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Socio-economic Analysis of Electric Vehicles in Morocco

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Abstract

Conscious of the economic and environmental stakes, Morocco tries to reconcile durably the economic development and the climate protection. This reconciliation is performed by developing new alternative sources of energy, encouraging the new practices and improving the measures of "electric mobility"; and driven by reducing the fuel consumption of the road vehicles. Therefore, this paper exhibits the reasons influencing the Moroccan choices of transportation modes, in particular, those taken according to electric vehicles technologies. Our aim is, then, to investigate possible options to integrate this mode of green transport in the Moroccan context, while respecting their expectations and limits.

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1. Introduction

Transport is undoubtedly one of the most energy intensive sectors in Morocco. It represents a level of 41% of national final energy consumption, which causes significant emissions of pollution and greenhouse gases (GAS) to more than 23% in the atmosphere of the Kingdom [1]. The energy consumed by this sector comes mainly from petroleum products that are imported entirely from outside countries. This energy dependence is therefore largely responsible for the heavy weight of the energy bill, and therefore the balance of payments [2].

The negative impact caused by several means of transport is important on our environment. In order to reduce it, we have to profoundly review our mobility "needs" and learn more about the travel patterns of users. This step is

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considered essential in order to promote new modes of mobility more ecological and more environmentally friendly. It is in this context that electric mobility is developed as an alternative transport mode to the thermal vehicle [3].

The electric car is often advanced as a possible solution for these energy and economic stakes. If it exists for more than a century, it's only for less than a decade that it's brought back to light and one again becomes a real option for motorists [4].

In this sense, a survey was carried out in order to better understand the reasons which influence the choice of Moroccan modes of transport, and especially their attitude towards electric cars to ensure an adequate integration of this green mode of transport, while respecting the expectations of the Moroccan consumer. From this perspective, several questions emerge: are the Moroccan users ready to change their mode of transport and to opt for electric cars? To what extent would electric cars correspond to the expectations of these users?

To bring to a successful conclusion in this survey, we developed a questionnaire which we disseminated over the period from November 2016 to January 2017, mainly during the 22nd Conference of the Parties (COP22). The target of this survey is all Moroccan users, including all socio-professional categories. The data which we collected and the indicators which we built allow finer conclusions about the phenomenon studied.

The paper is organized as follows: Section II presents a general methodology of the survey. Once the survey data is collected, section III proposes a processing, analysis and interpretation of results. Conclusions and recommendations are drawn in Section IV.

2. General methodology of the survey

2.1. Collecting survey data: Strategies

The survey aimed to interview a representative sample of Moroccan households composed of major people of at least 18 years old. An online platform dedicated to questionnaires creation and sharing was opted: i)- to obtain major parts of survey questions answered by interviewees; ii)- to allow a fluidity both for the collection and for the posterior treatment; and iii)- to reach large numbers of respondents coming from different categories. The aforesaid platform is able to transfer the collected data to a statistical software (Xlstat, SPSS, Statview,...).

Data collection was conducted in two ways [5]:

- On-line: consist of structured and simple forms offering instantaneous collecting of mass answers, as well as simple manipulation tools;
- Face-to-Face: consist of physical interviews offering a realistic insight about the interviewee opinions as well as more detailed answers.

2.2. Sampling methods

In order to ensure a better representativeness of the sample in relation to the target population, we opted for the method of simple random sampling. Thus, all the possible combinations pulled of the population have the same chances to be selected. In other words, all the elements of the population have an equal probability to be a member of the sample [6]. The size of the theoretical sample was calculated according as follows:

$$n = \frac{Z^2 P(1 - P)}{d^2}$$

Where Z ($= 1.96$) represents the value given in the normal law table for a 95% confidence level; d is the sampling error or tolerated margin of error; and P is the proportion of people whose behavior is estimated. For an infinite population, P is estimated to be 0.5.

For $P=0.5$, a confidence threshold of 95% and an accepted margin of error $\pm 5\%$ (0.05), the size of the theoretical sample is as follows:

$$n = \frac{Z^2 P(1-P)}{d^2} \approx 385 \text{ respondents}$$

Therefore, we need 385 respondents to have a maximum margin of error of 5% at a 95% confidence level.

After determining the required theoretical sample TS, it is necessary to determine the number of starting units in order to ensure the desired theoretical number. To this end, a pilot survey is required. This is a study of a small sample of the population surveyed (of the 385 respondents), taking into account the non-response rates, the invalidity of the selected units (taking into account errors and imperfections) and of the eligibility (the answers which should not appear on the list). The formula for the starting sample (ED) is as follows:

$$ED = TS \times \frac{1}{(Non_RR)} \times \frac{1}{IR} \times \frac{1}{ER}$$

Where TS is the theoretical sample, Non_RR is non-response rate, IR is the invalidity rate and ER is the Eligibility rate.

We remind that the collection of the obtained data was carried out in two ways: On-line and Face-to-Face. Thanks to these two methods of collection, we were able to anticipate the biases likely to give rise to errors in the results obtained. Indeed, an online survey allowed us to maximize the chances to obtain a satisfactory response rate. In other words, we cannot receive an answer to the inquiry without it being complete. The face-to-face surveys were used to adapt, to limit the abandonment of the respondents, reassuring them for example on the number of remaining questions...

It is noteworthy to mention that most of the responses were collected at The 22nd Conference of the Parties COP22. We have noticed a strong involvement of the respondents, for several reasons: i)-interest of visitors on the subject of electric cars; ii)-correct size of the questionnaire; iii)-simple and easy-to-fill questions. All of these reasons prompted the respondents to respond and complete the investigation.

Using these factors or reasons, we were able to determine the size of the starting sample, which is only the equivalent of the theoretical sample. However, for more certitude, we will add to this sample 5 others questioned. So, the size of the selected sample will be 390 people.

3. Analysis and processing of survey results

All The survey allows developing:

- The subjects related to the travel modes;
- The choices and the constraints of this mode;
- The level of satisfaction or knowledge of the people questioned related to the electric car.

3.1. Results analysis

are Several questions were asked to the interviewees concerning their attributes such that their profile; the most popular mode of travel; the daily traveled distance; their point of view in relation to purchasing and maintenance costs; their tolerated price of an electric car; their main motivating factors and obstacles to acquire an electric car; number of seats required in the electric car.

3.1.1. Respondent's profile

As an implicit indicator of purchasing power, respondents were asked about their socio-occupational category. Among our sample of respondents, private sector executives accounted for 56%, compared to 23% working as public servants, 14% are students and 7% working in a liberal profession.

3.1.2. The most popular mode of travel

In Figure 1, about 6 out of 10 people travel to their workplaces / universities by car. Whether they live in or near the urban center, users prefer this means of transport to reach their destination. They primarily use their car (61%), but they also benefit from the availability of public transport, bus or taxi: 25% of respondents primarily use this travel mode. We also have 8% of bike and motorcycle adepts to make daily trips. Compared to all possible travel modes, walking is the least practiced method at a rate of 5%.

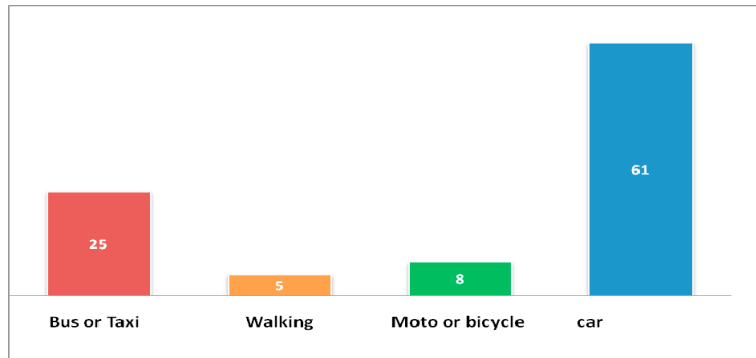


Figure 1. The means of transportation used most frequently

3.1.3. The daily traveled distance

68% of Moroccans travel daily on a journey of less than 30 km, compared to 23% traveling between 30 and 60 km in transport. This configuration is very interesting for the development of electric mobility for different considerations (autonomy of charge, development of the infrastructure, etc.). Therefore, we can conclude that the mobility patterns (mode of travel and traveled distance) of the majority of respondents are conducive to the development of electric vehicles.

3.1.4. Overview on electric cars

93% of the interviewed Moroccans said they had heard about the electric car, while 7% weren't aware of it. This is good news for automotive players wishing to penetrate this new market, although it will be necessary to see to what extent consumers pass in the action to buy n electric car.

3.1.5. High purchase cost of electric cars

One of the major lessons of this survey is also the initial knowledge of Moroccans regarding electric cars. Figure 2 show that 73.2% of respondents believe that the purchase cost of electric car is high:

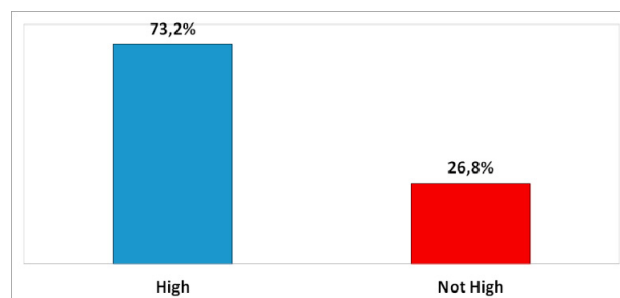


Figure 2. Point of view of respondents related to the purchase cost of electric cars

The price of electric cars is heavily debated. As we have just mentioned, the vast majority see these electric cars more expensive than their thermal equivalents. This additional cost to purchase is mainly due to the lack of scale economies in this electric car industry and the high cost of batteries. In order to make their prices competitive, some manufacturers have chosen to market their cars without batteries and to offer them for hire. This is the case of the Renault that has adopted this strategy in its zero emission.

3.1.6. High maintenance cost of the electric cars

In figure 3, about 9 out of 10 Moroccan respondents think that the maintenance cost of the electric cars is very expensive:

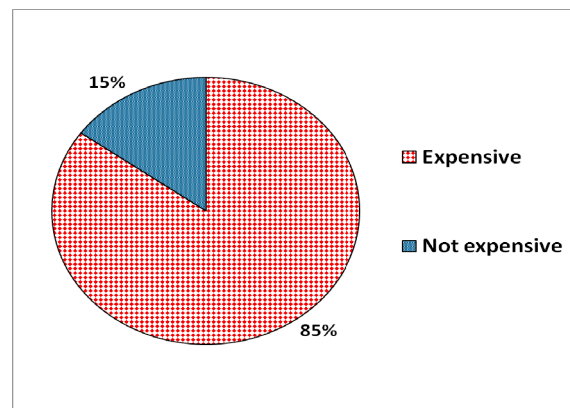


Figure 3. Point of view of respondents related to the maintenance cost of electric cars

However, this finding is completely wrong. Except the regular annual check requested by some manufacturers regarding the state of the battery, electric cars are fairly simple to maintain. Indeed, many maintenance operations disappear: drainage, chain of distribution, candles, exhaust pipes etc. Only elements such as brake pads / discs or tires are to be regularly changed, accompanied, of course, by the wipers and windscreen washer.

3.1.7. The tolerated price of an electric car

Price, which is the main buying factor, is a barrier to the interviewees. 75% of the sample will not pay more for an electric car, compared with 21% who tolerated an increase of 20% maximum compared to a classic car.

3.1.8. Electric car: ecological and economic

The awareness of the environmental stakes and the impact of the individual mobility on the environment is thus the first motivation of the future buyers of electric cars. Indeed, in Fig. 4, the questioned sees the electric car as being ecological (29 %) and could be globally interested in the electric car if only its costs in the purchase and in the maintenance are economic (31 % and 21 % respectively):

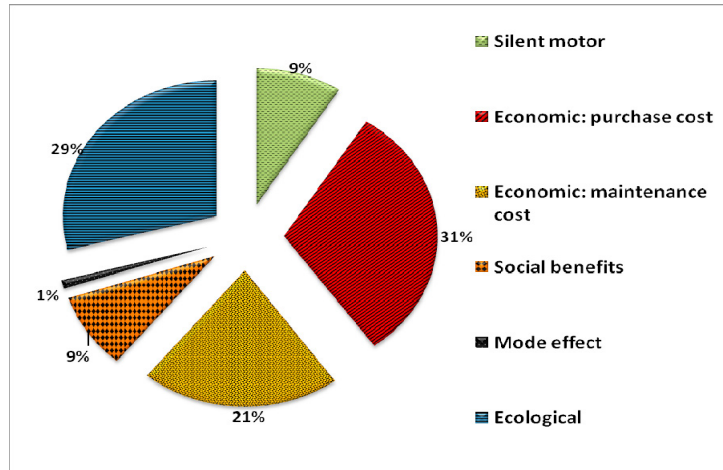


Figure 4. Main motivating factors to acquire an electric car

3.1.9. Main obstacle for buying an electric car: Cost to purchase

The electric car presents a very favorable market for the automobile sector. However, its development is limited by serious constraints. The first constraint is purely budgetary. In figure 5, 5 in 10 people believe that the purchasing cost of an electric car is an obstacle. The Zoe model of Renault is offered in Morocco for long-term leases over a period of four to five years, with a purchase option -leasing- for an amount of 6 999 MAD tax inclusive or 6 399 MAD tax inclusive per month. Unlike countries where the electric car market is developed, the Moroccan buyer of a new electric car doesn't yet benefit from the ecological bonus, or scrapping premium.

The high maintenance cost of an electric car compared to a thermal car is also a constraint for 16.5% of respondents. As for limited autonomy, it is a source of demotivation for about one-sixth of the respondents.

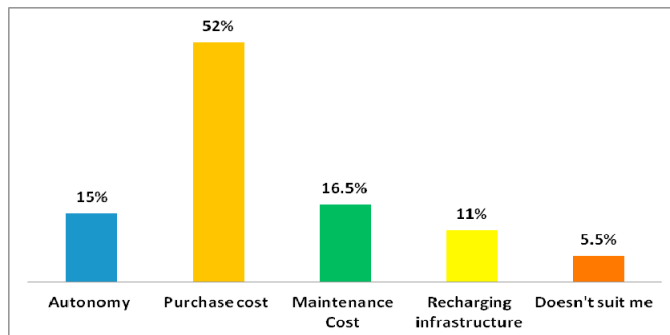


Figure 5: main element that demotivates you to get an electric car

The fourth constraint to the development of the electric car is the lack of availability of charging terminals as well as the recharging time of batteries which, depending on the installation, may take hours.

3.1.10. Recharging points for electric cars

We note that over two thirds of respondents (>66%) prefer to recharge their future electric cars on public parking, while 27% choose home recharging.

In the figure 6, recharging an electric car for a period ranging from 30 minutes to one hour satisfies roughly three quarters of the sample (78%). This means that you have to think, for example, of more advanced technologies allowing a quick recharge of the battery.

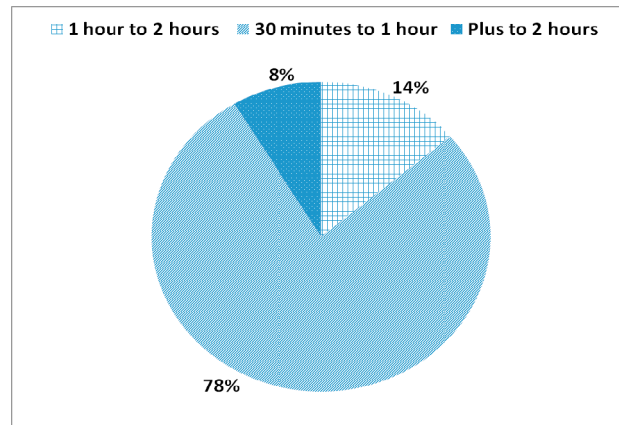


Figure 6: Charging time accepted

The integration of electric cars into the power grid in Morocco is still a controversy topic. Given the reduced autonomy of this type of vehicles, its recharging will lead to an additional and massive demand for electric power that the power grid will have to manage and satisfy.

3.1.11. *Autonomy of the electric car*

According to the sample, for 62% of Moroccans, an electric car meets their mobility needs perfectly if it offers more than 200 km of autonomy, compared with 38% which satisfy autonomy ranging between 100 and 200km. It is important to note that beyond the displayed capacity of the batteries, the real autonomy of electric vehicles depends on several factors related to the driving style, the speed, the altitude difference of the roads used (city, road...) and to electrical accessories (heating, air conditioning, headlights and other electrical equipment).

3.1.12. *Number of seats required: a trend towards large sizes*

We have noticed that the majority of respondents have a tendency towards spacious cars: 66% prefers electric cars containing 5 seats or more. 32% have a preference for medium-sized cars, while only 2% prefer the two-seater car.

3.1.13. *Multivariate Statistical Technique*

The Factor Correlation Analysis is a method for studying the association between two qualitative variables through the chi-square test. Developed by Karl PEARSON (1857-1936), this test is used to assess the existence or non-existence of a relationship between two characteristics within a sample, where these characteristics are qualitative or where one character is quantitative and the other qualitative, or where both characters are quantitative. Table 1 shows the data of a survey of 390 interviewees, about their intent to purchase electric cars and their age:

Table 1. Observed numbers (Electric car's purchase intention / Age)

Age	18 - 25 years	26- 35 years	36 - 50 years	50 years and +	Total
Electric car's purchase intention					
No	13	20	9	16	58
Yes	73	89	98	72	332
Total	86	109	107	88	390

To know if electric cars purchase intention has a significant influence on the age, we will do a chi-square test. The table 2 shows the results that we had:

Table 2: Independence test between electric cars purchase intention and age

Chi-square (Observed value)	6,481
Chi-square (critical value)	15,507
Degree of freedom	8
p-value	0,594
Alpha	0,05

- Interpretation of the test:

H0: electric car's purchase intention and age are independent.

Ha: There is links between the electric cars purchase intention and age.

Since the calculated p-value is greater than the threshold significance level $\alpha = 0.05$, we cannot reject the null hypothesis H0: Hypothesis H0 accepted. So, there is independence between the two variables, namely the electric car purchase intention and age. In other words, the age of respondents has no influence on buying or not an electric car.

In table 3, we will study the independence between family situation and desired size of electric car:

Table 3: Observed numbers (family situation and desired size of electric car)

Family situation	Desired size of electric car			Total
	2	4	5	
Single	6	74	74	154
Married with children	3	43	167	213
Married without children	2	8	13	23
Total	11	125	254	390

In the same way as the previous test, the table 4 presents the different variables allowing the development of the chi-square test.

Table 4: Independence test between family situation and desired size of electric car

Chi-square (Observed value)	40,386
Chi-square (critical value)	16,919
Degree of freedom	9
p-value	<0,0001
Alpha	0,05

- Interpretation of the test:

H0: The respondents' family situation and the desired size of electric car are independent.

Ha: There is a link between respondents' family status and size wanted from electric car.

Since the calculated p-value is lower than the level of significance $\alpha = 0.05$, the null hypothesis H0 must be rejected, and the alternative hypothesis Ha must be retained. In other words, there is a link between the respondents family situation and the desired size of electric cars.

In table 5, we will look for the possibility of independence between Socio-professional category SPC and the price of Electric Vehicle tolerated:

Table 5: observed numbers (SPC/ The price of EV accepted)

The price of EV accepted \ SPC	private sector executives	Student	Public servant	Liberal Profession	Total
Maximum 20% more expensive than the thermal car	45	10	21	5	81
More than 20% than thermal car	6	4	4	2	16
Same price as a thermal car	166	39	65	23	293
Total	216	53	87	29	390

In the same way as the previous test, the table 6 presents the different variables allowing the development of the chi-square test.

Table 6: Independence test between socio-professional category and the price of EV accepted

Chi-square (Observed value)	4,054
Chi-square (critical value)	21,026
Degree of freedom	12
p-value	0,982
Alpha	0,05

- Interpretation of the test:

H₀: SPC and the price of EV accepted by the survey are independent.

H_a: There is a link between SPC and the price of EV accepted by the survey.

Since the calculated p-value is greater than the threshold significance level $\alpha = 0.05$, we cannot reject the null hypothesis $H_0 \Rightarrow H_0$ accepted. In other words, there is no correlation between SPC and the price of EV accepted by the surveyed.

Conclusion

The various data collected and the observations made allow us to draw more precise conclusions about the expectations of Moroccans towards the electric cars.

Being risk averse, the Moroccan customer needs to be reassured about several parameters likely to affect his decision to buy. Indeed, the price of an electric car must be equivalent to that of a classic car; the autonomy of the electric car must be more than 200 km, and think about the possibility to easily recharge the electric car on public parking or at home.

For an accompaniment adapted to the green mobility in Morocco, it is recommended to think of motivating factors such as i)-granting ecological bonuses for any purchase of a new electric car; ii)- taxing the strongly emitting CO₂; and iii)- scrapping the classic cars put into circulation. Also, from an ecological point of view, and to avoid criticism of the origin of electricity, it is necessary to popularize projects (realized / planned) related to renewable energies.

To conclude, there are several countries at the international level which have taken the initiative to develop electric mobility on their territory. We mention Estonia, which was one of the first countries to set up a national network of fast shippers, installing 165 fast shippers for a population of 1.3 million [7]. This provided each city with a fast charger as well as charging stations every 40 to 60 km. These stations can recharge the battery of an electric car up to 80% in less than 30 minutes. The Swedish Energy Agency, on its side, provides financial support by offsetting the additional cost of the first 550 vehicles purchased under the framework procurement contracts. This means that organizations will receive up to 50% financing of the additional cost to a maximum of 14,000 dollars. The additional cost is the difference between the cost of an electric car and its nearest counterpart among the cars with combustion.

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