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# Factors Affecting the Adoption of Hybrid-Electric Buses in Egypt

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***ABSTRACT***
***Purpose –*** *The purpose of this paper is to study the factors affecting the adoption of hybrid electric buses in Egypt.*
***Design/methodology/approach –*** *The author applies Roger's diffusion of innovation model to test the influence of the independent variables on the intention to purchase hybrid electric buses in Egypt (the dependent variable).*
***Findings –*** *Relative advantage, compatibility, complexity and organizational norm were proven to influence the dependent variable. Visibility and testability were not significant.*
***Research limitations/implications –*** *Cluster sampling is classified as one of the probability sampling techniques and as the least generalizable among these techniques as it is exposed to a greater bias among them. In this study, it was recommended to use the cluster sampling as there was no available list of the population elements. Also to be able to have a second stage area cluster. On having a clearer list of population elements, a more generalizable sample technique is recommended for future researches.*
***Practical implications –*** *It is recommended for companies to invest in buses with ranges from 120 to 150 Km/day capacity. 80% of the sample buses operate up to 140 Km/day.*
***Social implications*** *– As the V2G technological model was represented to the respondents, educational transportation sector was a main target market to this product type (as it was expected to have only 2 round-cycles per day).*
***Originality/value*** *– This study is targeting to add value to the present literature on the diffusion of innovation theory and on the electric vehicles.*
***KEYWORDS:****Diffusion of innovation, Electric Vehicles*
***Paper type*** *Research paper*

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**List of Abbreviations**

| | |
|---|---|
| AMIC | Automotive Marketing Information Council's |
| B2B | Business to Business |
| B2C | Business to Customer |
| BEV | Battery Electric Vehicles |
| CFA | Confirmatory Factor Analysis |
| CV | Commercial Vehicles (including buses and trucks) |
| PEOU | Perceived Ease of Use (the negative or reverse of "Complexity") |
| EV | Electric Vehicles |
| HEV | Hybrid Electric Vehicles |
| HEV-Bus | Hybrid Electric Bus (usually including a Plug-in option) |
| ICE | Internal Combustion Engine |
| OEM | Original Equipment Manufacturers |
| PC | Passenger Cars |

V2G Vehicle-to-Grid: is one of the designs of the hybrid electric buses which are capable to charge their batteries from the network (grid) during stop periods or from their ICE engine during operation. Extra un-needed electricity savings stored in the batteries or generated from the ICE-engines could be re-sold back to the network (grid) during peak periods, especially during vacations and non-use of buses.

## I. INTRODUCTION

The Automotive industry is a real global sector. With more than 70 million vehicles produced annually, the industry turnover exceeds the United Kingdom Gross Domestic Product (GDP), the world's sixth largest economy (Kierzkowski, 2011).

According to AMIC from 2013 to 2016 results (AMIC Egypt Report, 2014, 2015& 2016), the overall Egyptian market volume increased from 195,869 units in 2013 to 292,983 units in 2014 (+49.6%), with a slight drop of 5% in 2015 (278,406 units) and a severe drop in 2016 (198,271 units).

Buses were the only sector which showed a unidirectional increasing trend from 2011 till 2015, 2016 showed a decreasing market volume too. Buses increased from 23,825 units in 2013 to 30,922 units in 2014 (+30%) and again increasing in 2015 to reach 32,556 units (+5%) but finally drops in 2016 to reach21,283 units (-35%).

Accordingly, the Egyptian automotive market solely seems so much interesting to explore. Egypt's trading agreements expands the market's potentials to include some African and Arab-world nations markets as well. Egypt is having some beneficial accessibility "Policies, trading agreements or geographical neighboring" to these markets. It looks that there is a huge business opportunities.

Egypt, Africa and the Arab nations would face a red-ocean market on deciding to compete in the present automotive powertrain technology, the internal combustion engine (ICE). OEMs have been developing their automotive ICE powertrain drivers for more than a 100 year.A critical question arises, how competitive would an "Af-rabo-gyptian" brand be? (African, Arab, Egyptian). ICE is a red-ocean for these countries to start competing in.

Nevertheless, with such huge markets, the automotive business should not beleft behind. A competitive niche in a blue-ocean needs to be discovered. A competitive advantage need to be invested on till reaching a sustainable one.Lucky Egypt, Africa and Arab nations, the ICE-age is on the edge. Energy scarce, variation in petroleum prices, climate changes, environmental aspects and other factors (Welzel and Schramm-Klein, 2013) are changing the rules of the game. A new powertrain driver technology needs to be developed to be ready to replace the ICE one.

OEMs have already started a couple of decades developing their new technologies drivers for small, micro and city cars (Lieven et al. 2011). Lucky again for these nations, investing on the ICE technologies(includingpetrol and diesel versions) to maintain their market positions,in parallel with investing on several types of new technologies, OEMs efforts & investments are scattered. Also, as the technology is still in its cradle, only few models of replacement technologies are available for the customers. The present variety offered does not meet the customers' needs (The National Academy of Sciences, 2013).Alternatives varieties for the internal combustion engine includeliquefied petroleum gas vehicles (LPG),compressed natural gas vehicles (CNG), liquefied natural gas vehicles (LNG),biofuel, hydrogen &methanol vehicles.

A promising alternative powertrain driver is to utilize the electro-mobility (Ehrler & Hebes, 2012). Electric Vehicles (EVs)were developed as early as the ICE. But by 1930s all electric driven vehicles have almost disappeared (Shen etal., 2011).Recently EVs are emerging again with different models.

According to Bianchi et al. (2017), new products are subjected to a high failure probability. Same wise, the electric vehicles are hardly selling themselves. EVs are usually seen as an optional second car (Jabeen et al. 2012). Lebeau et al. (2012) consider the innovative technologies behavior to be slow regarding their diffusion. Their potential market share will definitely need significant time. It's only through further analysis that new insights can be added to the EV demand (Hidrue et al. 2011). It is expected that not before 2020 that the EV could reach a significant market share that allows economic mass production volumes (Peters et al. 2011).

Meantime, the local market acceptance is the major key player defining the breakthrough of this new innovative technology through the market. The present technological disadvantages (see literature review) have positioned the pioneer EVs applications to have "a defined-route + stop-areas-availability + extended-range". That's why the focus of this study will be on the HEV-Buses, which is expected to be the market penetrator for the EV-family.

This paper is divided into three parts. In part one; the literature covering the general perspective of electric vehicles is reviewed, including their perceived positives and negatives, in addition to the theoretical framework. Part two will focus on the research question and the research methodology, the research model selected & the hypothesis to be tested, the instrument, its reliability and validity measures,the population and the sampling plan. Part three will includeresults, discussions, limitations, recommendations and conclusion.References are scripted at the end of the paper.

## II. LITERATURE REVIEW

2.1 Electrical Vehicles Literature Review

"A developed country is not a place where the poor have cars. It's where the rich use public transportation." Enrique Peñalosa, former Mayor of Bogotá (Panzuela, 2013). Public transportation sector needs

to be restructured. Its significant negative influence on the greenhouse gases emission, the fossil fuels consumption and traffic jams threatens the present structure pointedly (Welzel and Schramm-Klein, 2013). Moreover, the transportation sector has always been one of the major petroleum consuming sectors in the United States (Mazraati and Shelbi, 2011) which could reach up to 40% of the overall gasoline consumption (Sallee, 2011).

According to AMIC report (2014), there were 17 automotive manufacturers in Egypt. This number is expected to be deducted to just 7 by 2020 due to the Agadir agreement and the General Agreement on Tariffs and Trade (GATT) agreements with the European Union. The latest won't just allow the European brands to penetrate the Egyptian market with zero customs but also other brands manufactured in Europe. A similar scenario happened in Nigeria. Since 1962, Nigeria has established several assembly plants, none of which exists and were totally closed down by 2012 (Oigiagbe et al. 2012). These challenges ravel out the need to invest not only in the automotive trading business but also in the industrial automotive knowhow.

Governments and policy makers need to work together to develop incentives and economic stimulations for both B2B and B2C, to make it more attractive to use public transportation and to shift to the EV technology (Tal et al. 2013). According to Sallee (2011), the United States has introduced taxes subsidies for fuel efficient and electric vehicles in response to their petroleum consumption in the personal transportation sector concerns. This sector consumes 40% of the overall gasoline consumption and causes 20% of the greenhouse gases emissions. In addition to traffic jams, foreign currency requirements, economic instability ...etc., developing countries need to subsidies public transportation more and more.

Despite that governmental role is expected to operate at all levels (Klier, T. & Linn, J., 2015; Antweiler, W., & Gulati, S., 2013; Carle, et al., 2005; The Energy Saving Trust, 2002 and Weiss et al., 2000), the EV adoption factors need to be on their prime. Different levels of importance are placed on different factors when a consumer starts making decisions regarding EV (Accenture Research, 2011).

The present literature regarding the EV adoption is really rare, especially for the commercial vehicles.

Moreover, how far can we depend on the findings? The EV technologies had developed radically since the early studies. Major factors at that time are not the key players today; early obstacles were overcome and became obsolete barriers due to the developed technologies. Other studies were only focusing on the hybrid version, the HEV (Ozaki, 2011).

Lebeau et al. (2012) expressed the pros & cons factors of the EV over the ICE. Pros of BEV were summarized as the ecological benefits, relative low running cost, swift acceleration and a considerable low noise. The National Academy of Science (2013) highlighted the dependence on imported petroleum as one of the advantages for the EV over the ICE. On the other hand, its cons were summarized in four elements, the relatively high price, the limited range, the absence of charging stations infrastructure and the long charging times (Lebeau et al., 2012). The National Academy of Science (2013) considered the latest three elements as the technological limitations for EV.

Regarding the high price, a 10,000 Euro on average was the difference between an ICE passenger car and its equivalent EV one (Welzel and Schramm-Klein, 2013). This figure is a relative high percentage difference when it comes to passenger cars. The National Academy of Science (2013) indicates that customers hardly discount the value of future gains, represented in the low running cost benefits, leaving the cost figure as a pure negative indicator against the EV family.

Regarding the technological limitations, it consists of three elements that are related mainly to the battery design, which are the range, the charging stations and the charging time. On regards to the limited range, Franke et al. (2012) defined the range anxiety fear as the 'running out of charge' to be another barrier leading to a negative adoption customer behavior. A range of maximum 200 or 250 Km combined with no public charging stations infrastructure availability increases the customers' fears (Tal et al. 2013). Moreover, the present charging time of 6 to 8 hours becomes a fourth barrier element. On the other hand, Welzel and Schramm-Klein (2013) didn't consider the last two elements as major problematic factors to be handled by the customer. Such optimistic field study showed that users' daily routine and charging durations could be successfully integrated.

The present technological disadvantages discussed above, have positioned the EV penetration pioneer designs applications to be "an extended-range with a defined-route including stop-areas-availability" vehicles. Such concerns and considerable disadvantages justify this studies' focus on public transportation HEV-Buses in this study and the expectation for them to be the leaders of the EV family to penetrate the market. HEV-Buses are considered to have a range extender. Employees, schools and public transportation buses have defined routes and the expected kilometers and stoppages times could be easily calculated for range and charge-times forecasts. Moreover, bus-stops can act as charging stations reducing the infrastructure land investments sharply. School buses and universities fleets are also promising with different daily routine calculations. Fleets for transportation between provinces could be a stretching target.

Hidrue et al. (2011) considered family, above average income, high ecology-minded men as the early adopters of EV-PCs. However, Rogers (2003), consider an innovators segment earlier than the early adopters as

a segment in the innovation's adoption timeline. Rogers's methodology, the Diffusion of Innovations, first published in 1962 would be the backbone for the theoretical framework of this paper. It is also defined as the new products' process to achieve market penetration, driven by social influences including all interdependencies within a market segment, affecting different market players regardless their explicit knowledge (Oigiagbe et al. 2012).

2.2 Theoretical Framework

Diffusion of innovations is a theory that explores the new ideas and new technologies spread through different cultures. In his book "Diffusion of Innovations", Everett Rogers _a professor of communication studies_ popularized the theory. First published in 1962, the book is in its fifth edition now (2003).

His argument is that diffusion is a process where an innovation is communicated over time among social system participants through certain channels. Four major elements have the most influence on this process, the Innovation itself, the Communication Channels, Time and the Social System.

There are 5 main adopters' categories. New ideas and innovation technologies' diffusion manifests themselves in various ways in different fields and cultures. Moreover, they are highly subjected to both the adopters' categories and innovation decision process.

2.2.1 The adopters' categories.On the basis of innovativeness, Rogers considers a category of adopters being a segment or a classification of individuals among a social system. To facilitate the use of his model in researches, he standardized five main adopters' categories. These categories are:

The Innovators (2.5%) are the cluster of the social system who are willing to take risks, probably having the highest social status and a stable financial liquidity. They might have a close contact to scientific sources or a good interaction with innovators. They are also characterized as venturesome, well-educated and of multiple info sources. According to Welzel and Schramm-Klein (2013), innovators are the segment in the society who buys and uses the new innovative product. They also have an influence on the future diffusion. Despite of their failure probability, new technologies are primarily adopted by the innovators. This is due to main two factors, their high risk tolerance and their financial resources which help in absorbing such failures probabilities.

The Early adopters (opinion leaders – 13.5%) are the cluster of the social system who have the highest degree of opinion leadership. In comparison to the innovators, they are more discreet in their adoption choices. They generally havea higher social status, also financial liquidity, advanced education and are more socially forward. They are also characterized as social leaders, popular and educated. Accordingly they have a relatively earlier purchasing decision for new products than average clients (Bianchi et al., 2017).In order to maintain a central communication position, they use sage adoption choices.According to Hidrue et al. (2011), early adopters group for EV technology are characterized as young, educated, seeking a green life style, believing that fossil fuel prices will significantly rise in the near future and probably living in a plug accessible house. EV Technology will depend on this category to spread, through triggered word-of-mouth or benchmarking the transportation sector (Bianchi et al., 2017).

The Early majority (34%) are the cluster of the social system who adopts an innovation after longer time than the innovators and early adopters. Characterized as above average social status, deliberate, forethought, many informal social contacts, in direct contact with the early adopters but rarely act as an opinion leadership in a social system.

The Late majority (34%)are the cluster of the social system who adopts a new innovation after the averageparticipant has. Their approach to an innovation has a high degree of skepticism. To be in the safe-side, they adopt the innovation after the majority of society has. They are characterized as skeptical, more traditional and of lower socio-economic status (below average). Accordingly, they have little financial liquidity. Also they are defined to have little or limited opinion leadership.

The Laggards (16%)are the cluster of the social system who are last to adopt an innovation. Members of this segment show little to no opinion leadership. They are characterized to have family, neighbors and friends as main sources of information and having debt fears. They usually have an aversion to change-agents, traditional, the lowest in the social status and the lowest in their financial liquidity. Regarding their age, laggards are usually the oldest among the adopters' categories.

Special knowledge, about each segment, need to be gathered, including the opinion leadership, willingness or skepticism towards innovations and sensitivity to price. Accordingly, appropriate policies and marketing techniques need to be developed to motivate each customer within the different five segments to consider EVs (Oliver and Rosen, 2010). Members of a social system are also likely to move from one level to another (Timmor & Katz-Navon, 2008).

2.2.2 The key elements in diffusion research.According to Rogers (2003), four key elements shape the structure of the diffusion research.These elements are the innovation itself, the communication channels, time and a social system. This study will focus on the innovation element.

Hoogers (2012) considered an innovation as a management process rather than a product. The product should be the output of such process. This management process could be defined as the successful accomplishment of the new ideas. EVs are considered an innovation implementing the new product in the environment (Hoogers, J., 2012).

Potential adopters' categories evaluate the innovation, firstly, according to its relative advantage. According to Hoogers J. (2012) and Vollink et al. (2002), relative advantage could be defined as the perceived efficiencies of the innovation over its precursors. The relative advantage construct of the EV could be summarized as the degree to which the potential adopters consider the EV's perceived efficiencies over the ICE. Second comes the compatibility, it's the degree to which the new innovation match with the present system, values, needs or past experience (Rogers, 2003). A high acceptance degree for the EV arises when the new technology fits to the everyday life with no or limited restrictions. Charging infrastructure would be a major parameter that can have an effect on this construct (Tal et al. 2013).

Third the complexity, it's the degree to which the new innovation is difficult-to-learn. Complexity is the reverse of the perceived ease-of-use (PEOU) (Hoogers, J. 2012). In our case, complexity would be the degree to which the potential adopters perceive the difficulty to adapt to the EV differences. It is logic that it shall take time for EV drivers to adapt to the regenerative braking (Wheelen & Hunger, 2012). Regenerative braking slows down the car when the driver lifts his foot off the accelerator.

Forth comes the Testability. It's the degree to which the new innovation's possibility to be reviewed, checked and tested before being purchased. During the early market penetration process of electrical vehicles, this construct is not expected to be positive in favor of the HEV-Buses. The more the spread of EVs in the market, the more the development of the testability construct versus the purchase intention.

Testability will progress in parallel with the fifth variable, the observe-ability. Observe-ability, also known as visibility, is the degree to which the new innovation's usage is visible to customers (Welzel and Schramm-Klein 2013, Hoogers, J. 2012). Due to the limited dispersal of EVs, Peters et al. (2011) could not confirm the observe-ability measures. Accordingly, it was excluded from their study analyses.

According to Mahajan et al. (1990), the innovation diffusion should be independent regardless of all other innovations in the market. In other research models, the adoption of an innovation is considered not to complement, substitute, detract or enhance any other innovation. However, this could not be realistic. In real life, an innovation is not isolated from the surrounding environment. It can affect and can be affected by the development of other innovations present in the marketplace. The mutual effect could be either positive or negative on the overall diffusion process for both. For electrical vehicles, the development of energy storage systems, charging infrastructure systems, lighter vehicle body material would definitely enhance the EV diffusion.

### 2.3 Literature Review conclusions

According to the literature, the EV adoption and market penetration success depends on the adopters' attitude. Unexpectedly, more knowledge and more observe-ability of EV won't necessarily lead to a more positive adoption attitude. On the other hand, compatibility, trial-ability, less complexity and relative advantages have a positive influence on the attitude.

Welzel and Schramm-Klein (2013) utilized a conceptual framework model to measure the influence of the perceived innovation characteristics on the purchase intention. The constructs nomination will be used interchangeably. "Relative Advantage" is used interchangeably with "Perceived Usefulness". "Compatibility" is used interchangeably with "Innovation-system fit". "Testability" is used interchangeably with "Trial-ability". "Visibility" is used interchangeably with "Observe-ability". On the other hand, "Complexity" is used reversely with PEOU.

## III. RESEARCH QUESTION

Most adoption studies regarding EVs before 2013 were focusing mainly on PC vehicles and private customers. But Commercial Vehicles (including buses and trucks) expands the market wider. EVs are expected to play an important role in the commercial and public transportation (Globisch et al., 2013).

The purpose of this study is to have a closer look and understand what supports HEV-Buses to penetrate the Egyptian market. Welzel and Schramm-Klein (2013) concluded that researchers could not be sure of the barriers limiting EVs from penetrating the market and for having sufficient market share and volumes. Electric vehicles customer perception and the equivalent infrastructure findings were not yet consistent. The research question would be: "What are the factors affecting the adoption of Hybrid-Electric Buses in Egypt?"

Rogers' (2003) model was extended by organizational norm to check the different constructs effect. Based on the collected data, this study aims to provide an answer to the research question, which is expected to support both future researchers in this research area and organization's top management in making business decisions.

The research methodology is discussed in the next chapter, followed by the results chapter, then the discussion and conclusion chapter. In the research methodology, the research model is explored, validity and reliability or the marketing scale, hypotheses, population and sampling sections is discussed.

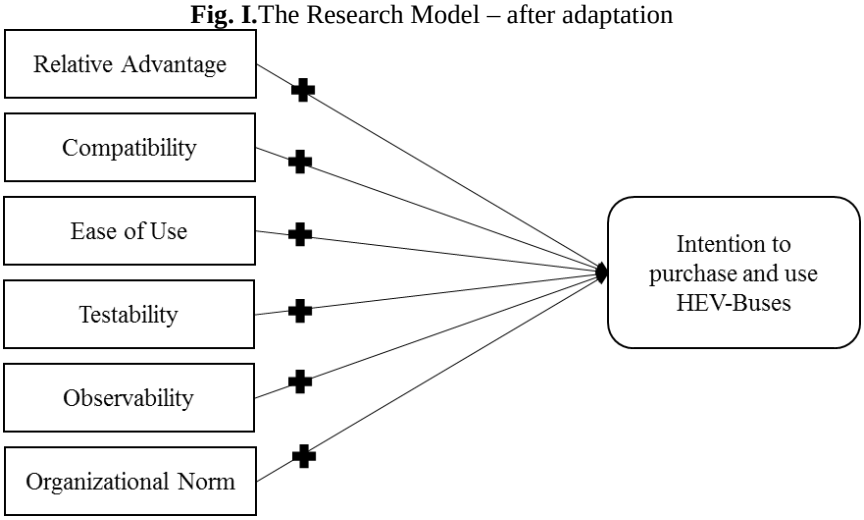
## IV. RESEARCH METHODOLOGY

The research model, the hypotheses, the marketing scales and the equivalent data collection instrument, the targeted population and the planned sampling design and sampling size will be explored in this section.
Out of the four key elements in diffusion research, the innovation, the communication channels, time and social system, this study will focus solely on the innovation elements to be measured.

4.1 The Research Model

The simple Rogers model was chosen to represent on one side the intention to purchase and use of an EV as a dependent variable and on the other side the relative advantage, compatibility, complexity, testability, visibility and social norm as the independent variables. Two minor adaptations were required to best fit the model. First, the social norm was modified to be organizational norm to reflect the B2B nature of the product. Second, the general electric vehicles was changed to hybrid electric buses specifically – Fig. I.This scope leads to the focus on the organizational buyer behavior and the commercial customers (Globisch et al. 2013) rather than the individuals'.

**Fig. I.**The Research Model – after adaptation




4.2 The Hypotheses

According to the model, six hypotheses need to be tested.
H1:Intention to purchase and use HEV-Buses is positively related to its Perceived Relative Advantage.
H2:Intention to purchase and use HEV-Buses is positively related to its Compatibility.
H3:Intention to purchase and use HEV-Buses is positively related to its Perceived Ease-of-Use.
H4:Intention to purchase and use HEV-Buses is positively related to its Testability.
H5:Intention to purchase and use HEV-Buses is positively related to its Visibility.
H6:Intention to purchase and use HEV-Buses is positively related to its Organizational Norm.

4.3 The Instrument

According to the previous studies, a seven point Likert scale will be used. The scale instrument reliability & validity is shown in the next tables according to Peters et al. (2011) – Table I and Table II.

All six constructs will be measured using different variables per construct. Each variable is code to be able to trace it throughout the paper. The updated instrument is attached at the appendix of this paper. Our instrument was forward and backward translated to Arabic to assure the delivered meaning to the respondents. It was also tested and fine adjusted.

**Table I.**Validity & Reliability of Scales According to Peters et al., 2011 (Relative Advantage)

| Items assessing relative advantages | Factor 1 (RA driving) | Factor 2 (RA operation) | Factor 3 (RA infra-structure) | Factor 4 (RA basic) |
|---|---|---|---|---|
| Driving pleasure | .826 | | | |
| Acceleration performance | .666 | | | .444 |
| Attainable maximum speed | .648 | | | .556 |
| Ability to simplify my life | .642 | .401 | | |
| Costs per 100 km | | .811 | | |
| Emissions generated when driving | | .787 | | |
| Follow-up costs for repairs and spare parts | | .706 | .428 | |
| Dependency on fossil fuels | | .704 | | |
| Breakdown frequency | | .600 | | |
| Supply network for service and refueling | | | .740 | |
| Choice of various models | | | .650 | |
| Range till refueling | | | .604 | |
| Purchase price | | | .593 | |
| Safety standard | | | | .823 |
| Comfort | | | | .814 |
| Loading capacity | | | | .720 |
| Explained variance of factors | 28.47 | 15.45 | 9.50 | 6.41 |
| Cronbach's alpha | .73 | .78 | .64 | .71 |

**Table II** Validity & Reliability of Scales According to Peters et al., 2011 (social norm, ease of use, trial-ability & compatibility)

| Items | Factor 1 (social norm) | Factor 2 (ease of use) | Factor 3 (trialability) | Factor 4 (compatibility) |
|---|---|---|---|---|
| People react positively when they see an electric car on the road. | .874 | | | -.429 |
| Other road users are pleased to see an electric car on the road. | .855 | | | -.406 |
| Electric cars have a positive image in society. | .771 | | | |
| The people who are important to me find electric cars good. | .734 | | | -.612 |
| An electric car is simple to drive. | | .706 | | -.428 |
| An electric car is easy to operate. | .420 | .745 | | -.413 |
| Operating an electric car is easy to understand. | | .713 | | |
| In order to use an electric car, I must know about some technical matters. (-) | | .514 | | |
| I have the opportunity to test an electric car as long as possible to form an opinion about it. | | | .864 | |
| I have the opportunity to try an electric car within my circle of friends. | | | .859 | |
| Driving an electric car is easily compatible with my habits. | .498 | | | -.869 |
| An electric car is well suited to carry out my daily tasks. | .520 | | | -.821 |
| It is difficult for me to schedule recharging the battery with my planning. (-) | | | | -.714 |
| An electric car suits my personality. | .600 | | | -.697 |
| I am confident that I can use an electric car efficiently. | .514 | | | -.692 |
| An electric car shows what is important to me. | .554 | | | -.636 |
| Explained variance of factors | 38.51 | 9.55 | 8.46 | 6.91 |
| Cronbach's alpha | .85 | .60 | .67 | .86 |

4.4 Population and Sampling

4.4.1 Defining the population.According to the Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS) about 130,000 buses are registered in Egypt. Of which 71,100 buses are considered as urban group, fleet and public transportation. Nearly 16,600 buses are considered for the governmental transportation sectors, 11,600 buses belong to schools' transportation sector, 42,900 buses for private, group and fleet transportation companies. The other 58,800 buses are split as 15,200 buses for tourism industry and 43,600 buses belong to other travelling sectors.

The focus of this study would consider the 71,100 urban buses as the targeted market size. Accordingly, opinion leaders in their owners' organizations and companies, would be considered as the population of this study.

4.4.2 Determining the sample design. On reviewing different probability and nonprobability sampling designs, and due to the heterogeneous in the population, multistage cluster sampling was selected as the most compatible sample design for this study, because:

- No clear list of the population elements is available. Neither the data of the population (the buses owners) is available nor the number of buses per owner.
- Area sampling, being a specific type of clusters sampling, would be utilized in one of the stages.

Accordingly, a multistage cluster sampling design consisting of two stages would be designed. First cluster stage will include the decision makers in two major groups. One group would cover all governmental and public transportation sectors. The second group would cover all private transportation sector.

a) Public transportation sector
i. Ministries' transportation, airports' transportation … etc.
ii. Private companies operating in public transportation – nearly 14 major companies.
b) Private transportation sector.
i. Students' transportation sector (schools and universities).
ii. Employees' transportation sector.

The second cluster stage would include decision makers in the previous stage but split into areas (i.e. Area sampling).

a) Giza governance (A1).
b) Cairo governance (A2).
c) Alexandria governance and North Coast (A3).
d) Delta governances (A4).
e) Canal and Upper Egypt governances (A5).

The multistage cluster sampling design would support in overcoming the population coverage error expected in the sample frame. It is also needed to overcome some issues like overcoming the influence of the minority of governmental respondents' verses their huge market size weight. Moreover, screening and classification questions are designed in the beginning of the questionnaire to differentiate the respondents on regards to the important characteristics fulfilling the target populations criteria fit.

4.4.3 Determining the sample size. Sampling size will follow the sample design to reach a reliable and valid sample and to be able to reach population generalizability on the studied population. In order to achieve this target, some assumptions need to be defined.

- A unit of 100 bus is assumed as the buses ownership, accordingly the whole population is defined to be N = 711 bus-owner-organizations.
- A confidence level of 90% (z-score = 1.65) was selected.
- A precision level of 10% (e = 0.1) is defined for the expected margin of error exploring how closely the results of the sample to the expectations in the population.
- A normal distribution (p = 0.5, i.e. 50%) is assumed.

Accordingly, substituting in the sample size calculator equation ➔ Sample Size = [{(z2 * p(1-p)) / (e2)}] / [1 + {(z2 * p(1-p))/(e2N)}], the sample size was planned to be 62.

## V. RESULTS

Exceeding the planned sample size of 62, data was gathered from 72 bus-owner-organization, leading to a higher than planned confidence level (from 90% to 92.5%). Demographics of the respondents are explored in this chapter.

Accordingly, data was gather and analyzed first using AMOS software for confirmatory factor analysis on three runs. This chapter will be focusing on these three runs and the hypothesis acceptance or rejection according to the sample perspectives. Data analysis will also be discussed in details through this chapter.

5.1 Demographics

Two screening questions were checked through the 72 respondents. The first was related to the ownership of buses, where 58% (42 respondents) totally own their bus fleet, 17% (12 respondents) totally rent their bus fleet and 25% (18 respondents) mix their needs between owning and renting.

The second screening question was related to the buses purchasing selection decision making, where 56% (40 respondents) were directly a decision maker in their organization when it comes to buses selection for purchasing and 44% (32 respondents) were indirectly related.

Our sample covered both public and private sectors for transportation, with 26% (19 respondents) in the public sector and 74% (53 respondents) in the private sector. Out of the 19 of the public sector, 17 organizations represented some of the public transportation companies while 2 organizations represented the governmental and ministries' transportation fleets. Governmental public transportation was not covered in this sample. This issue will be explored in more details in the recommendation section.

Private sector was also represented with 53 respondents. 21% of this sector (11 respondents) represents mainly employees' transportation whether through their own companies or outsourced. The other 79% represents the students' transportation sector for either schools or universities (42 respondents). This sector is proposed to be a main market for the proposed technological product (Vehicle-to-Grid HEV-Buses). Accordingly, it was targeted to represent more than 55% of the overall sample size.

Two more axes were also explored in the demographic classification questions. The first axis was related to the nature of the organization whether "a service organization" or "an industrial organization". A high weight was targeted to the service natured organization (92%). The second dimension was categorizing the "profitable organizations" versus the "non-profitable organizations". A high weight was targeted to the "profitable" organizations (90%). The targeted high weights in the previous axes were defined as a prediction assumption that service organizations and/or profitable organizations would be the proposed major targeted segments.

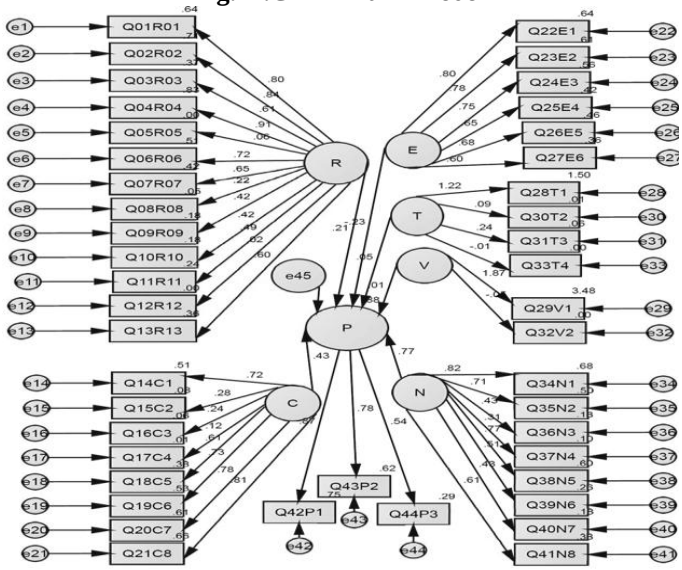
Area cluster were not represented on a mutually exclusive base as most organizations were operating in more than one of the clustered defined areas. Area coverage showed that 65 of the 72 respondents operated their fleet in Cairo governance (90% of respondents), 64 operated in Giza governance (89% of respondents), 24 in Delta governances (33%), 2 in Upper Egypt and Canal governances (3%). Alexandria governance and North Coast should be considered as a limitation in this study as organizations with the defined selection criteria during the data gathering period could not be reached.

The total number of buses in the tested sample was 2,027 buses (nearly 3% of the population), of which 1,391 buses are owned (69%) and 636 buses rented (31%). This sample operates on an average of one and half round trips per bus daily, with an average of approximately 130Km daily (a min of 60Km and a maximum of 260Km).

5.2 Data Analysis

To validate the hypotheses, a confirmatory factor analysis (CFA) was implemented to the data on three runs. The model first run was created as shown – Fig. II.

**Fig. II.**CFA – Run I Model



5.2.1 CFA first run analysis summary.
5.2.1.1 Model fit summary. Despite that the CMIN/DF equals 2.807 which are accepted; the total model fit needs deeper evaluation. Chi-square showed 2532.2, which is too high to be accepted, with a probability level of .000. Also, the baseline comparisons CFI showed a poor value of 0.182 which question the model fit deeply. Moreover, a high RMSEA figure (0.160) was observed.
5.2.1.2 Regression weight estimates. Visibility (with a level of significance p value of p=0.809) and Testability (with a level of significance p value of p=0.480) were not significantly validated to affect the dependent variable "the intention to purchase and use HEV-Buses". This could have happened due to the lack of knowledge and/or the availability of HEV-Buses in the Egyptian market.
On the other hand, relative advantage (p=0.012), complexity (p=0.009), compatibility (p=***) and organizational norm (p=***) showed a high significant level of less than 1% (ideal to be less than 5%).Taking the lead in influencing the "purchase intention", organizational norm showed a 0.472 regression weights estimate influence, followed by compatibility (.263), complexity (-.140), relative advantage (.130), testability (.028) then visibility (.006).
Due to such estimates, a second run was attempted to eliminate the noise coming from visibility and testability constructs on the whole model. Also, variables that showed less than .95 significance, were also eliminated (i.e. Q05R05 (.639), Q08R08 (.068), Q12R12 (.850), Q17C4 (.348)). In addition to the four testability variables and the two visibility ones which were eliminated in parallel to the elimination of their constructs.

5.2.2 CFA second run analysis summary.
5.2.2.1 Model fit summary. The CMIN/DF moved slightly up (3.035). The total model fit was improved as the Chi-square showed 1599.5 with a probability level of .000. But still the Baseline Comparisons CFI showed a poor value of 0.252 which still question the model fit. Moreover, the RMSEA figure increased more to reach 0.169.
5.2.2.2 Regression weight estimates. With the absence of visibility and testability, regression weight estimates showed impressive figures. Relative advantage significance improved from p=0.012 to p=0.007, complexity was slightly affected to reach p=0.013 rather than the original p=0.009, compatibility and organizational norm data were that powerful to keep their significance level (p=***).
In this scenario, the second run, the constructs effect on the purchase intention was not altered. Organizational norm showed .486 (rather than the .472 in run 1). Again, in the second place comes the compatibility (.254 instead of .263 in run1). Relative advantage slightly progressed with .138 (.130 previously). Finally, the complexity influence of .131 (.140 previously) keeping its negative trend.
A final confirmatory factor analysis trial was implemented to eliminate the noise coming from variables with less than .95 significance in the second run.

5.2.3 CFA third run analysis summary.
5.2.3.1 Model fit summary. The CMIN/DF moved slightly up (3.179). The total model fit was highly improved as the Chi-square showed 429.1 with a probability level of .000. The Baseline Comparisons CFI showed a developed value of 0.481. The RMSEA figure increased more to reach 0.175.

5.2.4 Data analysis conclusion.According to the previous three Confirmatory Factor Analysis (CFA) runs, it is concluded that the overall model fit is acceptable (as of the Chi-square values and its equivalent probability level of .000). On the other hand, most indices show that the model is relatively accepted but with limited generalization. This was expected on choosing the multistage cluster sampling design.
The Hypotheses test results,as discussed in 4.2, this study was concerned with six hypotheses. According to the data gathered and data analysis, only four hypotheses (H1, H2, H3 & H6) were accepted and factors were supported to have an effect on the intention to purchase and use of HEV-Buses in Egypt. H4 & H5 were rejected. In the next chapter, the discussion, limitations, recommendations and conclusion is explored.

## VI. DISCUSSIONS AND CONCLUSIONS

6.1 Discussion

According to the literature, the market success of EV depends on the adopters' attitude. The literature concluded that more knowledge and more observe-ability (visibility) of EV shall not lead to a more positive attitude. While, more compatibility, more testability, more relative advantages and less complexity (more ease-of-use) will have a positive influence on such attitude. Literature review also showed relative advantage as the key factor in the purchase intention decision.

Unlike most of the sources in the literatures, the collected data showed that the organizational norm has the highest influence on the intention to purchase. This difference appears to be due to the difference between the literatures B2C studies and the study's B2B scope.

In Egypt, the organizational norm (.472, p= ***) is the main factor affecting the adoption of HEV-Buses. The organization's top management influence showed the highest estimate (accordingly fixed with a variance of 1). The organization sponsors or board members (.574, p=***) and customers response (.554, p=***) comes next. Governmental influence, fellow bus' drivers' reaction and community image estimates were below 0.5. Regarding the competition between the organization drivers to drive HEV-buses, one respondent summarized it as: "What's 'New' is always attractive, regardless if it is a new technology, a new brand, a new traditional bus … doesn't matter. Our drivers compete for the 'New'".

Organizational norm construct won't be a 100% comparable one with the literature as it was one of the adaptations to the model. In the early model adaptation, Organizational norm replaced the original social norm factor. But it covered some aspects like the "Image". In Hoogers, J. (2012) study on PC EV cars owners mainly in Netherlands (population of 3000 EV owner), the respondents felt that it's good on their image to be an EV owner. Moreover they enjoyed when people knew that they are driving one. In this HEV-Buses study, community image was not a real affecting factor. Still the B2B versus the B2C difference issue highlights.

Compatibility (.263, p= ***) comes as the second influencer on the adoption of HEV-Buses in Egypt. Compatibility with the drivers' habits showed the highest estimate (accordingly fixed with a variance of 1). This agrees with Welzel and Schramm-Klein (2013). The general compatibility influence on the organization showed a high estimate (.699, p= ***), including the organization mission (.698, p= ***), culture (.630, p= ***) and reflection to what's important for the organization (.530, p= ***) still agreeing with the literatures (Hoogers, J., 2012).

On the other hand, confidence in an efficient daily use of HEV-Buses in the organization fleet showed low estimate. "Planning the batteries recharging schedule" showed both a low estimate (.104) and insignificancy (p=.348). These variables reflect a high un-satisfaction perspective regarding this daily scheduling routine homework which the organizations are not willingly to adapt easily. This will require manufacturers to develop a parallel program (may be a software) to manage this issue on behalf of the customers' organizations. Also a longer range would be more satisfactory to the customers.

Agreeing with the literature, compatibility showed a great acceptance to the general customer needs (Hoogers, J., 2012). In his PC owners study, Hoogers (2012) was also interested in measuring the "Number of charging points" as one of the compatibility scales. This issue was not covered in this paper questionnaire, assuming that most organizations, in contradiction to PC owners, could easily provide a charging point at their bus stops and/or their parking areas.

Complexity comes next with an estimate of -.140 and a level of significance p value of p= .009. As per Vollink et al. (2002), the negative direction indicates that the construct is reversed reflecting that complexity is inversely related to the innovation adoption rate (i.e. it reflects the positive influence of the ease-of-use rather than the negative 'complexity'). All variables showed a high regression weight estimate and a level of significance p value of p= ***. Easy operation (fixed with a variance of 1), easy understanding (.902), easy service technicality (.684), even the negative question regarding knowledge of technical matters and frustration of HEV-Buses were showing significant positive influences. Expectedly, complexity meets literature trends (Welzel and Schramm-Klein, 2013, Hoogers, J. 2012, Peters et al. 2011).

Relative advantage comes fourth with a regression weight estimate of .130 and p=.012. There is no common trend for Relative Advantage in the literatures. While Vollink et al. (2002) and Welzel and Schramm-Klein (2013) studies resulted that it is positively related to the purchase intention, Hoogers, J. (2012) admitting that relative advantage has no influence on purchase intention and rejected the hypothesis. Peters et al. (2011) split the relative advantage to four categories, RA driving, RA operations, RA infra-structure and RA basic. With a Cronbach's alpha exceeding 0.6 for the four categories, Peters et al. (2011) contradicted Hoogers, J. (2012) results. Except for breakdown frequency and comfort and quietness to our customers, all variables showed an accepted significance level.

Due to the limited dispersal of EVs, Peters et al. (2011) could not confirm the observe-ability measures; accordingly it was excluded from their study analyses. Carroll, S., and Walsh, C. (2010) had to design three events for test-drive to be able to capture their respondents 'customers' the testability opinion. In this study both testability (.028, p=0.480) and visibility (.006, p=0.809) showed limited influence affecting the adoption of HEV-Buses in Egypt, moreover they showed bad significance. Both were not significantly validated to affect the dependent variable. A total lack of knowledge and product availability in the Egyptian market could be a major factor for such results.

6.2 Limitations

Despite that Rogers' model has a respectable validity and reliability in the literature, it was previously tested in highly developed markets (Germany, Netherlands … etc.) and on present EV passenger cars' owners. The results showed that the model needs further adaptation to be implemented on emerging markets like Egypt,

on a non-existence innovation product and on a commercial rather than passenger scale. On other words, the model showed a high success to test the actual experience, while, this study is testing a perceptual experience. Another limitation to the sampling scheme was in the area cluster sampling in Alexandria and North Coast area region (zero respondents) also Canal & Upper Egypt (only 2 respondents). Targeted organizations based on the selection criteria scheme could not be reached during the data gathering period.

Despite its high equivalent weight in the targeted population (16,000 buses out of the 71,100 buses), public transportation, including the governmental public transportation, was not quantitatively totally covered in this study. It is recommended to introduce another technology providing a longer range and a shorter charging time to such sectors to be addressed in future researches.

6.3 Recommendations

Out of the four key elements in diffusion research, the innovation, the communication channels, time and social system, this study focused on the innovation elements to be measured and its influence on the intention to purchase. The communication channels elements, time elements and social system elements could be explored in future researches.

Out of the EV family, only HEV-Buses are explored in this study. BEV & Fuel Cell EV are yet a good opportunity for further studies. Also, EV passenger cars and EV trucks were not covered in this study.

"Knowledge" as a construct, is recommended to be added to the model. Testability and visibility failed to be tested with the original Rogers model due to lack of knowledge. Also, for practical marketing activities, "Experimental Research" would be recommended.

Also, there was a clear un-satisfaction among the respondents perspective regarding their ability to manage the daily scheduling charging routine. To support market penetration, a parallel software program is recommended to be developed to facilitate such daily homework on behalf of the HEV-Buses owners.

African and Arab nations' automotive markets were not explored in this study giving a potential market expansion and showing a pessimistic view to the present potential market width. In addition to the Egyptian market, the Nigerian market expands an extra 50,000 new traditional vehicles annually (Oigiagbe et al. 2012).

Further researches need to explore how to overcome the barriers at the automotive dealers and retailers side including both educating them and understanding their needs (The National Academy of Sciences, 2013). Also researches on different policies and its effectiveness is a scarce research area.

Commercial users of PC cars (weather company cars used for business activities or car pools) were also beyond the scope of this study due to their PC base (Globisch et al. 2013).

Standardization of a fast charging infrastructure including the payment method is highly recommended to support the fast spread of the EV (The National Academy of Sciences, 2013).

Given the concerns of EV technologies limitations and its consideration to be entry barriers, the Congress has assigned a research to the Department of Energy and the National Research Council (NRC) to investigate the present barriers and consider corrective actions to mitigate them (The National Academy of Sciences, 2013). This could be a clear recommendation for the Egyptian, Arab and African regimes.

**6.4** Conclusion

The purpose of this study is to explore the factors affecting the adoption and their influence on purchasing intention of hybrid-electric buses in Egypt. The research question was: "What are the factors affecting the Adoption of Hybrid-Electric Buses in Egypt?".

Out of the six independent variables, only four were accepted to influence the dependent variable with high agreement with the literature but with limited generalization. These four are relative advantage, compatibility, complexity and organizational norm. The other two, testability and visibility, were rejected.

The diffusion process interests a lot of marketers due to its influence on the success or failure of a new innovative product. Understanding such process would ensure a proper management for the product life cycle from growth to decline.

Electric vehicles fleets would have the potential in increasing the entire society awareness to the new technology and its benefits which definitely enhances the future adoption cycle(The National Academy of Sciences, 2013).

## REFERENCES

[1]. Accenture Research (2011). Plug-in electric vehicles: Changing perceptions, hedging bets. Accenture end-consumer survey on the electrification of private transport. ACC11-0320/7-1792.

[2]. Antweiler, W., & Gulati, S. (2013). Market-Based Policies for Green Motoring in Canada. Canadian Public Policy – Analyse de politiques, vol. xxxix, supplement/numéro spécial 2 2013.

[3]. Bianchi, M., Di Benedetto, A., Franzò, S. and Frattini, F. (2017) "Selecting early adopters to foster the diffusion of innovations in industrial markets: Evidence from a multiple case study", European Journal of Innovation Management, Vol. 20 Issue: 4, pp.620-644, https://doi.org/10.1108/EJIM-07-2016-0068

[4]. Carle, G., Axhausen, K.W., Wokaun, A., & Keller, P. (2005). Opportunities and Risks during the Introduction of Fuel Cell Cars. Transport Reviews, Vol. 25, No. 6, 739–760, November 2005.
[5]. Carroll, S., & Walsh, C. (2010). The Smart move trial. Description and initial results, Centre of excellence for low carbon and fuel cell technologies. CENEX: http://www.cenex.co.uk/LinkClick.aspx?fileticket=yUKAcRDJtWg%3D&tabid=60
[6]. Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS) http://www.capmas.gov.eg/
[7]. Ehrler, V.,& Hebes, P. (2012). Electromobility for City Logistics–The Solution to Urban Transport Collapse? An Analysis Beyond Theory. Procedia – Social and Behavioral Sciences, 48, 786–795.
[8]. Franke, T., Neumann, I., Bühler, F., Cocron, P., & Krems, J.F. (2012). Experiencing range in an electric vehicle - understanding psychological barriers. Applied Psychology: An International Review, 61(3), 368-391
[9]. Globisch, J., Dütschke, E. & Schneider, U. (2013). Acceptance of electric vehicles by commercial users in the electric mobility pilot regions in Germany. ECEEE 2013 Summer study – Rethink, Renew, Restart.
[10]. Hidrue, M.K., Parsons, G.R., Kempton, W.,& Gardner, M.P. (2011). Willingness to pay for electric vehicles and their attributes. Resource Energy Econ. doi:10.1016/j.reseneeco.2011.02.002.
[11]. Hoogers. J. (2012). Adoption of the electric car. Why do people buy an electric car?
[12]. Jabeen, F., Olaru, D., Smith, B., Braunl, T., & Speidel, S. (2012). Acceptability of electric vehicles: Findings from a driver survey. 2012 ATRF Proceedings.
[13]. Kierzkowski, H. (2011). A New Global Auto Industry? China & World Economy / 63 – 82, Vol. 19, No. 1, 2011
[14]. Klier, T. & Linn, J (2015). Using Taxes to Reduce Carbon Dioxide Emissions Rates of New Passenger Vehicles: Evidence from France, Germany, and Sweden. American Economic Journal: Economic Policy 2015, 7(1): 212–242http://dx.doi.org/10.1257/pol.20120256
[15]. Lebeau, K., Van Mierlo, J., Lebeau, P., Mairesse, O., & Macharis, C. (2012). The market potential for plug-in hybrid and battery electric vehicles in Flanders: A choice-based conjoint analysis. Transportation Research Part D: Transport and Environment, 17 (8), 592-597.
[16]. Lieven, T., Mühlmeier, S., Henkel, S.,& Waller, J.F. (2011). Who will buy electric cars? An empirical study in Germany. Center for Customer Insight, University of St. Gallen, doi:10.1016/j.trd.2010.12.001
[17]. Mahajan, V., Muller, E. & Bass, F.M. (1990). New Product Diffusion Models in Marketing: A Review and Directions for Research. Journal of Marketing. Vol. 54 (January 1990), 1-26
[18]. Mazraati, M & Shelbi, H. (2011). Impact of alternative fuels and advanced technology vehicles on oil demand in the United States up to 2030. OPEC Energy Review_184 70..89.
[19]. Oigiagbe, O; George, O & Owoyemi, O. (2012). Theorizing the Failure of Technological Innovation Diffusion in the Nigerian Automobile Industry: The Case of Ford Motors Nigeria. American Journal of Business and Management Vol. 1, No. 4, 2012, 223-229.
[20]. Oliver, J.D. & Rosen, D.E. (2010). Applying the Environmental Propensity Framework: A Segmented Approach to Hybrid Electric Vehicle Marketing Strategies. Journal of Marketing Theory and Practice, vol. 18, no. 4 (fall 2010), pp. 377–393.
[21]. Ozaki, R. (2011). Adopting Sustainable Innovation: What Makes Consumers Sign up to Green Electricity? Business Strategy and the Environment. DOI: 10.1002/bse.650.
[22]. Panzuela, M. (2013). Expanding hybrid and electric bus adoption in Latin America.
[23]. Peters, A., Popp, M., Agosti, R., & Ryf, B. (2011). Electric mobility – a survey of different consumer groups in Germany with regard to adoption. ECEEE 2011 SUMMER STUDY • Energy efficiency first: The foundation of a low-carbon society.
[24]. Rogers, E. (2003). Diffusion of Innovation. 5th edition.
[25]. Sallee, J.M. (2011). The Surprising Incidence of Tax Credits for the Toyota Prius. American Economic Journal: Economic Policy 3 (May 2011): 189–219http://www.aeaweb.org/articles.php?doi=10.1257/pol.3.2.189.
[26]. Shen, C., Shan, P. & Gao, T. (2011). A Comprehensive Overview of Hybrid Electric Vehicles. International Journal of Vehicular Technology, Volume 2011, Article ID 571683, 7 pages. doi:10.1155/2011/571683.
[27]. Tal, G., Nicholas, M.A., Woodjack,J., & Scrivano, D. (2013).Who Is Buying Electric Cars in California? Exploring Household and Vehicle Fleet Characteristics of New Plug-In Vehicle Owners. Institute of Transportation Studies ◦ University of California, Davis
[28]. Timmor, Y. & Katz-Navon, T. (2008). Being the same and different: A model explaining new product adoption. Joumal of Consumer Behaviour, DOI: 10.1002/cb.
[29]. The Automotive Marketing Information Council (2014). AMIC Egypt Report 2014.
[30]. The Automotive Marketing Information Council (2015). AMIC Egypt Report 2015.
[31]. The Automotive Marketing Information Council (2016). AMIC Egypt Report 2016.
[32]. The Energy Saving Trust (2002). Pathways to Future Vehicles, A 2020 Strategy. (London: EST).
[33]. The National Academy of Sciences (2013). Overcoming Barriers to Electric-Vehicle Deployment: Interim Report
[34]. Vollink, T., Meertens, R. & Midden, C.J. H. (2002). Innovating Diffusion of Innovation Theory: Innovation Characteristics and the Intention of Utility Companies to Adopt Energy conversation interventions. Journal of Environmental Psychology. doi:10.1006/jevp.2001.0237
[35]. Weiss, M. A., Heywood, J. B., Drake, E. M., Schafer, A. & AuYeung, F. F. (2000). On the Road in 2020: A Life-Cycle Analysis of New Automobile Technologies. Boston, MA: Laboratory for Energy and the Environment, MIT.
[36]. Welzel, M. & Schramm-Klein, H. (2013). Electric vehicles' adopter groups and their specific perceptions and needs – Findings from an empirical study conducted in eMERGE. Workshop "Future mobility. Markets and policy measures in the evolution of electric mobility" Oldenburg, December 5-6, 2013.
[37]. Wheelen, T.L. & Hunger, J.D. (2012). Strategic Management and business policy: toward global sustainability (13th ed.) International edition: Pearson.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