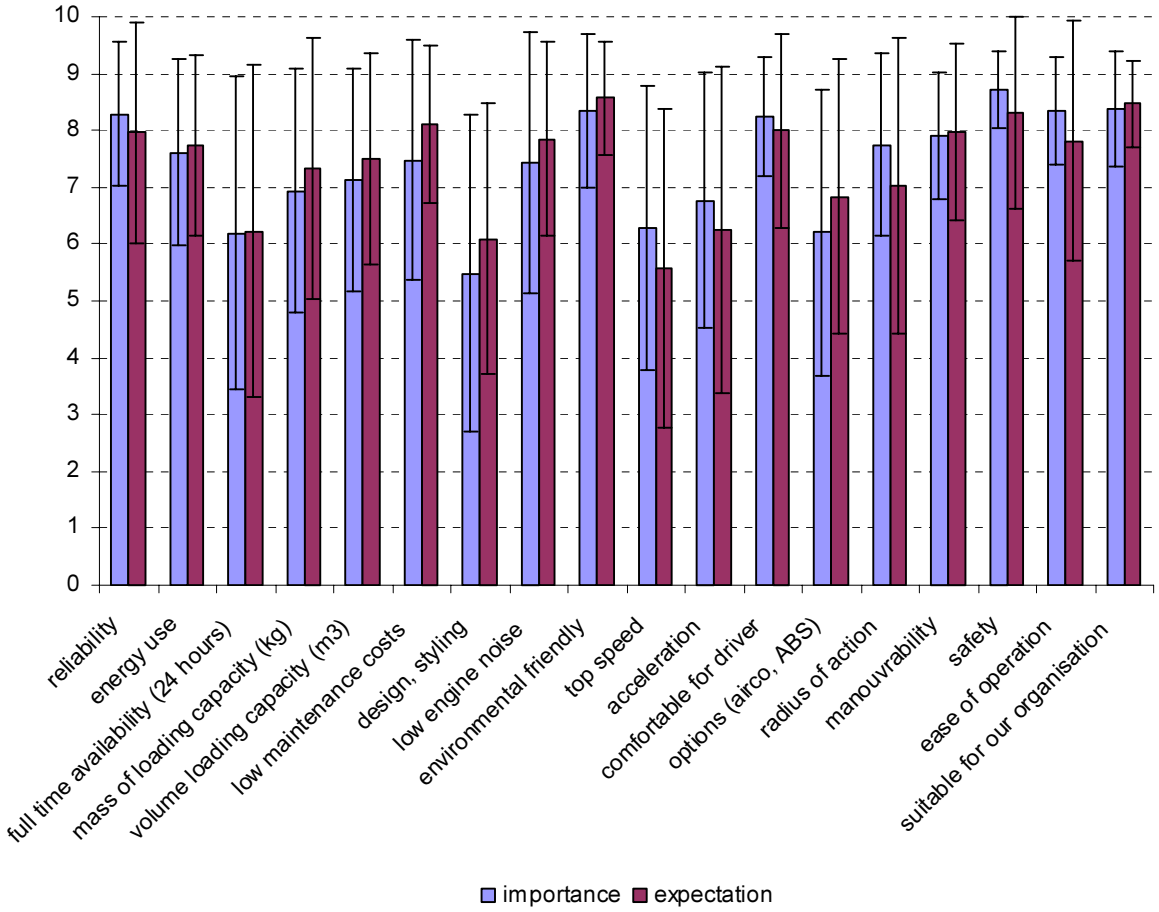

Figure 2.7 *Importance and expectations for several issues related to the use of electric vehicles*

There seems to be a striking resemblance for the score on relevance and expectations for the different aspects related to the use of the electric vehicle. This means that those aspects that are scored low on expectations are also considered being of less importance. Issues that are considered to be very important have also a high score on expected performance. This would suggest that, it is expected that the electric vehicles have no real weaknesses (high importance and low expectations). Highest score with respect to the importance of the different aspects are found for safety (8.7), suitable for our organisation (8.4), environmental friendly, reliability, ease of operation and comfortable for driver (8.3). These aspects have also the highest score on expectations. Aspects such as design and style (5.5) as well as full time availability (6.2) and options like airco and ABS (6.2) are considered to be the least important. These options also score lowest on expectations. The average score for both importance and expectations amounts to 7.4.

In Figure 2.8, the same graph is given for hybrid cars and trucks. Again, there seems to be a correlation between those aspects that are considered to be important and those aspects that are expected to perform well. Reliability (8.9), environmental friendly and safety (8.4) and ease of operation are considered to be the most important aspects with respect to the use of hybrid cars and trucks. The aspects reliability (8.0), environmental friendly (8.3) and safety (8.0) are also expected to perform well in practice. For ease of operation (7.3), the difference between the score relevance and expected performance is relative large (0.9). However, the largest gap between relevance and expected performance is found for radius of action (8.0 vs. 6.5), so on forehand, this aspect is identified as a possible weakness with respect to the use of hybrid cars and trucks.

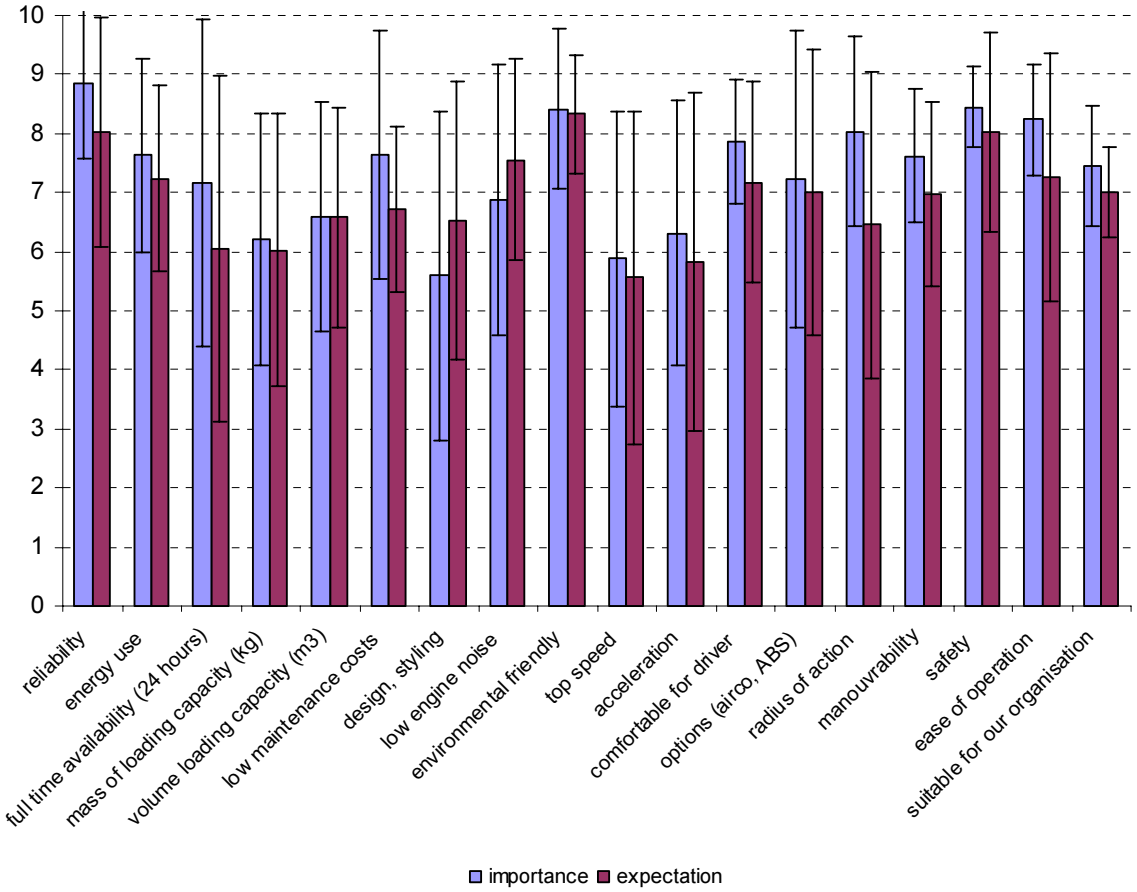

Figure 2.8 *Importance and expectations for several issues related to the use of hybrid cars and trucks*

Remarkably, 'suitable for our organisation' is considered to be less relevant for hybrid cars and trucks (7.4) in comparison to electric vehicles (8.4). This also yields for the expected suitability (7.0 vs. 8.5). On forehand, one would expect that this issue would be considered to be of the same relevance for electric vehicles and hybrid cars and trucks. The aspect 'options like airco and ABS is considered to be more relevant for hybrid cars and trucks (7.2) than for electric vehicles (6.2). This also yields for full time availability ((7.2) vs. (6.2)). The mass of loading capacity and low engine noise are considered to be of less importance for hybrid vehicles (6.2) than for electric vehicles (6.2 vs. 6.9 and 6.9 vs. 7.4).

With respect to the expected performance, largest differences between electric and hybrid vehicles are found for suitable for our organisation (EV: 8.5 hybrid: 7.0), low maintenance costs (EV: 8.1, hybrid: 6.7) and mass of loading capacity (EV: 7.3, hybrid: 6.0).

In order to investigate the existence of a correlation between expected performance and relevancy, the score for the different aspects are plotted in a graph, see Figure 2.9. Especially for the electric vehicles, there is evidence for the existence of such a relationship ($R^2 = 0.76$). This is less obvious for hybrid vehicles ($R^2 = 0.59$). The existence of this possible correlation could be just coincidental, but might also imply that people might have had problems answering the question.[1] Another possible explanation could be that 'wishful thinking' might have influenced the scores.[2]

[1] Perhaps the difference between relevance and expectancy was not understood well enough.
[2] If a certain aspect is considered to be very relevant, and the respondent wants the project to be a success (highly motivated), this issue has also have to have a good score on expected performance.

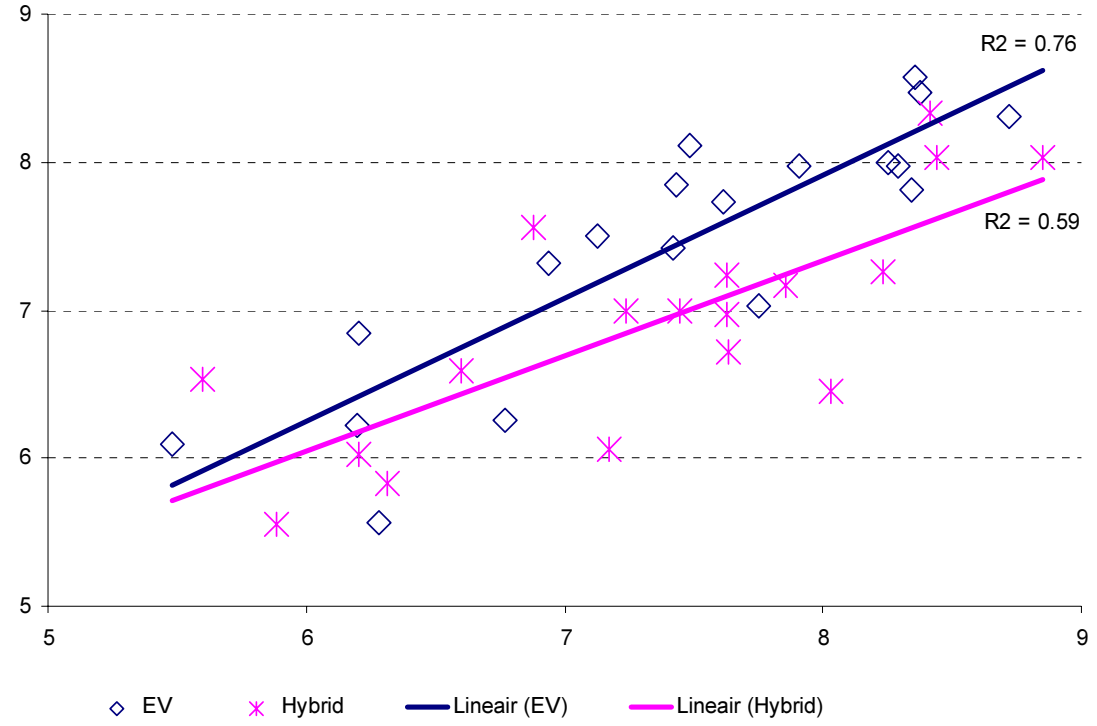

Figure 2.9 *Importance vs. expectations of several relevant aspects related to the use of electric and hybrid vehicles*

2.3.5 Statements

In the first questionnaire, some statements are included in order to make an inventory of the opinion about some general issues related to the prospects of electric and hybrid vehicles. The respondents are asked to give their opinion about the following statements (ranked A to N):

(A) *Electric* vehicles certainly have a future in urban goods distribution.
(B) Electric vehicles have no prospect without governmental support.
(C) Electric vehicles fit in easily in our organisation.
(D) Our town is very well suited for distribution of goods by means of electric vehicles.
(E) *Hybrid* vehicles certainly have a future in urban goods distribution.
(F) Hybrid vehicles have no prospect without governmental support.
(G) Hybrid vehicles fit in easily in our organisation.
(H) Our town is very well suited for distribution of goods by means of hybrid vehicles.
(I) It is very important that in our town more '*clean*' vehicles are deployed.
(J) It is very important that in our town more '*silent*' vehicles are deployed.
(K) I have high expectations for the ELCIDIS project in our town.
(L) Even if electric/hybrid transport turns out to be somewhat more expensive than conventional transport, it should still be preferred to conventional transport.
(M) I have high expectations of technological innovation in general.

The individual scores[3] on these statements are shown in Figure 2.10. High scores are given for (I) and (J), which dealt with the importance to use clean and silent vehicles. The respondents are also quite optimistic about technological innovation (M).

[3] Score from 1 – 10; 1 = I totally disagree, 10 = I totally agree.

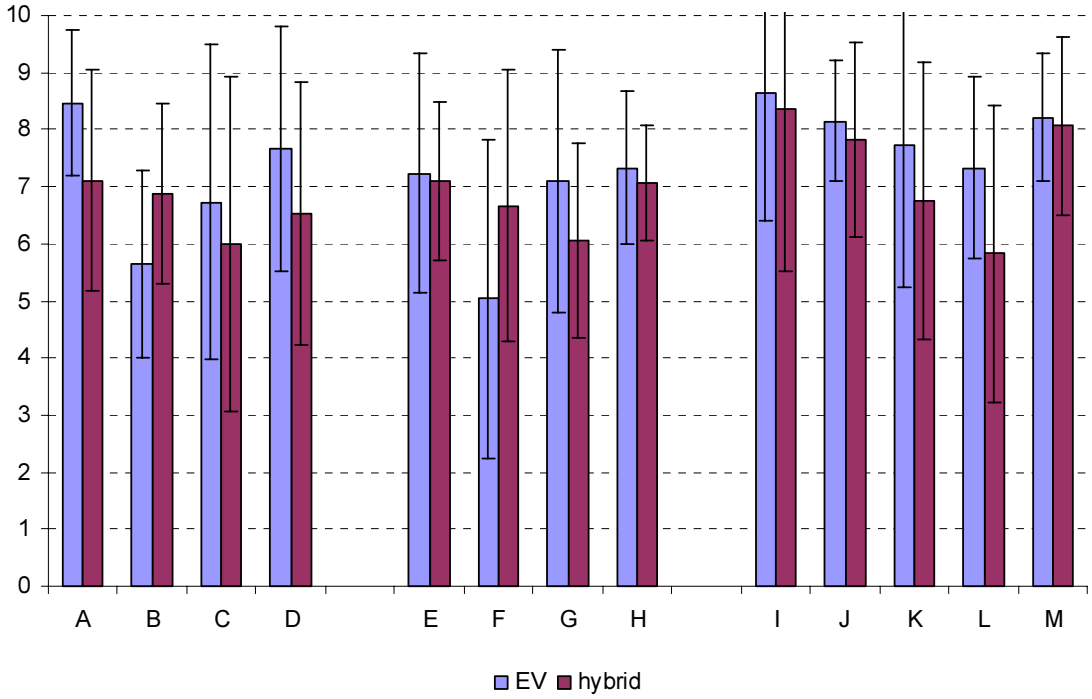

Figure 2.10 *Score*[3] *on different general statements regarding the prospects of electric and hybrid vehicles for respondents using electric vehicles and respondents using hybrid vehicles*

The respondents involved in using hybrid vehicles are more optimistic about the prospects of electric and hybrid vehicles without governmental support (issue (B) and (F)). For respondents involved in the use of hybrid vehicles, a relative low score is found for (L), 'preference of hybrid/electric vehicles even if they are a bit more expensive'.

2.4 Results of Questionnaire 2

The second questionnaire had to be answered every couple of months as soon as the vehicle was put into use. Part of the questions as given in the first questionnaire is repeated in questionnaire 2.

2.4.1 Respondents

In Figure 2.11, the position at the job of the respondents of the second questionnaire is given. Over 65% of the respondents were driver of the vehicle. About 13% of the questionnaires were filled in by 'others' and 8% by planners.

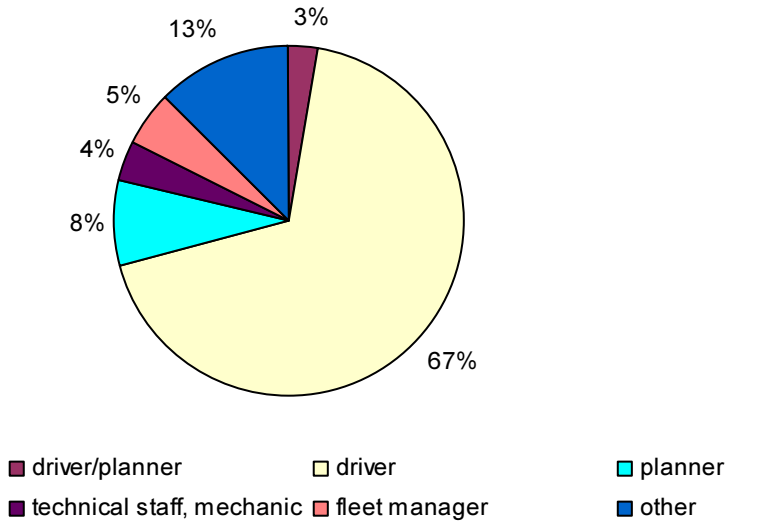

Figure 2.11 *Position at the job of the respondents of questionnaire 2 (n = 103)*

2.4.2 Information provided

In Figure 2.12 the way information was received of the ELCIDIS project is given. About one fifth of the respondents did not receive any information about the project. About 60% of the people who did receive information were informed about the project by means of face-to-face instructions (48% of the total). About 23% of the people who received information did obtain this by written information as well as face-to-face instructions.

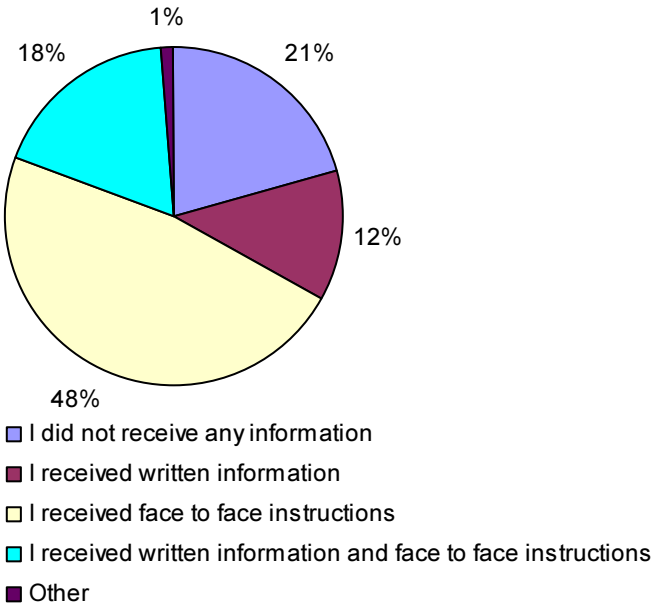

Figure 2.12 *Way of receiving information about the ELCIDIS project*

Next, the respondents are asked to indicate on what aspects more information is wanted, see Figure 2.13. This yields for a number of aspects, such as economic and environmental aspects, possibilities and limitations of the vehicle, energy consumption of the vehicle and the ELCIDIS project.

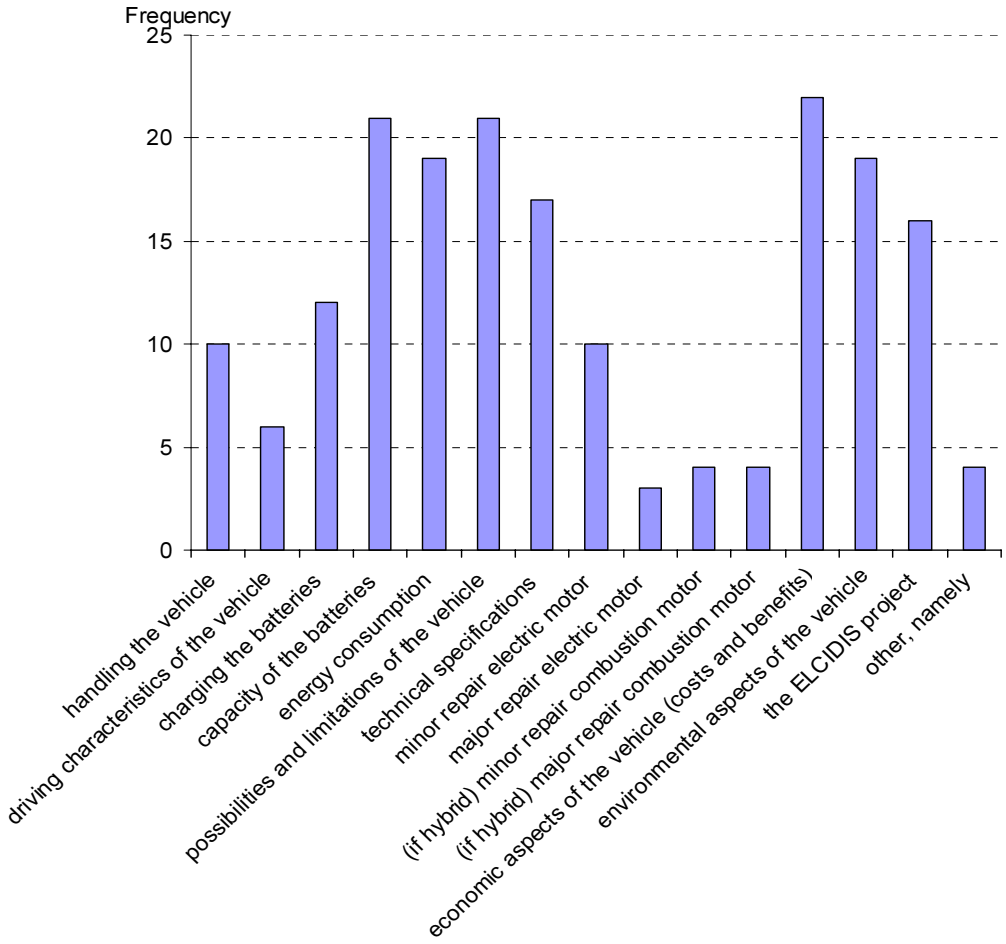

Figure 2.13 *Frequency of aspects on which more information is requested*

2.4.3 Experiences

In the first questionnaire, it is asked to score different aspects regarding the electric and hybrid vehicles on expected performance, see Section 2.3.4. This question is repeated in the second questionnaire. The results are shown in Figure 2.14. With respect to electric vehicles, highest scores are found for ‘environmental friendly’ (8.0), ‘comfortable for driver’ and ‘low maintenance costs’ (7.2). Remarkably, for hybrid vehicles the lowest score is given for ‘low maintenance costs’ (4.4), as well as for ‘mass of loading capacity’ (4.4). For electric vehicles, the aspects ‘options like airco and ABS’ (5.1), ‘full time availability’ (5.3) and ‘energy use’ (5.6) are rated relatively low. Highest score for hybrid vehicles is found for ‘environmental friendly’ (7.0).

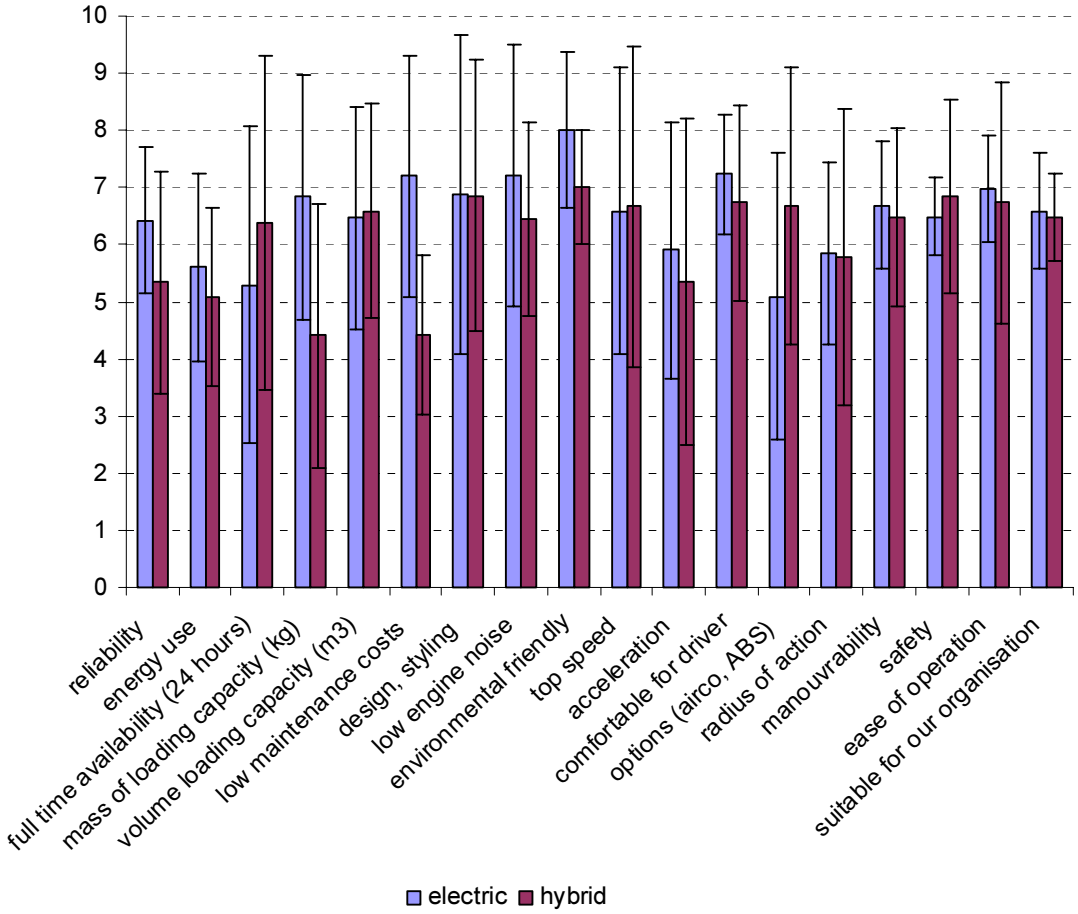

Figure 2.14 *Average score of different aspects of the actual performance of the electric vehicles*

If we compare the expected performance with the actual performance of the vehicles, it appears that for most aspects the actual performance is lower than the expected performance, see Figure 2.15. Large difference between the expected and actual performance of electric vehicles are found for 'energy use' (-2.1), 'suitable for our organisation' (-1.9), 'safety' (-1.8), 'options like airco and ABS' (-1.7) and 'reliability' (-1.5). However, 'top speed' (+1.0) as well as 'design, styling' were rated higher in questionnaire 2.

For hybrid cars and trucks, the shift in scores of the different aspects is similar. Large differences between expected and actual performance are found for 'reliability' (-2.7), 'energy use' (-2.2) and safety (-1.2). Again, 'top speed' (+1.1) and 'design, styling' (+0.3) were rated higher in questionnaire 2.

In Figure 2.16, the difference between the score on importance and actual performance is given for electric and hybrid vehicles, see also 2.3.4. This time, some significant discrepancies can be observed between the relevance of certain aspects and the actual performance. Reliability was, on forehand, rated as a very important aspect (+8.9) for hybrid vehicles. The score on reliability based on actual performance amounts to (+5.3), resulting in a gap of -3.5. With respect to hybrid cars and trucks, other large discrepancies between actual performance and importance are found for 'low maintenance costs' (-3.2), 'energy use' (-2.5) and 'radius of action' (-2.3). For electric vehicles, largest differences are found for 'safety' (-2.2), 'energy use' (-2.0), 'radius of action' and 'reliability' (-1.9) and 'suitable for our organisation' (-1.9). For both electric and hybrid vehicles, the actual performance on 'design and styling' (+1.4) and 'top speed' (EV: +0.3, hybrid: +0.8) was rated higher than the score for importance on these aspects. Based on Figure 2.16, it

can be concluded that especially aspects such as reliability, energy use, radius of action and low maintenance costs are identified as key elements that need improvement.

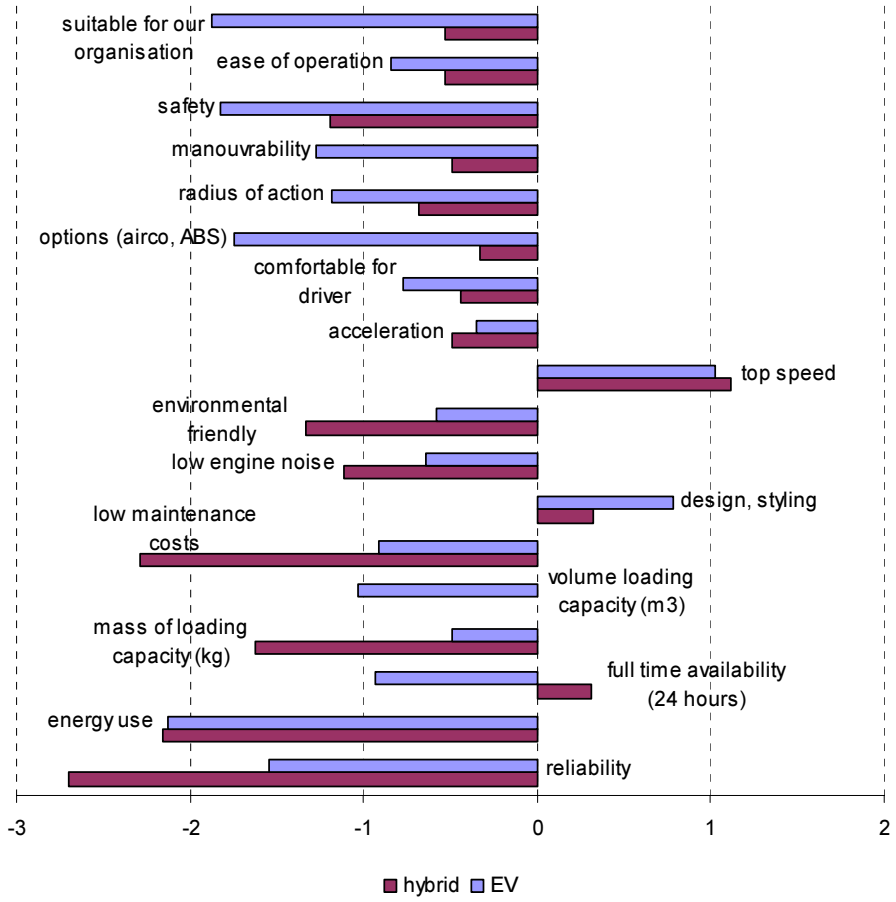

Figure 2.15 *Difference between expected performance and actual performance of several properties of the electric and hybrid vehicles*

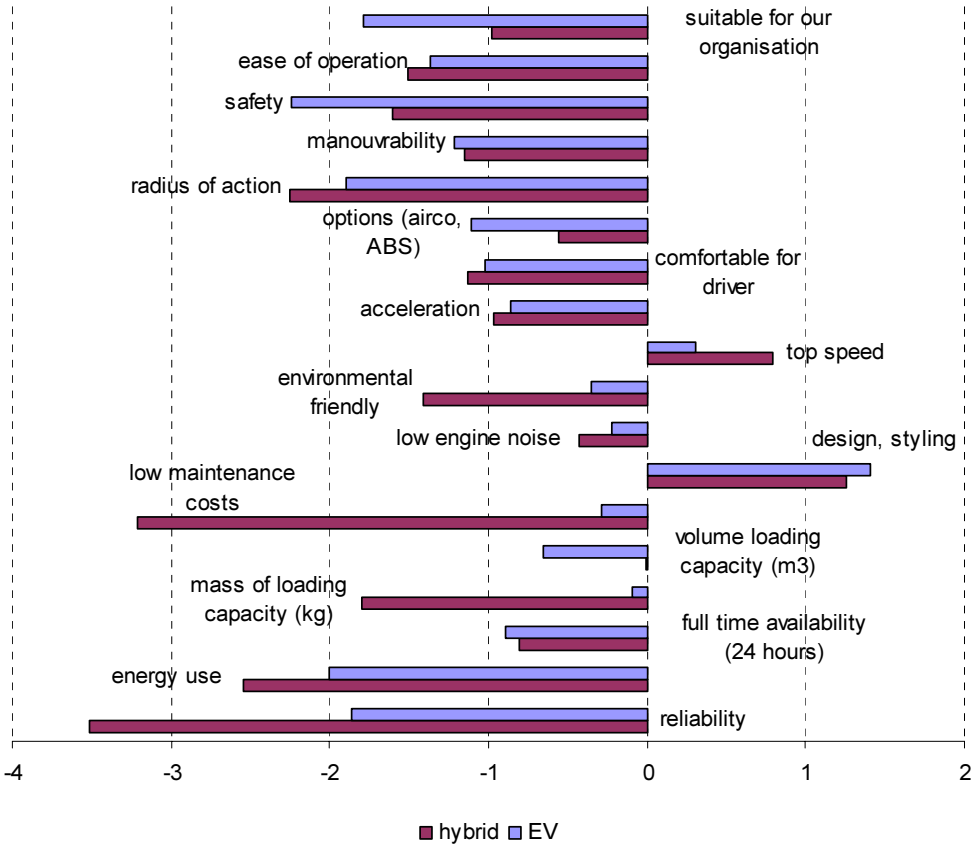

Figure 2.16 *Difference between importance and actual performance of several properties of the electric and hybrid vehicles*

In questionnaire two, it was asked to give the two most important benefits and drawbacks of electric and hybrid vehicles in comparison to a conventional combustion vehicle. Most important benefits were 'environment' and 'noise'. Most important drawbacks mentioned were 'radius of action' and 'power of the engine'.

2.4.4 Overall opinion

In Figure 2.17 the score on 'overall opinion' of the electric and hybrid vehicles are given. Highest score on overall opinion is found for the electric vehicle (+6.4 ± 1.8) and lowest score for hybrid trucks (5.6 ± 1.5). Average score for hybrid cars amounted to (5.9 ± 1.2). Although the number of respondent is quite high (n = 58), there still is a pretty large variance in the score on 'overall opinion' (standard deviation = 1.8). There seems to be relative little consistency with respect to the opinion whether or not the vehicles are performing well or not.

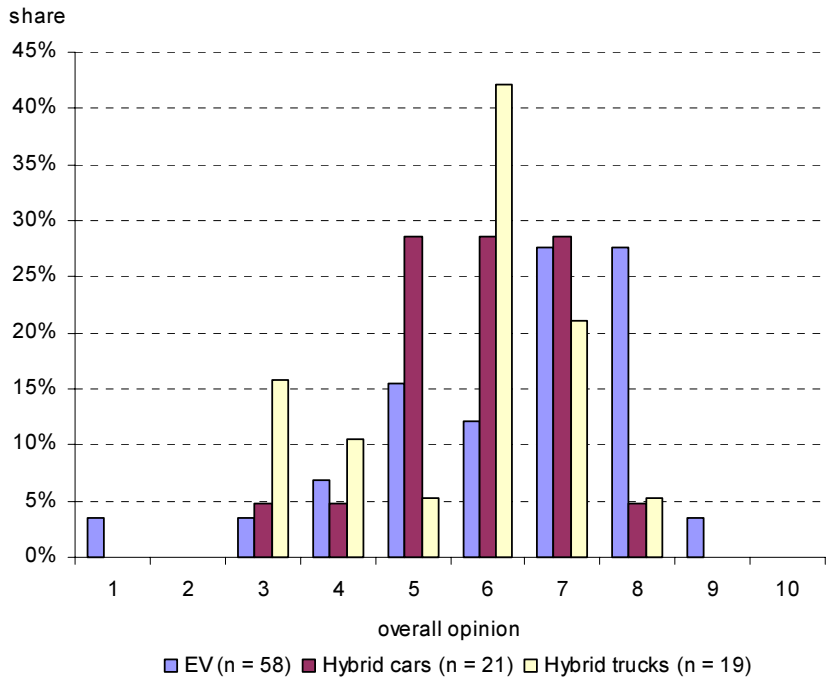

Figure 2.17 *Overall opinion about the actual performance of electric vehicles and hybrid cars and trucks*

2.4.5 General statements

Besides overall opinion, the users of the vehicles were also asked to give their opinion about some general statements referring to the prospects of electric and hybrid vehicles, see also Section 2.3.5. In Figure 2.18, the average score on these statements is given for electric and hybrid vehicles.

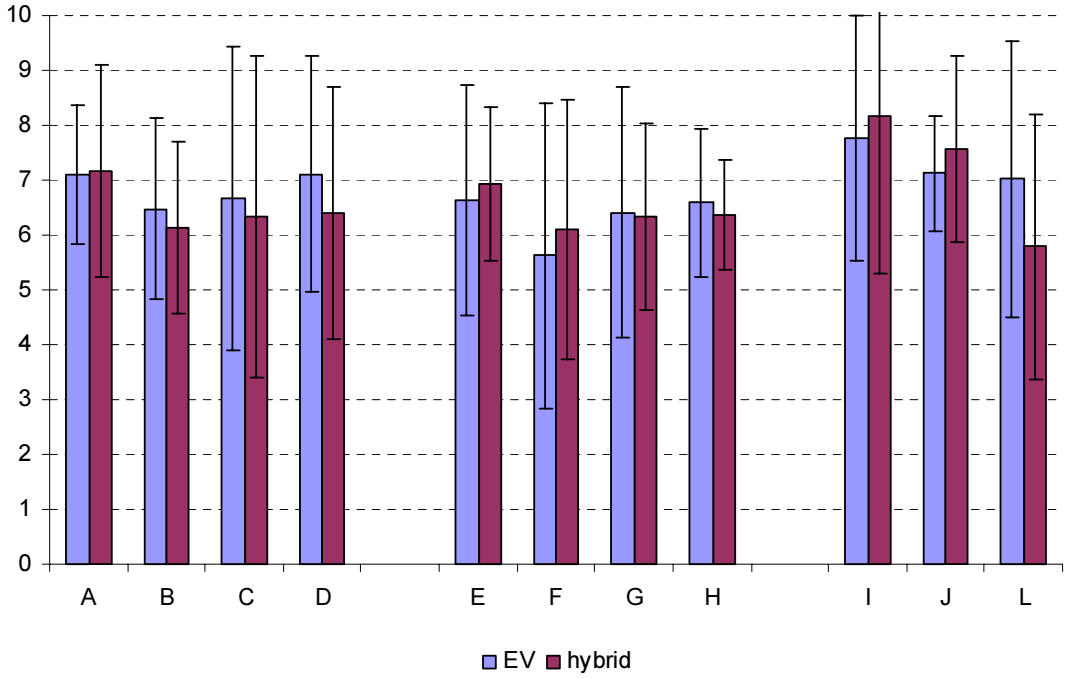

Figure 2.18 *Average score on several statements for electric and hybrid vehicles (1 = I totally disagree, 10 = I totally agree)*

(A) *Electric* vehicles certainly have a future in urban goods distribution.
(B) Electric vehicles have no prospect without governmental support.
(C) Electric vehicles fit in easily in our organisation.
(D) Our town is very well suited for distribution of goods by means of electric vehicles.
(E) *Hybrid* vehicles certainly have a future in urban goods distribution.
(F) Hybrid vehicles have no prospect without governmental support.
(G) Hybrid vehicles fit in easily in our organisation.
(H) Our town is very well suited for distribution of goods by means of hybrid vehicles.
(I) It is very important that in our town more **'***clean***'** vehicles are deployed.
(J) It is very important that in our town more **'***silent***'** vehicles are deployed.
(K) I have high expectations for the ELCIDIS project in our town.
(L) Even if electric/hybrid transport turns out to be somewhat more expensive than conventional transport, it should still be preferred to conventional transport.

For electric as well as hybrid vehicles, highest score is given for (I) 'It's important that more clean vehicles are deployed in our town'. Again, see Section 2.3.5, a relative low score (implying disagreement) is given on (L) 'even if the costs of electric/hybrid transport are somewhat higher, it should be preferred to conventional transport' by the respondents using hybrid vehicles. If we compare the scores on the general statements as given at the start of the project and during the project, a remarkable drop in the score on (A) 'electric vehicles certainly have a future in urban goods distribution' can be observed. A increase in score is found for (B) 'electric vehicles have no prospect without governmental support'. So, the respondents involved in the use of the electric vehicles have adjusted their opinion during the project in a way that they think there is less future and more need for governmental support.

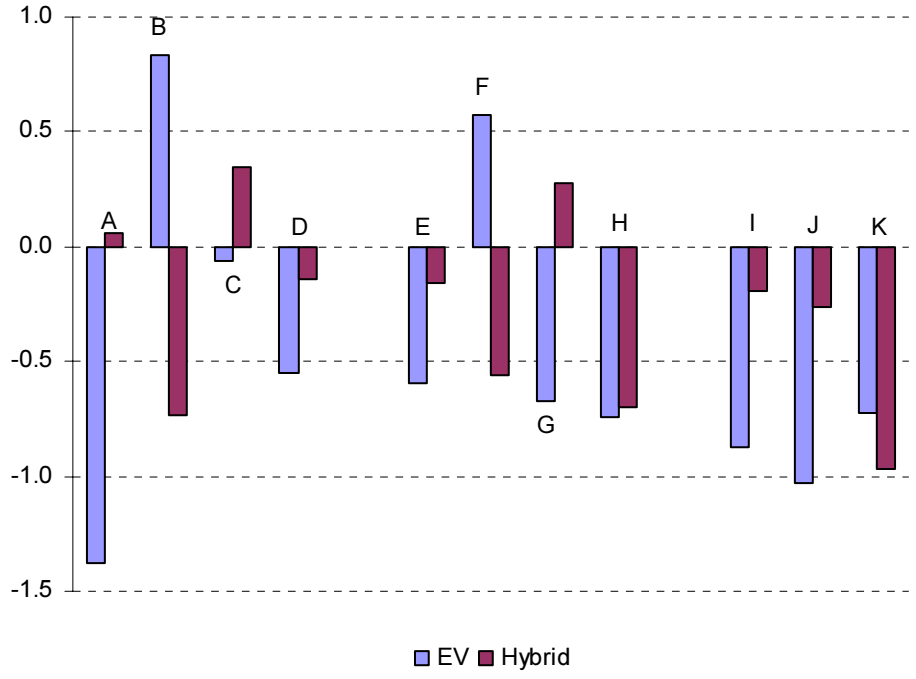

Figure 2.19 *Differences between the score on several general statements given at the start of the project (based on expectations) and during the project (based on experiences)*

For respondents involved in the use of EV's as well as hybrid vehicles, a decrease in score (agreement) van be observed for the statements (I), (J) and (K), being the need for deployment of clean and silent vehicles and the expectations for the ELCIDIS project. Judging on the differences in score for (E) - (H) for 'hybrid', in comparison to the differences for (A) - (D) for 'EV',

one might conclude that the experiences gained during the project were less disappointing for hybrid vehicles. However, further analysis shows that conclusion might not be valid for the hybrid cars (the Erlangen project), since very low scores were found on various relevant statements concerning the prospects and future of hybrid cars, see Figure 2.20 and Figure 2.21.

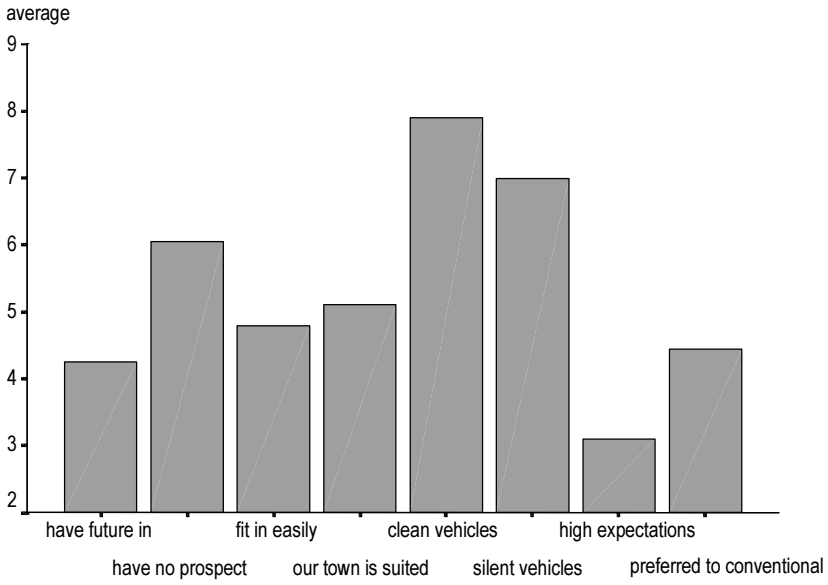

Figure 2.20 *Average score on several statements for hybrid cars*

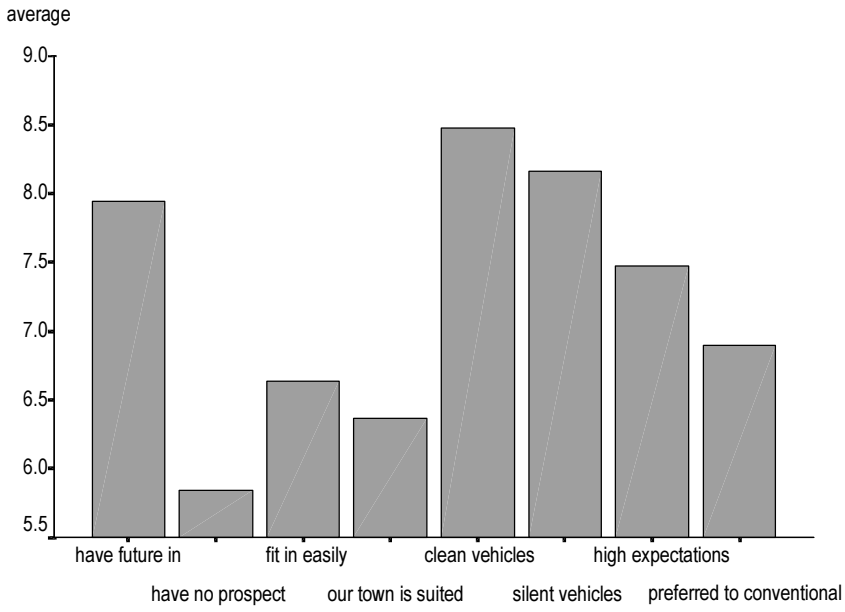

Figure 2.21 *Average score on several statements for hybrid trucks*

2.4.6 Shifts in valuation of the vehicles

Several drivers have filled in the second questionnaire a number of times during the project (every couple of months). By comparing the score on different aspects of the valuation of the vehicle, one might get an indication of possible shifts in opinion about these aspects during the project. For electric vehicles as well as hybrid trucks, the occurrence of shifts in score has been determined for ‘overall opinion of the vehicle’, ‘reliability’, ‘energy use’, ‘acceleration’, ‘radius of action’, ‘safety’, ‘ease of operation’ and ‘suitable for our organisation’, see Figure B.11 - Figure B.26 of Appendix B. It should be noted that only a limited number of drivers have filled

in the second questionnaire a number of times. Therefore, there might exist differences in outcome for this (limited) group of drivers in comparison to the results for all drivers.

The most important conclusion that can be derived from the graphs is the observation that during the project there is a tendency to adjust the pretty extreme valuation (in a positive as well as a negative sense) towards a less extreme level. So, very high scores on certain aspects at the beginning of the project have a tendency to go down and low scores have a tendency to go up. Another observation that can be made is that for some aspects, such as acceleration, safety and radius of action of the electric vehicles, shifts in score per driver are quite large.

2.5 General conclusions derived from the questionnaires

By means of the questionnaires, the following relationships (hypothesis) can be tested:

1. The relationship between the opinion of the vehicle normally used (at the job) and the expectations and overall opinion for the electric or hybrid vehicle. *Hypothesis*: a positive opinion of the conventional vehicle leads to less positive expectations and overall opinion for the electric or hybrid vehicle.
2. The relationship between familiarity with the use of electric and hybrid vehicles and the expected performance of electric and hybrid vehicles. *Hypothesis*: a high familiarity with (the use of) electric and hybrid vehicles before the vehicle is put into use leads to high expectations with respect to the performance of electric and hybrid vehicles.
3. The relationship between the expectations with respect to the performance of the electric and hybrid vehicles and the final valuation of the vehicle at the end of the project. *Hypothesis*: high expectations lead to a high overall opinion of the electric and hybrid vehicles.
4. The relationship between the quality of the information provided about the goal of the ELCIDIS project and the final opinion about the vehicle. *Hypothesis*: providing sufficient information at the start of the project leads to a higher valuation of the electric or hybrid vehicle.
5. The relationship between the overall opinion about the vehicle and the individual issues related to the performance of the electric or hybrid vehicle. *Hypothesis:* the overall opinion about the vehicle will be determined by a limited amount of issues, such as reliability, radius of action, engine noise and environmental aspects.

Other issues that can be tested and consistency checks that can be performed are:

6. Does it make any difference with respect to the valuation of the electric or hybrid vehicle if the driver has to share the vehicle with other drivers or if the driver 'owns' the vehicle. *Hypothesis*: not sharing the vehicle with other drivers leads to an increase in valuation of the vehicle.
7. It is expected that satisfaction with respect tot the capacity of the batteries (question 5.6 of Q2) correlates with the score on the radius of action (question 4.1 N of Q2) (consistency check). Moreover, it can be tested whether a correlation exists with top speed and acceleration (question 4.1 J and K).
8. It is expected that the occurrence of malfunctions (question 6.1 of Q2) correlates with the score given on reliability (question 4.1 A of Q2). There might also exist a correlation with 'full time availability', 'ease of operation' as well as 'suitable for our organisation' (question 4.1 C, Q and R of Q2).
9. There might exist a correlation between 'adjustments in the organisation, which could add to the success of the vehicle within the organisation' (question 8.2, Q2) and 'suitable for our organisation' (question 4.1 R, Q20) and the overall opinion about the ELCIDIS project (question 4.2, Q2).

Hypothesis 1: Opinion of the vehicle normally used vs. expectations and overall opinion of the electric or hybrid vehicle

In Figure 2.22, the overall opinion about the vehicle normally used is plotted vs. the (average) expected performance of the electric vehicle. Comparable graphs can be made with respect to expected performance of hybrid cars and trucks, see Figure B.7 and Figure B.8 of Appendix B.

Analyses of the data given in Figure 2.22 shows that here is no statistical evidence that supports the existence of the relationship as described in the hypothesis. Based on the empirical data, hypothesis 1 has to be rejected.

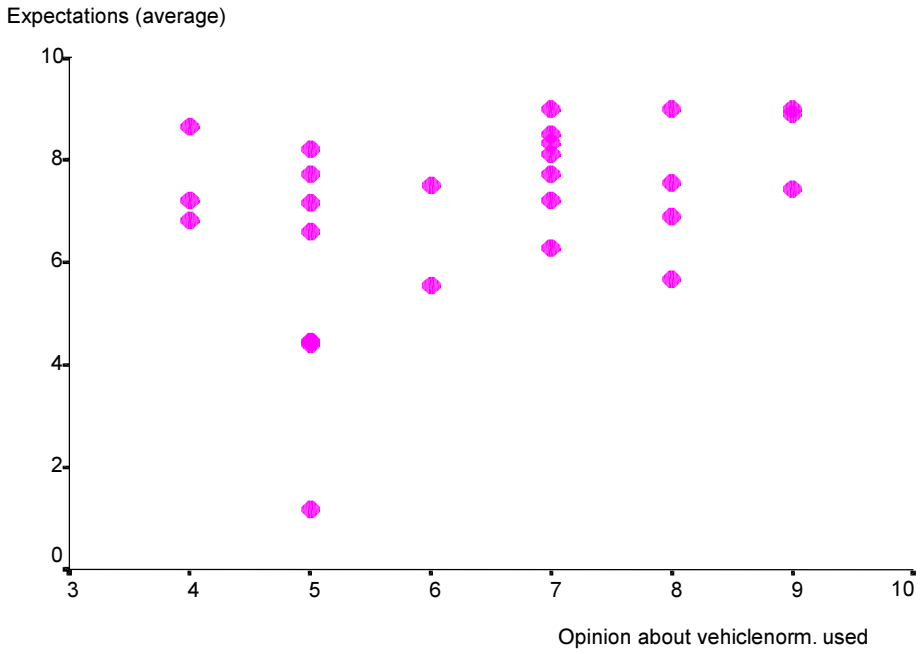

Figure 2.22 *Opinion about the vehicle normally used vs. expected performance of electric vehicles*

Figure 2.23 shows the opinion about the vehicle normally used vs. the expected energy use of electric vehicles. Comparable graphs are made for expected energy use of hybrid cars and hybrid vehicles, see Figure B.9, Figure B.10 of Appendix B. Again, there is no statistical evidence that supports the existence of a relationship between the opinion of the vehicle normally used and expected energy use of electric and hybrid vehicles.

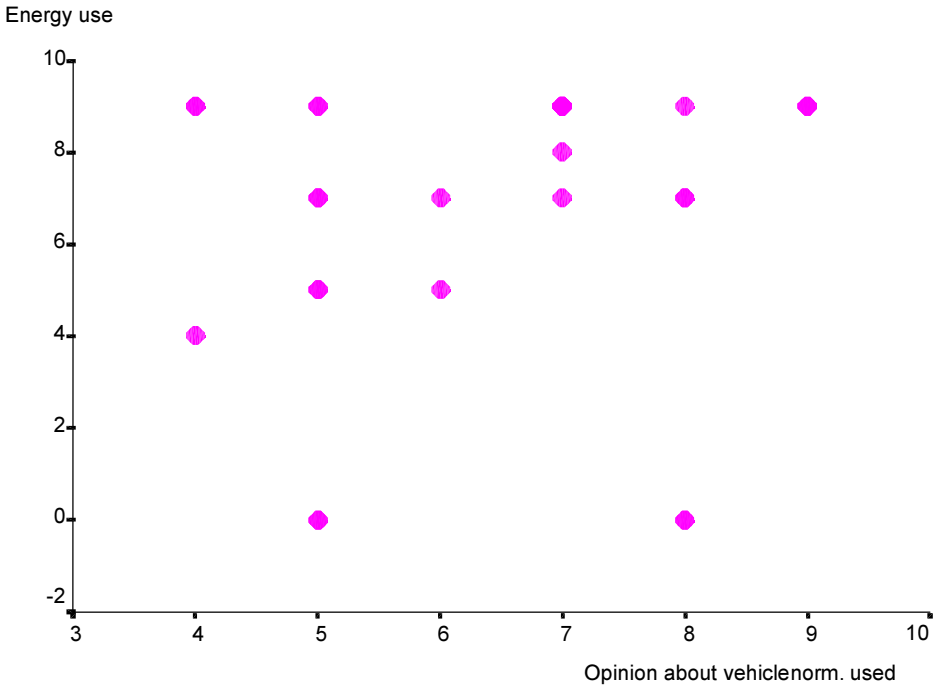

Figure 2.23 *Opinion about the vehicle normally used vs. expected energy use of electric vehicles*

Hypothesis 2: familiarity and expectations

By means of hypothesis 2, it is investigated whether or not familiarity with the use of electric and/or hybrid vehicles before the start of the project (experiences in the past) have an effect on the expected performance. In Figure 2.24 - Figure 2.26, the familiarity with electric or hybrid vehicles and trucks is plotted vs. the expected performance of these vehicles. Taking the variance in the score on expected performance into account, there seems to be hardly any difference in expectation between people who are not familiar, somewhat familiar and very familiar with electric and hybrid vehicles. Therefore, the hypothesis that high familiarity leads to higher average expectations for the performance of electric and hybrid vehicles has to be rejected.

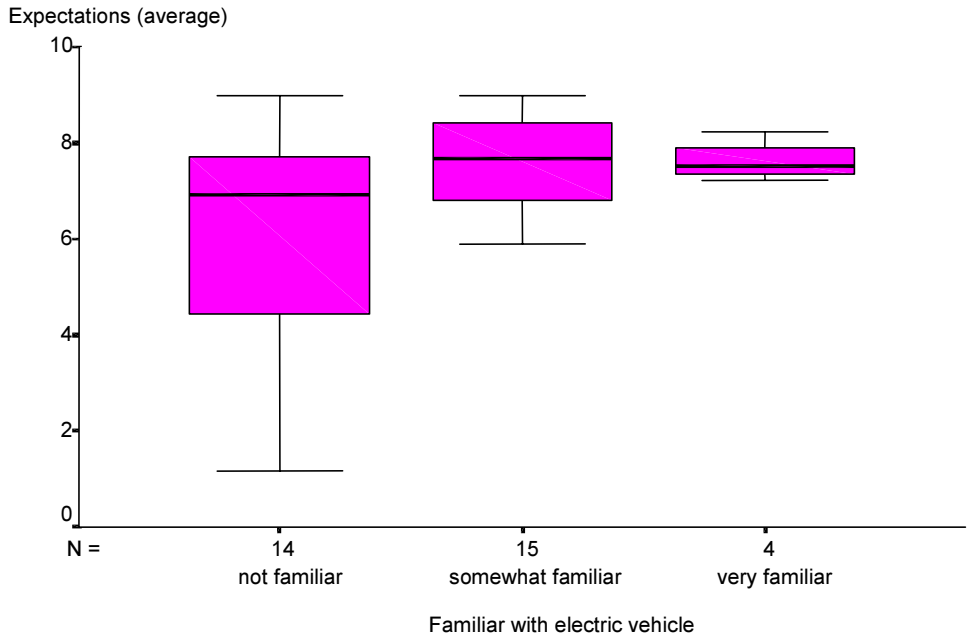

Figure 2.24 *Familiarity with the use of electric vehicles vs. the expected performance of electric vehicles*

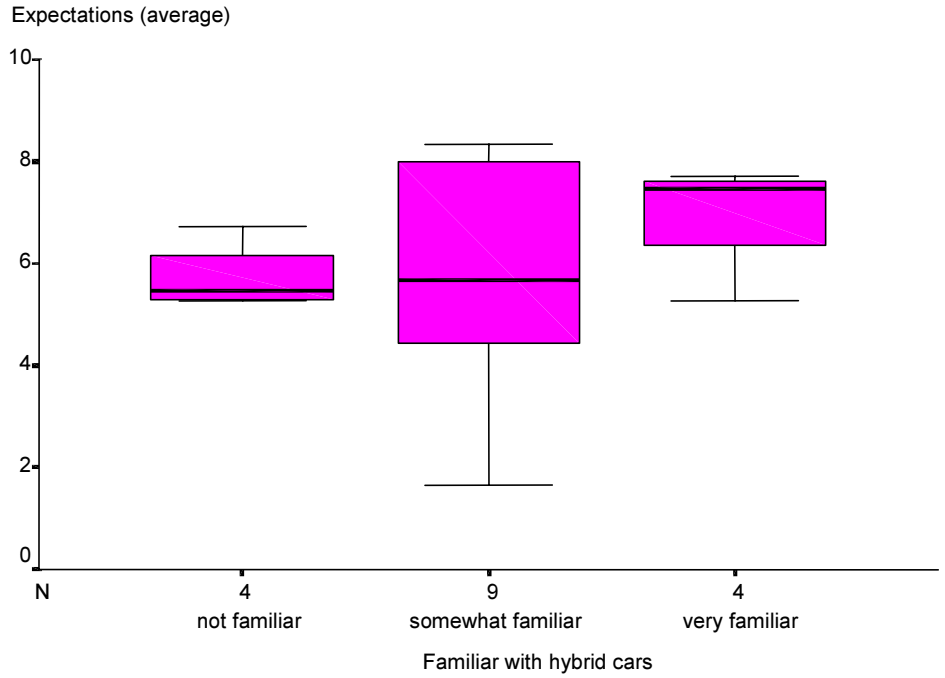

Figure 2.25 *Familiarity with the use of electric vehicles vs. the expected performance of hybrid cars*

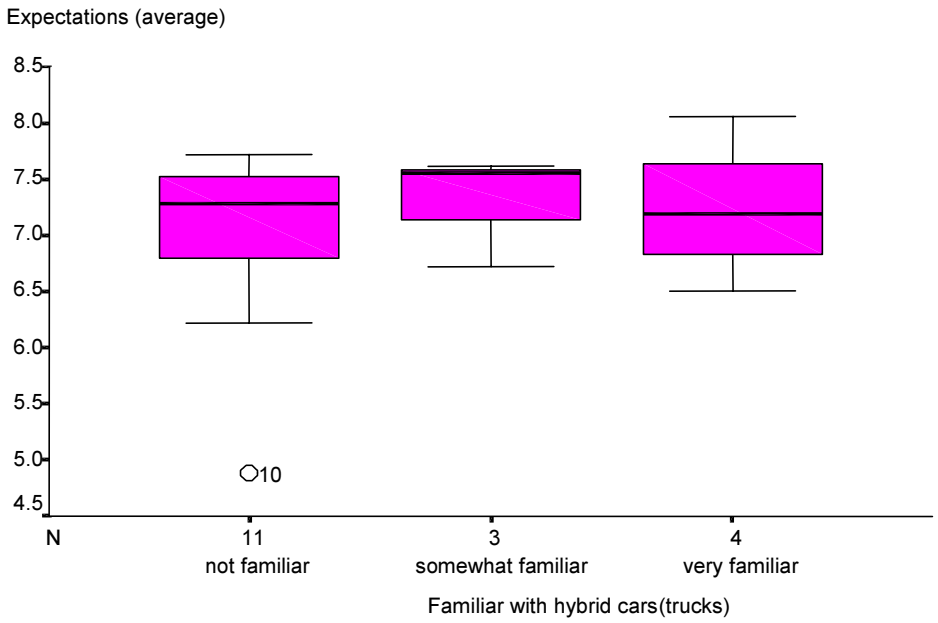

Figure 2.26 *Familiarity with the use of electric vehicles vs. the expected performance of hybrid trucks*

Hypothesis 3: expectations and overall opinion

By means of hypothesis 3, it is investigated whether or not there exists a correlation between the expected performance of the electric or hybrid vehicles as measured at the start of the ELCIDIS project and the overall opinion about the vehicle normally used at the end of the ELCIDIS project, see Figure 2.27 and Figure 2.28. The existence of such a correlation might imply that prejudgement might have played a role in the determination of the overall opinion about the vehicle. There is no statistical evidence that supports the existence of a relationship between expected performance (start of the project) and the score on the overall opinion (end of the project). Therefore hypothesis 3 has to be rejected.

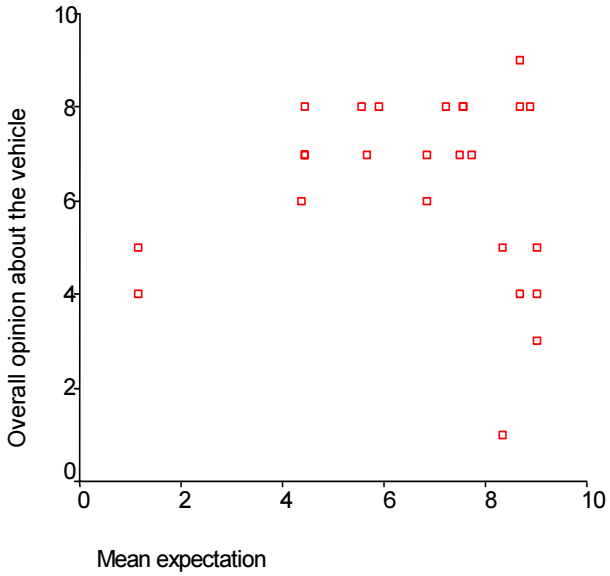

Figure 2.27 *Expected performance vs. the overall opinion of electric vehicles*[4]

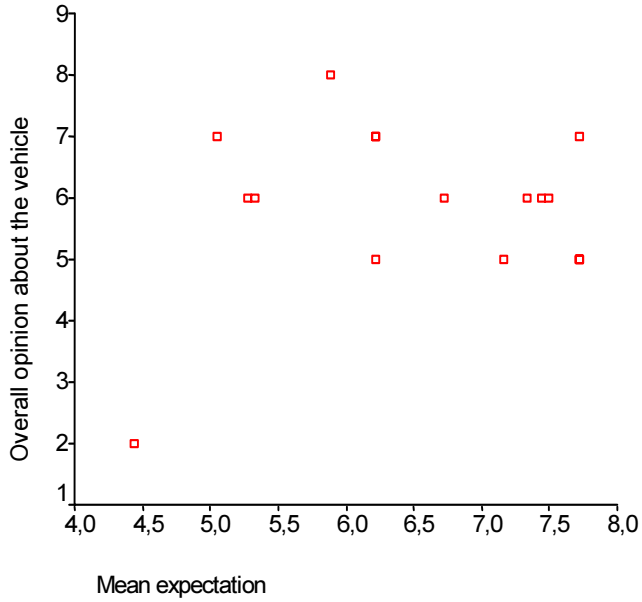

Figure 2.28 *Expected performance vs. the overall opinion of hybrid vehicles*[4]

Hypothesis 4: quality of information and overall opinion

In Figure 2.29, the quality of the information received about the ELCIDIS project is plotted vs. the overall opinion about the vehicle. No statistical correlation could be found between the type of information received and the overall opinion. Therefore, the hypothesis that proper information of the people involved in the ELCIDIS project would lead to a higher average opinion about the vehicle has to be rejected.

[4] Each dot plotted in the graph corresponds to the score of one or more respondents.

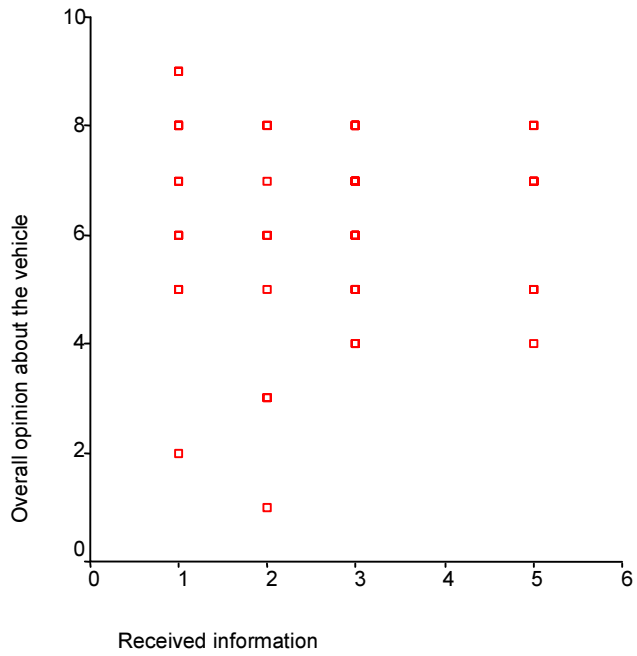

Figure 2.29 *Quality of the information received vs. overall opinion about the vehicle[4] (1= no information, 2 = written information, 3 = face to face information, 4 = written as well as face to face information, 5 = other)*

Hypothesis 5: overall opinion and specific characteristics of the vehicle

It appears that there is a significant relationship between the overall opinion about the ELCIDIS vehicle (question 4.2 of Q2) with only a limited number of characteristics of the vehicle (question 4.1 of Q2). Significant variables with a positive correlation are 'comfortable for driver', 'manoeuvrability', 'safety' and 'suitable for our organisation'. A positive correlation implies that the overall opinion increases when the score of the variable increases.[5] A negative correlation is found for 'loading capacity (in m^3)', meaning that the overall opinion about the vehicle is low when the 'loading capacity' is rated low.

However, when a correction is made for correlation between the significant variables,[6]. it appears that only three variables are significant: 'suitable for the organisation', 'manoeuvrability' and 'engine noise'. Together, these three variables explain 95% of the variance in the 'overall opinion'. On forehand, it was expected that the variables 'reliability' and 'radius of action' would be significant, in stead of 'suitable for the organisation'. This could be explained by a possible correlation of 'suitable for the organisation' with the variables 'reliability' and 'radius of action'.[7] In order to investigate the effects of this possible dependency between these variables, the analysis was repeated with exclusion of the variable 'suitable for the organisation'. In this case, the variables are 'environmental friendly', 'energy use', 'comfortable for driver' and 'loading capacity' explain 96% of the variance in the overall opinion about the vehicle.[8]

In conclusion: the overall opinion about the vehicle is determined by a limited number of specific characteristics: 'suitable for the organisation', 'manoeuvrability' and 'engine noise'. However, when the variable 'suitable for the organisation' is excluded, 96% of the variance in the overall opinion can be explained by 'environmental friendly', 'energy use', 'comfortable for

[5] The variables 'acceleration' and 'reliability' appear to be the next important variables, but are not statistical significant.
[6] 'stepwise'.
[7] So, if the vehicle is not reliable or has a low radius of operation, it is not suitable for the organisation.
[8] If 'comfortable for driver' is also excluded, the only significant variables found are 'environmental friendly', 'loading capacity' and 'options (airco and ABS)'.

driver' and 'loading capacity'. Aspects like 'reliability', 'acceleration' and 'radius of action' are, surprisingly, not significant.

Hypothesis 6: number of drivers per vehicle and the overall opinion
On forehand, it was expected that in case that the driver does not have to share the vehicle with other drivers, the overall opinion of the vehicle would be higher. In Figure 2.30, the overall opinion about the vehicle is given in case there is only one driver per vehicle and in case there are two or more drivers for the same vehicle. The first box in Figure 2.30 refers to the respondents who have not answered the question about the number of drivers per vehicle. The figure shows that there are indications that the overall opinion is somewhat higher when the vehicle is driven by only one driver. However, this cannot be stated for sure, as a result of the large variance in the overall opinion.

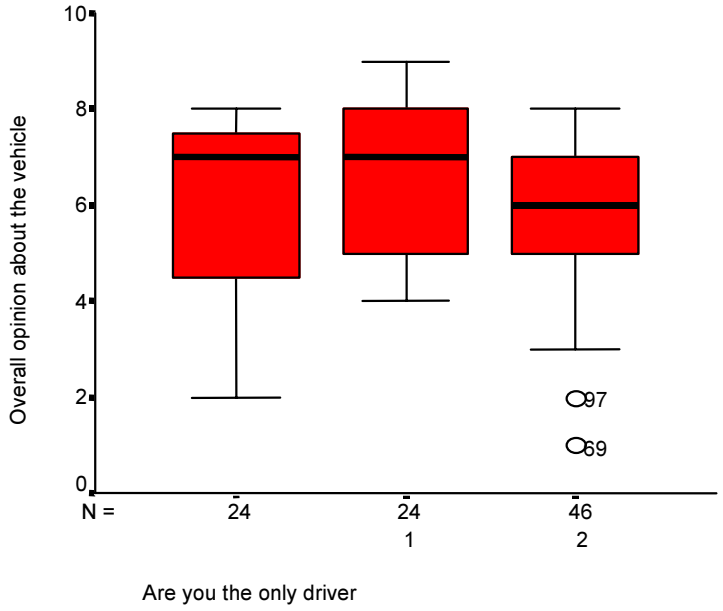

Figure 2.30 *Relationship between the number of drivers per vehicle and the overall opinion about the vehicle*

Hypothesis 7: capacity of the batteries and radius of action, top speed and acceleration
The radius of action is determined by the capacity of the batteries. There might also exist a more indirect relationship between the capacity of the batteries and other aspects such as top speed and acceleration. First, it is tested whether or not the relationship between capacity of the batteries and radius of action can be derived from the answers given on questionnaire 2, see Figure 2.31. There appears to be a correlation between 'satisfied with the capacity of the batteries' and 'radius of action'.[9] Next, the existence of a correlation between 'satisfied with the capacity of the batteries' and 'top speed' and 'acceleration' is examined, see Figure 2.32 and Figure 2.33. In both cases, there is no empirical evidence that supports the existence of such a correlation.

[9] $r = 0.6$, $R^2 = 0.36$

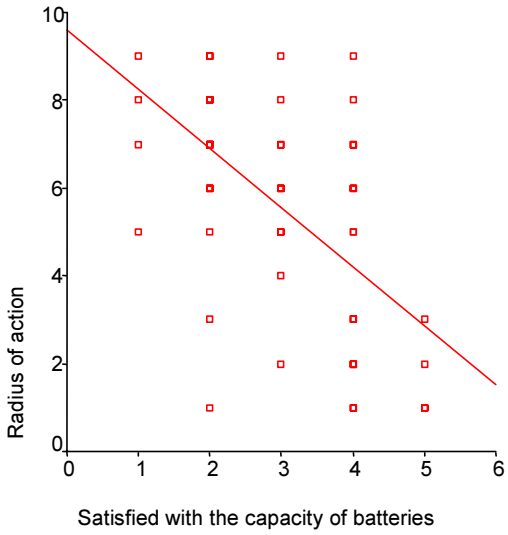

Figure 2.31 *Satisfaction with respect to the capacity of the batteries vs. radius of action*[4]

1 = very satisfied
2 = satisfied
3 = not satisfied/not unsatisfied

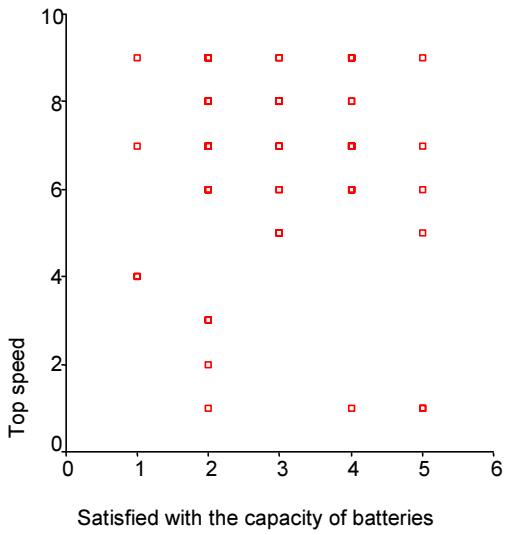

Figure 2.32 *Satisfaction with respect to the capacity of the batteries vs. top speed*[4]

4 = unsatisfied
5 = very unsatisfied

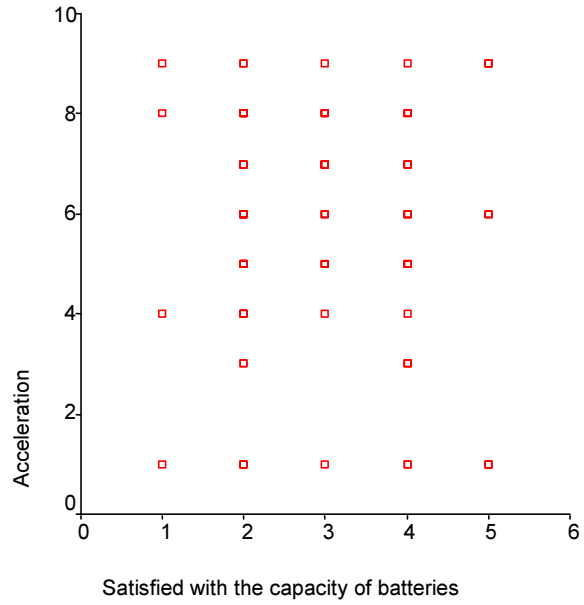

Figure 2.33 *Satisfaction with respect to the capacity of the batteries vs. acceleration*[4]

Hypothesis 8: Consistency between occurrence of malfunctions and reliability.
It is expected that there might be a positive correlation between the occurrence of malfunctions (question 6 of Q2) and i.e. 'reliability', 'full time availability', 'ease of operation' and 'suitable for our organisation' (question 4.1 A, C, Q, R of Q2) as well as the overall opinion about the vehicle (question 4.2 of Q2). The analysis shows that there are indications for a dependency between 'occurrence of malfunctions' and 'reliability', see Figure 2.34. As expected, the occurrence of malfunctions has a negative effect on reliability. The occurrence of malfunctions however seems to have little effect on 'ease of operation', see Figure 2.35, as well as 'suitable for our organisation', see Figure 2.36. Surprisingly, 'occurrence of malfunctions' seems tot have a positive effect on the 'availability 24 hours a day', see Figure 2.37. This cannot be explained

and has to be attributed to the large variance in the results and other not identified factors. As expected, the occurrence of malfunctions leads to a decrease in overall opinion about the vehicle, see Figure 2.38. This dependency is however not very strong, which is consistent with hypothesis 6.

In conclusion: there are indications that the occurrence of malfunctions has a negative effect on reliability as well as the overall opinion about the vehicle. There is no proof of a dependency of 'easy of operation' and 'suitable for our organisation' on the occurrence of malfunctions. The possible existence of a positive correlation of occurrence of malfunctions with 'availability', cannot be explained.

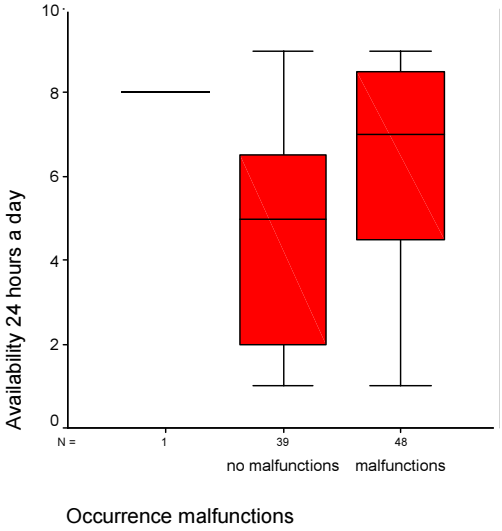

Figure 2.34 *Graphical presentation of the 'occurrence of malfunctions' vs. 'availability'*

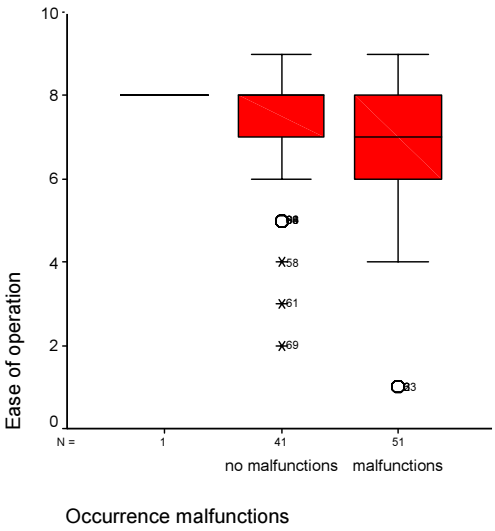

Figure 2.35 *Graphical presentation of the 'occurrence of malfunctions' vs. 'ease of operation'*

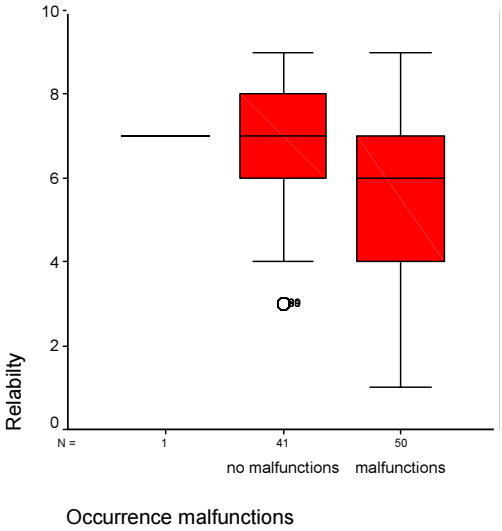

Figure 2.36 *Graphical presentation of the 'occurrence of malfunctions' vs. 'reliability'*

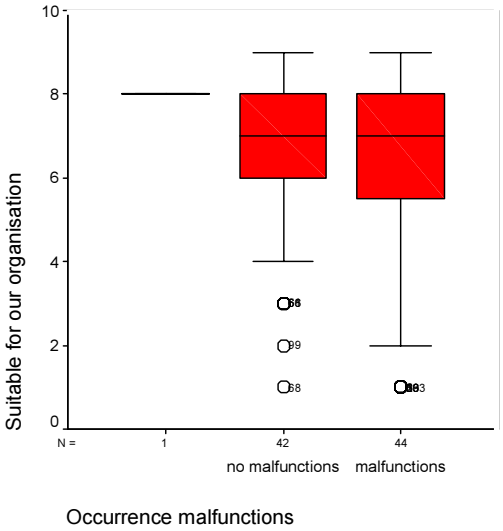

Figure 2.37 *Graphical presentation of the 'occurrence of malfunctions' vs. 'suitable for our organisation'*

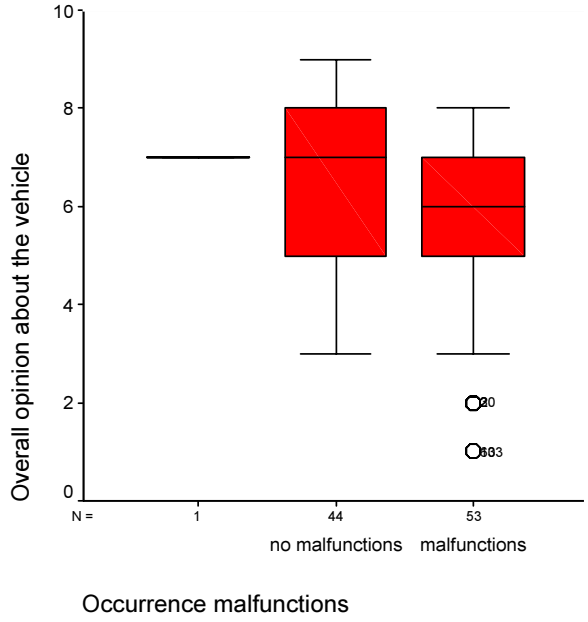

Figure 2.38 *Graphical presentation of the 'occurrence of malfunctions' vs. 'overall opinion about the vehicle'*

Hypothesis 9: adjustments and suitability for the organisation

The existence of adjustments (opportunities for improvement) that can be made within the organisation might be of influence on the suitability for the organisation as well as the overall opinion. In Figure 2.39 and Figure 2.40, the existence of possible adjustments within the organisation is plotted vs. the score on 'suitable for our organisation' and 'overall opinion'. Taking into account the variance in score, it must be concluded that the existence of adjustments in the organisation is little to no influence on the score on 'suitable for our organisation' as well as 'overall opinion about the vehicle'.

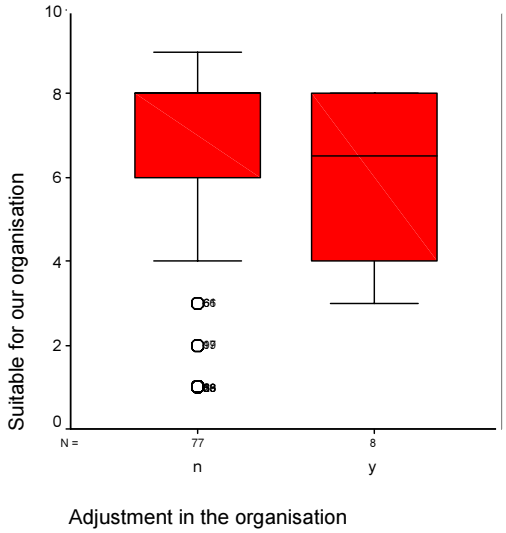

Figure 2.39 *Existence of 'adjustments in the organisation' vs. 'suitable for the organisation'*

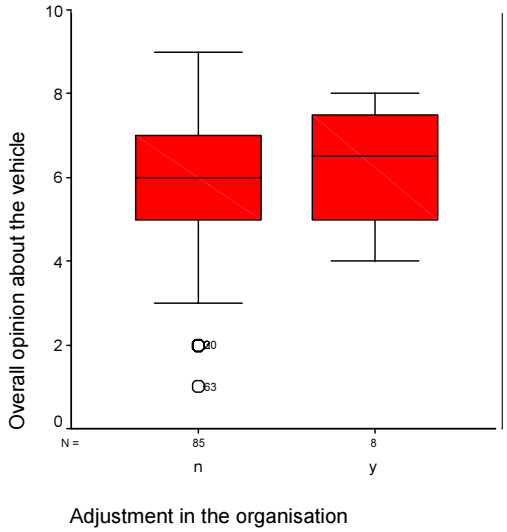

Figure 2.40 *Existence of 'adjustments in the organisation' vs. 'overall opinion about the vehicle'*

3. ENERGY CONSUMPTION

3.1 Introduction

In Table 3.1, an overview is given of the types of vehicles in the ELICIDS project. Basically, four different types of vehicles are used:

- electric cars (Stockholm, La Rochelle, Stavanger, Regione Lombardia)
- hybrid cars (Erlangen)
- electric vans (Rotterdam, Stavanger, La Rochelle)
- hybrid trucks (Stockholm).

Table 3.1 *Overview of types of vehicles per city for the ELCIDIS project*

Site	Logistics		Vehicles		
	Distribution service	Operating area	Number & type	Battery type	Payload [kg]
Rotterdam	parcels & packages	city centre	3 electric vans Mercedes Sprint	6 x sodium nickel chloride ZEBRA Z5C	1250
			4 electric vans Mercedes Sprint	12 x sodium nickel chloride ZEBRA Z5C	1000-1500*
Stockholm	parcels & packages	city centre & region	6 hybrid electric trucks Mercedes ATEGO 1217	6 x lead	2300
			3 electric vans Citroën Berlingo	3 x nickel cadmium	500
			6 electric vans Citroën Berlingo	6 x nickel cadmium	500
La Rochelle	parcels, packages & messages	city centre	1 FAAM Jolly 1200 electric van	1 x lead	900
			1 electric car Citroën Saxo	1 x nickelcadmium	300
Erlangen	courier and delivery service of goods and documents	city centre & region	10 hybrid electric Audi Duo	10 x lead	400
Regione Lombardia	mail delivery & services	city & city centre	13 electric vans Citroën Berlingo	13 x nickel cadmium	500
			3 electric vans Peugeot Partner	3 x nickel cadmium	500
	mail, packages,	city centre	2 electric vans Citroën Berlingo	2 x nickel cadmium	500
Stavanger	documents & equipment etc.	& region	2 electric cars Citroën Saxo	2 x nickel cadmium	300
			1 electric van Mercedes Sprint	1 x lead	500**

* If more than 1000 kg, Gross Vehicle Weight exceeds 3500 kg, meaning the van becomes a truck.
** With a Gross Vehicle Weight of 3500 kg.

In order to determine the performance of the electric and hybrid vehicles, part of the vehicles are equipped with so called mobi-boxes, see Table 3.2. With respect to the data recording in order to determine the performance of the vehicles, a number of problems have occurred. In a number of cases, it appeared not to be possible to fix the technical malfunctions. Due to these malfunctions, no data has been recorded by the mobi-box systems in 'Lombardia'. In La Rochelle, the charging data is not recorded. In Rotterdam, the reading of the kilometres driven appeared to be incorrect. This problem also seems to have occurred at the hybrid trucks in Stockholm, since daily distances over 700 kilometres were recorded. Therefore, it was not possible to assess the specific energy consumption for the vehicles in Lombardia, La Rochelle, Rotterdam and the hybrid trucks in Stockholm. Moreover, some of the vehicles have been put into use with serious delay. In these cases, the data is recorded over a relative short period.

Table 3.2 *Location and type of vehicles equipped with the mobi-box system*

Location	Car-ID	Company	Vehicle type	Start data-recording	End data-recording
Stavanger	EL 10066	Posten	Peugeot Partner	Sep 1999	May 2002
Stavanger	EL 10067	Posten	Peugeot Partner	Sep 1999	May 2002
Stavanger	EL 10068	Posten	Peugeot Partner	Sep 1999	May 2002
Stavanger	EL 10142	Posten	Mercedes Sprinter	Aug 2000	May 2002
Stavanger	EL 10075	Stavanger Kommune	Citroën Berlingo	Nov 1999	May 2002
Stavanger	EL 10074	Lyse Energi AS	Citroën Berlingo	Sep 1999	May 2002
Stavanger	EL 10079	Lyse Energi AS	Citroën Saxo	Oct 1999	May 2002
Stavanger	EL 10080	Vegvesenet	Citroën Saxo	Sep 1999	May 2002
Stockholm	PBT 335	Riksbyggen	Citroën Berlingo	Aug 2000	May 2002
Stockholm	ROR 337	Riksbyggen	Citroën Berlingo	Dec 2000	Apr 2002
Stockholm	RPC 222	Riksbyggen	Citroën Berlingo	Sep 2000	May 2002
Stockholm	SFX 780	GreenCargo	Mercedes ATEGO	May 2001	Apr 2002
Stockholm	SKR 246	GreenCargo	Mercedes ATEGO	May 2001	May 2002
Stockholm	SJH 468	Danzas	Mercedes ATEGO	March 2001	May 2002
Stockholm	SRP 258	Danzas	Mercedes ATEGO	Apr 2002	May 2002
Stockholm	SPJ 030	Trabé	Mercedes ATEGO	Oct 2001	May 2002
Stockholm	SSK 609	Grönsakshallen	Mercedes ATEGO	-	-
La Rochelle	Vehicle A		Citroën Berlingo	Sep 2001	Apr 2002
La Rochelle	Vehicle B		Citroën Berlingo	Apr 2001	Apr 2002
La Rochelle	Vehicle C		Citroën Berlingo	May 2001	Apr 2002
Rotterdam	BL-LT-89	Van Gend en Loos	Mercedes Sprinter	Feb 2002	Apr 2002
Rotterdam	BL-PT-05	Van Gend en Loos	Mercedes Sprinter	Feb 2002	Apr 2002
Rotterdam	Vehicle 1	TNT	Mercedes Sprinter	March 2002	March 2002
Rotterdam	Vehicle 2	TNT	Mercedes Sprinter	March 2002	March 2002
Lombardia	Vehicle 1	Milan Municipality	Citroën Berlingo	May 2001	Dec 2001
Lombardia	Vehicle 2	Milan Municipality	Citroën Berlingo	May 2001	Feb 2002
Lombardia	Vehicle 3	Milan Municipality	Citroën Berlingo	Apr 2001	March 2002
Lombardia	Vehicle 4	Milan Municipality	Citroën Berlingo	Apr 2001	March 2002
Lombardia	Vehicle 5	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002
Lombardia	Vehicle 6	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002
Lombardia	Vehicle 7	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002
Lombardia	Vehicle 8	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002
Lombardia	Vehicle 9	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002

By means of the date recorded by these mobi-boxes, the following characteristics can be determined:

nr of days	= Number of days driven in the car.
tot km	= Total km driven.
km/day	= Average km driven per day (tot km/nr of days).
hours/day	= Average number of hours driven per day.
tot kWh	= Total electricity charged in kWh.
kWh/charge	= Average kWh charged during 1 charging event.
hours/charge	= Average number of hours that 1 charging event takes.
kWh/km	= The average Energy use in kWh/km.

3.2 Total distance driven

La Rochelle

In Figure 3.1, the total distance driven per month is given for three electric vehicles equipped with the mobi-box system. Data acquisition for vehicle B started at April 2001. Data recording was ended for all vehicles in April 2002.

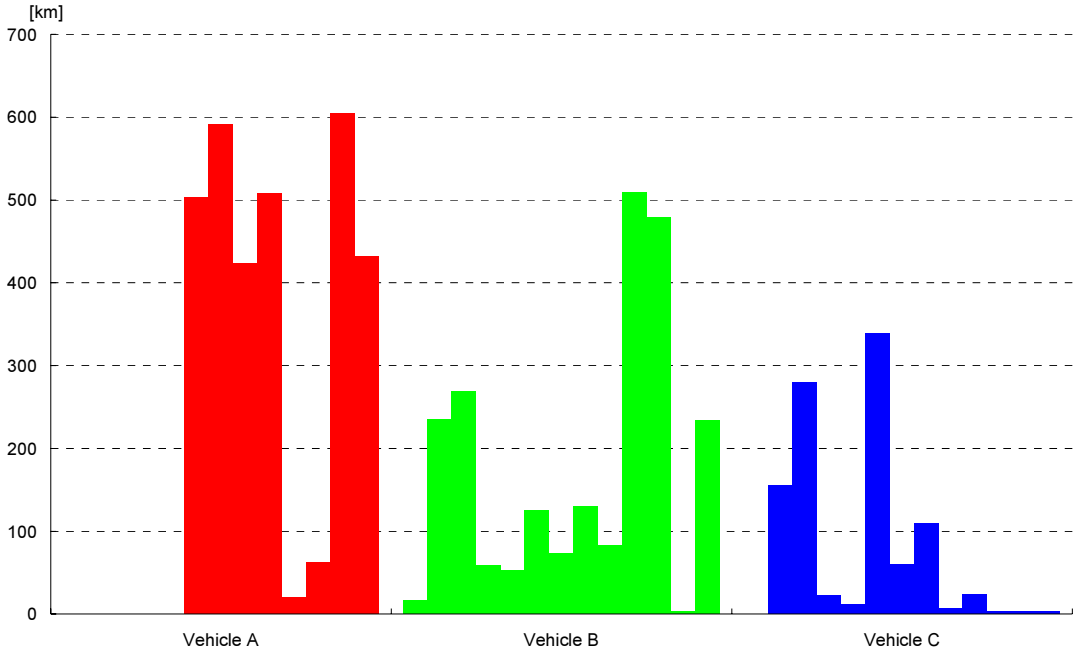

Figure 3.1 *Total distance driven (km/month) during the ELCIDIS project for the electric vehicles in La Rochelle*

In total, the three vehicles have covered about 6400 km in total in one-year time. A highest average daily distance of 19.2 km per day driven was achieved by vehicle A. Average daily distance per day driven for vehicle C amounted to a modest 4.4 km/day. The maximum distance driven on one day amounted to 41.6 km - 43.1 km per day.

Stavanger

In Stavanger, seven electric vehicles were equipped with the mobi-box system. Four of these vehicles were in use at the Posten company, see Figure 3.2, and three at other companies (see Figure 3.3). Data recording from the majority of the electric cars started at about September 1999. Date recording by the electric van (EL 10142) however started in August 2000. For all cars, data recording was ended in May 2002. Total distance driven by the seven electric vehicles over the period September 1999 to May 2002 amounts to over 155.000 km. Four of the electric vehicles drove over 20.000 km during the ELCIDIS project (31 months). This corresponds to an average yearly distance over 10.000 kilometres per car per year. The average daily distance of three of the vehicles was over 45 kilometres per day. All, cars besides EL1067, have at least once driven a distance of over 90 kilometres a day. Maximum distance driven on one day amounted to 115.6 km.

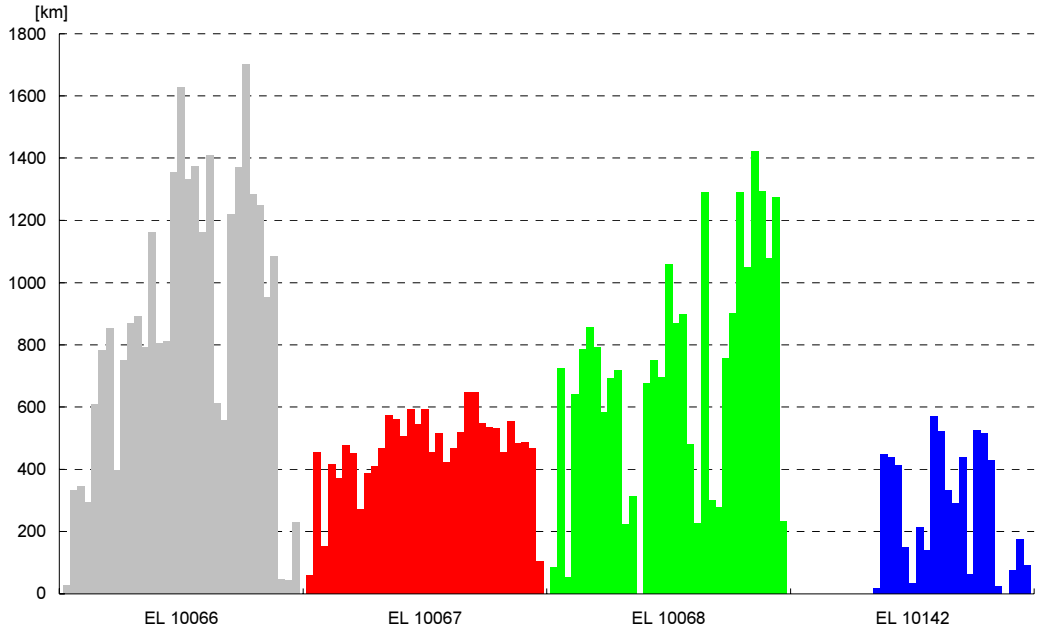

Figure 3.2 *Total distance driven (km/month) during the ELCIDIS project for the electric vehicles in Stavanger used at the Posten company*

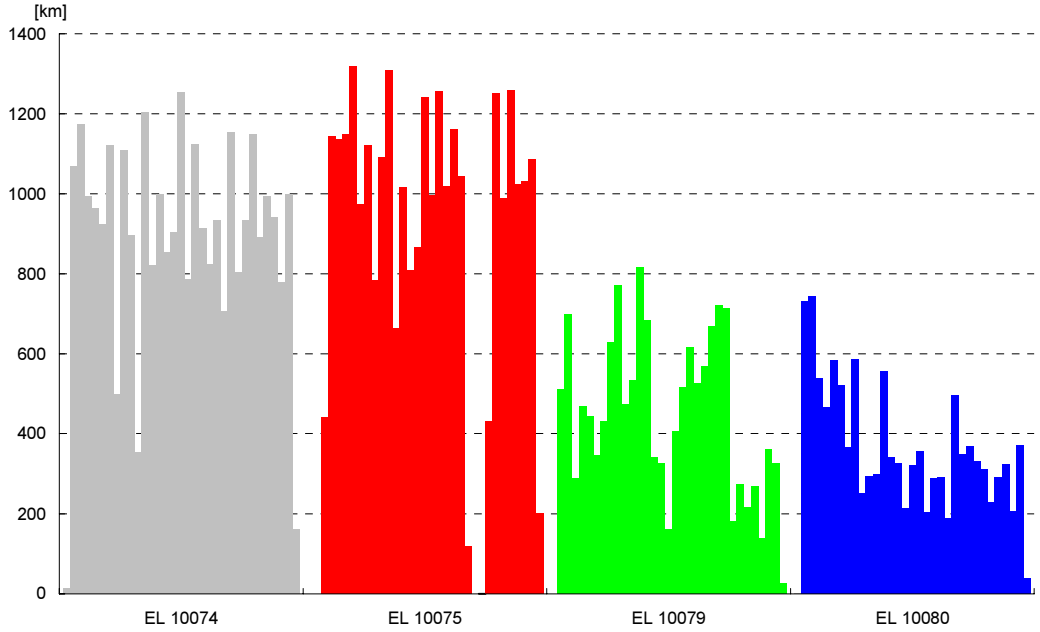

Figure 3.3 *Total distance driven (km/month) during the ELCIDIS project for the electric vehicles in Stavanger*

Stockholm

In Figure 3.4, the total distance driven per month is given for the three electric cars equipped with the mobi-box system.[10] The total distance covered by the three electric cars during the ELCIDIS project amounts to about 13.000 kilometres. The average yearly distance varied between 2.500 and 32.00 kilometres per year. The maximum distance driven on a single day varied between 39 and 84 kilometres a day. The low readings for several months can be ascribed to technical malfunctions of the vehicles.

[10] Distance driven by the hybrid trucks is not given, due to improper readings from the mobi-box system, see also Section 3.1.

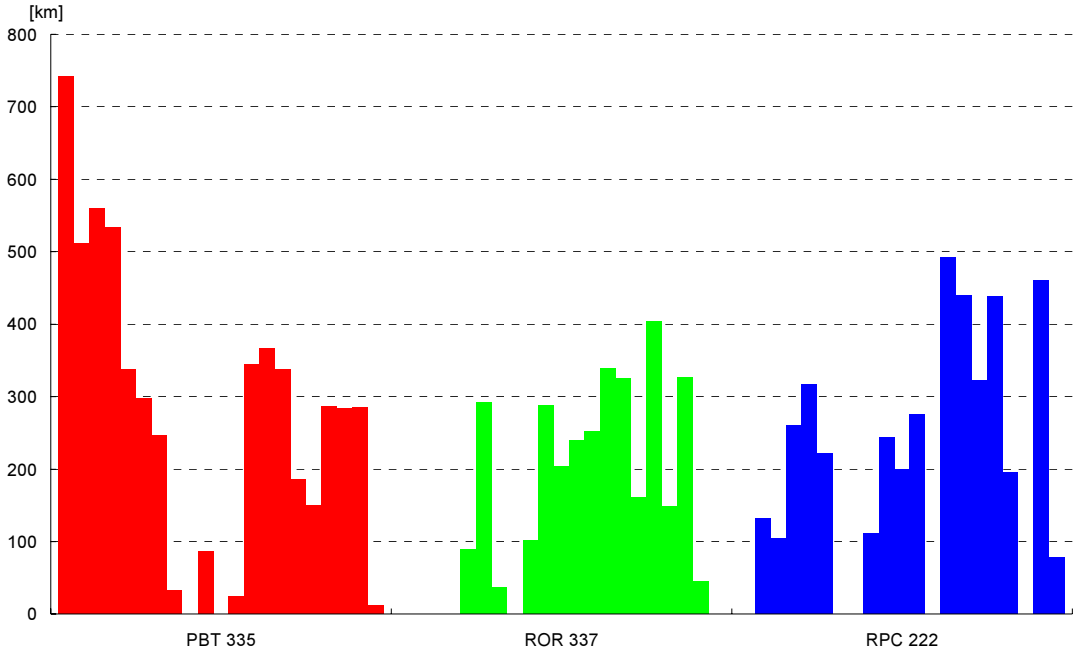

Figure 3.4 *Total distance driven (km/month) during the ELCIDIS project for the electric vehicles in Stockholm*

3.3 Specific energy consumption

The average specific energy consumption can be derived from the total distance driven and the charging data, see Table 3.3. The average electricity consumption of the electric cars varies between 0.25 kwh/km for a Citroen Saxo in Stavanger and 0.75 kWh/km for a Peugeot Partner in Stavanger. The average energy consumption of the electric van amounts to 0.88 kWh/km. In other projects, specific energy consumption of the same type of vehicle was found to be between 0.39 kWh/km in Paris to 0.50 kWh/km in Strasbourg (EVD, 2001) and 0.36 kWh/km in Ostend to 47.4 kWh/km in Brussels (EVWG, 2000).

It is remarkable that the three electric vehicles used in Stockholm use on average considerably more electricity per kilometre (0.55 ± 0.06 kWh/km) in comparison to identical vehicles in Lombardia (0.35 ± 0.02 kWh/km) and Stavanger (0.31 ± 0.02 kWh/km). This difference might be (partly) due to differences in trajectory.[11] Average daily distance for the vehicles amounted to about 43 km/day in Stavanger and 16 km/day in Stockholm and 36 km/day for Lombardia. In order to analyse this effect, the average specific energy consumption is plotted vs. the average daily distance driven, see Figure 3.6. After excluding the deviant values,[12] a trend line is calculated. Although the trend line suggests a decrease in specific energy consumption at increasing average outdoor temperatures, statistical analysis shows that the correlation between average daily distance and average specific energy consumption is not statistically significant.

Part of the variance in specific energy consumption might also be due to difference in the way of driving by the driver. However, based on the data for Lombardia, it is estimated[13] that due this factor the specific consumption might vary between identical cars by about 0.05 kWh/km. Last but not least, it cannot be excluded that the differences in energy consumption are (partly)

[11] The average energy consumption as calculated by TFK – Transport Research Institute, Stockholm, amounts to 0.4 kWh/km. The difference with the value calculated by ECN can, according to TFK, be explained by the selected evaluation period. Some of the vans have not been used for a long period of time. However, during this period, electricity was charged in regular use for the whole period.

[12] Marked as a ×.

[13] By taking three times the standard deviation.

due to improper readings by the mobi-box system.[14] The specific consumption of one of the electric vehicles in Stavanger (0.75 kWh/km) deviates considerably from the specific consumption of the other vehicles in Stavanger and comparable vehicles in other cities, see also Section 3.4.

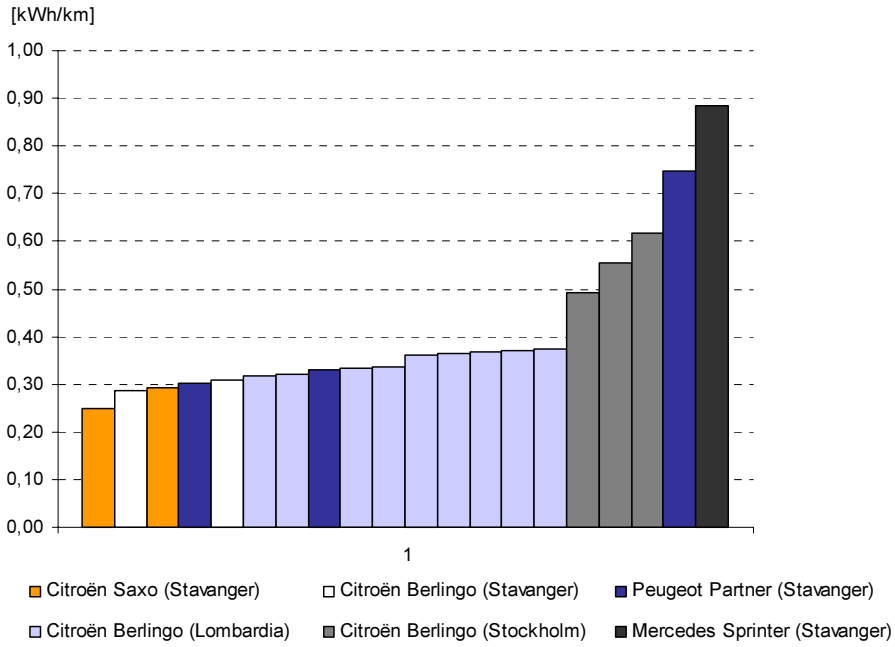

Figure 3.5 *Specific energy consumption of the electric vehicles*

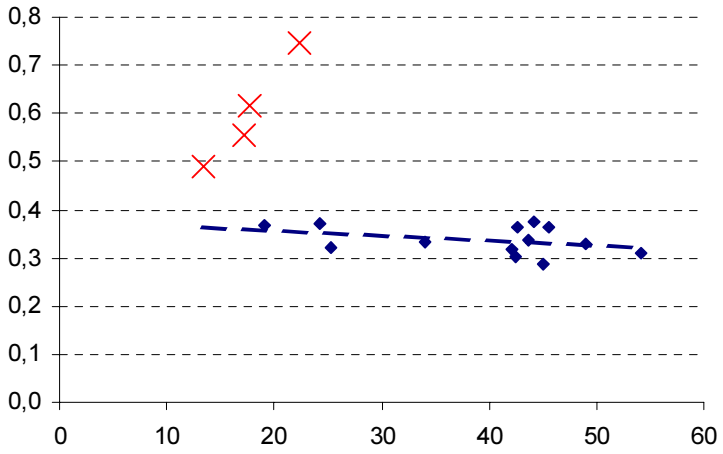

Figure 3.6 *Average daily distance [km/day] vs. specific energy consumption of the electric vehicles [kWh/km] (deviant values, market as ×, are excluded)*

[14] Although in Lombardia, the specific energy consumption was not calculated using the mobi-box system.

Table 3.3 *Overview of the performance of the vehicles equipped with the mobi-box system in the ELCIDIS project.*

Location	Car-ID	Company	Vehicle type	Start data-recording	End data-recording	Nr of days driven	Total driven [km]	Average km/day driven	Average time/day driven	Total charged [kWh]	Average energy use [kWh/km]
Stavanger	EL 10066	Posten	Peugeot Partner	Sep 1999	May 2002	578	28318	49.0	02:26	9355	0.33
Stavanger	EL 10067	Posten	Peugeot Partner	Sep 1999	May 2002	679	15119	22.3	02:08	11296	0.75
Stavanger	EL 10068	Posten	Peugeot Partner	Sep 1999	May 2002	548	23287	42.5	04:47	7069	0.30
Stavanger	EL 10142	Posten	Mercedes Sprinter	Aug 2000	May 2002	278	5895	21.2	01:40	5215	0.88
Stavanger	EL 10075	Stavanger Kommune	Citroën Berlingo	Nov 1999	May 2002	516	27922	54.1	02:37	8624	0.31
Stavanger	EL 10074	Lyse Energi AS	Citroën Berlingo	Sep 1999	May 2002	649	29231	45.0	01:31	8381	0.29
Stavanger	EL 10079	Lyse Energi AS	Citroën Saxo	Oct 1999	May 2002	488	14442	29.6	01:04	4211	0.29
Stavanger	EL 10080	Vegvesenet	Citroën Saxo	Sep 1999	May 2002	714	11779	16.5	00:46	2953	0.25
Stockholm	PBT 335	Riksbyggen	Citroën Berlingo	Aug 2000	May 2002	317	5618	17.7	07:14[15]	3470	0.62
Stockholm	ROR 337	Riksbyggen	Citroën Berlingo	Dec 2000	Apr 2002	241	3252	13.5	02:09	1598	0.49
Stockholm	RPC 222	Riksbyggen	Citroën Berlingo	Sep 2000	May 2002	250	4292	17.2	01:17	2381	0.55
Stockholm	SFX 780	GreenCargo	Mercedes ATEGO	May 2001	Apr 2002	282	Not available[16]		03:07	Not available	
Stockholm	SKR 246	GreenCargo	Mercedes ATEGO	May 2001	May 2002	275	Not available[16]		03:35	Not available	
Stockholm	SJH 468	Danzas	Mercedes ATEGO	March 2001	May 2002	195	Not available[16]		06:31	Not available	
Stockholm	SRP 258	Danzas	Mercedes ATEGO	Apr 2002	May 2002	25	Not available[16]				
Stockholm	SPJ 030	Trabé	Mercedes ATEGO	Oct 2001	May 2002	84	Not available[16]				
Stockholm	SSK 609	Grönsakshallen	Mercedes ATEGO	-	-	-	-				
La Rochelle	Vehicle 1		Citroën Berlingo	Sep 2001	Apr 2002	164	3145	19.2	02:49	Not available	
La Rochelle	Vehicle 2		Citroën Berlingo	Apr 2001	Apr 2002	245	2267	9.3	01:07	Not available	
La Rochelle	Vehicle 3		Citroën Berlingo	May 2001	Apr 2002	231	1019	4.4	00:35	Not available	
Rotterdam	BL-LT-89	Van Gend en Loos	Mercedes Sprinter	Feb 2002	Apr 2002	32	Not available[16]		02:54	Not available	
Rotterdam	BL-PT-05	Van Gend en Loos	Mercedes Sprinter	Feb 2002	Apr 2002	20	Not available[16]		02:05	Not available	
Rotterdam	Vehicle 1	TNT	Mercedes Sprinter	March 2002	March 2002	16	Not available[16]		03:30	Not available	
Rotterdam	Vehicle 2	TNT	Mercedes Sprinter	March 2002	March 2002	11	Not available[16]		01:48	Not available	

[15] The very high value for 'average time driven' is explained by a technical malfunction of the Mobi box.
[16] The Mobi boxes gives improper readings with respect to the distance driven. Therefore, total distance as well as specific energy consumption cannot be determined.

Table 3.3 *Continued*

Location	Car-ID	Company	Vehicle type	Start data-recording	End data-recording	Nr of days driven	Total driven [km]	Average km/day driven	Average time/day driven	Total charged [kWh]	Average energy use [kWh/km]
Lombardia	Vehicle 1	Milan Municipality	Citroën Berlingo	May 2001	Dec 2001	66	1673	25.3		539	0.32
Lombardia	Vehicle 2	Milan Municipality	Citroën Berlingo	May 2001	Feb 2002	142	5969	42.0		1904	0.32
Lombardia	Vehicle 3	Milan Municipality	Citroën Berlingo	Apr 2001	March 2002	194	6613	34.1		2202	0.33
Lombardia	Vehicle 4	Milan Municipality	Citroën Berlingo	Apr 2001	March 2002	89	4052	45.5		1479	0.37
Lombardia	Vehicle 5	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002	114	4866	42.7		1761	0.36
Lombardia	Vehicle 6	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002	132	5840	44.2		2190	0.38
Lombardia	Vehicle 7	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002	168	7331	43.6		2471	0.34
Lombardia	Vehicle 8	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002	88	2131	24.2		793	0.37
Lombardia	Vehicle 9	Milan Municipality	Citroën Berlingo	Apr 2001	Feb 2002	60	1144	19.1		420	0.37

3.4 Temperature and energy consumption

In Figure 3.7, the average monthly energy use is plotted vs. the average monthly outdoor temperature for the electric vehicles in Stavanger, see also Table 3.3. Data analysis shows there is little to no effect of the outdoor temperature on the specific energy consumption of the electric vehicles. However, some remarkable observations can be made.

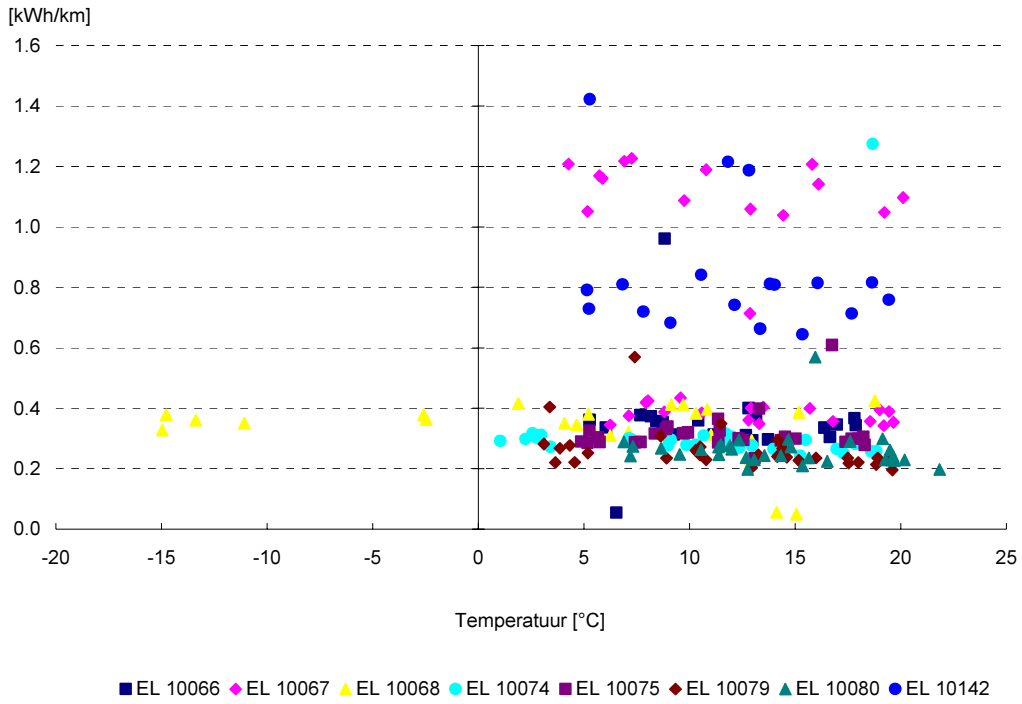

Figure 3.7 *Average monthly outdoor temperature [℃] vs. average monthly energy use [kWh/km] for electric vehicles in Stavanger*

For vehicle EL1068, some very low readings for the average outdoor temperature are found, although the vehicle has been in use over the same period as the other vehicles. The specific monthly energy consumption of vehicle EL1067 is divided into two intervals. The energy consumption in the low interval corresponds with the average monthly energy consumption of the other comparable vehicles (around 0.4 kWh/km). However, the specific monthly energy consumption in the second interval is much higher (about 1.0 - 1.2 kWh/km). This observation is in line with the observation made in Section 3.3, in which was found that the total specific energy consumption of vehicle EL1067 deviates significantly from the values found for comparable vehicles.

4. CONCLUSIONS AND RECOMMENDATIONS

The goal of the project carried out by ECN was twofold:
1. Measurement and analyses of (shifts in) opinion about the use of and opportunities for electric and hybrid vehicles.
2. Analyses of energy consumption of the electric and hybrid vehicles used in the ELCIDIS project.

4.1 Attitude and opinion

On forehand, a number of hypotheses have been developed which needed to be tested. In order to be able to do this, two questionnaires were developed. The first questionnaire had to be filled in before the vehicles were put into operation. The second questionnaire was repeated every couple of months during the period of operation of the vehicle, in order to be able to observe shifts in attitude and preferences.

It appeared that there was no statistical evidence for the existence of a relationship between the opinion about the vehicle normally used at the job and the opinion about the electric or hybrid vehicle. The familiarity with electric vehicles and the type and quality of information received before the start of the project also appeared to be insignificant with respect to the expected as well as actual performance of the electric and hybrid vehicles. Also the number of drivers per vehicle has no significant effect on the overall opinion. As expected, a correlation was found for 'satisfied with the capacity of the batteries' with 'radius of action'.

The overall opinion about the vehicle is determined by a limited number of characteristics. The variables 'manoeuvrability', 'engine noise' and 'suitable for our organisation' determine over 95% of the variation in the overall opinion. When the variable 'suitable for our organisation' is excluded, the variables 'environmental friendly', 'energy use', 'comfortable for driver' and 'loading capacity' are found to be statistically significant. On forehand, it was expected that aspects such as 'reliability', 'acceleration' and 'radius of action' would determine the overall opinion to a large extent. These variables, however, appear to be statistically insignificant.

As expected, the 'occurrence of malfunctions' has a negative effect on 'reliability' but hardly any effect on 'ease of operation' as well as 'suitable for our organisation'. The existence of opportunities for adjustments within the organisation has little to no influence on 'suitable for our organisation' as well as 'overall opinion about the vehicle'.

A remarkable resemblance was found for the score on 'relevance' and 'expected performance' of several issues related to the use of the electric and hybrid vehicles. This means that those aspects, which are expected to perform low, are also considered to be off less importance. So, on forehand, no real 'weaknesses' of the electric and hybrid vehicles could be identified. High scores were found for expected performance and relevance on aspects such as 'safety', 'suitable for our organisation', 'environmental friendly', 'reliability', 'ease of operation' and reliability'. 'Design and style' was considered to be of little importance.

When comparing the scores on these aspects between the first questionnaire (based on expectations) and the second questionnaire (based on experiences), it was found that for most aspects the actual performance is lower than the expected performance (so the vehicles are performing less well than expected). Largest differences (decrease) between expected performances and actual performance were found for 'energy use', 'suitable for our organisation', 'safety', 'options like airco and ABS' and 'reliability'. However, the electric vehicles appear to perform better than expected with respect to 'top speed' as well as 'design and styling'. The most important

drawbacks of electric and hybrid vehicles mentioned were 'radius of action' and 'power of the engine'.

The respondents involved in the use of the electric vehicles have adjusted their opinion during the project in a way that they think there is less future and more need for governmental support. During the project there, a tendency can be observed to adjust extreme scores on several aspects (in a positive as well as a negative sense) towards a less extreme level. So, very high scores on certain aspects at the beginning of the project have a tendency to go down and low scores have a tendency to go up. Another observation that can be made is that for some aspects, such as acceleration, safety and radius of action of the electric vehicles, shifts in score per driver are quite large.

4.2 Specific energy consumption

Part of the vehicles used in the ELCIDIS project is equipped with so-called Mobi box systems. By means of these systems, a number of characteristics have been recorded, such as 'total km driven', 'total kWh charged', 'trip length' and 'time driven'. Unfortunately, the reliability of the data recording of by means of the Mobi box systems was beyond expectation. In some cases, characteristics such as 'total kWh charged' were not recorded. In other cases, the readings were incorrect (i.e. improper 'trip length' or 'time driven').

During the project, some of the vehicles have covered large distances. The three electric vehicles in Stockholm drove over 13.000 km during the project. The maximum distance driven on one single day ranged from 39 to 84 km for these vehicles. Remarkably, the vehicles in Stockholm use more energy per km (0.55 ± 0.06)[17] in comparison to comparable vehicles in Lombardia (0.35 ± 0.02) and Stavanger (0.31 ± 0.02). Values for specific energy consumption for comparable electric vehicles used in other projects range from on average 0.36 kWh/km to 0.50 kWh/km (EVWG, 2000; EVD, 2001). The differences in specific energy consumption might be partly due to differences in trajectory (such as average trip length) and way of driving. Further analysis shows that the relationship between the specific energy plotted and the average daily distance driven is not statistically significant. Also, based on the data for Lombardia, the effects of differences in driving style are (roughly) estimated to have an effect on the specific energy consumption of about 0.05 kWh/km. Finally, it cannot be excluded that the differences in specific energy consumption are (partly) due to improper readings by the mobi-box system.[18] The average monthly outdoor temperature appeared to have little to no effects on the average specific energy consumption.

It is recommended to pay more attention to validation as well as reliability of the readings of the data recording devices. During this project, in some cases it appeared not to be possible to fix major technical malfunctions. As a result, in some cases crucial information needed in order to be able to evaluate the performance of the electric vehicles has not been collected. In case all relevant parameters were recorded, some inexplicable values were found. Unfortunately, it cannot be excluded that these deviating values are due to improper readings by the data collection system.

[17] The average specific energy consumption of the electric vehicles in Stockholm has also been calculated by TFK (Transport Reasearch Institute, Stockholm). According to TFK, the average specific energy consumption amouted to 0.4 kWh/km. The difference with the value calculated by ECN can, according to TFK, be explained by the selected evaluation period. Some of the vans have not been used for a long period of time. However, during this period, electricity was charged in regular use for the whole period.

[18] Although in Lombardia, the specific energy consumption was not calculated using the mobi-box system.

APPENDIX A

- Questionnaire 1
- Questionnaire 2

THE ELCIDIS PROJECT

Questionnaire 1

Dear participant,

You are involved in the **El**ectric Vehicle **Cl**ty **DIS**tribution Systems project. In the ELCIDIS project, six European cities are exploring the possibilities of new forms of city distribution systems operating with electric and hybrid vehicles. In order to collect the experiences of the participating companies and authorities, surveys of persons involved in the project will be performed on a regular basis.
This is the first survey, meant to determine your expectations prior to the introduction of the vehicles. Your answers will be processed *anonymously.*

---

1. What is (the best description of) your position?

- ❑ driver →→GO TO QUESTION **2.1**
- ❑ planner (responsible for the day to day operation) →→GO TO QUESTION 4
- ❑ technical staff, mechanic →→GO TO QUESTION 4
- ❑ fleet manager (responsible for the acquisition of the fleet) →→GO TO QUESTION 4
- ❑ other …… →→GO TO QUESTION 4

2.1. What kind of vehicle will you use in the ELCIDIS project?

- ❑ don't know (not yet clear)
- ❑ electric →→ make:……
  model:……
  loading capacity……**kg**
  loading capacity……**m³**
- ❑ hybrid →→ make:……
  model:……
  loading capacity……**kg**
  loading capacity……**m³**

2.2. Do you take part in the project on a voluntary basis?

- ❑ Yes, I voluntarily take part in the project
- ❑ No, my superiors decided on my taking part

3.1 What kind of vehicle do you normally use at the job (= prior to the electric or hybrid vehicle)?

- ❑ not applicable →→ question 4
- ❑ make…… model/type …….. loading capacity……kg
  loading capacity …….m³

3.2 What kind of fuel does this vehicle use?

3.3 On a scale of 1-9, where 1 is "very poor" and 9 is "excellent", please indicate (by circling the right figure) *your opinion* about the vehicle you described in question 3.1

Table 1

	very poor 1 2 3 4 5 6 7 8 9 excellent								
My opinion about the vehicle I normally use at the job	1	2	3	4	5	6	7	8	9

4. To what extent are you familiar with the objectives of the ELCIDIS project?

- ❑ Very familiar
- ❑ Somewhat familiar
- ❑ Not familiar

5 There are several objectives of the ELCIDIS project. Please indicate on a scale of 1-9, where 1 is "not important at all" and 9 is "very important", how important you would say the objectives of the ELCIDIS project are?

Table 2

		not important at all 1 2 3 4 5 6 7 8 9 very important								
A	Explore **more efficient** urban distribution systems	1	2	3	4	5	6	7	8	9
B	Demonstrate the **environmental benefits** of electric/hybrid vehicles for goods distribution	1	2	3	4	5	6	7	8	9
C	Realise **technical improvement** of electric/hybrid vehicles	1	2	3	4	5	6	7	8	9

6.1 To what extent are you familiar with <u>electric</u> vehicles?

- ❑ Very familiar
- ❑ Somewhat familiar
- ❑ Not familiar

6.2 In the current situation, does your organisation already use <u>electric</u> vehicles for distribution purposes?

- ❑ Yes
- ❑ No
- ❑ Don't know

6.3 Have you ever driven an <u>electric</u> vehicle (either a car, a van or a lorry)?

- ❑ Yes
- ❑ No

7.1 To what extent are you familiar with <u>hybrid</u> vehicles?

- ❑ Very familiar
- ❑ Somewhat familiar
- ❑ Not familiar

7.2 In the current situation, does your organisation already use <u>hybrid</u> vehicles for distribution purposes?

- ❑ Yes
- ❑ No
- ❑ Don't know

7.3 Have you ever driven a <u>hybrid</u> vehicle (either a car, a van or a lorry)?

- ❑ Yes
- ❑ No

QUESTION 8.1/8.2 FOR TECHNICAL STAFF (MECHANICS) ONLY. ALL OTHERS GO TO QUESTION 9

8.1 To what extent do you have experience in the technical maintenance of ELECTRIC vehicles?

- ❑ Much experience
- ❑ Some experience
- ❑ Little experience
- ❑ No experience at all

8.2 To what extent do you have experience in the technical maintenance of HYBRID vehicles?

- ❑ Much experience
- ❑ Some experience
- ❑ Little experience
- ❑ No experience at all

8.2 To what extent do you have experience in the technical maintenance of HYBRID vehicles?

- ❑ Much experience
- ❑ Some experience
- ❑ Little experience
- ❑ No experience at all

9. On a scale of 1-9, where 1 is "not important at all" and 9 is "very important", please indicate the importance of the following aspects for successful operation of the electric/hybrid vehicle within your organisation.

PLEASE FILL IN YOUR FIGURES (BETWEEN 1 TO 9) IN COLUMN **A** OF TABLE 3.

IF YOU DON'T KNOW AN ANSWER, PUT A QUESTIONMARK (?)

10. On a scale of 1-9, where 1 is "very poor" and 9 is "excellent ", please indicate your <u>expectations</u> of the performance of electric and hybrid vehicles in your organisation.

PLEASE FILL IN YOUR FIGURES (BETWEEN 1 TO 9) IN COLUMN **B** OF TABLE 3.

IF YOU DON'T KNOW AN ANSWER, PUT A QUESTIONMARK (?)

Table 3

		COLUMN A *How important are these aspects for success?* 1= not important at all 9=very important ?=don't know	**COLUMN B** *What do you expect of electric and hybrid vehicles?* 1= very poor 9=excellent ?= don't know	
			electric vehicles	**hybrid vehicles**
a	RELIABILITY OF THE VEHICLE			
b	ENERGY USE OF THE VEHICLE			
c	FULL TIME AVAILABILITY (24 hours a day)			
D	MASS OF LOADING CAPACITY (kg)			
e	VOLUME OF LOADING CAPACITY (m^3)			
f	LOW MAINTENANCE COSTS			
g	DESIGN,STYLING			
h	LOW ENGINE NOISE			
i	ENVIRONMENTALLY FRIENDLY			
j	TOP SPEED			
k	ACCELERATION			
l	COMFORTABLE FOR DRIVER			
m	OPTIONS (AIRCO, ABS)			
m	RADIUS OF ACTION			
o	MONOEUVRABILITY			
p	SAFETY			
q	EASE OF OPERATION			
r	SUITABLE FOR OUR ORGANISATION			

11. On a scale of 1-9, where 1 is "I totally disagree" and 9 is "I totally agree", please indicate your personal opinion about the following statements.

PLEASE FILL IN YOUR FIGURES (BETWEEN 1 TO 9) IN TABLE 4. IF YOU DON'T KNOW AN ANSWER, PUT A QUESTIONMARK (?).

Table 4

	I totally disagree 1 2 3 4 5 6 7 8 9 I totally agree, ?=don't know	***Your figure***
A	***Electric** vehicles certainly have a future in urban goods distribution*	
B	*Electric vehicles have no prospect without governmental support*	
C	*Electric vehicles fit in easily in our organisation*	
D	*Our town is very well suited for distribution of goods by means of electric vehicles*	
E	***Hybrid** vehicles certainly have a future in urban goods distribution*	
F	*Hybrid vehicles have no prospect without governmental support*	
G	*Hybrid vehicles fit in easily in our organisation*	
H	*Our town is very well suited for distribution of goods by means of hybrid vehicles*	
I	*It is very important that in our town more **'clean'** vehicles are deployed*	
J	*It is very important that in our town more **'silent'** vehicles are deployed*	
K	*I have high expectations for the EICIDIS project in our town*	
L	*Even if electric/hybrid transport turns out to be somewhat more expensive than conventional transport, it should still be preferred to conventional transport*	
M	*I have high expectations of technological innovation in general*	

Your organisation……

Your name……Initials……

Postal address……..

Phone number……

country>.

< Name organisation>
< Name project manager>
< Postal address >

Thank you for your co-operation!

Your remarks on this questionnaire or on the ELCIDIS project:

THE ELCIDIS PROJECT

Questionnaire 2

Dear participant,

You are involved in the **El**ectric Vehicle **CI**ty **DIS**tribution Systems project. In the ELCIDIS project, six European cities are exploring the possibilities of new forms of city distribution systems operating with electric and hybrid vehicles. In order to collect the experiences of the participating companies and authorities, surveys of persons involved in the project will be performed on a regular basis.
This is Questionnaire 2, meant to determine your experiences in the ELCIDIS project so far. Your answers will be processed *anonymously.*

---

1. What is (the best description of) your position?

- ❑ driver →→GO TO QUESTION 2.1
- ❑ planner (responsible for the day to day operation) →→GO TO QUESTION 3.1
- ❑ technical staff, mechanic →→GO TO QUESTION 3.1
- ❑ fleet manager (responsible for the acquisition of the fleet) →→GO TO QUESTION 3.1
- ❑ other:…… →→GO TO QUESTION 3.1

2.1 Do you drive an electric or a hybrid vehicle in the ELCIDIS project?

- ❑ electric →→ please fill in table 2.1.1
- ❑ hybrid →→ please fill in table 2.1.2

Table 2.1.1 Please fill in

A **What kind of electric vehicle do you drive in the ELCIDIS project?**	B **How many vehicles of this particular model do you drive regularly?**	C **Please indicate the number plate(s) of this/these electric vehicle(s)**	D **In case of more vehicles, please put a tick against the vehicle you drive *mostly***
Make:……. Model:…… Loading capacity……kg Loading capacity……m³	❑ only 1 vehicle ❑ 2 vehicles ❑ 3 vehicles ❑ more, namely ……	…… …… …… ……	❑ ❑ ❑ ❑

Table 2.1.2 Please fill in

A What kind of hybrid vehicle do you drive in the ELCIDIS project?	B How many vehicles of this particular model do you drive regularly?	C Please indicate the number plate(s) of this/these hybrid vehicle(s)	D In case of more vehicles, please put a tick against the vehicle you drive *mostly*
Make:……. Model:…… Loading capacity……kg Loading capacity……m³	❑ only 1 vehicle ❑ 2 vehicles ❑ 3 vehicles ❑ more, namely ……	…… …… …… ……	❑ ❑ ❑ ❑

THE FOLLOWING QUESTIONS REFER TO THE ELECTRIC OR HYBRID VEHICLE YOU DRIVE MOSTLY.

2.2 Are you the only driver of this particular vehicle?

- ❑ Yes
- ❑ No, there are (about) ….. drivers altogether who drive this vehicle.

2.3 How many weeks' experience do you have with the vehicle?

2.4 As a rule, how many days a week is the vehicle used, whether by you or any other driver?

2.5 How many kilometres does the vehicle cover on an average day?

2.6 How many stops does the vehicle make on an average day? (A STOP INVOLVES PARKING THE VEHICLE IN ORDER THAT GOODS ARE LOADED OR UNLOADED)

……weeks
……days a week
……kilometres daily
……stops a day

2.7 IF YOU ARE TALKING ABOUT A HYBRID VEHICLE: How many kilometres are covered on an average day using the electric motor and how many using the conventional motor?

Daily ……kilometres electric
Daily ……kilometres with the conventional motor

Information about the vehicle

3.1 When you were first involved with the ELCIDIS project, you may have received information on the project and the vehicle/vehicles concerned. In what form did you receive this information?

- ❑ I did **not** receive any information
- ❑ I received written information
- ❑ I received face-to-face instructions
- ❑ Other:……

3.2 Would you say you were sufficiently informed in order to do your job properly?

- ❑ Yes → GO TO QUESTION 3.5
- ❑ No → GO TO QUESTION 3.3

3.3 About which aspects was the information provided insufficient?

3.4 In which form would you prefer to be informed on these aspects (for example written information or face-to-face instructions)

3.5 Would you indicate in the table below about which aspects you currently want MORE information?(several answers possible)

❑ Handling the vehicle	❑ (if hybrid) minor repair combustion motor
❑ Driving characteristics of the vehicle	❑ (if hybrid) major repair combustion motor
❑ Charging the batteries	❑ economic aspects of the vehicle (costs and benefits)
❑ Capacity of the batteries	❑ environmental aspects of the vehicle
❑ Energy consumption	❑ the ELCIDIS project
❑ Possibilities and limitations of the vehicle	❑ other, namely
❑ Technical specifications	……
❑ Minor repair electric motor	……
❑ Major repair electric motor	

Impressions of the vehicle

NEXT QUESTIONS REFER TO THE VEHICLE (MAKE & MODEL) YOUR ORGANISATION IS USING IN THE ELCIDIS PROJECT. SO PLEASE COMMENT ON THE MAKE & MODEL RATHER THAN A PARTICULAR VEHICLE. **IN CASE YOUR ORGANISATION IS USING MORE THAN ONE MAKE & MODEL IN THE ELCIDIS PROJECT, PLEASE COMMENT ON THE MAKE & MODEL YOU KNOW BEST.**

4.1 On a scale of 1-9, where 1 is "very poor" and 9 is "excellent ", please indicate your impressions of the performance of the vehicle (MODEL) your organisation is using in the ELCIDIS-project.

PLEASE FILL IN YOUR FIGURES (BETWEEN 1 TO 9) IN COLUMN A.
IF YOU DON'T KNOW AN ANSWER, PUT A QUESTIONMARK (?)

The vehicle you comment on: **Make:……..** **Model:……..**		**COLUMN A** ***What are your impressions of the vehicle?*** **1= very poor, 9=excellent ?= don't know**
A	RELIABILITY	
B	ENERGY USE	
C	FULL TIME AVAILABILITY (24 hours a day)	
De	LOADING CAPACITY **(kg)**	
E	LOADING CAPACITY **(m^3)**	
F	LOW MAINTENANCE COSTS	
G	DESIGN,STYLING	
H	ENGINE NOISE	
I	ENVIRONMENTALLY FRIENDLY	
J	TOP SPEED	
K	ACCELERATION	
L	COMFORTABLE FOR DRIVER	
M	OPTIONS (AIRCO, ABS)	
N	RADIUS OF ACTION	
O	MONOEUVRABILITY	
P	SAFETY	
Q	EASE OF OPERATION	
R	SUITABLE FOR OUR ORGANISATION	

4.2 On a scale of 1-9, where 1 is "very poor" and 9 is "excellent", please indicate (by circling the right figure) *your overall opinion* about the vehicle.

	Very poor	1	2	3	4	5	6	7	8	9	excellent
My overall opinion about the vehicle in the ELCIDIS project		1	2	3	4	5	6	7	8	9	

4.3 Have you noticed significant differences in performance between two or more vehicles of the same make and model?

- ❑ No →→GO TO QUESTION 5.1
- ❑ Yes →→GO TO QUESTION 4.4

4.4 Could you describe these differences in performance?	**4.5 Could you explain these differences?**
	❑ **No** ❑ **Yes, as follows:**

4.6 Please indicate the number plates of vehicles that perform strikingly poor as compared to other vehicles of the same make and model.

……

……

Charging the batteries

5.1 Are you personally involved with the charging of the batteries?

- ❑ No →→GO TO QUESTION 6.1
- ❑ Yes →→GO TO QUESTION 5.2

5.2 Where does the charging of the batteries take place? (several answers possible)

- ❑ At the work site/distribution centre
- ❑ At the driver's home
- ❑ At customers
- ❑ other, namely ……

5.3 How often are the batteries charged?

- ❑ several times a day
- ❑ exactly once a day
- ❑ several times a week
- ❑ no fixed procedures

5.4 To what extent are you satisfied with charging the batteries?

- ❑ very satisfied
- ❑ satisfied
- ❑ not satisfied/not unsatisfied
- ❑ unsatisfied
- ❑ very unsatisfied

5.5 Please explain your answer

5.6 To what extent are you satisfied with the capacity of the batteries?

- ❑ very satisfied
- ❑ satisfied
- ❑ not satisfied/not unsatisfied
- ❑ unsatisfied
- ❑ very unsatisfied

Technical malfunctions

6.1 Did any malfunctions occur at one or more vehicles in the ELCIDIS project?

- ❑ No →→ GO TO QUESTION 7.1
- ❑ Yes →→ GO TO QUESTION 6.2

6.2 Could you give a precise description of the malfunction; please, indicate if and by whom the malfunction was repaired.

Description malfunction	Functionary who repaired the malfunction?
Vehicle numberplate: …… Malfunction …… ……	❑ Driver himself ❑ Mechanic of the own organisation ❑ Mechanic of a repair firm ❑ Other, namely……
Vehicle numberplate: …….. Malfunction …… …… ……	❑ Driver himself ❑ Mechanic of the own organisation ❑ Mechanic of a repair firm ❑ Other, namely……
Vehicle numberplate: …….. Malfunction ……..…… ……	❑ Driver himself ❑ Mechanic of the own organisation ❑ Mechanic of a repair firm ❑ Other, namely……

Evaluation

7.1 If you compare the electric/hybrid vehicle with a conventional vehicle (combustion engine), what would you say are THE TWO MOST IMPORTANT BENEFITS of the electric/hybrid vehicle? Could you also indicate WHY THESE BENEFITS ARE IMPORTANT TO YOU?

1. Benefits of the electric/hybrid vehicle:	Important because:
2. Benefits of the electric/hybrid vehicle:	**Important because:**

7.2 If you compare the electric/hybrid vehicle with a conventional vehicle, what are TWO MOST IMPORTANT DRAWBACKS of the electric/hybrid vehicle? Could you also describe WHY these aspects are important to you?

1. Drawback of the electric/hybrid vehicle:	**Important because:**
2. Drawback of the electric/hybrid vehicle:	**Important because:**

Improvements

8.1 Could you think of any TECHNICAL ADJUSTMENTS to the vehicle, which could add to the success of the vehicle within your organisation?

- ❑ Yes
- ❑ No →→ GO TO QUESTION 8.2

If yes, please describe your suggestions:

8.2 Could you think of any ADJUSTMENTS IN YOUR ORGANISATION, which could add to the success of the vehicle within your organisation?

- ❑ yes
- ❑ No →→ GO TO QUESTION 8.3

If yes, please describe your suggestions:

8.3 Could you think of any ADJUSTMENTS IN YOUR WORK AREA who could add to the success of the vehicle within your organisation? (FOR EXAMPLE OF TRAFFIC RULES, ADAPTATIONS OF STREETS AND SO ON)

- ❑ Yes
- ❑ No →→ GO TO QUESTION 9.1

If yes, please describe your suggestions:

9.1 On a scale of 1-9, where 1 is "I totally disagree" and 9 is "I totally agree", please indicate your personal opinion about the following statements.

PLEASE FILL IN YOUR FIGURES (BETWEEN 1 TO 9) IN TABLE 4. IF YOU DON'T KNOW AN ANSWER, PUT A QUESTIONMARK (?)

	I totally disagree 1 2 3 4 5 6 7 8 9 I totally agree, ?=don't know	***Your figure***
A	***Electric*** *vehicles certainly have a future in urban goods distribution*	
B	*Electric vehicles have no prospect without governmental support*	
C	*Electric vehicles fit in easily in our organisation*	
D	*Our town is very well suited for distribution of goods by means of electric vehicles*	
E	***Hybrid*** *vehicles certainly have a future in urban goods distribution*	
F	*Hybrid vehicles have no prospect without governmental support*	
G	*Hybrid vehicles fit in easily in our organisation*	
H	*Our town is very well suited for distribution of goods by means of hybrid vehicles*	
I	*It is very important that in our town more* ***`clean'*** *vehicles are deployed*	
J	*It is very important that in our town more* ***'silent'*** *vehicles are deployed*	
K	*I have high expectations for the EICIDIS project in our town*	
L	*Even if electric/hybrid transport turns out to be somewhat more expensive than conventional transport, it should still be preferred to conventional transport*	

Your organisation……

Your name……..Initials……..

Postal address……..

Phone number……

Please return this questionnaire to <the organisation in charge of the ELCIDIS project in your country>.

< Name organisation>
< Name project manager>
< Postal address >

Thank you for your co-operation!

Your remarks on this questionnaire or on the ELCIDIS project:

APPENDIX B

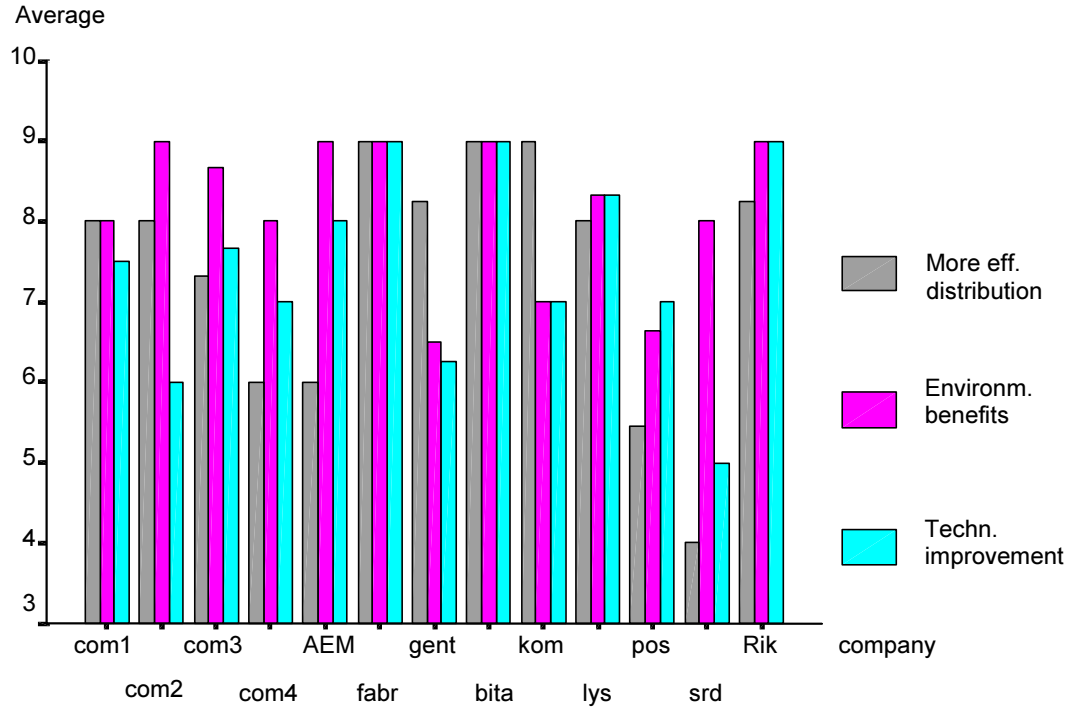

Figure B.1 *Average value per company for three objectives of the ELCIDIS project for electric vehicles*

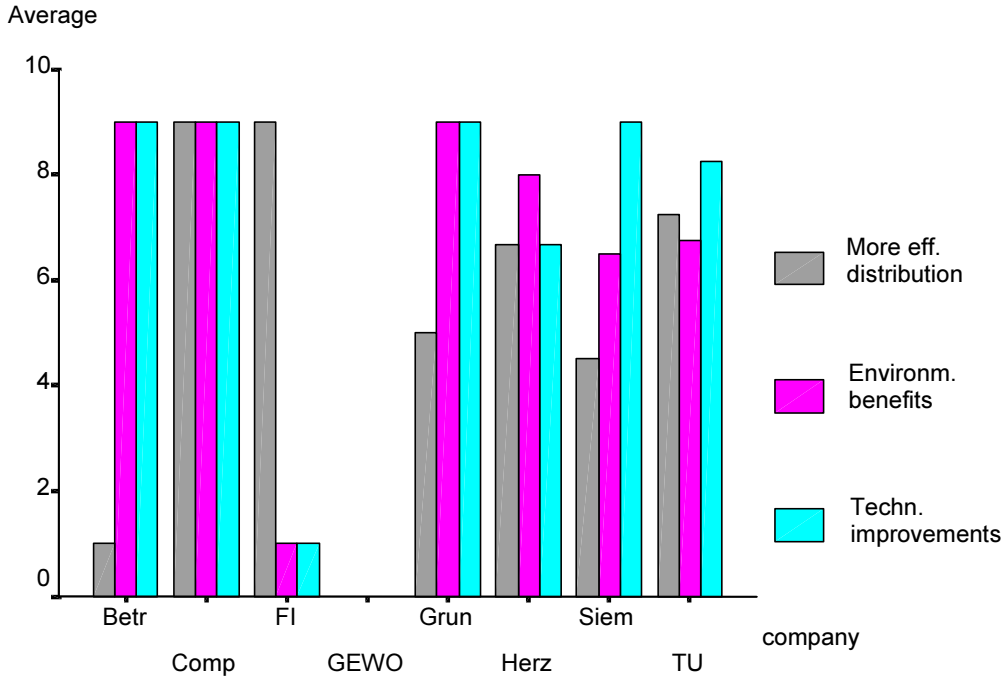

Figure B.2 *Average value per company for three objectives of the ELCIDIS project for hybrid vehicles (Erlangen)*

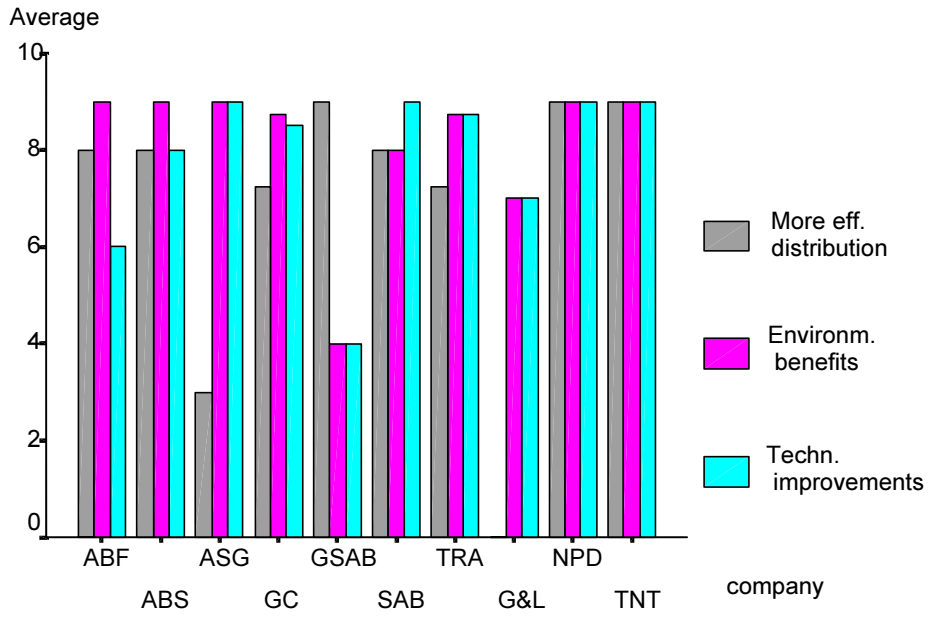

Figure B.3 *Average value per company for three objectives of the ELCIDIS project for hybrid trucks vehicles*

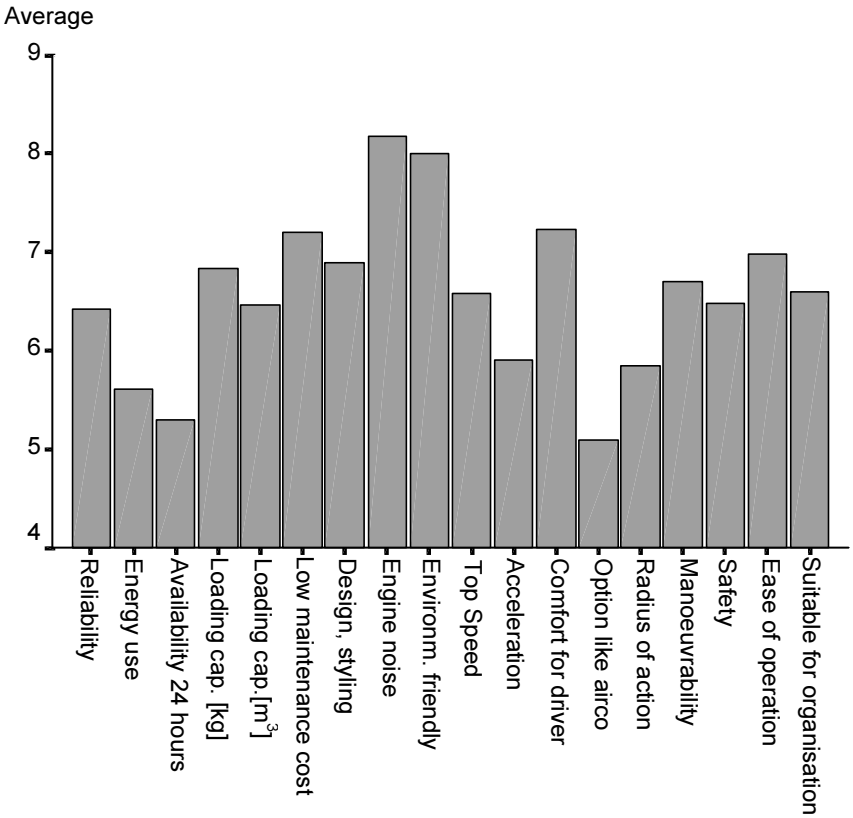

Figure B.4 *Average score of different aspects of the actual performance of the electric vehicles*

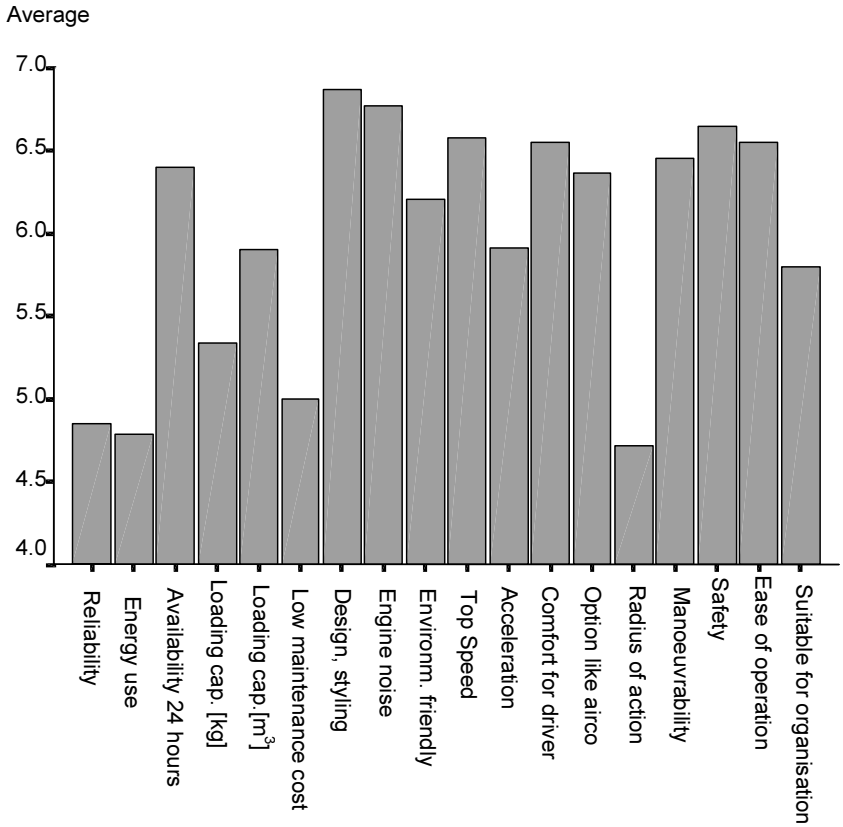

Figure B.5 *Average score of different aspects of the actual performance of the hybrid cars*

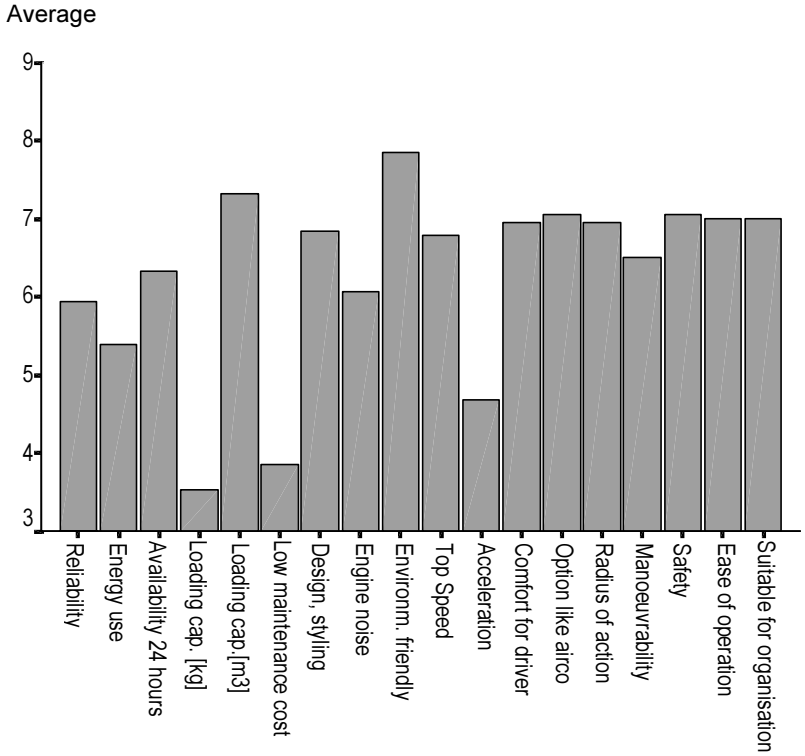

Figure B.6 *Average score of different aspects of the actual performance of the hybrid trucks*

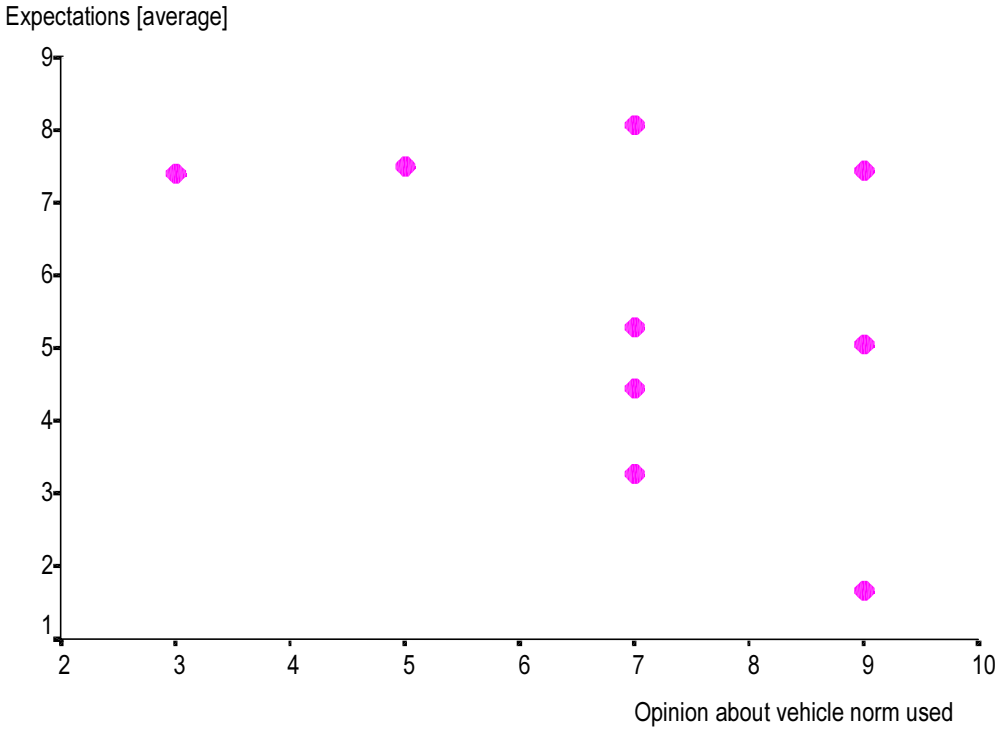

Figure B.7 *Opinion about the vehicle normally used vs. expected performance of hybrid vehicles*

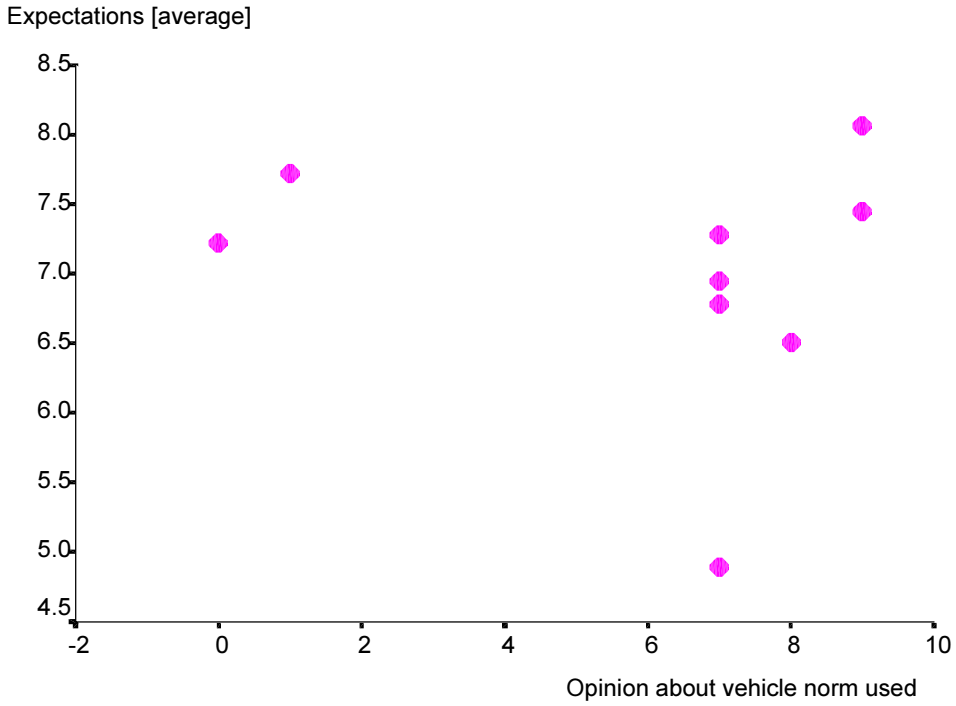

Figure B.8 *Opinion about the vehicle normally used vs. expected performance of hybrid trucks*

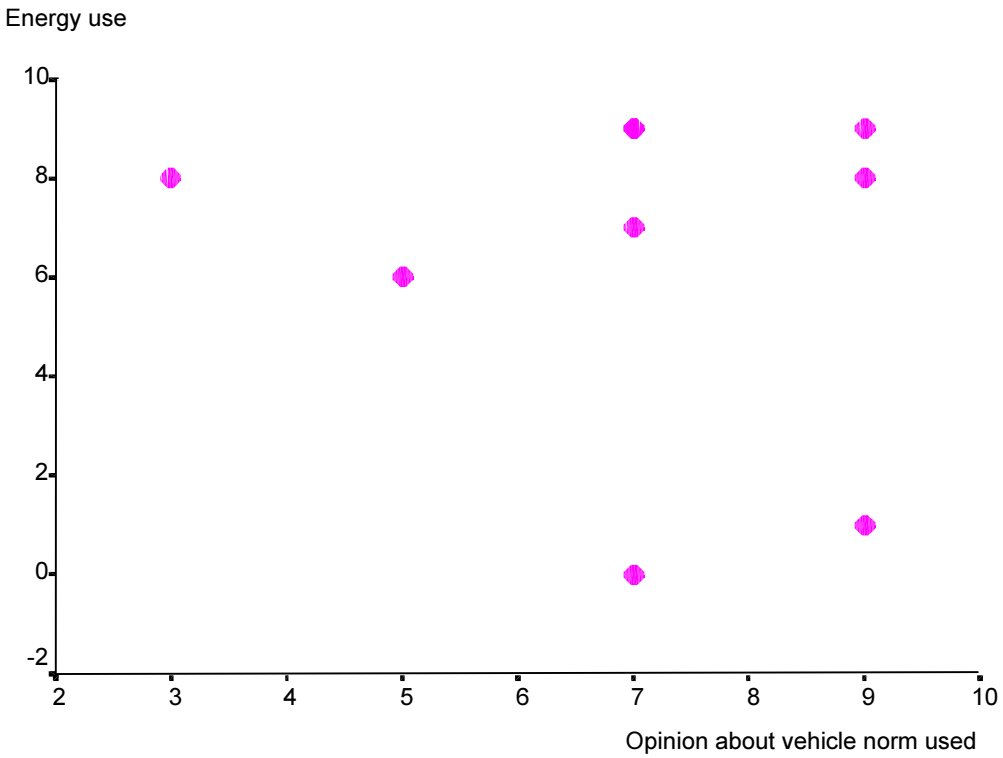

Figure B.9 *Opinion about the vehicle normally used vs. expectated performance of hybrid vehicles*

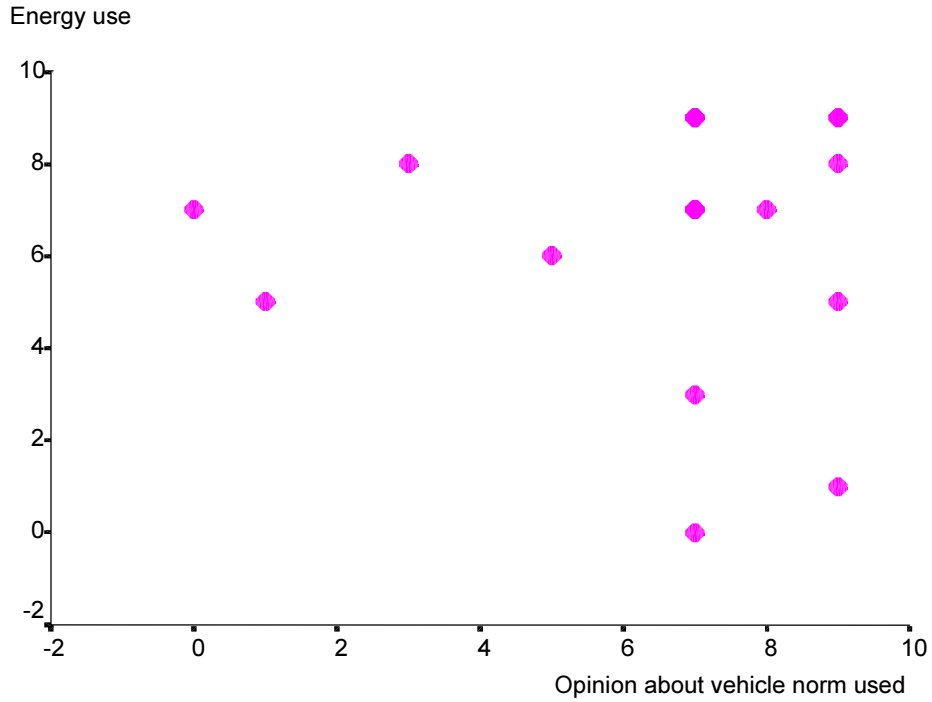

Figure B.10 *Opinion about the vehicle normally used vs. expectated performance of hybrid trucks*

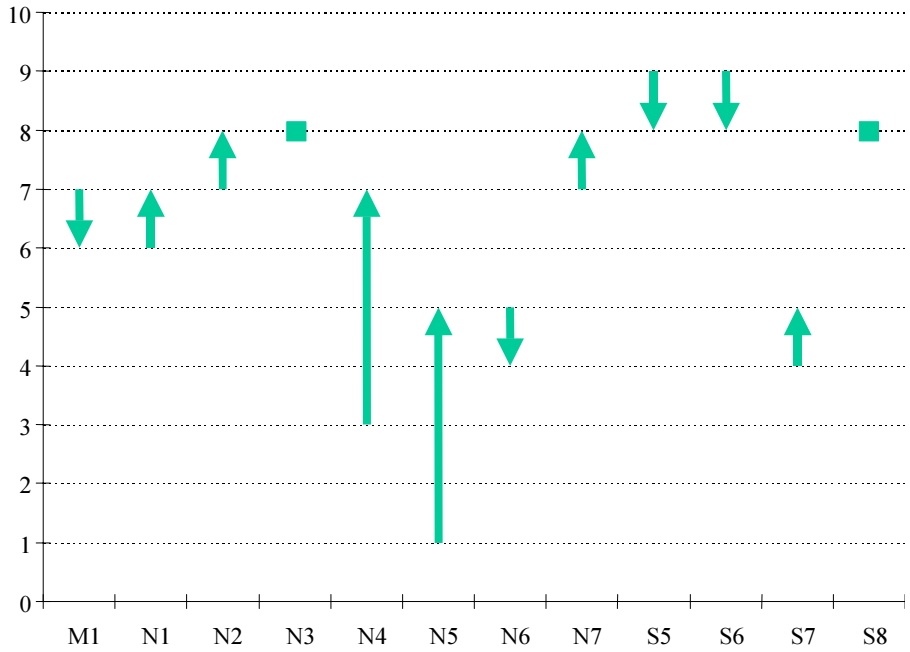

Figure B.11 *Observed shift in the score on overall opinion during the project for electric vehicles (M = Milan, N = Stavanger, S = Stockholm)*

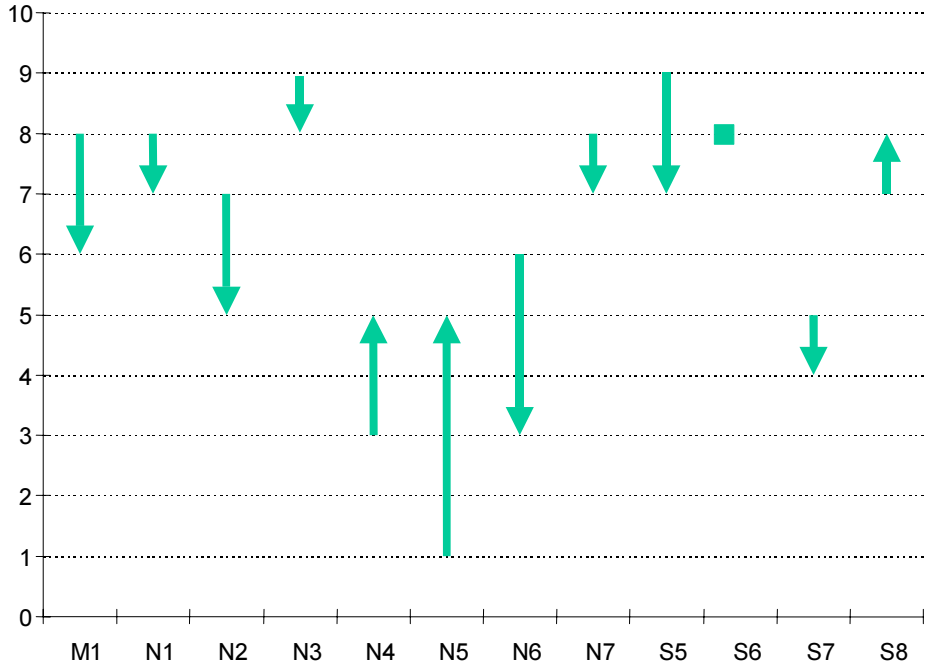

Figure B.12 *Observed shift in the score on reliability of electric vehicles during the project (M = Milan, N = Stavanger, S = Stockholm)*

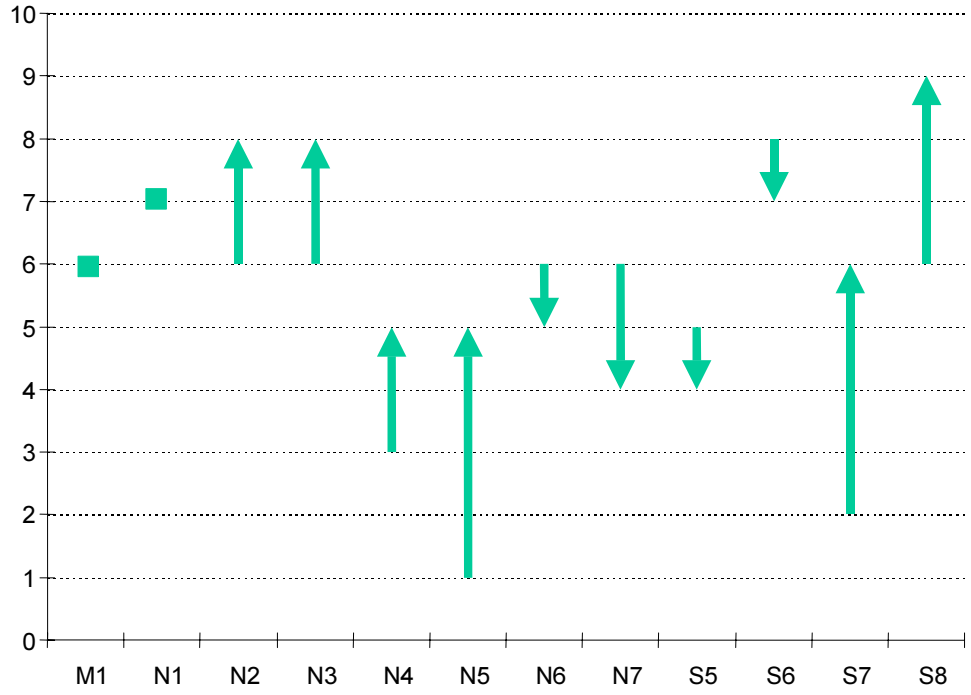

Figure B.13 *Observed shift in the score on energy use of electric vehicles during the project (M = Milan, N = Stavanger, S = Stockholm)*

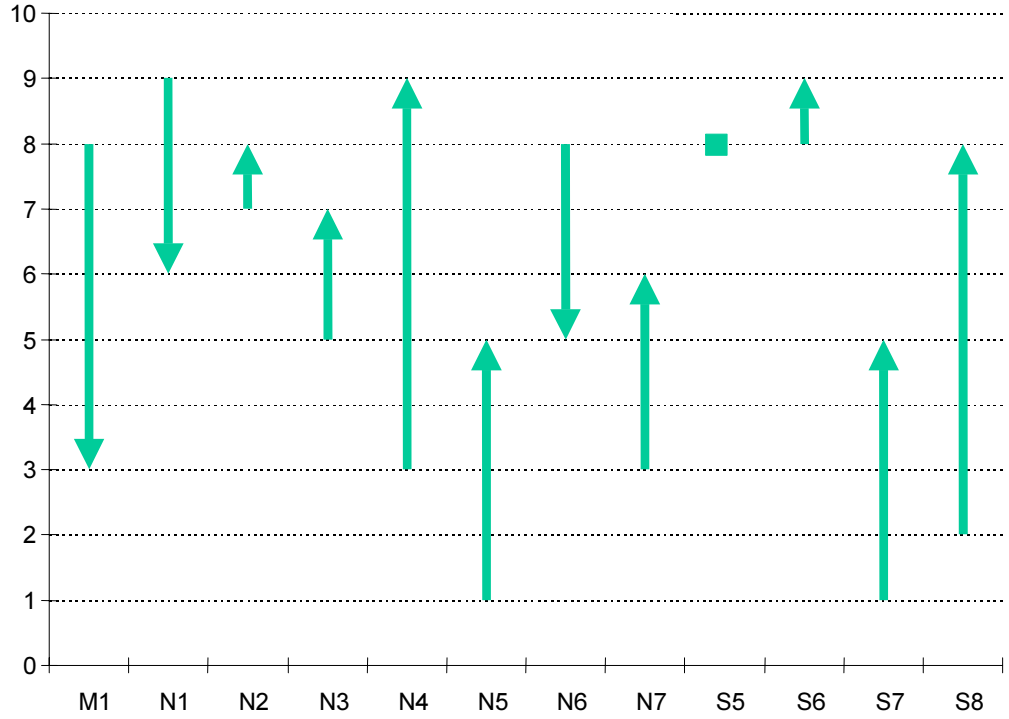

Figure B.14 *Observed shift in the score on acceleration of electric vehicles during the project (M = Milan, N = Stavanger, S = Stockholm)*

Figure B.15 *Observed shift in the score on radius of action of electric vehicles during the project (M = Milan, N = Stavanger, S = Stockholm)*

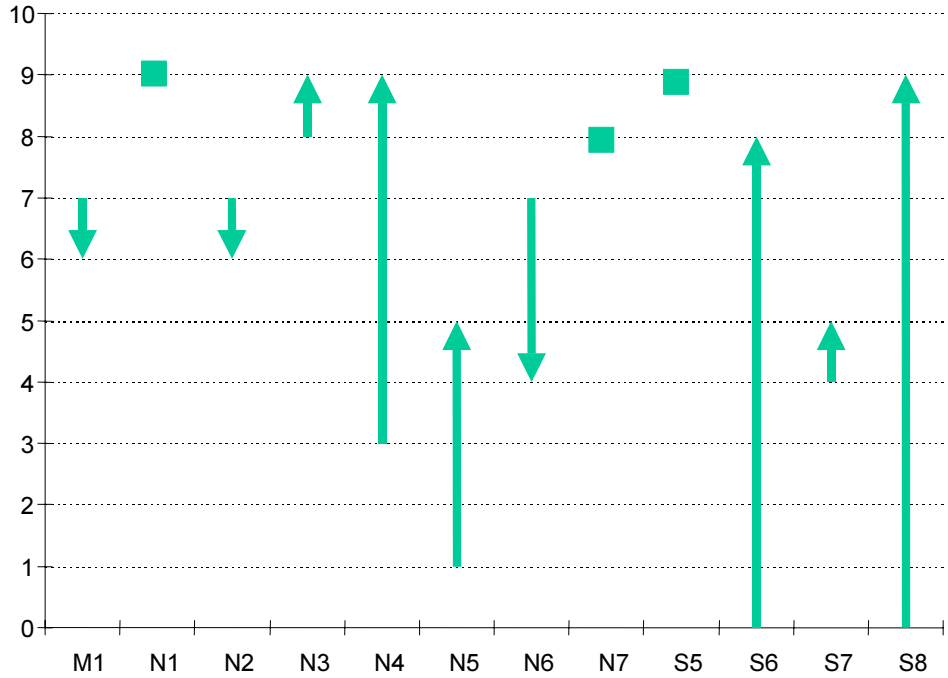

Figure B.16 *Observed shift in the score on safety of electric vehicles during the project (M = Milan, N = Stavanger, S = Stockholm)*

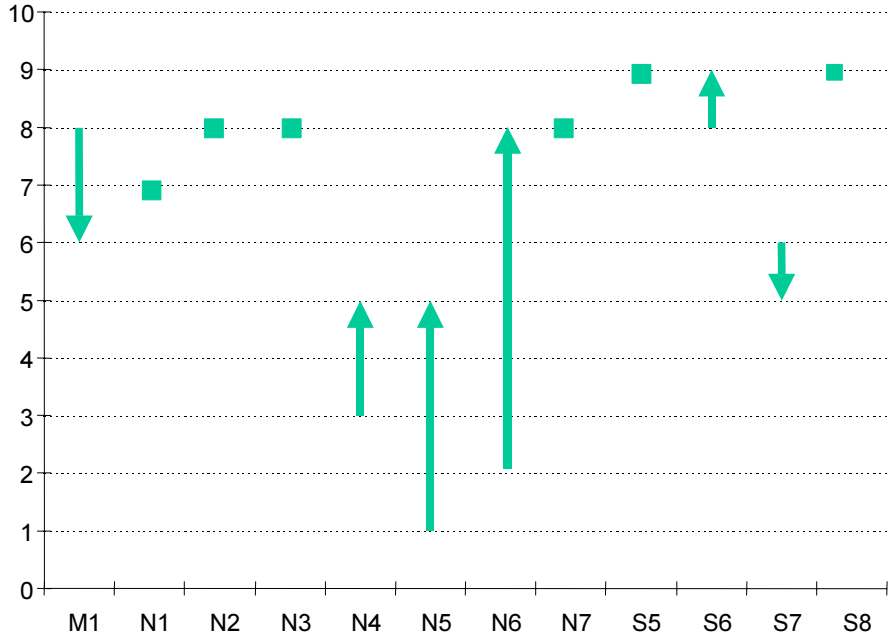

Figure B.17 *Observed shift in the score on ease of operation of electric vehicles during the project (M = Milan, N = Stavanger, S = Stockholm)*

Figure B.18 *Observed shift in the score on suitable for our organisation during the project for electric vehicles (M = Milan, N = Stavanger, S = Stockholm)*

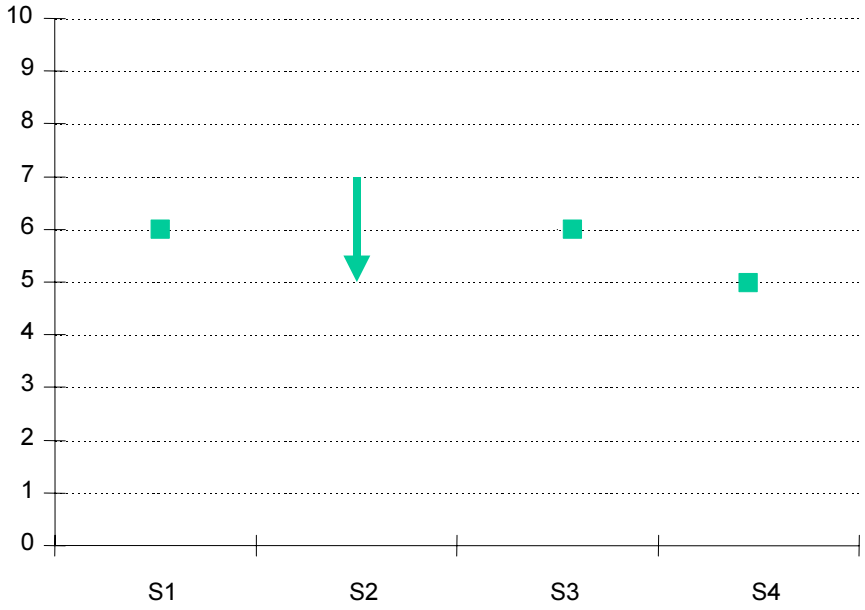

Figure B.19 *Observed shift in the score on overall opinion during the project for hybrid trucks in Stockholm*

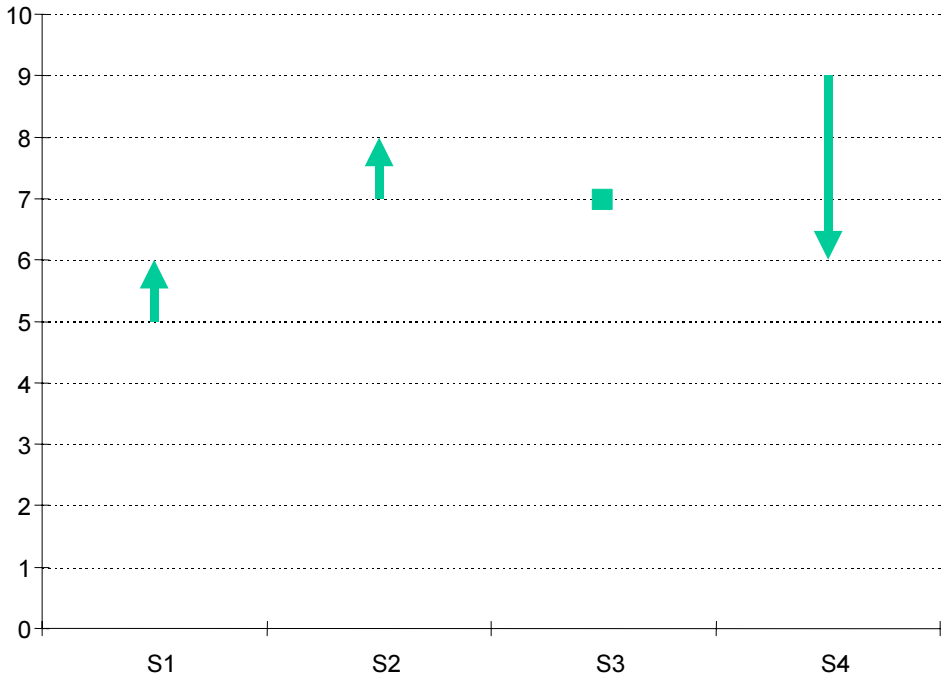

Figure B.20 *Observed shift in the score on reliability of hybrid trucks during the project in Stockholm*

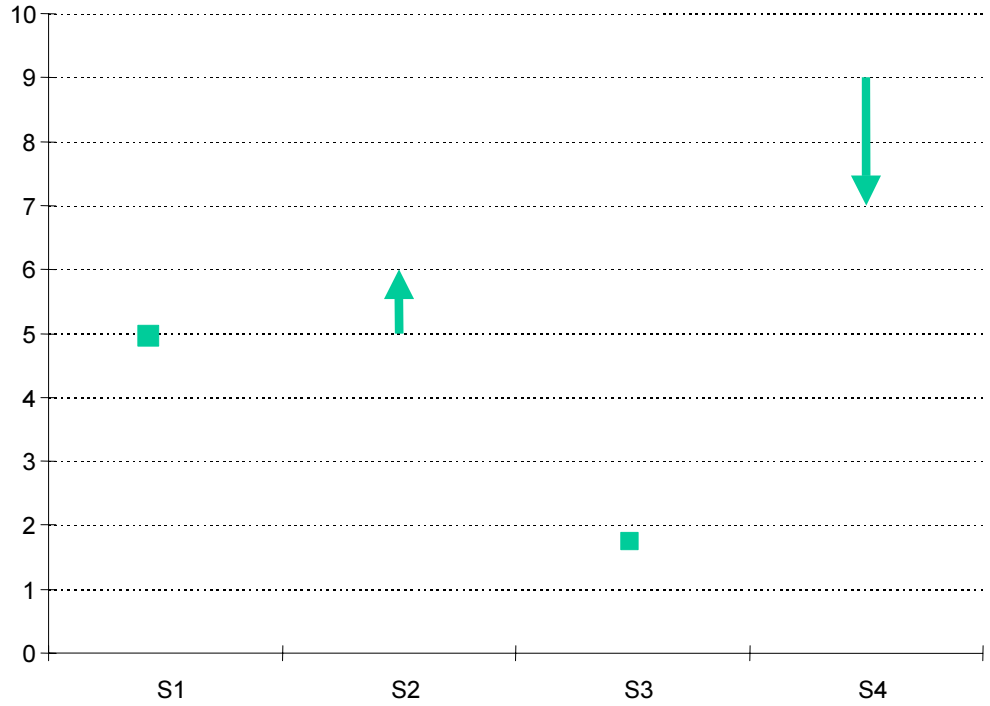

Figure B.21 *Observed shift in the score on energy use of hybrid trucks during the project in Stockholm*

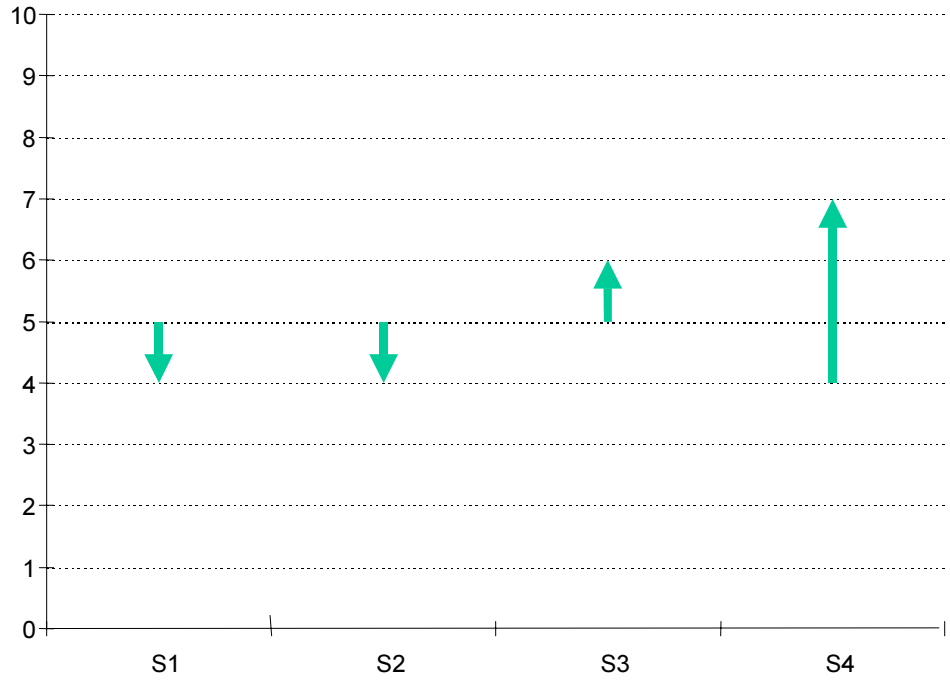

Figure B.22 *Observed shift in the score on acceleration of hybrid trucks during the project in Stockholm*

Figure B.23 *Observed shift in the score on radius of action of hybrid trucks during the project in Stockholm*

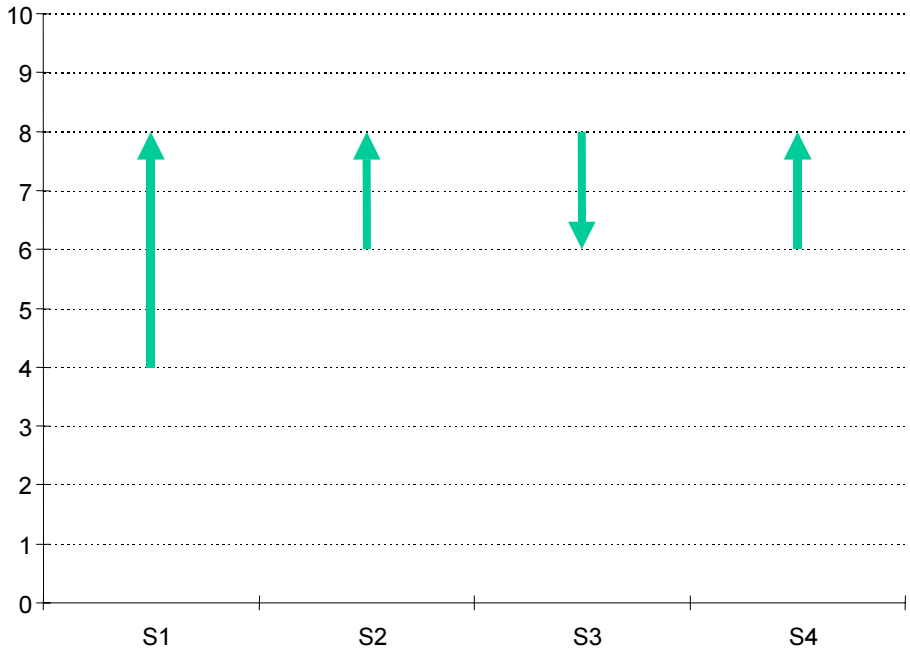

Figure B.24 *Observed shift in the score on safety of hybrid trucks during the project in Stockholm*

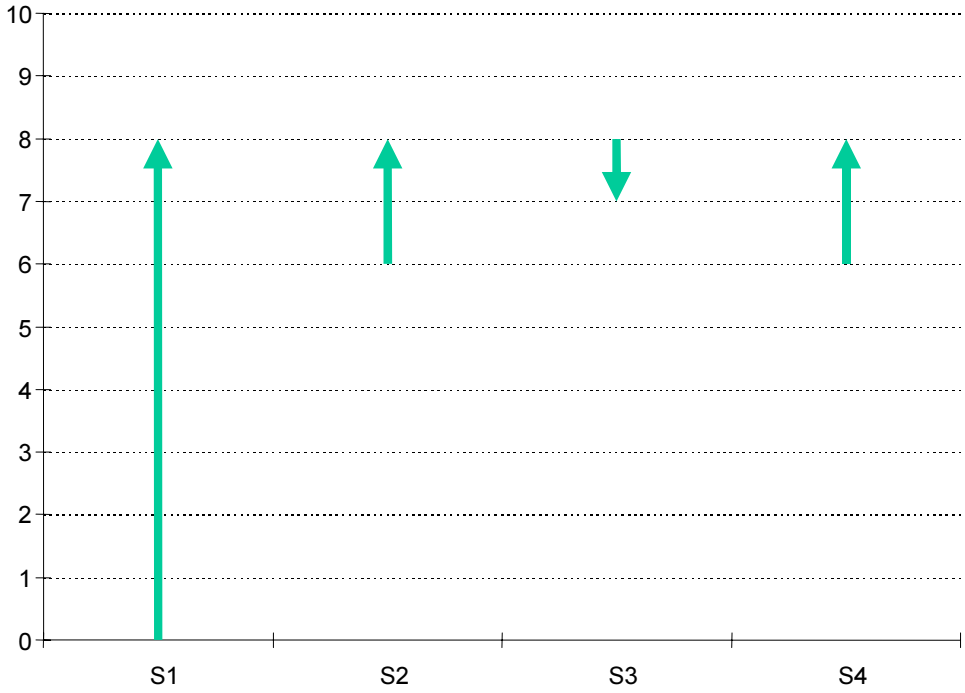

Figure B.25 *Observed shift in the score on ease of operation of hybrid trucks during the project in Stockholm*

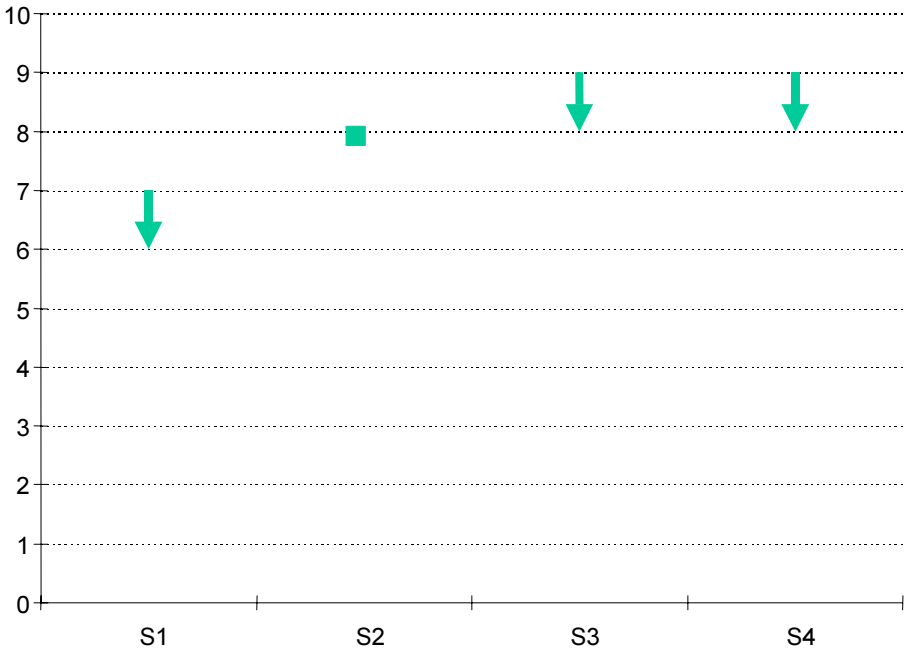

Figure B.26 *Observed shift in the score on suitable for our organisation during the project for hybrid trucks in Stockholm*

REFERENCES

EVD (2001): *Electric Vehicle Deliveries in Postal Services*.

EVWG (2000): Electric Vehicle Working Group. Evaluation of Targeted Transport Projects.