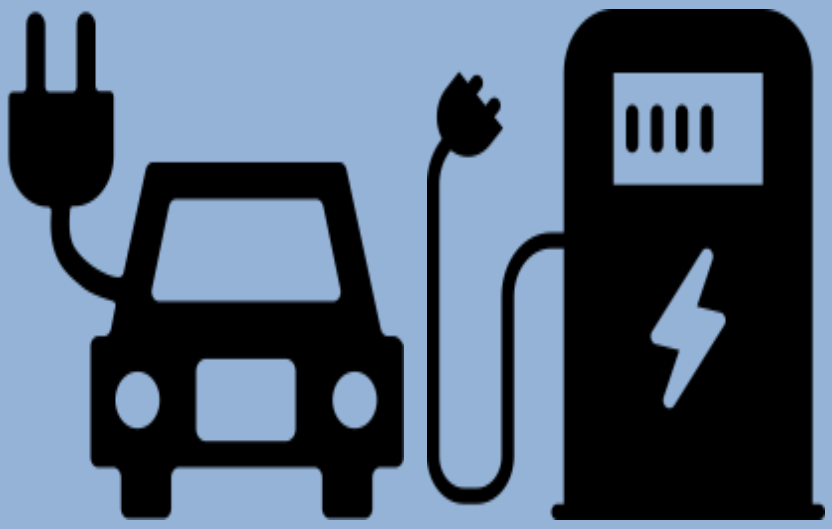

Image source: thenounproject.com

Master Thesis

Barriers and Strategies for Transition to Electric Vehicles in BRICS Countries

Case Study of South Africa, India, and Brazil

TU Delft Delft University of Technology

This manuscript is designed for double-sided printing

Title

Barriers and Strategies for Transition to Electric Vehicles in BRICS Countries: Case Study of South Africa, India, and Brazil

Author

Name	Lusi Pratiwi
Student number	4416090
Date	July 2016
Program	M.Sc. Management of Technology
Faculty	Technology, Policy, and Management
University	TU Delft, The Netherlands

Graduation committee

Chairman of committee	Prof.dr. C.P. (Cees) van Beers Section Economics of Technology and Innovation
1st supervisor	Dr. L.M. Kamp (Linda) Section Energy and Industry
2nd supervisor	Dr. J.R. (Roland) Ortt Section Economics of Technology and Innovation

This page is intentionally left blank

Executive Summary

BRICS countries are considered to be five countries with important roles worldwide. These countries nearly account for half of population in the world, with economic growth exceeded the growth of industrialized countries. Therefore, these countries become an interesting target markets for all sorts of technologies, including sustainable technologies.

One of the prominent issues related to sustainable technologies is the high level of carbon emission, one of which is a result of transportation sector. Electric vehicles are perceived to be a solution to reduce carbon emission from transportation sector. With high population and high economic growth rate, BRICS countries also contribute to the global carbon emission. It is then interesting to see if electrical vehicles could be adopted in BRICS countries.

Hence, this research aims to identify barriers to adoption of electric vehicles in BRICS countries and investigate how companies deal with these barriers. For further understanding, this research discusses the relationship between barriers and strategies. This research also investigates the relative importance of barriers and strategies based on the case study to identify if the companies have similar or different perspective on the barriers and strategies.

This research is conducted in three steps; first step covers the current literature of barriers and strategies in general, using the literature of barriers and strategies for new high tech products as well as barriers and strategies for sustainable technologies. The second step covers the current literature of barriers and strategies in BRICS countries. Both steps generate the pre-specified list of barriers and strategies that are used for the third step, which is the case study to investigate whether the barriers and strategies from the list are occurred and if there are other barriers and strategies. The case study covers three different companies from three different countries, which are Nissan in South Africa, Mahindra Reva in India, and Renault in Brazil.

The outcome of this research is the total 13 barriers, which are *Production system; Complementary technologies; Network; Demand; Institutional; Technological; Natural resources and labour; Social, cultural, behavioural, and psychological; Macro-economic; Accident or events; Infrastructure; Financial; and Undesirable societal and environmental effect*. It is discovered that demand, institutional, and infrastructure barriers as the most important barriers from the three companies' perspective.

Moreover, this research also result in the total of 15 strategies, which are *Demo, experiment, and develop niche strategy; Top niche market strategy; Pilot project strategy; Lobbying strategy; Redesign niche strategy; Dedicated system or stand-alone niche strategy; Hybridization or adaptor niche strategy; Knowledge*

development' Geographic niche strategy; Market research; Explore multiple markets niche strategy; Financial aid strategy; Establishment of standard strategy; Network creation strategy; Development of infrastructure strategy. It is discovered that lobbying and development of infrastructure strategies are the most important strategies to support the adoption of electric vehicles in BRICS countries. Lobbying strategy is important to get government support in order to accelerate the adoption of electric vehicles. The development of infrastructure is also important in order to provide the customers with sufficient public charging stations and eliminate range anxiety.

The relationship between barriers and strategies are also discovers during the case study phase of the research. Specific strategy is implemented to tackle specific barrier, but more supporting strategy could also be implemented to gain more benefit or higher impact. However, the amount of resource dedicated for the supporting strategies might be less than its main strategy. Furthermore, one strategy could also be implemented and overcome more than one barrier. For example, lobbying strategy to get government support can overcome both demand and infrastructure barrier, depends of what kind of advocacy or lobbying done by the companies.

It is also discovered that barriers can change overtime, depend on the current situation of the companies as well as the countries. Country that imports their cars might not experience technological and production system barriers, but once the production is established within the country, these barriers might occur and possible to be the most important barriers. Moreover, changing macro-economic situations could also result in different perspective of how macro-economic pose as a barrier in the country. It is understandable that in countries with unstable macro-economic condition, companies will consider macro-economic barrier to be important. However, once the macro-economic condition is stabilized, it is possible that the company will consider the macro-economic barrier as not exist. Macro-economic condition also affects government's support for adoption to electric vehicles. The three countries investigated experience difficult macro-economic conditions; hence adoption to electric vehicles is not considered as top priority by the government, resulting in limited support from the government in adoption to electric vehicles within the countries.

Lastly, findings in this research can be important for both managerial and academic perspective. For managerial perspective, this research can serve as a tool in deciding when to enter the electric vehicles market in BRICS countries as well as what kinds of barriers to be expected in the countries. This research could also serve as a tool in identifying appropriate strategies to be implemented in order to overcome the barriers. As for academic perspective, this research offers several possible further researches in relation with this field of research, such as government's point of view and strategies for adoption of electric vehicles (or other sustainable technologies) in developing countries, investigation for dynamic nature of barriers which then would affect the changes in strategies, collaboration of triple helix industry – government – university to accelerate adoption of electric vehicles in developing countries, and comparison study between developed and developing countries to serve as a knowledge and learning possibility for developing countries.

Acknowledgements

This master thesis report represents the end of my journey in studying Management of Technology in TU Delft. The previous months conducting this research was a high value of experience to me. It is a chance to explore my interest in technology and understanding the market of developing countries. I am grateful than I can finish my study here after two years of learning, it is all going to be an unforgettable journey. I surely hope to bring the knowledge back to Indonesia and use it to help build Indonesia in the future.

Firstly, I would like to express my gratitude towards my graduation committee for the opportunity to do research in this field and explore my interest thoroughly. To Dr. Linda Kamp and Dr. Roland Ortt, I thank you for the discussions and feedbacks throughout the research. I am grateful for all the guidance, advice, and motivation in finalizing this research.

This thesis would also never be finished without the support from my family. I thank my husband for his patience, motivation, and great support for the whole two years studying here. You were there when I was at rock bottom and you helped me stand up again. To my family back home; my parents, brother, and sisters, thank you for all the prayers, love, and patience you have given me. Thank you for the laugh we share during the toughest time I experienced here.

Thank you for the whole new family I found here, my MoT friends. I am thankful for all the moments that we shared during our stay in Delft. You have made these two years very memorable and studying here in Delft became so much for fun with you here.

Lastly, I would like to give recognition to the Ministry of Finance of Indonesia that has given me the opportunity to pursue higher degree of study in TU Delft. Thank you Lembaga Pengelola Dana Pendidikan (LPDP – Indonesia Endowment Fund for Education) for the scholarship and all the assistance during my study period.

Delft, July 2016

Lusi Pratiwi

This page is intentionally left blank

Contents

List of Figures

List of Tables

Appendix

1. Introduction

1.1 Background

1.1.1 Sustainable Energy Technologies to Prevent Further Global Warming

In accordance with the growth of population, there is also an increase in the energy consumption which leads to an increase of CO_2 emission from fuel combustion (Enerdata, 2015). As the carbon emission keeps increasing, organizations become aware of its effect, one of which is the global warming issue. Apart from carbon emission, other environmental impact such as greenhouse gases also contributed to the global warming. A lot of attention has now been given to reduce the carbon emission. This reduction of carbon emission is considered important to prevent further damage on the environment, as well as to provide a decent environment to be inhabited by future generations. The issues of environmental impact have forced human to come up with innovative solution to prevent further damages of environment while still fulfilling the energy demand, one of which is by moving towards sustainable energy technologies.

Other than the issue of global warming, the issue of oil scarcity also pushes the research and implementation of sustainable energy technologies even further. To avoid crisis in energy, countries especially developed countries have been implemented sustainable energy technologies, such as implementation of wind energy in Denmark (Lund & Mathiesen, 2009), hydropower in Norway (Kjærland, 2007), and solar energy in Germany (Wirth, 2015). Furthermore, the awareness of implementing sustainable energy technologies has also reached developing countries. Several case studies have been conducted to see the possibility of installing sustainable energy technologies in developed countries, mainly in Asia and Africa (Acker & Kammen, 1996; Islam, Islam, & Rahman, 2006; Pegels, 2009). From the aforementioned case studies, it was found that developing countries also have potential for sustainable energy technology. For example, in South East Asia, the exposure of solar energy could be categorized as high exposure, since the sun shines all year long with stable hours of exposure. Other form of sustainable energy technologies such as biomass could also be effectively implemented in developing countries.

1.1.2 Introduction to BRICS Countries

Among the abundant number of developing countries, there are five countries that are perceived to have important roles worldwide, which are Brazil, Russia, India, China, and South Africa (known as BRICS countries). These countries are seen as a group of leading emerging economies of the world (Bhat, 2015). According to (Bhat, 2015) the combined population of BRICS countries nearly account for half of the total population in the world. Moreover, the combined real GDP of those five countries reaches USD 20.47 trillion. According to (Cheng, Gutierrez, Mahajan, Shachmurove, & Shahrokhi, 2007), these countries are likely to be the largest global economic group by the middle of this century. Furthermore, economic growth in these countries has exceeded

the growth of industrialized countries (Biggemann & Fam, 2011). From those evidences alone, it can be seen that BRICS countries can possess high influence worldwide, including its influence to contribute to the global carbon emission level. Therefore, it becomes important to promote sustainable energy technologies in BRICS countries.

Moreover, BRICS countries have implemented policies to reduce its carbon emission, showing that BRICS countries currently raise its awareness to reduce carbon emission as well as to prevent further damage to the environment. For example, Brazil as one of the BRICS country is now listed as a global leader in ethanol production, only second to United State of America (Bhat, 2015). Biofuels is also one of the most developed sustainable energy technology in Brazil (La Rovere, Pereira, & Simões, 2011). Furthermore, since the establishment of Horizon 2020 in Europe, Russia also takes a huge part in developing sustainable energy technologies. It has set target to reach 15 to 25 GW of new sustainable energy capacity by 2020 (Bhat, 2015). The government of Russia also starts to make more investment for renewable technologies (Clark, 2015). Both Russia and China are blessed with the abundant availability of hydro resources as one of the sustainable energy resources. Currently, China ranks first follow by Russia for the potential of hydroelectricity (Bhat, 2015). The government of China also sought consultation from a renowned consulting firm in analyzing the potential of renewable energy in China (McKinsey & Company, 2009), showing that the country is moving toward sustainable technologies. Looking deeper to India, it is now rank fifth in the world as the country with most installed generation capacity from renewable sources (Bhat, 2015). Moreover, India is also listed as the first country to operate its airport fully by solar energy (Ali-Oettinger, 2015).As for South Africa, the solar energy is considered as the most potential renewable energy source. Therefore, it is interesting to discover the current situation of adoption to sustainable energy technology in BRICS country.

1.1.3 Electric Vehicles to Reduce Greenhouse Gas Emission from Transportation Sector

According to (Eurostat, 2015), there are two sectors that contribute the most to greenhouse gas emission in 2013; fuel combustion (without transport) with and transportation sector. Compare to 1990, the greenhouse gas emission from transportation sector increases from 14.9% to 22.2% while the greenhouse gas emission from fuel combustion has been reduced from 62.1% to 57.2% (see Figure 1-1)

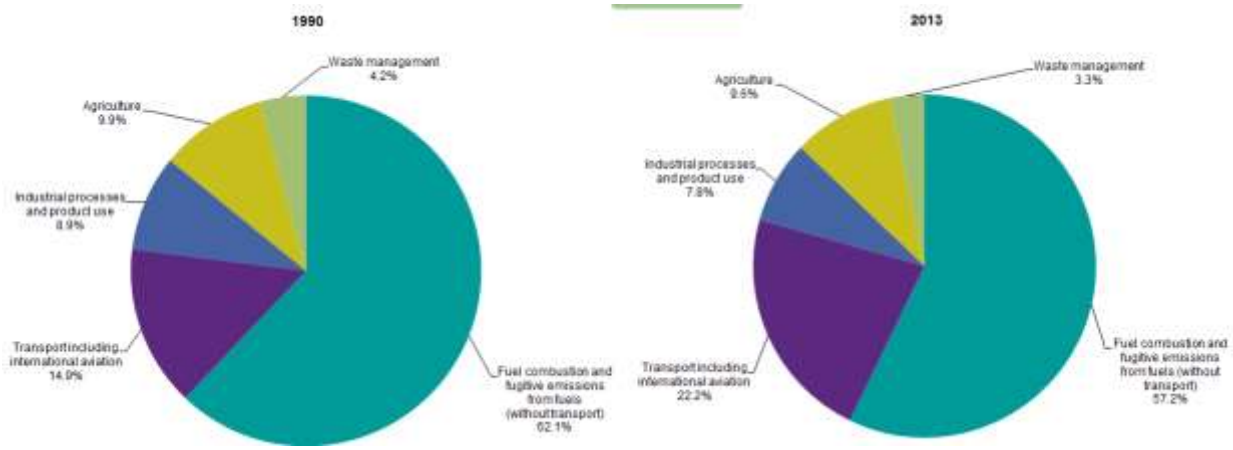

Figure 1-1 Greenhouse gas emission by sector (Eurostat, 2015)

Even though the transportation sector ranks two in the report, it can be seen that the greenhouse gas emission from transportation sector is increasing. Moreover, the growing trends of online shopping can also account to the increase level of greenhouse gas emission by transportation sector. Nowadays, even groceries shopping can be done through online shopping. A simple product such as tissue toilet can be delivered right in front of the customer's home. Globalization also accounts for the increase level of greenhouse gas emission from transportation sector. Trades can now be made internationally. Shipping becomes important to facilitate international trade. Therefore, it is important to reduce the greenhouse gas emission from transportation sector in order to reduce the overall greenhouse gas emission.

One of the proposed solutions to reduce the greenhouse gas emission from transportation sector is by shifting to electric vehicles and leaves the fuel-combustion vehicles behind. Several firms are now focuses in introducing electric vehicles while still maintaining to build infrastructure to support the electric vehicles, such as installation of charging station. The transition from fuel-combustion vehicles to electric vehicles are not only occurring in developed countries but also in developing countries. Adoption to electric vehicles in developing countries is even more important than in developed countries since public transportation in developing countries seems to be unattractive. Middle-class people in developing countries preferred to have their own cars or more popularly, motorcycle. Therefore, the greenhouse gas emission from that mode of transportation is higher than using public transport. The sales of electric vehicles are also occurring in BRICS countries, makes it interesting to investigate the transition to electric vehicles in BRICS countries.

In fact, several firms have penetrated the BRICS market in order to introduce electric vehicles to the customers. It was even predicted that China would be the biggest market of electric vehicles for years to come (Bär, 2013). As of September 2015, 136,733 units of electric vehicles, consisting of 87,531 all-electric vehicles and 49,202 plug-in hybrid vehicles were sold in China (China Association of Automobile Manufacturers (CAAM), 2015). Nissan in 2013 made a big move to penetrate the South African market. With the introduction to Nissan Leaf, Nissan became the first company to launch electric vehicles in South Africa (Lamprecht, 2013). The government

of India also have been actively promoting transition to electric vehicles, by giving incentives to the owners of electric vehicles (The Times of India, 2015). With government support, Russia also started to promote the electric vehicles by ensuring that charging stations would be provided in every gas station (Bazenkova, 2015). The government of Brazil also considered the transition to electric vehicles as one of the solution to reduce air pollution. The government of Brazil launched the green car incentives program to encourage the sales of electric vehicles (Edelstein, 2014). It was predicted that the number of electric vehicles sold in Brazil will reach more than 80,000 vehicles annually in 2020 (Research and Market, 2012).

However, even with government support, the number of sales of electric vehicles is still considered very low (Perkowski, 2014). Therefore, this research will investigate the reasons behind the slow adoption of electric vehicles, especially in BRICS countries.

1.2 Research Framework

1.2.1 Research Objective

The objective of this research is to identify barriers that hamper the transition to electric vehicles in BRICS countries as well as strategies to overcome those barriers. It is very interesting to focus on BRICS countries since BRICS countries have large population. According to (Bhat, 2015) the combined population of BRICS countries nearly account for half of the total population in the world. These countries are also considered as a group of leading emerging economies of the world (Bhat, 2015) that are growing quickly. Economic growth in these countries has exceeded the growth of industrialized countries (Biggemann & Fam, 2011). Moreover, according to (Cheng et al., 2007), these countries are likely to be the largest global economic group by the middle of this century. By looking at those evidences, the growing pollution is inevitable if we keep doing nothing.

Therefore, it is important to investigate the efforts to reduce pollution related to greenhouse gas emission in BRICS countries, especially in transportation sector. This is because according to (Eurostat, 2015), the greenhouse gas emission from transportation sector increased from 14.9% in 1990 to 22.2% in 2013, showing the importance to reduce greenhouse gas emission from transportation sector. One of the proposed solutions is by transition to electric vehicles.

This research covers several case studies in which comparisons are being made to see if different barriers of adoption of electric vehicles emerge in different BRICS countries or if the same barriers are treated with different strategies. Different results are expected due to different context of the countries. By doing this research, it is also possible to see how the barriers change overtime.

Several studies have been conducted to identify market potential of BRICS countries since they are viewed as the new economic strength (Biggemann & Fam, 2011). However, more of this studies focus on the difficulties on entering the market in BRICS countries rather than to achieve large scale market for the firms already exist in those countries (Biggemann & Fam, 2011; Johnson & Tellis, 2008; Parker, Don, & McLoughlin, 2010; Ulrich, Hollensen, & Boyd, 2014). On the other hand, several studies focus on how firms can achieve large scale market, regardless the countries that the firms' explore (Ortt & Delgoshaie, 2008; Ortt, Langley, & Pals, 2013). This research combines both views, in which it emphasized the importance of BRICS countries and investigates how firms in BRICS countries can achieve large scale market. Therefore, the result of this research will add more perspective to the current knowledge.

By the end of this research, a summary of list of barriers and strategies in BRICS countries related to transition to electric vehicles will be presented, along with the relationships between them. Therefore, as practical relevance, this research can provide input for firms concentrating to penetrate the market in BRICS countries, especially to introduce the electric vehicles. Moreover, on the perspective of MoT program, this research can also provide input for managers on how to formulate strategies in order to be able to tackle barriers in technology adoption, especially in BRICS countries.

To obtain the expected result, a multiple case study approach is selected. This method is considered appropriate since it demands a real-life context of the current situation of electric vehicles markets. Moreover, the situation is perceived as temporary situation, meaning that the situation can change overtime. Furthermore, the researchers interested in this topic have no or little control over what happen in the event, in this case the adoption of electric vehicles. Therefore, the multiple case study approach is considered best suited for this research.

1.2.2 Research Question and Sub Question

To be able to answer the research objective, research questions are formulated and serve as a guideline of the research. The main research question of this thesis is:

"How do firms in BRICS countries overcome barriers of adoption of electric vehicles?"

Several sub-questions are developed to support in answering the main questions:

1. *What are the barriers based on current literatures that can hamper the transition to new technologies?*
   This question will result in list of barriers based on theory as well as previous case studies in BRICS countries. It will be the basis of the research.

2. *What are the strategies implemented based on current literatures that can overcome the barriers of transition to new technologies?*

Scholars have proposed strategies to be implemented in order to overcome the barriers of transition to new technologies. It discusses also the strategies implemented in BRICS countries. The literatures will be studied and furthermore will be served as the foundation in conducting the case studies.

3. *What are the barriers of transition to electric vehicles in BRICS countries?*
   In transition to electric vehicles, barriers are often served as the challenge for successful transition. Therefore, it is important to analyze the type of barriers that are existed in BRICS countries.

4. *What are the current strategies implemented to overcome the barriers of transition to electric vehicles in BRICS countries? What are the results of these strategies?*
   In promoting electric vehicles in BRICS countries, firms implement specific strategies to overcome specific barriers. Analysis is conducted to see what kind of strategies that are implemented and how effective these strategies are in overcoming the barriers.

5. *What are the differences in barriers and strategies in BRICS countries, as well as the results of the strategies?*
   Each country possesses different context in which different barriers might emerge. These different barriers are treated differently in different countries and possibly different results occurred. Therefore, it is interesting to analysis why the differences occur.

1.2.3 Research Scope

Taking into consideration the time limit in conducting the master thesis, this research is limited in the following aspect:

1. Market or region
   This research focuses on market in BRICS countries, due to consideration discussed previously in section 1.1.2 of this thesis report.
2. Sustainable technology
   The specific sustainable technology investigated in this research is electric vehicles.
3. Time
   The research is conducted from February 2016 and ended with a thesis defence in first week of July 2016.
4. Actors
   Actors that will be investigated are limited to private firms in BRICS countries. Therefore, actions carried out by government are not going to be further investigated in this research.

1.2.4 Overview

The thesis report will consist of six sections. The detailed structure of the report can be found in section 4 of this thesis proposal. Section 1 of the thesis report consists of the general introduction of the research conducted for the master thesis, including the research framework in which research question and sub questions are discussed. Subsequently, section 2 discusses the literature review related to the topics in which the literature can help in building the starting point of the research. Later in section 3, the research approach is discussed. It consists of the selected methodology that is applied in the research as well as the data collection method. The result of data collection will be presented in section 4 of the thesis report. Analysis and cross case analysis are presented in section 5. Section 6 will conclude the thesis report with conclusions, discussion, reflections, and recommendation for further research.

2. Literature Review

Literatures that are relevant to the topic are reviewed and it served as a foundation in conducting this research. Several literatures that are included in this research are:

1. Literatures related to technology diffusion pattern

   This literature will give an insight to the phases of technology diffusion. This research investigates how firms can move from one phase to another phase, which is from market adaptation phase to market stabilization phase or large scale production. Understanding the nature of each phase will give an overall view of how a technology is being diffused.

2. Literature about barriers in transition to new technology, in which sustainable energy technologies can be categorized as one.

   Several literatures are taken into account to serve as the basis of this research, which are (Kemp, Schot, & Hoogma, 1998; Ortt et al., 2013; Painuly, 2001). Literature by (Ortt et al., 2013) is chosen because it summarizes the strategies that can be implemented to achieve large scale market. Literature by (Painuly, 2001) and (Kemp et al., 1998) are chosen because both explain barriers as well as strategies to overcome the barriers. Moreover, (Kemp et al., 1998) mentions electric vehicles as the technology that were being studied. The output of this part of literature review is the list of barriers based on the studied literature. However, barriers that are not relevant to this research will be excluded from the list. Further during the case study process, it would be analyzed which barriers occur in the cases. The keyword 'barriers renewable energy' was used for the search.

3. Literature about strategies to be implemented to overcome the barriers

   Many literatures have proposed the strategies that would overcome barriers in promoting new technology or an existing technology to a new market. However, strategies that are not relevant to this research will be excluded from the list. During the literature review, the list of the strategies would be combined and would be compared to the real-life strategies taken by firms during the case study process. In this literature review, the literature from (Kemp et al., 1998; Ortt et al., 2013; Painuly, 2001) will be further discussed after identification of barriers in the previous literature review.

4. Literatures related to barriers in BRICS countries.

   Since this research focuses on BRICS countries, literatures on case studies regarding barriers to enter the market in BRICS countries in general are analyzed. The list of barriers would then be compared to the previous list of barriers in general. This literature review is conducted to get familiar with the situation and context in BRICS countries. The search was done by using the keywords: 'market barriers BRICS', 'renewable energy BRICS'

5. Literatures related to strategies implemented in BRICS countries to overcome the barriers

Literatures regarding strategies to enter BRICS market as well as to reach large-scale market in BRICS countries are investigated to serve as the starting point of the research. Keywords used during the search: 'renewable energy BRICS'.

After presenting the relevant literature, the categorization for barriers and strategies is presented. This is done to avoid overlapping of barriers and strategies as well as to make a comprehensive list of barriers and strategies. However, the work does not stop there. Further analysis is conducted based on the literature on how the barriers and strategies are linked. The linkages will serve as the starting point for the research. It is assumed that the linkages between barriers and strategies also occur in transition to electric vehicles in BRICS countries. By the end of this research, it will be concluded whether the linkages really occurred or if the framework should be adjusted based on the real-life event of transition to electric vehicles in BRICS countries.

2.1 Technology Diffusion Pattern

(Ortt & Schoormans, 2004) proposed three phases of technology diffusion. These phases consist of:

1. Innovation phase

   This phase starts right after the invention of a new technology is established and ends at the time the technology is introduced to the market.
2. Market adaptation phase

   This phase starts when the technology is introduced to the market up until the large scale diffusion of the technology takes place.
3. Market stabilization phase

   This phase begins after the large scale diffusion takes place until the technology is saturated or substituted by other technology. This substitution of technology is known as technological discontinuity.

This research is focused on how the company can move from the market adaptation phase to the market stabilization phase. Barriers will be discussed specifically on challenges faced by the companies starting from the first introduction of the electric vehicles as well as barriers to create large scale diffusion of electric vehicles in BRICS countries.

2.2 Literature on Barriers

This section focuses on the current literature of barriers. Two types of main literatures are studied:

1. Literature on barriers to commercialize new hi-tech product: Based on literature by (Ortt et al., 2013). As electric vehicles can fit to the category of new technology, it is then important to see what kind of barriers that can hamper the transition to sustainable energy technologies from this perspective
2. Literature on barriers to promote sustainable energy technologies: Based on literature by (Kemp et al., 1998) and (Painuly, 2001). As these barriers are related to transition to sustainable energy technologies, it is expected that transition to electric vehicles in BRICS countries faces similar barriers.

2.2.1 Barriers to Commercialize New Hi-Tech Product

(Ortt et al., 2013) formulated twelve factors that are necessary for large-scale diffusion of new technology. Table 2-1 summarizes the factors that are necessary for large-scale diffusion of new technology. The absence of these factors could serve as barriers that hamper the transition to the new technology. The twelve barriers identified by (Ortt et al., 2013) are:

Table 2-1 Barriers to commercialize new hi-tech product

No	Barriers	Explanation
1	New high-tech product	The unavailability of one of the functionality provided by the product, the technological principle(s) used and the main components in the system (first tier of subsystems)
2	Production system	The unavailability of a good production system to support the transition to large scale diffusion
3	Complementary products and services	The unavailability of products and services required for the production, distribution, adoption, or use
4	Suppliers (network of organizations)	The absent of actors that are involved to supply the necessary product as well as coordination between the actors
5	Customers	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product
6	Institutional aspects (laws, rules and standards)	Laws and regulations that hamper the large scale diffusion of the product
7	Knowledge of technology	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product
8	Natural resources and labour	The unavailable natural resources and labour that are required to support production system and use a new high-tech product
9	Knowledge of application	Lack of knowledge about the practical application of the product
10	Socio-cultural aspects	Different perspectives norms and culture in regards to the use of the product
11	Macro-economic aspects	Unstable economic situation
12	Accidents or events	Occurrence of events that cannot be foreseen beforehand that affect the companies

According to (Ortt et al., 2013), the barriers represents a cause and effect relationship. The barriers knowledge technology, knowledge application, natural resources and labour, socio-cultural aspects, macro-economic aspects, and accidents or events precede the barriers new high tech product, production system, complementary product and services, suppliers, customers, and institutional aspect. Figure 2-1 represents the relationship between barriers.

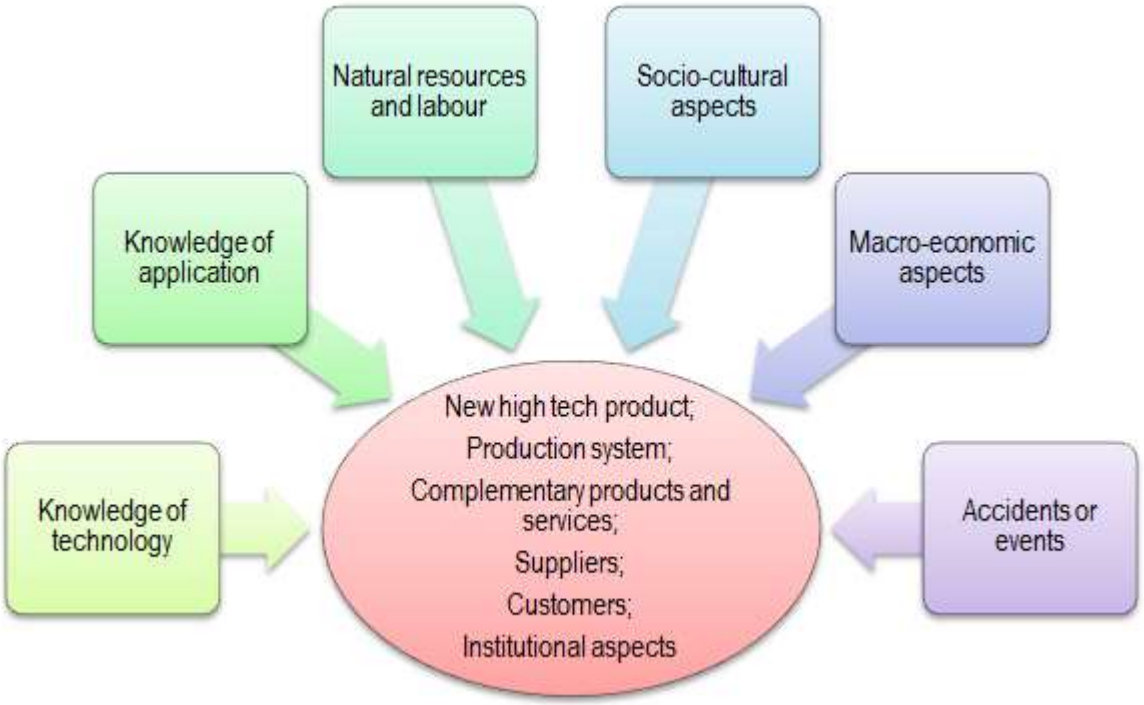

Figure 2-1 Relationship between barriers(Ortt et al., 2013)

From the above barriers, it is considered that barrier 'knowledge of application' is not relevant to this research since practical application of electric vehicles is widely known, which is not different than combusted-engine vehicles (Brain, 2002). This application relates to the daily usage of the vehicle, meaning that both electric vehicles and combusted-engine vehicles are used for transportation. However, knowledge in regards to the battery as well as maintenance for the electric vehicles is categorized as barrier of customers barrier (barrier that occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product). Therefore, from the literature of (Ortt et al., 2013), only 11 barriers are relevant for this research.

2.2.2 Barriers to Promote Sustainable Technologies

(Painuly, 2001) made a categorization of barriers that can hamper the penetration of renewable energy technology. The term renewable energy is uses in this literature. However, it refers to the same technologies as sustainable energy technologies. (Painuly, 2001) listed six categories of barriers in which each category consist of more detailed barriers. Table 2-2 summarizes the barriers.

Table 2-2 Categorization of barriers (Painuly, 2001)

No	Category	Barriers
1	Market failure/imperfection	- High controlled energy sector. It can cause little to no interest to invest in renewable energy technologies. - Lack of information and awareness of the importance of renewable energy technologies. Therefore, it increases uncertainty for the firms to invest in renewable energy technologies. - Restricted access to technology. Meaning that the availability of the technologies is limited. The reasons could vary, for example the price of

No	Category	Barriers
		the technology is too high or the number of available technology is very small. - Lack of competition. - High transaction cost. - Missing market infrastructure. This could lead to difficulty in transferring the product to the customer or hinder the use of the technology itself. - High investment requirement. This could lead to little competition due to only a small number of firms investing in the technology.
2	Market distortions	- Favour (such as subsidies) to conventional energy. This could lead the customer to also favour the conventional energy rather than the renewable one. - Taxes on renewable energy technologies. - Non-consideration of externalities. It can cause the price of conventional energy to be lower than it should have been. - Trade barriers.
3	Economic and financial	- Economically not viable, for example the price is too high then the cost should be reduced to get a lower price of the technology. - High discount rate. - High payback period, leads to investors become uninterested to invest in the technology. - Small market size. Therefore it might not be possible to achieve economic of scale, leading to high cost of the technology. - High cost of capital. - Lack of access to capital. - Lack of access to credit to consumers. Since the price of the technology is high, credit might be a viable solution to attract market. However, if there is a lack of access to credit, then the market size is possibly become smaller. - High up-front capital costs for investors. - Lack of financial institutions to support renewable energy technologies, lack of instruments
4	Institutional	- Lack of institutions/mechanism to disseminate information. It could lead to lack of information that can create market failure. - Lack of a legal/regulatory framework - Problems in realizing financial incentives - Unstable macro-economic environment - Lack of involvement of stakeholders in decision making - Clash of interests - Lack of R&D culture. This can cause the difficulty in adaption to the technology. - Lack of private sector participation. This would lead to lack of competition. - Lack of professional institutions
5	Technical	- Lack of standard and codes and certification - Lack of skilled personnel/training facilities, making it difficult for the producers to set up a plant in the country or city. - Lack of O&M (operation and maintenance) facilities - Lack of entrepreneurs - System constraints - Products are not reliable
6	Social, cultural, and behavioural	- Lack of consumer acceptance of the product - Lack of social acceptance for some renewable energy technologies

After making a comprehensive list of barriers from the literature, the next step is to determine whether all the barriers are relevant for this research. The following explain barriers that are considered irrelevant and will be excluded from the research:

1. High controlled energy sector from market failure category. According to (Painuly, 2001), this barrier refers to governmental monopoly of energy sector; therefore makes it difficult for firms to penetrate energy market in the country. Based on the explanation from (Painuly, 2001), this barrier is intended for penetrating energy market, not electric vehicles. Therefore, this barrier is excluded.
2. Economically not viable from economic and financial category. This barrier means that the production cost is too high, leading to a very high price of the product. In the case of electric vehicles, the production cost can be considered high. However, electric vehicles cannot simply be categorized as economically not viable, since it is still affordable in the market, even to only small market. The market shares of electric vehicles compare to the combusted-engine vehicles is very small (Perkowski, 2014). Therefore, electric vehicles can be considered economically viable, making this barrier irrelevant for this study.
3. High discount rate from economic and financial category. This is related to the discount rate used to see the present value of a technology, mostly in cost and benefit analysis (Ackerman & Finlayson, 2006). However, this is not related to transition to electric vehicles since this discount rate is used as a decision making tool for creation of policy, mostly to decide whether to shift to sustainable energy technology or not (Ackerman & Finlayson, 2006). Since the decision to shift to electric vehicles relies to the customer, not to the policy, then this barrier is not relevant.
4. Lack of involvement of stakeholders in decision making from institutional category. This is related to the decision making process in policy creation (Painuly, 2001). Since the transition to electric vehicles relies mostly to the customers' decision, then this barrier is excluded since it refers more to the policy or government's decision rather than customers.
5. Clash of interest from institutional category. This refers to clash of interest between actors in decision making process regarding policy creation (Painuly, 2001); therefore it is also excluded for this research.

Therefore, the modified barriers become:

Lack of information and awareness
Restricted access to technology
Lack of competition.
High transaction cost.
Missing market infrastructure
High investment requirement
Favour for conventional technology
Taxes on sustainable technology
Trade barriers
High payback period
Small market size
High cost of capital
Lack of access to capital
Lack of access for credit for customers
High up-front capital costs
Lack of financial institution to support sustainable technology
Lack of information sharing mechanism
Lack of legal/regulatory framework
Problems in realizing financial incentives
Unstable macro-economic environment
Lack of R&D culture
Lack of private sector participation
Lack of professional institutions
Lack of standardization
Lack of skilled personnel
Lack of O&M facilities
Lack of entrepreneurs
System constraints
Products are not reliable
Lack of consumer acceptance
Lack of social acceptance

Other than (Painuly, 2001), literature from (Kemp et al., 1998) from the perspective of strategic niche management is also studied. This studied is relevant because it took a case of sustainable transport technologies, in which electric vehicles is one of the technologies. Table 2-3 summarizes the barriers.

Table 2-3 Barriers in introducing new technology (Kemp et al., 1998)

No	Barriers	Explanation
1	Technological factors	- The new technology does not fit to the existing system - Require complementary technology to implement the new technology that not yet available in the market - Development of the new technology is still required because the first development might be considered as 'ill-development'. - The market of the new technology is still small, which causes the design specifications to be uncertain
2	Government policy and regulatory framework	- No clear view of what kind of new technologies is needed, leading to market uncertainty. - Strict regulation could serve as a barrier then hamper the development of new technologies.
3	Cultural and psychological factor	- Values hold by customers can affect the perception of the new technology. - New technology is perceived to have different image with the existing technology, therefore creating a barrier to shift to the new technology. - The customers are unfamiliar to the new technologies, thus leading to skepticism.
4	Demand factors	- Customers are unsure of what to expect from the new technology - The new technology does not cater any specific demand - High price of the new technology - Customer's demand cannot yet be articulated clearly
5	Production factors	- Risk in scaling up production - Lack of capital - Lack of competence
6	Infrastructure and maintenance	- Require infrastructure to be adjusted to the new technology - Require new maintenance system - High cost of investing in new infrastructure
7	Undesirable societal and environmental effects of new technologies	Negative side effect from the new technology, e.g.: waste

The study conducted by (Kemp et al., 1998) emphasized the barriers of transition to more sustainable transportation technology, which electric vehicles is included in this category. Therefore, all of the barriers mentioned in this study can be considered relevant for transition to electric vehicles in BRICS countries.

2.3 Literature on Strategies

2.3.1 Ten Niche Strategies to Commercialize New Hi-Tech Product

(Ortt et al., 2013) formulated ten niche strategies to overcome barriers to commercialize new hi-tech product. Table 2-4 summarizes the niche strategies.

Table 2-4 Ten niche strategies to commercialize new hi-tech product (Ortt et al., 2013)

No	Generic niche strategies	Description of the niche strategy
1	Demo, experiment and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem.
2	Top niche strategy	Targeting the high-end market by providing tailored technology
3	Subsidized niche strategy	Subsidy is embedded to the new technology
4	Redesign niche strategy	A simpler version of the technology is introduced by using current knowledge, fewer resources, leading to reduced price.
5	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology.
6	Hybridization or adaptor niche strategy	The new technology is combined with the existing technology to make the new technology compatible with existing system.
7	Educate niche strategy	The knowledge about the technology is transferred to both suppliers and customers
8	Geographic niche strategy	The new technology targets specific geographical area.
9	Lead user niche strategy	Involving lead users to co-develop the technology.
10	Explore multiple markets niche strategy	The new technology is introduced to multiple markets

All ten strategies are considered relevant to promote transition to electric vehicles in BRICS countries. However, the definition of strategy 3 of 'subsidized niche strategy' will be modified to fit the research. As this research focus on strategies implemented by firm while subsidies are given by the government, then the possible strategy to be implemented by the firms is to lobby the government to provide subsidies for the technology (Hekkert, Suurs, Negro, Kuhlmann, & Smits, 2007). According to (Hekkert et al., 2007), this strategy can be categorized as advocacy. This modification will not change the name of strategy, but explain more on how the firm can implement this strategy.

2.3.2 Strategies to Promote Sustainable Technologies

This literature review focuses on strategies proposed by scholars to promote sustainable energy technologies in general. Both literatures were intended to advice government to promote sustainable energy. Therefore, for the purpose of this research, relevant strategies that can be implemented by private firms are discussed after the summary of strategies. Modifications of strategies could also be applied in order to make it more suitable for private companies. Table 2-5 summarizes strategies proposed by (Painuly, 2001) and (Kemp et al., 1998).

Table 2-5 Strategies to promote sustainable energy technologies

No	Paper	Author(s)	Strategy(ies)
1	Barriers to renewable energy penetration: A framework for analysis.	(Painuly, 2001)	- Energy sector liberalization, for example restructuring of the energy sector, removing controls over energy sector. - Create guaranteed markets for renewable energy producers. - Financial incentives - Government investments. - Information and awareness campaigns to promote renewable energy technologies. - Establishment of standards and regulations. - Establishment of agencies that support renewable energy technologies producers in promoting the

No	Paper	Author(s)	Strategy(ies)
			technology. - Long term R&D planning. - Establishment of institutions to facilitate the need of producers. - Include moral and ethical considerations in decision making process.
2	Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management	(Kemp et al., 1998)	- Adaptations of legislation to facilitate the development of sustainable energy technology. - In-depth market research. - Cooperation between incumbents and new entrants. - Change the structure of incentive - Creation and building of a new socio-technical regime. - Build on the ongoing dynamics of socio-technical change and to exert pressures so that the socio-technical change will move into desirable directions. - Create temporary protected spaces for more sustainable technologies

Strategies that are not relevant to promote transition to electric vehicles are:

1. Energy sector liberalization strategy. According to (Painuly, 2001), this strategy is specifically implemented to overcome the barrier of controlled energy sector. However, in section 2.2.2 Barriers to Promote Sustainable Technologies, this barrier is excluded. Therefore, the strategy is also excluded.
2. Include moral and ethical considerations in decision making process. As this refer to policy creation or policy making process (Painuly, 2001), this will be excluded in this research. The focus of this research relies on private firms; therefore decision making for policy creation is not relevant.

Modification of the strategy is also required in order for the strategies to fit the purpose of the research:

1. Create guaranteed markets for renewable energy producers. The guaranteed market is only possible to be created by the government. The term renewable energy producers will also be changed to sustainable technology. According to (Hekkert et al., 2007), advocacy can function as catalyst for transition to new technology, Therefore, this strategy can be modified as an advocacy activity, which is 'persuade the government to create guaranteed market for sustainable technology'.
2. Financial incentives. According to (Painuly, 2001), this strategy refers to financial incentives given by the government, for example in the form of tax exemption, credit facilities, and third party financing mechanism. However, since the focus of this research is the strategy implemented by firms, not the government, then this strategy is modified to 'advocacy to gain financial incentives from the government'.
3. Government investments. This strategy also refers to what the government can do; therefore it is modified to 'seek government investments', as lobbying for government resources can also serve as catalyst for transition to new technology (Hekkert et al., 2007).
4. Establishment of standards and regulations. While establishment of standard can be done by firms to standard committee or consortia (Baron, Ménière, & Pohlmann, 2014), only the government can establish

regulation. Therefore, this strategy is divided into two different strategies: 'establishment of standard' and 'lobby for establishment of regulations'.

5. Adaptation of legislation. It is not possible for firms to adapt the current legislation in order to help them promote the transition to electric vehicles. However, the adaptation of legislation might be important to the success of transition to electric vehicles. Therefore, by adopting the function of creation of legitimacy proposed by (Hekkert et al., 2007), this strategy is modified to 'lobby the government to modify the current legislation'.
6. Change the structure of incentive. This is also strategy more suitable to be deployed by the government. Therefore, this strategy is modified to 'lobby the government to change the structure of incentive'.

Based on the analysis of relevancy as well as modification of the strategies, Table 2-6 summarizes the strategies to promote sustainable technology:

Table 2-6 Modification of strategies from (Painuly, 2001) **and** (Kemp et al., 1998)

Modification from (Painuly, 2001)	Modification from (Kemp et al., 1998)
1. Persuade the government to create guaranteed market for sustainable technology 2. Advocacy to gain financial incentives from government 3. Seek for government investment 4. Information and awareness campaigns 5. Establishment of standards 6. Lobby for establishment of regulations 7. Establishment of agencies that support sustainable energy producers in promoting the technology 8. Long term R&D planning 9. Establishment of institutions to facilitate the need of producers	1. Lobby the government to modify the current legislation 2. In-depth market research 3. Cooperation between incumbents and new entrants 4. Lobby the government to change the structure of incentive 5. Creation and building of a new socio-technical regime 6. Build on the ongoing dynamics of socio-technical change 7. Create temporary protected spaces for more sustainable technologies

2.4 Barriers in BRICS Countries

Several literatures are discussed to find existing barriers that can hamper the market entry for the firms as well as the product in BRICS countries. Table 2-7 summarizes the barriers.

Table 2-7 Barriers in BRICS countries

No	Paper	Author(s)	Barrier(s)
1	A future global economy to be built by BRICs	(Cheng et al., 2007)	- Government regulation - Taxes - Corruption
2	Institutional barriers to firm entry and exit: Case-study evidence from the Brazilian textiles and electronics industries	(Campos & Iootty, 2007)	- Financing - Infrastructure - Taxes and regulation - Policy instability/uncertainty - Inflation - Exchange rate - Functioning of the judiciary - Corruption - Street crime/theft/disorder

No	Paper	Author(s)	Barrier(s)
			- Organized crime/mafia - Anti-competitive practices by government or private enterprises
3	A survey on institutions and new firm entry: How and why do entry rates differ in emerging markets?	(Estrin & Prevezer, 2010)	- Labor regulation - Finance - Infrastructure - IPR - Lack of legal infrastructure - Corruption
4	Russia: Firm entry and survival barriers	(Aidis & Adachi, 2007)	- High criminal rate - Taxes - Unstable regulatory environment - Corruption - Labor regulation - Customers' income - Weak law enforcement - Uncertain political situation - Lack of capital - Lack of labor resources
5	Motivations and Barriers of the Model of Non-Traditional Market Economy: A Case to Study in BRICS	(Phat, 2012)	- Low incomes, impoverishment and social conflicts - Political connections, disputes and arms race
6	Trade and Investment in Renewable Energy Technologies: A Study of BRICS	(Bhat, 2015)	- Inadequate long-term funding sources - High cost of renewable energy technology - Subsidies for conventional energy technologies such as fossil fuels - Pricing rules - Lacked of integrated national economic perspective - Driven by uncoordinated state policies - Lack of access to the renewable energy technology - Lack of supporting infrastructures - Lack of supporting institutional structure - Weak laws regarding intellectual property rights - Lack of efficient legal structure - Difficulties in adopting technologies that are coming from other countries - Poverty - Presence of superstitions - Lack of initiative - Lack of openness to changes - Low level of awareness - Absence of standards of renewable energy technologies, resulting in poor quality technologies - Lack of technical and commercial skills - Lack of international cooperation

Table 2-7 provides an overall view of barriers in BRICS countries from different literature. However, it can be seen that several barriers from different literature are overlapping. The following provide explanations for the combined list of barriers:

1. The issue of government regulation has been mentioned in several literature as well as unstable policy situation and unstable regulatory environment (Aidis & Adachi, 2007; Bhatti, 2012; Campos & Iootty, 2007; Cheng et al., 2007; Estrin & Prevezer, 2010). Since those issues are basically discussing the same material, which are related to government regulation, therefore on the combined list of barriers, those two barriers are being merged to barrier 'government regulation'. Moreover, issue on Intellectual Property Rights (IPR) (Bhatti, 2012; Estrin & Prevezer, 2010) is also considered as part of barrier 'government regulation'.
2. Corruption has been mentioned in several literature as well as unstable political situation (Aidis & Adachi, 2007; Campos & Iootty, 2007; Cheng et al., 2007; Estrin & Prevezer, 2010; Phat, 2012). Since corruption is a part of political situation, therefore corruption will not be included while unstable political situation will be referred as the barrier in which corruption is included in it.
3. Financing issue is also discussed in several literatures even though it was mentioned in different term, such as lack of capital and inadequate long-term funding sources (Aidis & Adachi, 2007; Bhat, 2015; Campos & Iootty, 2007; Estrin & Prevezer, 2010). Therefore this will be referred as financing barriers.
4. Both street crime and organized crime lead to less investors interested to invest in BRICS countries, therefore it can be referred to the barrier 'anti-competitive practices by government or private enterprises'
5. Lack of integrated national economic perspective (Bhat, 2015). This barrier is not related since the transition to electric vehicles has no relation with national economic perspective.
6. Other barriers that are mentioned in one or more literatures are included in the combined list of barriers without changing the term used in the literatures.

From the aforementioned explanations, this research used the following list of combined barriers in BRICS:

- Government regulation
- Taxes
- Financing
- Infrastructure
- Exchange rate
- Lack of legal structure
- Anti-competitive practices by government or private enterprises
- Labor regulation
- Customers' income
- Uncertain political situation
- Lack of labor resources
- High cost of renewable energy technology
- Subsidies for conventional energy technologies
- Pricing rules
- Lack of access to the renewable energy technology
- Lack of institutional structure
- Difficulties in adopting technologies that are coming from other countries
- Poverty
- Presence of superstitions
- Lack of initiative
- Lack of openness to changes
- Low level of awareness
- Absence of standards of renewable energy technologies, resulting in poor quality technologies
- Lack of technical and commercial skills
- Lack of international cooperation

2.5 Strategies Implemented in BRICS Countries

To survive the market in BRICS countries, firms have implemented several strategies. Table 2-8 summarizes strategies implemented in BRICS countries to overcome barriers.

Table 2-8 Strategies implemented in BRICS countries

No	Paper	Author(s)	Strategy(es)
1	Market Entry Strategies in Emerging Markets: An Institutional Study in the BRIC Countries	(Holtbrugge & Baron, 2013)	- Establishing production plant in the country - Collaboration (joint ventures) with local producers
2	The Kyoto mechanisms and the diffusion of renewable energy technologies in the BRICS	(Freitas, Dantas, & Iizuka, 2012)	- Simultaneous promotion of demand and supply of renewable energy technologies - Increase the capabilities of potential national adopters to search and evaluate the relevant technological information regarding renewable energy technologies. - Collaboration with private partners regarding investment in sustainable energy technologies.
3	Comparison of renewable energy policy evolution among the BRICs	(Zhang, Li, Cao, Zhao, & Wu, 2011)	- Industrial planning of renewable energy - Emphasizing on technical R&D, credit and market mechanism - Strengthen the system support of the technology diffusion from the perspective of integration of industrial chain
4	Trade and Investment in Renewable Energy Technologies: A Study of BRICS	(Bhat, 2015)	- Stimulate trade of renewable energy technologies within BRICS countries - Join Kyoto Protocol to get access for CDM and JI - Subsidies and tax rebates to overcome high cost of capital - Provide easy access to credit as well as lower interest rates for loans - Encourage public-private partnership - Implementation of suitable policies to reduce emission - Creating awareness of the importance of renewable energy technologies - Strengthening legal and institutional framework - Strengthening infrastructure - Efficient policy framework - International collaboration and cooperation

Table 2-8 provides an overall view of strategies implemented in BRICS countries from different literature. However, it can be seen that several strategies from different literature are overlapping. The following provide explanations for the combined list of strategies:

1. Collaboration with private partners regarding investment in sustainable energy technologies can be combined with strategy to join Kyoto Protocol to get access for CDM and JI. Both focusing on how to get more financial aid. Therefore, the strategies are combined to 'collaboration to get financial aid for investment for sustainable technology'.
2. Industrial planning of renewable energy is excluded since it is not relevant for this research. This strategy concerns more on how to implement renewable energy in the country.

3. Emphasizing on technical R&D, credit, and market mechanism is modified. It is being separated. Emphasizing on technical R&D becomes one strategy wile credit and market mechanism is being combined with strategy 'provide easy access to credit as well as lower interest rates for loans'. However, the firms are the one in need for the credit and they cannot provide easy access to credit themselves. Therefore the strategy is modified 'request easy access to credit as well as lower interest rates for loans to invest in sustainable technology'.
4. Subsidies and tax rebates to overcome high cost of capital is modified to 'persuade for subsidies and tax rebates to overcome high cost of capital' since the only party capable of providing subsidies and tax rebates is government, not the firms.
5. Implementation of suitable policies to reduce emission. This strategy is not relevant for the case of transition to electric vehicles. Firms might be asked by the government to reduce their emission in their production process; however it will not lead to more people using electric vehicles. Therefore, this strategy is excluded.
6. Efficient policy framework. The firms have no control over policy framework. However, efficient policy framework can help them to promote transition to electric vehicles. For example, good policy framework in Norway has made the country as one of the leader in electric vehicles users (Hjorthol, Vågane, Foller, & Emmerling, 2014). Therefore, this strategy is modified to 'lobby for more efficient policy framework'.

Based on the combination as well as modification of strategies, the following are the comprehensive list of strategies implemented in BRICS countries:

- Establishing production plant in the country
- Collaboration with local producers
- Simultaneous promotion of sustainable technology
- Increase the capabilities of potential national adopters to search and evaluate the relevant technological information regarding sustainable technology
- Collaboration to get financial aid for investment for sustainable technology
- Emphasizing on technical R&D
- Request easy access to credit as well as lower interest rates for loans to invest in sustainable technology
- Integrated industrial chain
- Stimulate trade of renewable energy
- Persuade for subsidies and tax rebates to overcome high cost of capital
- Public-private partnership
- Create awareness of the importance of sustainable technology
- Strengthening infrastructure
- Lobby for more efficient policy framework
- International collaboration and cooperation

2.6 Categorization of Barriers

From the studied literature, it reveals that there are a lot of barriers discussed by scholars, both in general as well as specifically in BRICS countries. However, these barriers might be overlap with each other. Therefore, for the purpose of this research, the relevant barriers of adoption to electric vehicles in BRICS will be categorized. The relevant barriers from BRICS literature are also added in the categorization. This research proposes the following categorization:

Table 2-9 Categorization of barriers

#	Category	Explanation	(Ortt et al., 2013)	(Painuly, 2001)	(Kemp et al., 1998)	Combined barriers in BRICS
1	Production system	The unavailability of a good production system to support the transition to large scale diffusion	Production system	- Lack of O&M facilities - System constraints	Risk in scaling up production	
2	Complementary technologies	The unavailability of complementary products and/or services that support the product	Complementary products and services		Require complementary technologies	
3	Network	The absent of actors or organizations that are involved to supply the necessary product as well as coordination between the actors, including lack of international cooperation	Suppliers	Trade barriers		Lack of international cooperation
4	Demand	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product or when the price of the product is considered too	Customers	- Lack of information and awareness - High transaction cost - Small market size - Lack of access for credit for customers	- Unsure expectation - No specific demand is catered - High price of the new technology - Unclear articulation of customers' demand	- Customers' income - High cost of sustainable technology - Low level awareness

#	Category	Explanation	(Ortt et al., 2013)	(Painuly, 2001)	(Kemp et al., 1998)	Combined barriers in BRICS
		high.				
5	Institutional	Laws and regulations that hamper the large scale diffusion of the product, lack of supporting laws and regulations, as well as lack of competition and information sharing between the producers and customers	Institutional aspects	- Lack of competition - Lack of information sharing mechanism - Lack of legal/regulatory framework - Problems in realizing financial incentives - Lack of R&D culture - Lack of private sector participation - Lack of professional institutions - Lack of entrepreneurs - Favour for conventional technology - Taxes on sustainable technology	- No blue print of technological development - Strict regulation	- Government regulation - Taxes - Lack of legal structure - Anti-competitive practices - Labour regulation - Uncertain political situation - Lack of institutional structure
6	Technological	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product, as well as lack of standardization of the product	- New high tech product	- Lack of standardization - Products are not reliable	- The new technology does not fit to the existing system - Require more development of the technology - Uncertain design specifications	Absence of standards
7	Natural resources and labour	The unavailable natural resources and labour that are required to support production system, for example lack competent labour	- Natural resources and labour - Knowledge of technology	Lack of skilled personnel	Lack of competence	- Lack of labour resources - Lack of technical and commercial skills
8	Social, cultural, behavioural, and psychological	Different perspectives norms and culture in regards to the use of the product, lack of social acceptance of the	Socio-cultural aspects	- Lack of consumer acceptance - Lack of social acceptance	- Values hold by customers - Perception of new technology - Unfamiliar to the new	- Difficulties in adopting technologies from other countries - Poverty

#	Category	Explanation	(Ortt et al., 2013)	(Painuly, 2001)	(Kemp et al., 1998)	Combined barriers in BRICS
		product			technology	- Presence of superstitions - Lack of initiative - Lack of openness to changes
9	Macro-economic	Issues related to economic situation	Macro-economic aspect	Unstable macro-economic environment		- Exchange rate
10	Accident or events	Occurrence of events that cannot be foreseen beforehand that affect the companies	Accidents or events			
11	Infrastructure	The unavailability of technology or infrastructure that are required for the distribution and usage of the technology		- Restricted access to technology - Missing market infrastructure	- Require new infrastructure - Require new maintenance system	- Infrastructure - Lack of access to the sustainable technology
12	Financial issue	The absent of financing sources or lack of financial capabilities to support high scale production		- High investment requirement - High payback period - High cost of capital - Lack of access to capital - High up-front capital costs - Lack of financial institution to support sustainable technology	- Lack of capital - High cost of investing in new infrastructure	Financing
13	Undesirable societal and environmental effect	Negative side effect from the new technology			Negative side effect from the new technology	

The categorization of barriers generated thirteen categories: Production system; Complementary technologies; Network; Demand; Institutional; Technological; Natural resources and labour; Social, cultural, behavioural, and psychological; Macro-economic; Accident or events; Infrastructure; Financial; and Undesirable societal and environmental effect. These combined barriers will be used as the basis for this research.

2.7 Categorization of Strategies

From the studied literature, it reveals that there are a lot of strategies discussed by scholars, both in general as well as specifically in BRICS countries. However, these strategies might be overlap with each other. Therefore, for the purpose of this research, the relevant strategies of adoption to electric vehicles in BRICS will be categorized. The relevant strategies from BRICS literature are also added in the categorization. This research proposes the following categorization:

Table 2-10 Categorization of strategies

#	Category	Explanation	(Ortt et al., 2013)	(Painuly, 2001)	(Kemp et al., 1998)	Combined strategies in BRICS
1	Demo, experiment, and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem	Demo, experiment, and develop niche strategy			
2	Top niche market strategy	Targeting the high-end market by providing tailored product	Top niche strategy			
3	Pilot project strategy	Conducting pilot project to see how the product would be accepted by the market and how the customers would behave towards the product			Create temporary protected spaces for more sustainable technologies	
4	Lobbying strategy	Involve lobbying activities to the government to provide subsidies and other supports for the product	Subsidize niche strategy	- Persuade the government to create guaranteed market - Lobby for establishment of regulations - Advocacy to gain financial incentives from government	- Lobby the government to modify the current legislation - Lobby the government to change the structure of incentive	- Persuade for subsidies and tax rebates - Lobby for more efficient policy framework
5	Redesign niche strategy	A simpler version of the product is introduced by using current knowledge, fewer resources, leading to reduced price	Redesign niche strategy			
6	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology	Dedicated system or stand-alone niche strategy			
7	Hybridization or	The new product is combined with the	Hybridization or adaptor niche			

#	Category	Explanation	(Ortt et al., 2013)	(Painuly, 2001)	(Kemp et al., 1998)	Combined strategies in BRICS
	adaptor niche strategy	existing product to make the new product compatible with existing system	strategy			
8	Knowledge development	The knowledge about the product is transferred to both suppliers and customers, campaign to increase awareness of the importance of the product, enhancement of the R&D system of the company	Educate niche strategy	- Information and awareness campaigns - Long term R&D planning - Establishment of agencies that support renewable energy technologies producers in promoting the technology		- Simultaneous promotion - Increase the capabilities of potential national adopters - Emphasizing on technical R&D - Create awareness of the importance of sustainable technology
9	Geographic niche strategy	The new product targets specific geographical area	Geographic niche strategy			
10	Market research	Conducting an in-depth market research to explore the market needs, for example by involving lead user	Lead user niche strategy		In-depth market research	
11	Explore multiple markets niche strategy	The new product is introduced to multiple markets	Explore multiple markets niche strategy			
12	Financial aid	Collaboration with other institutions (for example international organization) to get financial support, both for producers or customers		Seek for government investment		- Collaboration to get financial aid - Request easy access to credit for consumer
13	Establishment of standard	Standard is imposed to the product		Establishment of standard		
14	Network creation	Establishment of cooperation between institutions, both locally and internationally		Establishment of institution to facilitate the need of producers	Cooperation between incumbents and new entrants Build on the ongoing dynamics of socio-technical change	- Collaboration with local producers - Integrated industrial chain - Stimulate trade - Public private partnership

#	Category	Explanation	(Ortt et al., 2013)	(Painuly, 2001)	(Kemp et al., 1998)	Combined strategies in BRICS
						- International collaboration and cooperation - Establishing production plant in the country
15	Development of infrastructure	Creation of infrastructure to support the distribution and usage of the product			Creation and building of a new socio-technical regime	Strengthening the infrastructure

The categorization of strategies generated fifteen strategies: Demo, experiment, and develop niche strategy; Top niche market strategy; Pilot project strategy; Lobbying strategy; Redesign niche strategy; Dedicated system or stand-alone niche strategy; Hybridization or adaptor niche strategy; Knowledge development' Geographic niche strategy; Market research; Explore multiple markets niche strategy; Financial aid strategy; Establishment of standard strategy; Network creation strategy; Development of infrastructure strategy.

2.8 Linkages between Barriers and Strategies

Linkages between barriers and strategies are made in order to have a comprehensive view on how the barriers affect the strategies. The linkages discussed in this section are based on the studied literature. First, the linkages between strategies and barriers according to (Ortt et al., 2013) are presented in Table 2-11. Two more columns are added to present the barriers category as well as strategies category in which the strategies are implemented.

Table 2-11 Linkages between strategies and barriers (Ortt et al., 2013)

#	Strategies	Explanation	Barriers category	Strategies category
1	Demo, experiment and develop niche strategy	Lack of knowledge of technology leads to insufficient quality of the product.	Technological	Demo, experiment and develop niche strategy
2	Top niche strategy	Lack of knowledge can affect the price, production system, and quality of the product. Moreover, lack of resources can also affect the price	- Technological - Demand - Production system - Natural resources and labour	Top niche strategy
3	Subsidized niche strategy	Lack of knowledge affects the production system and price. Lack of resources also affects the price.	- Technological - Production system - Demand - Natural resources and labour	Lobbying strategy
4	Redesign niche strategy	Lack of knowledge affects the production system and price. Lack of resources also affects the price. Lack of knowledge of application or cultural aspects lead to unavailability of institutional aspect. Socio-cultural aspect also can affect the availability of suppliers or customers.	- Technological - Production system - Demand - Natural resources and labour - Institutional - Socio, cultural, bahavioural, and psychological - Network	Redesign niche strategy
5	Dedicated system or stand-alone niche strategy	Lack of knowledge of technology leads to lack of complementary products and services.	- Technological - Complementary technologies	Dedicated system or stand-alone niche strategy
6	Hybridization or adaptor niche strategy	Lack of knowledge of technology and/or lack of resources leads to lack of complementary products and services.	- Technological - Natural resources and labour - Complementary technologies	Hybridization or adaptor niche strategy
7	Educate niche strategy	Lack of knowledge of technology leads to unavailable suppliers or customers.	- Technological - Network - Demand	Knowledge development
8	Geographic niche strategy	Lack of knowledge of technology, socio-cultural aspect, macro-economic, and accidents and unexpected events lead to lack of	- Technological - Socio, cultural, bahavioural, and psychological - Macro-economic	Geographic niche strategy

#	Strategies	Explanation	Barriers category	Strategies category
		institutional aspect. Lack of resources can affect the availability of product, complementary products, and services. Socio cultural aspect leads to lack of suppliers and customers.	- Accidents or events - Institutional - Natural resources and labour - Complementary technologies - Network - Demand	
9	Lead user niche strategy	Lack of knowledge of application affects the customers' perspective on the product. Socio-cultural aspects, macro-economic aspects, or accidents and unexpected events affect the availability of suppliers or customers.	- Socio, cultural, bahavioural, and psychological - Macro-economic - Accidents or events - Network - Demand	Market research
10	Explore multiple markets niche strategy	Lack of knowledge of application affects the availability of a clear view on application, usage patterns, and product benefits by customers	- Socio, cultural, bahavioural, and psychological - Demand	Explore multiple markets niche strategy

(Painuly, 2001) proposes strategies that are expected to remove barriers for sustainable innovations.

Table 2-12 Linkages between barriers and strategies based on (Painuly, 2001)

#	Strategies	Explanation	Barriers category	Strategies category
1	Persuade the government to create guaranteed market for sustainable technology	To overcome the high cost of sustainable technology by implementation of regulations as well as to provide access for trading	Demand Network	Lobbying strategy
2	Advocacy to gain financial incentives	Subsidies are given by government to reduce the cost of capital as well as to reduce the price of sustainable technology	Demand Financial	Lobbying strategy
3	Seek government investment	Investment to improve the development of sustainable technology	Financial Technological	Financial aid
4	Information and awareness campaigns	Informative programs to promote sustainable technology to educate customers in order to gain acceptance in the market	Demand Socio, cultural, behavioural, and psychological	Knowledge development
5	Establishment of standards	Standard is established to boost the production of sustainable technology	Technological Production system	Establishment of standard
6	Lobby for establishment of regulations	Regulations are implemented to increase	Institutional Demand	Lobbying strategy

#	Strategies	Explanation	Barriers category	Strategies category
		market share		
7	Establishment of agencies to promote sustainable technology	To help inseminate information regarding sustainable energy technology	Institutional Demand	Knowledge development
8	Long term R&D planning	To overcome the barrier of lack of R&D culture as well as to reduce the cost of sustainable technology in the long run	Institutional Demand	Knowledge development
9	Establishment of institutions to facilitate the need of producers	Institutions that provide raining for labour, financial aid for feasibility studies, and other benefits for producers, including the development of infrastructure	Natural resources or labour Financial Infrastructure	Network creation

On (Kemp et al., 1998), the linkages between barriers and strategies sometimes were not mentioned explicitly. Based on the explanation of strategies, it will be determine which barriers can be overcome by the strategies.

Table 2-13 Linkages between barriers and strategies based on (Kemp et al., 1998)

#	Strategies	Explanation	Barriers category	Strategies category
1	Lobby the government to modify the current legislation	This is specifically discussed to potentially overcome the barrier of government policy and regulatory framework	Institutional	Lobbying strategy
2	In-depth market research	This is specifically discussed to overcome the demand barrier as well as to determine the design specification of the technology	Demand Technological	Market research
3	Cooperation between incumbents and new entrants	This is specifically discussed to overcome the barrier in production	Production system	Network creation
4	Lobby the government to change the structure of incentives	Change the regulation such as exemption of tax	Institutional	Lobbying strategy
5	Creation and building of a new socio-technical regime	Example of this strategy is development of large infrastructure to overcome infrastructure barrier	Infrastructure	Development of infrastructure
6	Build on the ongoing dynamics of socio-technical change	Stimulate that co-evolution of supply and demand are going into a desirable direction, as well as minimize undesirable effect	Demand Undesirable societal and environmental effect	Network creation

7	Create temporary protected spaces for more sustainable technologies	The space in which technology can develop and grow. Once it is sufficiently developed, the target market would be enriched	Demand Infrastructure Production system Technological	Pilot project strategy

Furthermore, the linkages between barriers and strategies in BRICS countries also need to be formulated. However, the literatures do not address this matter explicitly. Only some of the barriers and linked with the strategies in some of the literatures. Therefore, if one strategy is implemented to overcome one barrier, then it is assumed that all the barriers in the same category can be treated with the same strategy. Table 2-14 summarizes the linkages between barriers and strategies based on literature. This table is presented to see what kind of possible strategies to be implemented to overcome a barrier. Therefore, the table first presents the barrier, followed by the possible strategies the firm can choose to overcome the barrier.

Table 2-14 Linkages between barriers and strategies

#	Barriers	Strategies	Literature
1	Production system	Top niche market strategy	(Ortt et al., 2013)
		Pilot project strategy	(Kemp et al., 1998)
		Redesign niche strategy	(Ortt et al., 2013)
		Network creation	(Kemp et al., 1998; Painuly, 2001)
		Establishment of standard	(Painuly, 2001)
		Lobbying strategy	Added in this report, modified from (Ortt et al., 2013)
2	Complementary technologies	Dedicated system or stand-alone niche strategy	(Ortt et al., 2013)
		Hybridization or adaptor niche strategy	(Ortt et al., 2013)
		Geographic niche strategy	(Ortt et al., 2013)
3	Network	Redesign niche strategy	(Ortt et al., 2013)
		Knowledge development	(Ortt et al., 2013)
		Lobbying strategies	Added in this report, modified from (Painuly, 2001)
		Market research	(Ortt et al., 2013)
		Geographic niche strategy	(Ortt et al., 2013)
4	Demand	Top niche market strategy	(Ortt et al., 2013)
		Pilot project strategy	(Kemp et al., 1998)
		Lobbying strategy	Added in this report, modified from (Ortt et al., 2013; Painuly, 2001)
		Redesign niche strategy	(Ortt et al., 2013)
		Geographic niche strategy	(Ortt et al., 2013)
		Knowledge development	(Bhat, 2015; Freitas et al., 2012; Ortt et al., 2013; Painuly, 2001)
		Market research	(Kemp et al., 1998; Ortt et al., 2013)
		Explore multiple markets niche strategy	(Ortt et al., 2013)
		Network creation	(Kemp et al., 1998)
5	Institutional	Lobbying strategy	Added in this report, modified from (Kemp et al., 1998; Painuly,

#	Barriers	Strategies	Literature
			2001)
		Redesign niche strategy	(Ortt et al., 2013)
		Knowledge development	(Painuly, 2001)
		Geographic niche strategy	(Ortt et al., 2013)
6	Technological	Demo, experiment, and develop niche strategy	(Ortt et al., 2013)
		Top niche market strategy	(Ortt et al., 2013)
		Pilot project strategy	(Kemp et al., 1998)
		Redesign niche strategy	(Ortt et al., 2013)
		Hybridization or adaptor niche strategy	(Ortt et al., 2013)
		Knowledge development	(Ortt et al., 2013)
		Geographic niche strategy	(Ortt et al., 2013)
		Market research	(Kemp et al., 1998; Ortt et al., 2013)
		Establishment of standard	(Painuly, 2001)
		Lobbying strategy	(Ortt et al., 2013)
		Dedicated system or stand-alone niche strategy	(Ortt et al., 2013)
		Financial aid	(Painuly, 2001)
7	Natural resources and labour	Top niche market strategy	(Ortt et al., 2013)
		Lobbying strategy	Added in this report, modified from (Ortt et al., 2013)
		Redesign niche strategy	(Ortt et al., 2013)
		Hybridization or adaptor niche strategy	(Ortt et al., 2013)
		Knowledge development	(Ortt et al., 2013)
		Geographic niche strategy	(Ortt et al., 2013)
		Network creation	(Painuly, 2001)
8	Social, cultural, behavioural, and psychological	Redesign niche strategy	(Ortt et al., 2013)
		Geographic niche strategy	(Ortt et al., 2013)
		Market research	(Ortt et al., 2013)
		Explore multiple markets niche strategy	(Ortt et al., 2013)
		Knowledge development	(Painuly, 2001)
9	Macro-economic	Geographic niche strategy	(Ortt et al., 2013)
		Market research	(Ortt et al., 2013)
10	Accidents or events	Geographic niche strategy	(Ortt et al., 2013)
		Market research	(Ortt et al., 2013)
11	Infrastructure	Development of infrastructure	(Bhat, 2015; Kemp et al., 1998)
		Network creation	(Painuly, 2001)
		Pilot project strategy	(Kemp et al., 1998)
12	Financial	Lobbying strategy	Added in this report, modified from (Ortt et al., 2013; Painuly, 2001)
		Financial aid	(Bhat, 2015; Freitas et al., 2012; Painuly, 2001)
		Network creation	(Painuly, 2001)
13	Undesirable societal and environmental effect	Network creation	(Kemp et al., 1998)

From Table 2-14, several strategies from (Ortt et al., 2013) were modified in this report in order to be implemented to smoothened the adoption of electric vehicles in BRICS countries. (Ortt et al., 2013) explains as the knowledge to produce the technology has not yet advanced, it would lead to high price of the product, which

is part of production system barrier. Therefore, subsidize niche strategy would be advisable. However, company is not in place to provide subsidy. This subsidy must come from the government. Therefore, this strategy is modified to 'lobbying strategy'. Lobbying is required in order to get the necessary subsidy for the production system. Lobbying strategy could also be implemented to overcome high price of electric vehicles which leads to demand barrier. Through lobbying, company can achieve subsidy to reduce the selling price of electric vehicles. Lack of resources could also affect the price of electric vehicle; hence subsidy could be beneficial for both customers and company. Therefore, lobbying could be implemented in order to get the subsidy. Lobbying can also be implemented to overcome financial issues, in which lobbying can be address to get subsidy from government.

Several strategies from (Painuly, 2001) were also modified since those strategies were intended for the government to help sustainable technology companies in competition with current technologies. Therefore, from company's point of view, lobbying activities are required to get these assistances. For network barrier, lobbying is required in order for the government to provide access for trading. While to overcome demand barrier and financial barrier, company is advised to do lobbying in order to get financial assistance from government and to get subsidy to reduce the price of electric vehicles. Lobbying is also required to overcome institutional barrier. This refers to lobbying activities to advise government in implementing regulations that support the electric vehicles. Regulations in a form of incentives should also be implemented to increase the demand of electric vehicles, hence overcoming the demand barrier. Modification of strategy proposed by (Kemp et al., 1998) was also done in which lobbying can be implemented to overcome institutional barrier.

Other than linkages between barriers and strategies, the relationship between barriers will also be explored. According to (Ortt et al., 2013), the represents the relationships between barriers, in which barriers group 1 precede barriers group 2 (the name of the barriers have been changed based on the categorization of barriers in section 2.6)

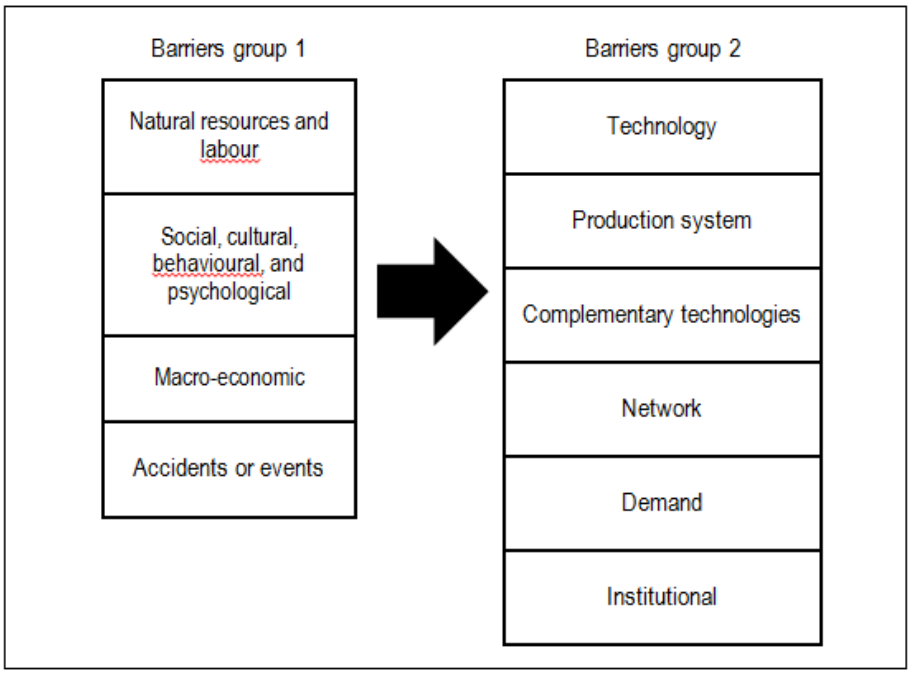

Figure 2-2 Relationships between barriers

However, not all the barriers are included in this relationship. Barriers infrastructure, financial, and undesirable societal and environmental effect are not included since those barriers are not mentioned in (Ortt et al., 2013). Therefore, this research tried to established the aforementioned barriers to fit the cause and effect relationship established by (Ortt et al., 2013).

1. Infrastructure: Infrastructure barrier include barriers restricted access to technology, missing market infrastructure, require new infrastructure, and require new maintenance system. Based on these barriers, it is considered that demand barriers can be affected by barrier infrastructure because if the access to technology is restricted, it will affect the market size (Painuly, 2001). The size of market size is one of the components in demand barriers; therefore it can be concluded that infrastructure barrier can be placed in barrier group 1.
2. Financial: This barrier related to the financial issues faced by firm, including the high cost of capital as well as high up-front investment. In order to achieve large scale market, the production systems should be adjusted to meet the demand of large scale market. However, since the cost of capital is high, then the lack of financial capabilities will affect the availability of sufficient production system. Therefore, it can be concluded that financial barrier will affect production system barrier. Moreover, high price of product can also effect the demand (Kemp et al., 1998). Therefore, financial barrier then can be included in barrier group 1.
3. Undesirable societal and environmental effect: According to (Kemp et al., 1998), this barrier could affect the image of the new technology, in which also affecting the demand. If the technology is perceived to be environmentally harming due to negative side effect to the technology, it is possible that the market size would be reduced. Therefore, this barrier can be included in barrier group 1 because this barrier affects demand barrier.

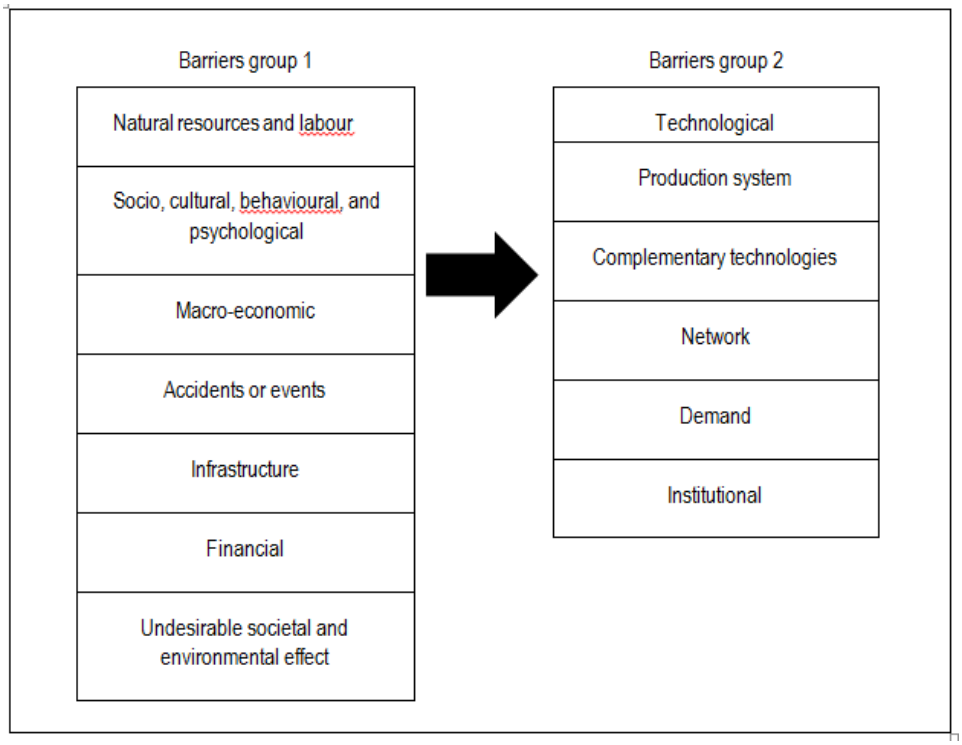

Figure 2-3 Relationship between the pre-specified list of barriers

These modified relationships will be the starting point to investigate the relationship between barriers. However, it is possible that the relationships would be further modified based on the interview result.

2.9 Summary

This section provides an overview of barriers and strategies as well as the linkages between the two. The list of barriers and strategies are gathered from the literature by (Kemp et al., 1998; Ortt et al., 2013; Painuly, 2001), and literature from BRICS countries. Those barriers then are categorized based on the similarity of the barriers. Strategies are also categorized based on the similarities of the strategies. After categorization, the linkages between barriers and strategies are established by looking deeper at the literature. During the research, it will be investigated whether the barriers are occurring in BRICS countries and whether the strategies implemented in accordance with this existing list. Adjustment of the list will be made if different barriers occur or different strategies are implemented in BRICS.

3. Research Approach

3.1 Research Methodology

In order to answer the research question of "How do firms in BRICS countries overcome barriers of adoption of electric vehicles?", a suitable method should be applied. This research question demands a real-life context of the current situation of electric vehicles markets. However, this real-life situation is perceived as temporary situation. The situation can change overtime. Furthermore, the researchers interested in this topic have no or little control over what happen in the event, in this case the diffusion of electric vehicles. Therefore, it meets the common characteristic of research that can be conducted through case study research. According to (Yin, 2009), case studies are preferred when:

a. "how" or "why" questions are being asked
b. the investigator has little control over events, and
c. the focus of the research is on a contemporary phenomenon within a real-life context.

Therefore, it is concluded that case study method is the most suitable method to be applied in the research. The real-life context that is going to be investigated in this research is the barriers experienced by companies in the transition to electric vehicles in BRICS countries as well as the strategies implemented to overcome the barriers. Furthermore, the effect of those strategies will also be investigated to see if the strategies change the current conditions of the barriers, or if new barriers emerge as the impact of the strategies.

Figure 3-1 gives the overview of how the research was conducted.

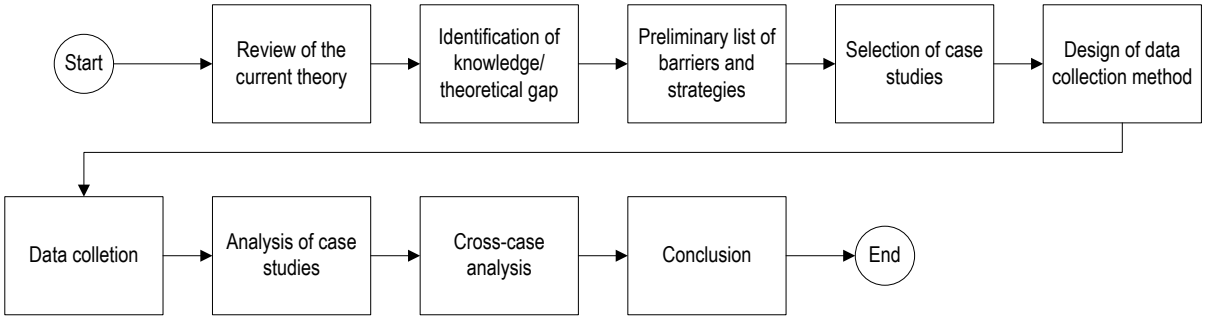

Figure 3-1 Research Approach

This research starts with the current literature on barriers and strategies published by (Ortt et al., 2013), (Painuly, 2001), and (Kemp et al., 1998). Then, further literature review is conducted to see whether the barriers and strategies occur in BRICS countries (Brazil, Russia, India, China, and South Africa) or if some adjustment should be done. These barriers cover both barriers to entry as well as to expand the market to achieve large-scale market. More literature review is also conducted to determine strategies implemented by firms in BRICS

countries. Adjustment of the list of strategies from the first literature review will also be done. The result will be preliminary list of barriers and strategies which are possible to occur in BRICS.

After the preliminary list is obtained, the cases were selected by choosing manufacturers of electric vehicles in BRICS countries. The data collection method then was established in order to obtain relevant data for the research. Data was collected by interview with representative of the companies and the data was analysed to identify specific barriers occur in the region and strategies implemented to overcome the barriers. Based on the result, conclusion is drawn to close the research.

3.2 Selection of Cases

Moreover, case studies of diffusion electric vehicles in BRICS countries will be selected to determine barriers that occur in real-life context as well as strategies implemented by the specific firms to overcome the barriers. Table 3-1 summarizes the selected case studies.

Table 3-1 Case studies

Countries	Firms
India	Mahindra Reva
South Africa	Nissan
Brazil	Renault

These three cases are chosen because each case has different characteristics. Moreover, the cases occurred in different countries of BRICS. Therefore, it is assumed that the firms face different barriers as well as implementing different strategies. Furthermore, the current situation of the sales of the electric vehicles is also different. Further explanation of the uniqueness of the cases as follow:

1. Mahindra Reva India

   Mahindra Reva is the only company that focus in the development of electric vehicles for Indian market. As company that produces electric vehicles locally, Mahindra is assumed to have knowledge of the culture and societal situations of Indian markets, thus Mahindra might have advantage to implement the most proper strategies to successfully bring electric vehicles to large scale market.
2. Nissan South Africa

   Nissan Leaf was the first electric vehicle introduced in South Africa (Lamprecht, 2013). It was considered a very risky move, considering that electric vehicles might not be accepted well by the people in the region
3. Renault Brazil

   Renault has developed its electric vehicles in France sin 2008. From then, it has been importing the electric vehicles worldwide, including Brazil in 2012. Its first move was to introduce the vehicles in business-to-business market, by approaching government and other corporation to purchase the electric vehicles.

3.3 Data Collection Method

To find out the real barriers and strategies implemented by the firms selected, interviews with the firms will be conducted. During the interview, it is possible to identify that companies unknowingly implement the available

strategies from literatures or implement different strategies that are not discussed in current literature Furthermore, the interview will identify the result of each implemented strategies, and if further actions were taken as follow ups. It is expected that different strategies with different results are occurring in each case. It is also possible that the implementation of one strategy can result in emergence of new barriers. If so, then it will be investigated what the firm did to overcome the barriers. Cross-case analysis then will be conducted to find the reason behind the different barriers that occur in different countries, different strategies that are implemented, as well as different results of the strategies. Detail of the interview process is discussed in the following section.

3.3.1 General Information

The interview is designed to be carried through Skype call, due to the distance between the Netherlands to India, South Africa, and Brazil. The interview was conducted in English and taken around one hour. The interview is semi-structure, in which several open questions and closed questions are presented to the representative (or the expert) of the companies.

3.3.2 Interview Process

a. Initial contact with the companies

   In order to get in touch with the representative of the companies, the short version of research proposal is sent to Nissan, Mahindra Reva, and Renault. From the email, the interview schedule was set up with the representative of the companies.

b. Opening

   The interview was opened by introduction from both parties, as well as brief explanation of the research objective. The expert was also given opportunities to explore more about the research.

c. Interview stages

   The interview stages are based on (Ortt, Kamp, & Doe, 2015). During the interview the following processes are conducted:

   1. Stage 1: Addressing the background of the experts as well as the company.

      Questions in this part of interview are intended to see if the experts have sufficient knowledge in answering all of the questions. It is also intended to see how strong the company's position is in the market.

   2. Stage 2: Addressing the barriers for adoption of electric vehicles

      Three steps in addressing the barriers:

      2.1 Open questions about barriers for adoption of electric vehicles. The experts are asked to identify barriers that the company is facing in introducing the electric vehicles to the mass market and if the barriers have changed overtime.

      2.2 Closed questions using the pre-specified list of barriers. The experts are asked to identify the importance of each barrier in regards to the adoption of electric vehicles.

      2.3 Closed questions using the pre-specified list of barriers. The experts are asked to rank the barriers based on its importance.

2.4 Discussion to ensure that all the possible barriers have been covered during the open and closed questions.

3. Stage 3: Addressing the strategies to overcome the barriers

   Three steps in addressing the strategies

   3.1 Open questions about the strategies implemented by the company to overcome the barriers. The experts are asked to identify strategies implemented to overcome each barrier. Moreover, the effects of the strategies are also discussed to investigate whether the strategies could tackle the barriers successfully as well as the possible reasons for unsuccessful strategies.

   3.2 Closed questions using the pre-specified list of strategies. The experts are asked to identify the importance of each strategy to overcome barriers.

   3.3 Closed questions using the pre-specified list of strategies. The experts are asked to rank the strategies based on its importance.

   3.4 Discussion to ensure that all the possible strategies have been covered during the open and closed questions.

4. Stage 4: Discussion on linkage between the most important barriers and the selected strategies.

d. Closing

3.3.3 Interview Questions

Stage 1

1. What is your role in the company?
2. Do you have prior knowledge or experience in this field? Especially in regards to electric vehicles and its market.
3. Why did your company decide to enter the market in India/South Africa?
4. Could you briefly explain your company activities regarding the adoption of electric vehicles in the country?
5. What is your company's method is selling the electric vehicles to the customers? For example, is it direct selling or the company utilizes distributors?
6. In your opinion, how is your company's position in the current market?

Stage 2

7. What barriers are your company experiencing in promoting the adoption of electric vehicles?
8. Do the barriers change overtime?
9. Based on the list of pre-specified barriers (questionnaire), are there any barriers that you consider also relevant for the adoption of electric vehicles?
10. Closed questions using the pre-specified list of barriers, included also the barriers mentioned by expert in question 1. Could you identify the importance of each barrier in regards to the adoption of electric vehicles? The questionnaire is presented via googlesheet. 7 scale would be used:

    1 – not at all important

2 – low important
3 – slightly important
4 – neutral
5 – moderately important
6 – very important
7 – extremely important

11. Closed questions using the pre-specified list of barriers, included also the barriers mentioned by expert in question 1. Could you rank all the barriers based on their importance? 1 for the most important barriers, 2 for the 2nd most important barriers, and so forth. (This is also provided via googlesheet)

Stage 3

12. What are your company's strategies to overcome each barrier?
13. How are the effects of the implemented strategies? Are the strategies effectively overcome the barriers? If not, why?
14. Based on the list of pre-specified strategies (questionnaire), are there any strategies that you consider also relevant for the adoption of electric vehicles?
15. Closed questions using the pre-specified list of strategies, included also the strategies mentioned by expert in question 1. Could you identify the importance of each strategy in regards to the adoption of electric vehicles? The questionnaire is presented via googlesheet. 7 scale would be used:
    1 – not at all important
    2 – low important
    3 – slightly important
    4 – neutral
    5 – moderately important
    6 – very important
    7 – extremely important
16. Closed questions using the pre-specified list of strategies, included also the strategies mentioned by expert in question 1. Could you rank all the strategies based on their importance? 1 for the most important strategy, 2 for the 2nd most important strategies, and so forth. (This is also provided via googlesheet)

Stage 4

Discussion to identify the linkages between barriers and selected strategies.

4. Case Results

In this section, the results of interviews with Nissan, Mahindra Reva, and Renault are presented.

4.1 Nissan South Africa

4.1.1 Company Profile

Nissan Motor Co., Ltd. is an automotive company that was first established in Yokohama City, Japan in 1933. Main business activities of Nissan include manufacturing, sales and related business of automotive products and marine equipment. It currently manufactures vehicles in 20 areas around the world, while offers products and services in more than 160 areas worldwide (Nissan Motor Corporation, 2016). According to (Murphy, 2015) in Forbes Magazine, Nissan is the 8th largest auto companies in the world.

Nissan manufactures vehicles under two brands, Nissan and Infiniti. Infiniti differs from Nissan's usual vehicles because it offers vehicles with advanced design and powerful performance. Nissan started to manufactures 100% electric vehicles in October 2010 at Opama plant, branded Nissan Leaf. Nissan Leaf first launched in Japan in December 2010. It has since considered as the best-selling electric vehicles worldwide with 45% market share in 2014 (Automotive World, 2014).

Following the success introduction of Nissan Leaf in Japan, Europe, and United States, Nissan aims to achieve the same success in African market. It's first moved was to launch the Nissan Leaf in South Africa in 2012. Nissan Leaf is now considered as the market leader of electric vehicles in the region.

4.1.2 Interview Result Stage 1 – Background Information

The interview was conducted by phone call with Thomas Ebeling, The General Manager Product Marketing of Nissan Sub Sahara Africa. He has been appointed for that position since 2015. Before appointed in Nissan Sub Sahara Africa, he worked in Nissan Europe product planning site and was responsible for the launch of Nissan Leaf in 2010 as well as the n-NV200 (an electric van produced by Nissan) in 2014.

According to (Ebeling, 2016), the decision to enter the African market was in line with the global strategy of Nissan. Nissan planned to become the global leader of electric vehicle in the world. Nissan also wanted to become the first company that launch electric vehicle in African region. Therefore, the Nissan Leaf, was launched in South Africa, two years after the launch of Nissan Leaf in Europe, United States, and Japan.

Before the launch of Nissan Leaf in 2012, Nissan had actively got engaged with the government of South Africa since 2010 to raise interest and awareness about issues regarding electric vehicles, mainly related to the unavailability of charging stations in the region (Ebeling, 2016). Nissan also got in touch with electricity providers

to ensure that there was sufficient knowledge in regards to electric vehicles as well as the charging networks. Nissan also engaged with BMW in cooperation to provide charging stations that are able to charge both Nissan's and BMW's electric vehicles due to the differences in charging system between the two cars (dual connectivity). More on this will be discussed in the Interview Result Stage 3 – The Strategies.

Currently there are seven dedicated outlets, the dealers that have invested in servicing the cars and charging. Dealers need to invest in training to obtain the knowledge of electric vehicles as well as provide charging facility available within the outlets. All the effort from the dealers is dedicated for private customers. However, Nissan also pursue governments, done centrally from office in Rosslyn. Sales are directed to two government department, i.e. Department of Environment Affairs and Department of Transport and Industries. Nissan also sell the electric vehicles to large fleets, such as the national electricity company Eskom.

As for competition, even though BMW is also active in the region, it is not considered as a direct competition for Nissan due to BMW i3 cars produced by BMW is positioned as the luxury cars with far more expensive price. Therefore, currently Nissan is considered as the market leader and the best-selling electric vehicles in South Africa.

4.1.3 Interview Result Stage 2 – The Barriers

During this stage, the barriers of adoption to electric vehicles in South Africa are discussed. During the interview, four barriers were mentioned:

1. There are no government support in creating charging infrastructure for electric vehicle
2. There are no government incentives to promote the sales of electric vehicles. This leads to difficulties to sell the electric vehicles due to the high price of electric vehicles. According to (Ebeling, 2016), the high production cost of electric vehicles arises due to the low production volume. If the production volume can be increased, it could be assumed that the production cost would also get reduced. However, the absence of government incentives has made it difficult to obtain large scale production since the demand for electric vehicles is still low.
3. Long driving distance in the region, compare with driving distance in Europe or Japan. This leads to range anxiety, meaning that the drivers are worried that the battery will run out before reaching the destination or the next charging station. This barrier is related to the lack of charging stations in the region, making it difficult for long-distance travel. This barrier also related to the current battery capacity of Nissan's electric vehicles. Therefore, there are two possible ways to circumvent this barrier, which are either by having dense charging network or increasing the battery range. Particularly in South Africa, this barrier raises the issue of safety. People do not want to run out of battery especially during the evening. Therefore, people have additional fear of not having enough range (or battery) to get back home.
4. Frequent power outage in the country and in Sub Sahara in general. This situation leads to unwillingness to buy the electric vehicles.

According to (Ebeling, 2016), the barrier of coverage of charging station existed in the early phase of the introduction of the electric vehicles. If the coverage of charging station can be increased or the battery range can be improved, then this barrier might disappear and improve the acceptability of electric vehicles.

Moreover, based on the discussion, it was agreed that the first and second barrier can be included to the institutional barrier. Furthermore, the first barrier leads to the infrastructure barrier since Nissan together with BMW require government support to provide customers with sufficient charging station. The third barrier covers both barrier of complementary technology in term of the battery capacity and infrastructure barrier in term of the lack of charging facilities. The fourth barrier is considered to be included in accident or event barrier.

Several other barriers from the pre-specified list (appendix) were also discussed in regards to the situation of Nissan in South Africa. The following elaborates the detail:

1. Barrier of production system, technological, as well as natural resources and labour were considered as not important. Currently, the electric vehicles are produced out of South Africa and are imported to South Africa to fulfil the demand. Nissan currently has a large production system in United States, Europe (in UK and Spain), and Japan. This mass production is also related to the production of battery. Nissan is currently trying to cut the production cost of lithium-ion battery in order to make the cost of electric vehicle more competitive.
2. In network barrier, the actors that are considered important in adoption of electric vehicles in the country are the government and electricity suppliers. Although the actors exist, the support from the actors itself is missing, especially to provide charging infrastructure is considered. Therefore, the network barrier can be considered occur but it is highly related to the institutional barrier.
3. The demand barrier also occurs but it highly related with other barrier, such as the absence of incentive (institutional barrier), the insufficient charging stations (infrastructure barrier), safety risk due to range anxiety (complementary technologies barrier, infrastructure barrier), and unwillingness to buy due to frequent power outage (accident or events barrier). From the interview, it could be concluded that the demand barrier is a result of other barriers occurring in South Africa.
4. The current price of patrol affects the perspective of the people in South Africa. Due to the low price of patrol, they cannot yet see the importance of alternative energy, in which electric vehicles can be categorized to be using alternative energy. It is currently considered that the benefit offered by electric vehicles cannot yet boost the acceptance of electric vehicles due to lack of environmental awareness. This can be considered as social, cultural, behavioural, and psychological barrier.
5. Macro-economic barrier also occurs and is considered as the cause of the government's reluctancy to spend money in support of electric vehicles, such as for the provision of charging stations as well as incentives for electric vehicles.

6. Financial issue barrier is also considered as a held back for adoption to electric vehicles, but mainly related to government support for charging infrastructure, not for the production of the electric vehicles itself.

Based on the open question and the closed question based on the pre-specified list of barriers, Table 4-1 provides the information of barriers discussed during the interview.

Table 4-1 Discussion of barriers Nissan

#	Barrier category	Discussed during the open question	Other barriers experienced by firm
1	Production system		
2	Complementary technologies	X	
3	Network		X
4	Demand	X	
5	Institutional	X	
6	Technological		
7	Natural resources and labour		
8	Social, cultural, behavioural, and psychological		X
9	Macro-economic		X
10	Accidents or events	X	
11	Infrastructure	X	
12	Financial Issue		X
13	Undesirable societal and environmental effect		

Note: X represents that the barrier occurred and was further discussed. Some barriers were not discussed further during the interview because those barriers did not apply to the company.

Among the thirteen barriers; two were considered extremely important, two were considered very important, two were considered moderately important, one was considered neutral, one was considered slightly important, and five were considered not at all important. Table 4-2 summarizes the importance of the barriers. The answers given by Thomas Ebeling can be seen in Appendix A.

Table 4-2 Summary of the importance of the barriers Nissan

Scale	Barriers
7	Network
	Institutional
6	Demand
	Infrastructure
5	Social, cultural, behavioural, and psychological
	Macro-economic
4	Accidents or events
3	Complementary technologies
1	Production system
	Technological
	Natural resources and labour
	Financial Issue
	Undesirable societal and environmental effect

Moreover, the expert, in this case Thomas Ebeling also was asked to rank the barriers from the most important to the least important. The top five barriers considered by Thomas Ebeling are presented in Table 4-3. The full list of the ranking is available in Appendix B.

Table 4-3 Five highest rank barriers Nissan

Rank	Barrier
1	Infrastructure
2	Institutional
3	Network
4	Macro-economic
5	Demand

4.1.4 Interview Result Stage 3 – The Strategies

This stage addresses the strategies implemented by Nissan. It was first discussed the strategies to circumvent four barriers discussed during the open question in stage 2. Table 4-4 summarizes the strategies to overcome barriers from the open question.

Table 4-4 Strategies to overcome the barriers Nissan

#	Barriers	Strategies
1	No government support in creating charging infrastructure	- Lobby the government - Cooperation with BMW to provide charging infrastructure
2	No government incentives	Lobby the government
3	Range anxiety	- Research to increase the range of the battery - Lobby the government in regards to provision of charging infrastructure - Cooperation with BMW to provide charging infrastructure
4	Frequent power outage	It is considered as government issue, therefore there is no strategies could be taken by Nissan to circumvent this barrier

Detail discussion on the strategies as follow:

1. Lobbying activities to the government have been done ever before Nissan penetrated the market of electric vehicles in South Africa. There had been a formal body that cooperate with the government regularly to address the issue of charging infrastructure as well as incentives for electric vehicles.
2. Cooperation with BMW is undertaken in order to provide customers with charging stations. Currently, Nissan's electric vehicles implemented CHAdeMO, a DC charging system while BMW implemented an AC charging system called CCS2 (Combined Charging System 2). This cooperation with BMW ensures that all the available charging stations provide fast charging for both charging systems. (Ebeling, 2016) emphasized that it is a mistake to go independent in providing charging stations. Therefore, the cooperation with BMW is very important.
3. Since Nissan produces the lithium-ion battery requires for the electric vehicles, it is doing an intensive research to improve the battery capacity. According to (Ebeling, 2016), the improvement is done roughly in every three years.

4. Although there is no current strategy taken to circumvent barrier of power outage, Nissan is hopeful that the government could resolve this problem soon. It is noticed that there has been no single power outage in the last three months, which can be considered as a sign of improvement.

From those aforementioned strategies, it can all be categorized to the pre-specified list of strategies. The lobbying activities can be categorized as lobbying strategy as well as network creation strategy through the formal body that is constantly in touch with the government to carry the lobbying activities. Moreover, the cooperation with BMW is also considered as network creation strategy as well as the development of infrastructure strategy. This is because the cooperation which considered as network creation strategy leads to the development of charging infrastructure which is categorized as development of infrastructure strategy. Lastly, the research on lithium-ion battery capacity can be considered as knowledge development strategy as well as dedicated system or stand-alone niche strategy.

Even though Nissan has been implemented the strategies since before the launch of the electric vehicles, the effect of those strategies to the sales is considered low. This is because to the strategies implemented require a lot of government support which was not yet fully gained, especially for charging infrastructure. Therefore, while Nissan is considered as the market leader, it still cannot yet be considered to achieve mass market.

During the interview, all the pre-specified strategies were discussed. The results are as follow:

1. Nissan is doing demo, experiment, and develop niche strategy by showing the electric vehicles in relevant events
2. Top niche strategy was not intended to be implemented, however due to the nature of .the high price of electric vehicles, it ended up targeting quite a high end market, but no tailored product.
3. Pilot project was conducted in 2012 before the launch of Nissan Leaf. It was discovered that the acceptance of electric vehicles was quite low but Nissan decided to go ahead with the launch to be the number one electric vehicles manufacturer in South Africa. This strategy was not part of strategies to overcome barriers but more as a part of Nissan's strategy to evaluate the market in South Africa.
4. Nissan also actively improving the technology of the electric vehicles overtime as part of redesign niche strategy in order to reduce the cost of electric vehicles.
5. Dedicated system or stand-alone niche strategy is implemented by keep improving all the auxiliary equipment such as the battery and heat exchanging system of the vehicles. The current heat exchanging system is using half of the energy used by the first generation heater technology of Nissan Leaf. This is intended to improve the efficiency and packaging of battery. Currently, more cells can be packed into the same space with the previous generation, giving improvement on the battery range
6. Nissan manufactures hybrid vehicles but it is currently not available in South Africa.

7. As part of knowledge development for the customers, Nissan conducts supporting initiatives through PR department by attending local events in which the electric vehicles were promoted. Nissan also actively educate the government and public in general of the benefit of electric vehicles.
8. Geographic niche strategy is also implemented by focusing on seven cities in South Africa, limiting to the dense urban areas such as Cape Town and Johannesburg. These dense urban areas are considered to have a better chance for the success adoption of electric vehicles. Moreover, in urban area, the environmental issue is more pressing due to higher emission. Therefore, the use of electric vehicles in such areas has the most contribution to overcome the environmental issue.
9. Market research was also conducted before the launch of electric vehicles. However, Nissan did not rely much on the result of the market research because it is considered that the potential customers might not understand what they need or want in the future. They might have little understanding of what the future technology could do for them. Therefore, Nissan decided to take the risk by being the first one in the market and then developing the need for electric vehicles.
10. Explore multiple markets niche strategy is also implemented, by pursuing private market as well as public market or the government.
11. Financial aid strategy is implemented but not directly to fund Nissan itself, but mostly to lobby the government in financing the development of charging infrastructure within the region.
12. Establishment of standard strategy is implemented by getting in touch with several manufacturers of electric vehicles to get agreement on the same charging system before the launch of Nissan Leaf in South Africa. However, at that time, no manufacturer was interested. Therefore, Nissan go ahead with its current charging system (CHAdeMo). As the result, there are some manufacturers that adopt Nissan's system but there are still others with different charging system.

Based on the open question and the closed question from the pre-specified list of strategies, Table 4-5 provides the information of strategies discussed during the interview.

Table 4-5 Discussion of strategies Nissan

#	Strategy category	Discussed during the open question	Other strategies implemented by firm
1	Demo, experiment, and develop niche strategy		X
2	Top niche market strategy		X
3	Pilot project strategy		X
4	Lobbying strategy	X	
5	Redesign niche strategy		X
6	Dedicated system or stand-alone niche strategy	X	X
7	Hybridization or adaptor niche strategy		
8	Knowledge development	X	X
9	Geographic niche strategy		X
10	Market research		X
11	Explore multiple markets niche strategy		X

#	Strategy category	Discussed during the open question	Other strategies implemented by firm
12	Financial aid		X
13	Establishment of standard		X
14	Network creation	X	
15	Development of infrastructure	X	

Note: X represents that the strategy was implemented and further discussed. Hybridization or adaptor strategy was not discussed further during the interview because this strategy was not implemented by the company

.

Among the fifteen strategies; four were considered extremely important, four were considered very important, two were considered moderately important, one was considered slightly important, three were considered low important, and one was considered not at all important. Table 4-2 summarizes the importance of the strategies. The answers given by Thomas Ebeling can be seen in Appendix C

Table 4-6 Summary of the importance of the strategies Nissan

Scale	Strategies
7	Lobbying strategy
	Explore multiple markets niche strategy
	Financial aid strategy
	Development of infrastructure strategy
6	Demo, experiment, and develop niche strategy
	Dedicated system or stand-alone niche strategy
	Knowledge development strategy
	Geographic niche strategy
5	Redesign niche strategy
	Network creation strategy
3	Pilot project strategy
2	Top niche market strategy
	Hybridization or adaptor niche strategy
	Establishment of standard strategy
1	Market research strategy

Moreover, the expert, in this case Thomas Ebeling also was asked to rank the strategies from the most important to the least important. The top five strategies considered by Thomas Ebeling are presented in Table 4-7. The full list of the ranking is available in Appendix D.

Table 4-7 Five highest rank strategies Nissan

Rank	Strategy
1	Financial aid
2	Development of infrastructure
3	Lobbying strategy
4	Demo, experiment, and develop niche strategy
5	Network creation

4.1.5 Interview Result Stage 4 – The Relationship between Barriers and Strategies

During this stage, the expert emphasized that electric vehicles should be made more accessible in order for it to achieve mass market, which are by reducing the cost of electric vehicles and improving the battery range above 200 km. The battery range of 200 km is very convenient for countries with long distances such as South Africa. When electric vehicles are more accessible, then it would also lead to higher acceptance of electric vehicles in the country, both financially and psychologically. Moreover, based on the interview, it is concluded that in South Africa, Nissan relies on government's help to create the demand, proven by active lobbying activities started in 2010, two years prior to the launch of electric vehicles in the country. The involvement from the government includes incentive and support for development of charging infrastructure.

Furthermore, several strategies are conducted by Nissan before introducing the electric vehicles in South Africa, such as pilot project and market research. However, these strategies were conducted to evaluate the market in South Africa rather than to overcome any specific barriers. More on the relationship can be seen in Figure 4-1.

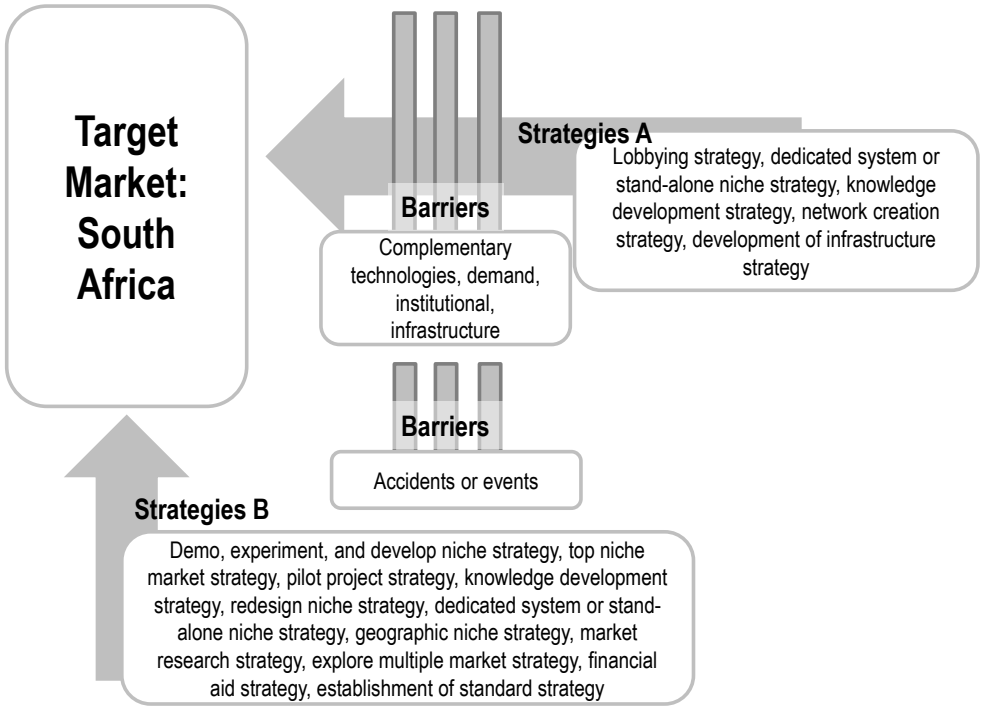

Figure 4-1 Relationship between barriers and strategies in South Africa

Figure 4-1 distinguishes two types of strategies implemented by Nissan, strategies A and strategies B. Strategies A were specifically implemented to overcome barriers that were experienced by Nissan. However, the barrier of frequent power outage which was categorized as accidents or events barriers is not included in barrier since there is no available strategy to circumvent that barrier. Strategies B, on the other hand, were implemented regardless of the barriers. Strategies B were part of the company's overall strategies that are implemented not only in Nissan South Africa but worldwide.

Knowledge development strategy and dedicated system or stand-alone niche strategy are mentioned in both strategies A and strategies B. The reason is that since both strategies have quite a broad definition, some of the strategies included in those categories were mentioned during the open questions as the strategies to overcome the barriers while some others were mentioned during the closed questions. All the strategies discussed during the closed questions were not implemented to directly overcome the barriers. Furthermore, for accidents or events barrier, there is currently no strategy implemented since it is simply beyond Nissan's control.

4.2 Mahindra Reva India

3.2.1 Company Profile

Mahindra Reva, formerly known as Reva was established in the United States in 1994; one of its founders was India, Chetan Maini. In 1999, Reva moved its operation to India. In 2010, Reva was acquired by Mahindra Group, one of India's large conglomerates. As part of its vision, Mahindra Reva only manufactures electric vehicles, not only in India but worldwide as well.

In 2013, Mahindra Reva launched its newest electric vehicles, the Mahindra e2o. In the same year, Mahindra Reva was listed as top 50 in Fast Company Magazine for Most Innovative Companies (Fast Company, 2013).

3.2.2 Interview Result Stage 1 – Background Information

The interview was conducted via Skype call with Kartik Gopal, the Head of Strategy and Business Planning of Mahindra Reva. His main responsibility is to define the company's product and technology roadmap. He is also responsible to decide what kind of business that Mahindra Reva should be targeted as well as different market penetration. Moreover, he is responsible to define the Mahindra Reva's strategy. He has been appointed in that position since April 2010, three years prior to the launch of Mahindra e2o, the electric vehicles manufactured by Mahindra Reva.

According to (Gopal, 2016), Mahindra Reva has a goal to create affordable electric vehicles that would create a strong value to customers to opt for electric vehicles instead of combustion-engine vehicles. Based on that goal as well as a consideration of environmental aspect, Mahindra Reva decided to enter the market in India.

Mahindra Reva focuses its sales through Mahindra dealers, currently in eight large cities in India. As the only company that sells electric vehicles in India, it can be considered that Mahindra Reva was the first mover in the market. However, the sales since 2013 were moving slowly, probably due to the lack of incentives given to the customers. Currently, the government subsidies 10% of the electric vehicles' price, which is still considered to be very low (Gopal, 2016). More detail on the incentives is discussed in stage 2 (section Interview Result Stage 2 – The Barriers).

3.2.3 Interview Result Stage 2 – The Barriers

During this stage, the barriers of adoption to electric vehicles in India were discussed. During the interview, four barriers were emphasized by (Gopal, 2016):

1. Lack of government subsidies for electric vehicles. This is very different from countries in which the government is promoting the electric vehicles aggressively, such as in Europe, United States and China. The sales of electric vehicles in those countries are considered high. However, in India, the subsidy given by the government to the electric vehicles' customers only counts to 10% of the price. This leads to the low sales figure of electric vehicles in India.
2. Insufficient charging infrastructure in the country. The government has not yet funding any public charging infrastructure needed for the electric vehicles.
3. Lack of awareness of the importance of electric vehicles. The people in India still have little information in regards to the benefit of the electric vehicles. Electric vehicles are currently viewed as low performance vehicles. This leads to the low demand of electric vehicles in India.
4. Range anxiety. This barrier arose due to the limited range of the battery as well as the insufficient available charging infrastructure.

Moreover, based on the discussion, it was agreed that the first barrier can be categorized as institutional barriers. This barrier can also be categorized as demand barrier due to the high price of the electric vehicles lead to the customer's unwillingness to buy. The second barrier can be categorized as infrastructure barrier. This barrier was a result of no government funding for charging infrastructure, which can also be categorized as subsidies or institutional barrier. The third barrier can be categorized as social, cultural, behavioural, and psychological barrier as well as demand barrier, while the fourth barrier can be both categorized as complementary technology barrier due to the limited range of battery and infrastructure barrier due to the insufficiency of charging infrastructure. According to (Gopal, 2016), if the government can support the electric vehicles by providing more subsidies, than it could eliminate the first and second barriers. However, for the third and fourth barriers, it is considered to be more difficult to change.

Several other barriers were discussed during the closed question. The detail is as follow:

1. Currently, due to the low demand of electric vehicles, Mahindra Reva had not yet invested for large production system. Therefore, when the demand increases, this could be a challenge since the current production system might not be able to cater all the demand. However, according to (Gopal, 2016), this was not considered as a barrier because the production system can be set up to follow the change in the demand.
2. Complementary technology barrier occurred due to the fact that Mahindra Reva does not produce the battery themselves and there is no local manufacturer for the battery. Therefore, Mahindra Reva needs to import the battery for their electric vehicles.

3. Network barrier does exist due to the limited players in the industry, especially for the suppliers of components required for electric vehicles, including the battery.
4. Demand barrier was considered as the biggest issue, as also already discussed in the open question.
5. According to (Gopal, 2016), for institutional barrier, there was no regulation that actively hamper the adoption of electric vehicles. However, the emphasis is more on the lack of supporting regulation to encourage the diffusion of electric vehicles. The expert considered these as two different things. Therefore, the definition of this barrier might need to be enhanced.
6. Natural resources and labour barrier occurred due to the fact that India has no natural resources for battery, leading to the decision to import the battery.
7. Macro-economic barrier also occur due to the low price of oil, making electric vehicles more unattractive.
8. Financial issue barrier was considered to exist to some extent.
9. Undesirable societal and environmental issue barrier exists in regards to the battery waste but it is still manageable by Mahindra Reva.

Table 4-8 provides information on the discussion on barriers during open and closed question.

Table 4-8 Discussion on barriers Mahindra Reva

#	Barrier category	Discussed during the open question	Other barriers experienced by firm
1	Production system		
2	Complementary technologies	X	X
3	Network		X
4	Demand	X	
5	Institutional	X	
6	Technological		
7	Natural resources and labour		X
8	Social, cultural, behavioural, and psychological	X	
9	Macro-economic		X
10	Accidents or events		
11	Infrastructure	X	
12	Financial Issue		X
13	Undesirable societal and environmental effect		X

Note: X represents that the barrier occurred and was further discussed. Some barriers were not discussed further during the interview because those barriers did not apply to the company.

Among the thirteen barriers; three were considered extremely important, two were considered very important, two were considered moderately important, two were considered neutral, three were considered low important, and one was considered not at all important. Table 4-9 summarizes the importance of the barriers. The answers given by Kartik Gopal can be seen in Appendix E.

Table 4-9 Summary of the importance of the barriers Mahindra Reva

Scale	Barriers
7	Demand
	Institutional

Scale	Barriers
	Infrastructure
6	Social, cultural, behavioural, and psychological
	Macro-economic
5	Network
	Financial issue
4	Complementary technologies
	Technological
2	Production system
	Natural resources and labour
	Undesirable societal and environmental effects
1	Accidents or events

Moreover, the expert, in this case Kartik Gopal also was asked to rank the barriers from the most important to the least important. The top five barriers considered by Kartik Gopal are presented in Table 4-10.The full list of the ranking is available in Appendix F.

Table 4-10 Five highest rank barriers Mahindra Reva

Rank	Barrier
1	Demand
2	Institutional
3	Infrastructure
4	Macro-economic
5	Social, cultural, behavioural, and psychological

4.2.4 Interview Result Stage 3 – The Strategies

During this stage, three main strategies of Mahindra Reva were discussed, which were:

1. Targeting the market with high support of electricity. Since the electric vehicles rely heavily on the availability of electricity to charge the battery, it is considered important to enter the market in which the support of electricity is high. Therefore, there will be sufficient supply to fulfil the additional electricity demand to charge electric vehicles.
2. Targeting the market in which the level of awareness of the importance of electric vehicles is high. If the people are aware of the benefit of electric vehicles, then the demand is predicted to be higher than in the area in which the awareness is low.
3. Creating several electric vehicles to provide customers with more options. Currently, Mahindra Reva is designing different vehicles to capture different market, such as offering the customers with sedan, van, etc. By implementing the strategy, Mahindra Reva hoped to cater a wider market. Customers would be provided with more options and this can be used to compete with combustion-engine vehicles.

Based on the discussion with (Gopal, 2016), all the three major strategies are considered to be categorized as explore multiple markets niche strategy. The aforementioned strategies were considered to improve the sales of electric vehicles.

Several other strategies were discussed during the closed question. Detail is as follow:

1. Pilot project strategy was conducted with lead customers.
2. Lobbying strategy was implemented to encourage more incentives for electric vehicles.
3. Dedicated system or stand-alone niche strategy was implemented by providing home charging kit for them to charge their electric vehicles at home rather than at public charging station.
4. Knowledge development strategy was carried out by educating the customers as well as suppliers in regards of electric vehicles. Advertisements and campaigns have been actively spread by Mahindra Reva to increase the awareness of electric vehicles.
5. Geographic niche strategy was also implemented by targeting eight specific cities in India.
6. Market research strategy was conducted by involving lead users.
7. It was emphasized that Mahindra Reva is targeting multiple markets by providing different products to the market.
8. Financial aid strategy was implemented sometimes, such as endowment and soft loans.
9. Currently, other manufacturers are working to enter the market in India. Mahindra Reva is working with the government to establish the standard for electric vehicles. Therefore, the strategy of establishment of standard has been implemented.
10. Network creation strategy was implemented but it was mostly driven by necessity, for example the engagement with government.
11. Development of infrastructure had been implemented by providing fast charging station for customers. However, this strategy was no longer implemented. Currently, Mahindra Reva relies on government support to provide charging infrastructure.

Based on the open question and the closed question from the pre-specified list of strategies, Table 4-11 provides the information of strategies discussed during the interview.

Table 4-11 Discussion on strategies Mahindra Reva

#	Strategy category	Discussed during the open question	Other strategies implemented by firm
1	Demo, experiment, and develop niche strategy		
2	Top niche market strategy		
3	Pilot project strategy		X
4	Lobbying strategy		X
5	Redesign niche strategy		
6	Dedicated system or stand-alone niche strategy		X
7	Hybridization or adaptor niche strategy		
8	Knowledge development		X
9	Geographic niche strategy		X
10	Market research		X
11	Explore multiple markets niche strategy	X	

#	Strategy category	Discussed during the open question	Other strategies implemented by firm
12	Financial aid		X
13	Establishment of standard		X
14	Network creation		X
15	Development of infrastructure		X

Note: X represents that the strategy was implemented and further discussed. Some strategies were not discussed further during the interview because the company did not implement those strategies.

Among the fifteen strategies; two were considered extremely important, three were considered very important, three were considered moderately important, two were considered neutral, one was considered slightly important, and four was considered not at all important. Table 4-12 summarizes the importance of the strategies. The answers given by Kartik Gopal can be seen in Appendix G.

Table 4-12 Summary of the importance of the strategies Mahindra Reva

Scale	Strategies
7	Explore multiple markets niche strategy
	Development of infrastructure strategy
6	Lobbying strategy
	Knowledge development strategy
	Market research strategy
5	Pilot project strategy
	Financial aid strategy
	Network creation strategy
4	Geographic niche strategy
	Establishment of standard strategy
3	Dedicated system or stand-alone niche strategy
1	Demo, experiment, and develop niche strategy
	Top niche market strategy
	Redesign niche strategy
	Hybridization or adaptor niche strategy

Moreover, the expert, in this case Kartik Gopal also was asked to rank the strategies from the most important to the least important. The top five strategies considered by Kartik Gopal are presented in Table 4-13. The full list of the ranking is available in Appendix H.

Table 4-13 Five highest rank strategies Mahindra Reva

Rank	Strategy
1	Explore multiple markets niche strategy
2	Development of infrastructure strategy
3	Lobbying strategy
4	Knowledge development strategy
5	Market research strategy

4.2.5 Interview Result Stage 4 – The Relationship between Barriers and Strategies

During this stage, the expert emphasized that among all barriers, demand barrier is the most important barrier and Mahindra Reva is focusing its effort to overcome the demand barriers. Mahindra Reva is currently ready with its technology, but the biggest challenge is to create the demand. As mentioned in Interview Result Stage 3 – The Strategies, three main strategies are currently implemented by Mahindra Reva to create this demand, which are by entering market with enough electrification, market with high awareness of electric vehicles, providing different products to different market. All these strategies are considered to be categorized as explore different markets niche strategy. However, other strategies are also implemented regardless of the barriers. These other strategies are viewed as supporting strategies for demand creation. Figure 4-2 represents the relationship between the barriers and strategies.

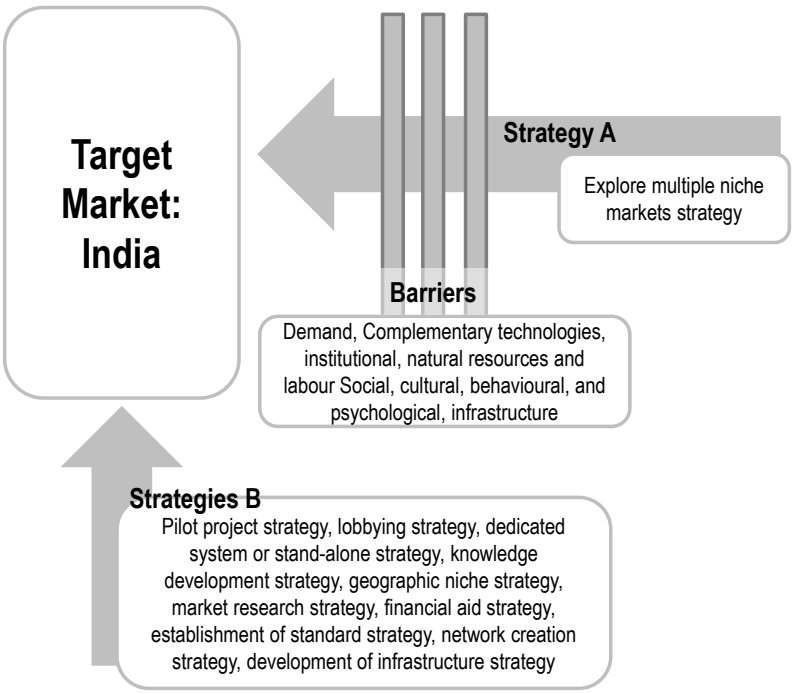

Figure 4-2 Relationship between barriers and strategies in India

As can be seen in Figure 4-2, there are two types of strategies implemented by Mahindra Reva. Strategy A refers to strategies that are implemented to overcome specific barriers while strategies B refer to strategies that are implemented as part of the company's business strategy and not linked directly to the barrier. Mahindra Reva is focusing their effort to create the demand of electric vehicle; therefore, explore multiple markets niche strategy is perceived to be the most suitable strategy to create the demand. Other strategies are perceived as supporting strategies that support the main strategy to explore multiple markets niche. By implementing multiple markets niche strategy, the company wishes to achieve more sales or mass market.

4.3 Renault Brazil

4.3.1 Company Profile

Renault was first established as an automobile manufacturer in French, 1899. In 1998, Renault expanded to Brazil by establishing a factory in São José dos Pinahis, Paraná state. A year later, Renault grew by establishing an Engines Factory and the growth continued, led to the opening of Utility's Factory in 2001. By the end of 2015, Renaults are operating in 128 countries(Renault Group, 2016b), with Brazil ranks as the sixth most customers for Renault's cars (Koskas & Thormann, 2016).

Renault manufactures their vehicles under three brands; Renault, Dacia, and Renault Samsung Motors (RSM) in South Korea. As for electric vehicles under the Renault brand, it has 23.6% of market share of electric vehicles in Europe in 2015, with total sales over than 23,000 electric vehicles (Renault Group, 2016a). The electric vehicles were manufactured in France in 2008-2009 and the electric vehicles to be spread around the world. Renault first introduced their electric vehicles in Brazil in 2012. As of now, around 100 Renault's electric vehicles have been sold in Brazil.

4.3.2 Interview Result Stage 1 – Background Information

The interview was conducted by phone call with Silvia Barcik and Adriano Castro. Silvia Barcik was responsible in the launch of Renault's electric vehicles in Brazil in 2012 while Adriano Castro is responsible for electric vehicles in Brazil and Latin America since 2015. In the first launch of electric vehicles in 2012, the vehicles were not intended for mass market, it was mostly for business-to-business with government as one of the customers as well as other big companies. Silvia Barcik was responsible the first introduction as well as cooperation with the government. By middle of 2015, Adriano Castro took over the responsibility of electric vehicles division by middle of 2015. Before taking over the role, Castro had 5 years' experience in electrical department of engineering in Brazil, in area such as electrical component of cars. Therefore, Castro thinks that it was natural that he was appointed to be responsible for electric vehicles in Brazil

According to (Barcik, 2016), the fact that 87% of Brazil energy was generated from hydropower made Brazil a unique candidate for sustainable technology such as electric vehicles. Renault perceived this condition as a good opportunity to promote electric vehicles in the country. For the time being, the adoption of electric vehicles in Brazil can be categorized to be in preliminary phase (Castro, 2016). Renault wanted to be sure to have electric vehicles in proper conditions; in terms of infrastructure, mileage (battery range), security, as well as technical and economic aspects.

Renault has more than 200 dealers in Brazil; however the dealers are not allowed to directly sell the electric vehicles to the public. This is due to Renault's decision to focus on business-to-business market. All activities in regards to purchasing the electric vehicles must be conducted through corporation. Currently, Renault has

contract with big fleet companies, such as rent car companies, FedEx, Energy Distribution companies, and government institutions. As for the public charging point, in big cities such as Sao Paolo, around 10-15 charging points are available. Nevertheless, the limited number of available public charging points is not a problem for the fleet companies since the have their own channel for the charging purpose. As for the company's position, Renault is considered as the leader in electric vehicles in Brazil. It is the first in sales, image, and action in government level. However, more promotion should be conducted by Renault by giving more offers to the customers to maintain its current position.

4.3.3 Interview Result Stage 2 – The Barriers

During this stage, three barriers were expressed by (Castro, 2016) while (Barcik, 2016) emphasized one barrier, as follow:

1. High price of electric vehicles. Including the import tax impose to the electric vehicles, the electric vehicle's price is five times higher than combustion-engine vehicles. However, since last year, the government has implemented tax waiver for electric vehicles. Nevertheless, the electric vehicles are still considered very expensive, leading to low demand of electric vehicles in the market.
2. Lack of infrastructure, mainly the charging stations. Even though Brazil has a lot of electrical power available, the limited number of public charging stations, especially in big cities, makes it difficult to equip the electric vehicles with sufficient energy.
3. Autonomy (mileage or commonly refer as battery range). The limited range of battery then leads to the range anxiety. Since Brazil is a big country, long distance travels become common. However, limited charging stations as well as limited battery range make long distance travels not feasible. Therefore, there is concern if the electric vehicles will run out of battery before reaching the destination or the next charging stations.
4. Lack of incentives from government for electric vehicles' customers. Compare to Europe, there is no attractive incentives given to the public by government to attract more potential customers.

The first barrier of high price of electric vehicles can be categorized as demand barrier while the second barrier can be categorized as infrastructure barrier. The barrier of battery range can be categorized as complementary technology barrier since it relates to the capacity of the battery and the last barrier of lack of government's incentives can be categorized as institutional barrier.

Other barriers were discussed during the closed question. The detail is as follow:

1. Currently, Renault produces limited amount of electric vehicles (low volume production) and experiences over-demand to some of their models. Therefore, the barrier of production system exists to some extent.
2. Since the electric vehicles are manufactured outside of Brazil, specifically in Europe, then technological as well as natural resources and labour barriers are not applicable in the case of Renault Brazil. However, once the production is established in Brazil, the technological barrier is possible to occur. Moreover, once the

electric vehicles are used in a large scale, natural resource barrier could also occur. However, the large scale usage of electric vehicles are not going to occur until maybe 2030 (Castro, 2016).

3. Complementary technology barrier also occur in other form, which is the different charging connectivity available currently in the market.
4. In network barrier, the actors that are considered important in adoption of electric vehicles in the country are the government. Although the actor (government) exists, the support from the actor itself is missing, mainly to provide charging infrastructure. Therefore, the network barrier can be considered occur but it is highly related to the institutional barrier.
5. In regards to demand barrier, (Castro, 2016) emphasized that the potential customers in Brazil currently do not have sufficient knowledge of the benefit of electric vehicles. Due to high price of electric vehicles, the long-term benefits of electric vehicles sometimes are not considered by the potential customers.
6. Social, cultural, behavioural, and psychological barrier is considered to be inapplicable in Brazil. Even though Brazil experiences barrier in regards to lack of infrastructure, the people in Brazil have high curiosity of electric vehicles, leading to electric vehicles to be well accepted and attractive in Brazil. However, even though it is well accepted and attractive, high price of electric vehicles make the diffusion to be quite difficult.
7. At this moment, Brazil is experiencing problems in terms of macro-economic condition. Therefore, electric vehicles are not the top priority for the government. This means that macro-economic serves as a barrier in Brazil. The macro-economic situation in Brazil greatly affects the adoption to electric vehicles.
8. There is no accident or event that serves as barrier in Brazil.
9. There are government banks that help financing electric vehicles. Moreover, Renault group is already an established company with sufficient financial capabilities in producing electric vehicles. Therefore, in terms of company wise, this barrier does not occur. However, financial issue came as a barrier for customers. Since electric vehicles are offered in quite a high price, this slows down the adoption of electric vehicles. This barrier relates to demand barrier.
10. The barrier of undesirable societal and environmental effect does not exist. The batteries from electric vehicles can be used as storage for big buildings, reducing the issue of battery waste.

Based on the open question and the closed question based on the pre-specified list of barriers, Table 4-1 provides the information of barriers discussed during the interview.

Table 4-14 Discussion of barriers Renault

#	Barrier category	Discussed during the open question	Other barriers experienced by firm
1	Production system		X
2	Complementary technologies	X	X
3	Network		X
4	Demand	X	
5	Institutional	X	
6	Technological		
7	Natural resources and labour		
8	Social, cultural, behavioural, and psychological		

#	Barrier category	Discussed during the open question	Other barriers experienced by firm
9	Macro-economic		X
10	Accidents or events		
11	Infrastructure	X	
12	Financial Issue		
13	Undesirable societal and environmental effect		

Note: X represents that the barrier occurred and was further discussed. Some barriers were not discussed further during the interview because those barriers did not apply to the company.

Among the thirteen barriers; three were considered extremely important, three were considered very important, one was considered moderately important, two were considered neutral, and four were considered low important. Table 4-2 summarizes the importance of the barriers. The answers given by Silvia Barcik and Adriano Castro can be seen in Appendix I.

Table 4-15 Summary of the importance of the barriers Renault

Scale	Barriers
7	Macro-economic
	Infrastructure
	Financial issue
6	Network
	Demand
	Institutional
5	Production system
4	Complementary technologies
	Technological
2	Natural resources and labour
	Socio, cultural, behavioural, and psychological
	Accidents or events
	Undesirable societal and environmental effect

Moreover, the experts, in this case Silvia Barcik and Adriano Castro also were asked to rank the barriers from the most important to the least important. The top five barriers considered by the expert are presented in Table 4-16. The full list of the ranking is available in Appendix J.

Table 4-16 Five highest rank barriers Renault

Rank	Barrier
1	Financial issue
2	Macro-economic
3	Infrastructure
4	Institutional
5	Demand

4.3.4 Interview Result Stage 3 – The Strategies

This stage addresses the strategies implemented by Nissan. It was first discussed the strategies to circumvent four barriers discussed during the open question in stage 2. Table 4-4 summarizes the strategies to overcome barriers from the open question.

Table 4-17 Strategies to overcome the barriers Renault

#	Barriers	Strategies
1	High price of electric vehicles	- Lobby the government - Tax exemption - Providing financial assistance to customers through Bank of Renault
2	Lack of infrastructure	- Cooperation with suppliers, governments, and federal (state) by participating in chamber of discussion to promote installation of public charging infrastructure
3	Battery range	- R&D to improve the battery
4	Lack of government's incentives	Lobby the government

Detail discussions on strategies as follow:

1. Renault is doing discussion and lobbying activities to the government in order to get more support for electric vehicles. The lobby activity finally got impact when government impose tax exemption to the imported electric vehicles. However, tax exemption alone is not enough. Renault maintain its lobbying activities to ensure the government would promote electric vehicles by providing incentives for electric vehicles' customers, in order to make electric vehicles more attractive.
2. To circumvent the high price, Renault also offers several options to customers with cooperation with Bank of Renault (also own by Renault group). Through Bank of Renault, customers can opt for leasing and other financial leverage option.
3. Discussion through chamber of discussion with suppliers, government, and other federal or state institutions are conducted in order to promote the installation of public charging stations. This activity also includes lobbying activities to provide customers with sufficient charging stations.
4. Renault also conducts continuous research to improve battery range.

Those aforementioned strategies can be categorized to the pre-specified list of strategies. Strategies related to lobbying activities are considered as lobbying strategy while providing financial assistance can be categorized as financial aid strategy. Moreover, this cooperation with Bank of Renault can also be categorized as network creation strategy. Cooperation with government and other federal institution can be categorized as network creation strategy and R&D conducted by Renault as a corporation is categorized as knowledge development.

Strategies implemented by Renault can be categorized successful, by taking into consideration that Renault is currently the leading company in electric vehicles in Brazil. However, to achieve mass market, other supports or incentives from government should be implemented, to overcome the high price of the electric vehicles.

During the interview, all the pre-specified strategies were discussed. The results are as follow:

1. Renault is conducting demo, experiment, and develop niche strategy to introduce electric vehicles to its customers. This demo was conducted quite often to promote the electric vehicles.
2. Top niche market, redesign niche, dedicated system or stand-alone niche, hybridization or adaptor niche, geographic niche strategies as well as market research were not implemented by Renault Brazil.
3. Pilot project strategy was conducted by lending the electric vehicles to selected customers so they could try the vehicles and gain good experiences. The selected customers signed contracts with Renault to specify the length of duration of the lending (either three or six months duration). At the end of the contract, the selected customers should return the electric vehicles.
4. Besides R&D, other form of knowledge development strategy is implemented, such as awareness campaign and seminar to educate the potential customers.
5. Explore multiple niche markets strategy is implemented by targeting several markets in Brazil, such as government and currently moving towards customers market.
6. Establishment of standard strategy is implemented by establishing association to discuss about the electric vehicles market in Brazil.
7. Participation in chamber of discussion as well as association for standard is categorized as network creation strategy. Collaboration with Bank of Renault can also be categorized as network creation strategy. Therefore, the network creation strategy is applied in Renault's case. Moreover, Renault also has relationship with importer to provide them with electric vehicles' parts, in case of defect or replacement of the parts is needed.
8. Development of infrastructure is not implemented directly by Renault. The development or installation of charging stations is done by third party, which is electrical charging point manufacturers.

Based on the open question and the closed question from the pre-specified list of strategies, Table 4-18 provides information of strategies discussed during the interview.

Table 4-18 Discussion of strategies Renault

#	Strategy category	Discussed during the open question	Other strategies implemented by firm
1	Demo, experiment, and develop niche strategy		X
2	Top niche market strategy		
3	Pilot project strategy		X
4	Lobbying strategy	X	
5	Redesign niche strategy		
6	Dedicated system or stand-alone niche strategy		
7	Hybridization or adaptor niche strategy		
8	Knowledge development	X	X
9	Geographic niche strategy		
10	Market research		

#	Strategy category	Discussed during the open question	Other strategies implemented by firm
11	Explore multiple markets niche strategy		X
12	Financial aid	X	
13	Establishment of standard		X
14	Network creation	X	X
15	Development of infrastructure		

Note: X represents that the strategy was implemented and further discussed. Some strategies were not further discussed because the company did not implement those strategies

.

Among the fifteen strategies; three considered extremely important, three considered very important, four considered moderately important, and five were considered as NA (not applicable). Table 4-19 summarizes the importance of the strategies. The answers given by experts can be seen in Appendix K.

Table 4-19 Summary of the importance of the strategies Renault

Scale	Strategies
7	Lobbying strategy
	Knowledge development
	Financial aid
6	Demo, experiment, and develop niche
	Pilot project
	Development of infrastructure
5	Redesign niche
	Explore multiple markets niche
	Establishment of standard
	Network creation
NA	Top niche market
	Dedicated system or stand-alone niche
	Hybridization or adaptor niche
	Geographic niche
	Market research

Moreover, the experts were also asked to rank the strategies from the most important to the least important. The top five strategies considered by the experts are presented in Table 4-20. The full list of the ranking is available in Appendix L.

Table 4-20 Five highest rank strategies Renault

Rank	Strategy
1	Demo, experiment, and develop niche
2	Pilot project
3	Lobbying
4	Financial aid
5	Knowledge development

4.3.5 Interview Result Stage 4 – The Relationship between Barriers and Strategies

During the interview, the expert emphasized the importance of availability of public charging stations. The expert refer a situation of 'chicken and egg problem', meaning that if there is no demand then no infrastructure would be developed but if there is no infrastructure, then there would be no demand. However, the expert emphasized that availability of infrastructure should be considered as a very important factor in order to gain more demand of electric vehicles.

Moreover, from the interview, it can be concluded that Renault has formed quite extensive network with other institutions (government, federal institutions, banks, and cars' manufacturers) in order to promote electric vehicles in Brazil. The cooperation are intended to achieve standard for electric vehicles in terms of its charging connectivity, to promote the installation of charging stations, as well as providing customers with leverage options for purchasing electric vehicles. Figure 4-3 represents the relationship between the barriers and strategies.

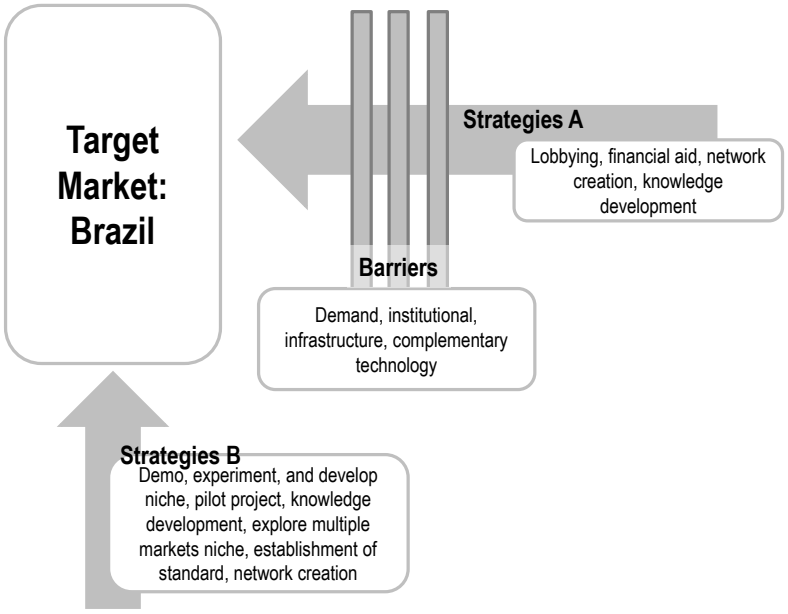

Figure 4-3 Relationship between barriers and strategies in Brazil

Renault implements quite a lot of strategies in order to promote the adoption of electric vehicles in Brazil. Strategies A represent strategies that implemented to overcome the specific barriers discussed during the open question in stage 2 of the interview. However, other strategies, categorized as strategies B are implemented regardless the barriers discussed during the open question.

5. Case Analysis

This section provides individual analysis for Nissan South African, Mahindra Reva India, and Renault Brazil. Moreover, cross case analysis is presented to identify the similarities and differences of the all three cases. Furthermore, relative importance of barriers and strategies are discussed as well as the relationship between barriers and strategies.

5.1 Individual Case Analysis

5.1.1 Nissan South Africa

Table 5-1 summarizes the barriers experienced by Nissan South Africa including the strategies implemented along with categorizations of the barriers and strategies:

Table 5-1 Barriers and strategies Nissan South Africa

#	Barriers	Categories of barriers	Strategies	Categories of strategies
1	No government support in creating charging infrastructure	Institutional barrier, infrastructure barrier	- Lobby the government - Cooperation with BMW to provide charging infrastructure	Lobbying strategy, network creation strategy, development of infrastructure strategy
2	No government incentives	Institutional barrier	Lobby the government	Lobbying strategy
3	Range anxiety	Complementary technology barrier, infrastructure barrier	- Research to increase the range of the battery - Lobby the government in regards to provision of charging infrastructure - Cooperation with BMW to provide charging infrastructure	Knowledge development strategy, dedicated system or stand-alone niche strategy, lobbying strategy, network creation strategy, development of infrastructure strategy
4	Frequent power outage	Accidents or events barrier	No strategy implemented	

The relationships between barriers and strategies are described as follow (based on the discussion during the interview):

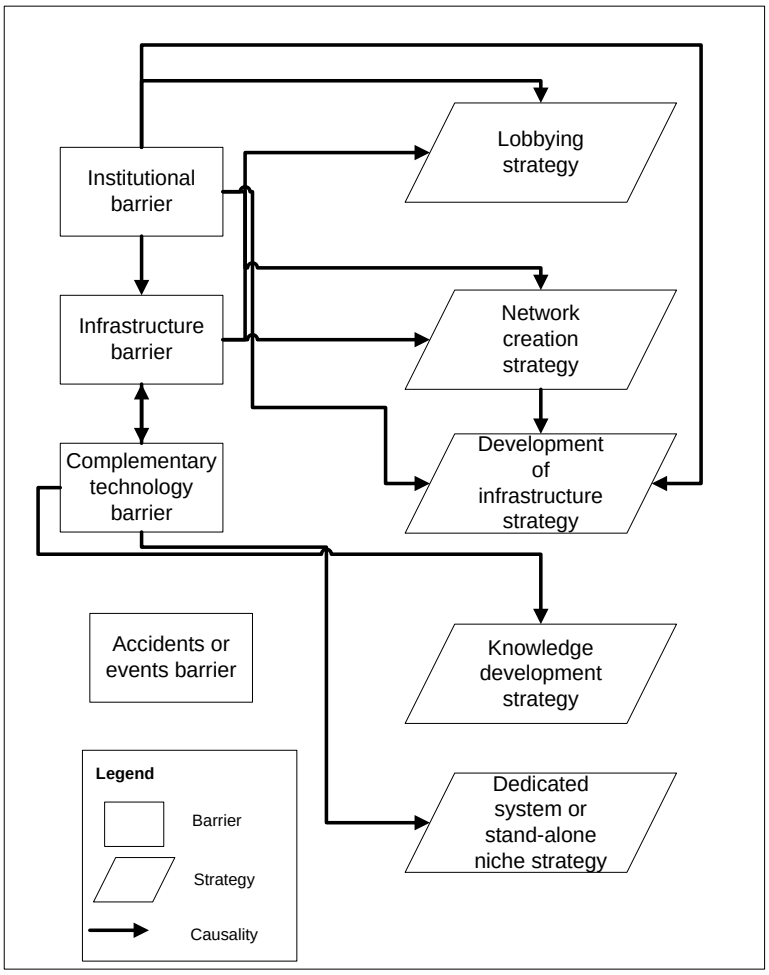

Figure 5-1 Relationship between barriers and strategies of Nissan South Africa

From Figure 5-1, it can be seen that the presence of institutional barrier lead to the presence of infrastructure barrier. In this case, the institutional barrier points to the no support of government to provide charging station. Since charging station is part of infrastructure required for the adoption of electric vehicles, then it in considered that the barrier of infrastructure occurs in South Africa.

Moreover, this barrier also relates to the complementary technology barrier. Complementary technology barrier represents the range anxiety, in which the customers are considering the electric vehicles as unsafe due to the range or battery capacity as well as the limited number of charging station. Since the range or battery capacity is also limited, the dense network of charging stations is required to provide electric vehicles with sufficient electrical supply. However, no government support for charging stations means that the current network is not dense enough to provide sufficient electricity for long distance travel. Therefore, the two barriers of infrastructure and complementary technology affect each other.

The relationship also occurs between strategies; in this case the network creation strategy leads to development of infrastructure strategy. Both Nissan and BMW engage in collaboration (network creation strategy) to develop charging stations (development of infrastructure strategy) for the customers.

However, it should be noticed that barrier accidents or events in this case study could not be resolved by Nissan South Africa. During the interview, the expert mentioned that this barrier is related to the electrical situation in South Africa and nothing can be done to circumvent this barrier. In fact, the event discussed, the power outage, is a common situation in Sub Sahara. Therefore, it can be concluded that although literature has provided possible strategies to circumvent barriers of accidents or events (Ortt et al., 2013), the implementation itself depends on the case experienced by the company. Proven in this case, though the barrier can be categorized as accidents or events barrier, two strategies suggested by (Ortt et al., 2013), the geographic niche strategy and market research strategy cannot be implemented in South Africa. Therefore, it is important to note that each barrier should be treated case by case, not solely circumvent by strategies suggested by literature. It is also interesting to note that it is a possibility that company is not able to circumvent a specific barrier.

Table 5-2 provides further analysis to investigate whether the strategies implemented by Nissan are in accordance with strategies suggested by literature.

Table 5-2 Strategies implemented by Nissan in comparison with literature

#	Barriers	Strategies	Literature
1	Institutional	Lobbying	Added in this report, modified from (Kemp et al., 1998; Painuly, 2001)
		Network creation	-
		Development of infrastructure	-
2	Infrastructure	Lobbying	-
		Network creation	(Painuly, 2001)
		Development of infrastructure	(Bhat, 2015; Kemp et al., 1998)
3	Complementary technology	Knowledge development	-
		Dedicated system or stand-alone niche	(Ortt et al., 2013)
4	Accidents or events	-	-

From Table 5-2, it can be seen that several strategies implemented by Nissan are not in accordance with literature discussed in this research. This is possible due to the causal relationship between barriers. In institutional barrier, it was mentioned by the expert that no government support for providing charging stations (institutional barrier) has led to the lack of public charging stations (infrastructure barrier) and pushed Nissan and BMW to established cooperation (network creation) to install public charging station (development of infrastructure). However, in the literature, there was no mention of infrastructure barrier as a result of institutional

barrier. Therefore, it is possible that the literature did not foresee the possibility of network creation and development of infrastructure strategies as a solution for institutional barrier.

In the infrastructure barrier, the focus is on the lack of public charging station in which Nissan tries to circumvent by asking for government support (lobbying strategies). However, it was not mentioned in the literature that the infrastructure barrier can possibly be overcome through lobbying strategies. This could happen due to the different situation or case discussed in the literature. In this research, it is really highlighted that specific barrier is treated with specific strategies that are perceived as most appropriate by the company.

In the complementary technology barrier, one strategy implemented by Nissan was not discussed in literature, which is knowledge development. It is possible that cases discussed in the literature in regards with complementary technology were different than complementary technology referred in this research. In this case, the complementary technology discussed was the battery range or battery capacity. The current battery range induces range anxiety. Therefore, Nissan is improving their battery range by doing research and development (knowledge development). Furthermore, the insight of complementary technology barrier being circumvented by implementing knowledge development strategy could be considered by other companies as well as for further research. It is also noted that it is possible that there is no feasible strategy implemented to circumvent a specific barrier such as in the case of power outage (accidents or events barrier) in South Africa.

Furthermore, the importance of barriers is discussed to see if the expert was consistent in evaluating the importance of each barrier and ranking the barriers based on its importance (the five highest ranking of barriers are discussed). According to the expert, network and institutional barriers are considered as extremely important barriers with scale of 7. Moreover, demand and infrastructure barriers are considered as very important barriers with scale of 6. Social, cultural, behavioural, and psychological as well as macro-economic barriers are considered as moderately important barriers with scale of 5. Therefore, it is logical to assume that two barriers with scale 7 would be positioned as first and second most important barrier while the two barriers with scale of and 6 would be positioned as third and fourth most important barrier. As for the fifth most important barrier, it is logical to assume that either the social, cultural, behavioural, and psychological or macro-economic barriers would be considered to be positioned in the rank (the barriers with importance scale of 7, 6, and 5 can be seen in Table 5-3).

Table 5-3 Barriers with importance scale of 7, 6, and 5 Nissan

Scale	Barriers
7	Network
	Institutional
6	Demand
	Infrastructure
5	Social, cultural, behavioural, and psychological
	Macro-economic

However, the ranking of the barriers were discovered to be different than the assumption. Infrastructure barrier with importance scale of 6 was considered to be the most important barrier while network barrier with importance scale of 7 was considered as third most important barrier. Moreover, demand barrier with importance scale of 6 was considered as fifth most important barrier while macro-economic barrier with importance scale of 5 was considered as fourth most important barrier. To have a better understanding of the inconsistency, Table 5-4 provides the rank of barriers together with its importance scale.

Table 5-4 Rank of barriers with the importance scale of each barrier Nissan

Barrier	Rank	Importance Scale
Infrastructure	1	6
Institutional	2	7
Network	3	7
Macro-economic	4	5
Demand	5	6

From Table 5-4, it can be seen that there is a slight inconsistency between the importance scale with the ranking, proven that there are two barrier with lower importance scale positioned in higher ranking. This is possible to occur if during assigning the importance scale, the expert assigned the barrier of infrastructure with a scale 6 while when assigning the ranking, the expert considered it as the most important barrier. This could happen if the differences between scale of 7 and 6 and the difference between scale 6 and 5 are considered to be insignificant. Therefore, during the ranking process, the expert found difficulties to assign the ranking.

The consistency between the importance of strategies and its rank is also investigated. Four strategies were considered as extremely important with scale of 7, which are; lobbying, explore multiple markets niche, financial aid, and development of infrastructure strategies. Four other strategies were considered as very important with scale of 6, which are; demo, experiment, and develop niche, dedicated system or stand-alone niche, knowledge development, and geographic niche strategies. Therefore, it is logical to assume that four strategies with scale of 7 would be positioned in the highest four rank while one of the strategy with a scale of 6 would be positioned as fifth most important strategy (the strategies with importance scale of 7 and 6 can be seen in Table 5-5).

Table 5-5 Strategies with importance scale of 7 and 6 Nissan

Scale	Strategies
7	Lobbying strategy
	Explore multiple markets niche strategy
	Financial aid strategy
	Development of infrastructure strategy
6	Demo, experiment, and develop niche strategy
	Dedicated system or stand-alone niche strategy
	Knowledge development strategy
	Geographic niche strategy

However, the ranking of the strategies were discovered to be different than the assumption. Explore multiple markets niche strategy with a scale of 7 was not considered as one of the five most important barriers. Three strategies with scale of 6 were also not considered to be included as the five most important barriers, which are; dedicated system or stand-alone niche, knowledge development, and geographic niche strategies. The strategy with a scale of 5, however, was considered as the fifth most important strategy, which is network creation. To have a better understanding of the inconsistency, Table 5-6 provides the rank of strategies together with its importance scale.

Table 5-6 Rank of strategies with the importance scale of each strategy Nissan

Strategy	Rank	Importance Scale
Financial aid	1	7
Development of infrastructure	2	7
Lobbying strategy	3	7
Demo, experiment, and develop niche strategy	4	6
Network creation	5	5

From Table 5-6, it can be seen that there is inconsistency between the importance scale with the ranking, proven one strategy with scale of 7 and three strategies with scale of 6 were not considered to be in the five most important strategies while one strategy with scale of 5 was considered to be the five most important strategies. This could indicate that the expert could be tired during or confused the interview, due to the fact that he had to make the importance scale as well as ranking for barriers and strategies.

For further investigation, it is considered that the importance scale is more reliable than the ranking. This is because during assigning the importance scale, the expert only needed to focus on one barrier or strategy at a time and assess the importance of each, rather than assessing the relative important between one barrier/strategy to other barrier/strategy. Therefore, barriers and strategies with scale of 7 and 6 are considered as the most important barriers and strategies experienced by Nissan South Africa. As consequences, there are four most important barriers since the expert only assigned two barriers for both scale 7 and 6 as well as eight most important strategies implemented by Nissan since the expert assigned four strategies with scale of 7 and four strategies with scale of 6.

Moreover, the interview also discussed the relation between barriers and strategies, including barriers and strategies that were not mentioned during open questions. As can be seen in Figure 4-1, Nissan South Africa conducted several strategies to penetrate the market in South Africa but the strategies were not directly related to the barriers discussed in open question. This is possible if those strategies are part of formal procedures of each Nissan's branch worldwide so the expert could not recognize the direct relationship between the barriers and strategies. It is also possible that during open questions, the expert focused on specific barriers that occurring in South Africa with specific strategies to circumvent it that are unique to the situation of South Africa. Therefore, during the open question, the expert did not address other barrier that might as well occur in other

countries. Further research is possible to be conducted to see how Nissan address barriers in different country with different situation than South Africa.

5.1.2 Mahindra Reva India

Table 5-7 summarizes the barriers experienced by Mahindra Reva India including the strategies implemented along with categorizations of the barriers and strategies:

Table 5-7 Barriers and strategies Mahindra Reva India

#	Barriers	Categories of barriers	Strategies	Categories of strategies
1	Lack of government subsidies	Institutional barrier, demand barrier	- Targeting the market with high support of electricity - Targeting the market with high level of awareness of electric vehicles - Offering customers with wide range of electric vehicles design	Explore multiple markets niche strategy
2	Insufficient charging infrastructure	Infrastructure barrier		
3	Lack of awareness of the importance of electric vehicles	Social, cultural, behavioural, and psychological barrier, demand barrier		
4	Range anxiety	Complementary technology barrier, infrastructure barrier		

From Table 5-7, it can be seen that Mahindra Reva India implemented three major strategies to overcome their barriers, all of which can be categorized as explore multiple markets niche strategy (as agreed by the expert). In this case, market with high support with electricity and high awareness of electric vehicles both can be categorized as niche markets. Moreover, offering wide range of vehicles also opens up the opportunity to enter multiple markets with different needs of vehicles. Therefore, it could also be categorized as multiple niche market.

Furthermore, Mahindra Reva India considered that all the barriers lead to demand barrier and therefore, explore multiple markets niche strategy can be implemented to create the demand of electric vehicle. Other strategies such as lobbying strategy were implemented but the main focus of the company is to enter multiple markets in order to boost the demand.

The relationships between barriers and strategies are described as follow (based on the discussion during the interview):

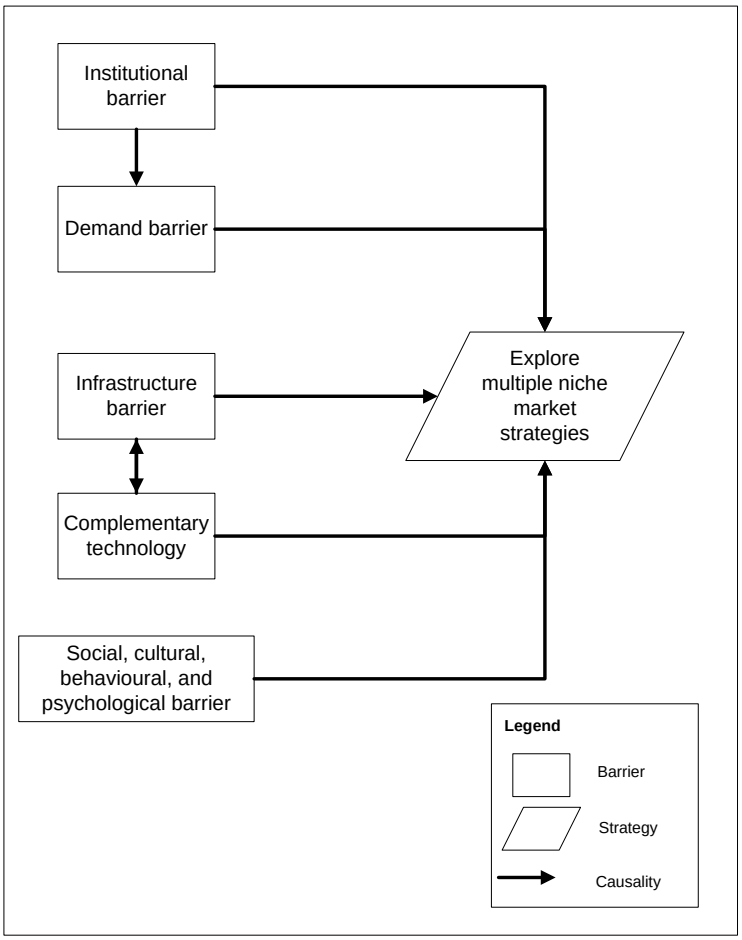

Figure 5-2 Relationship between barriers and strategies of Mahindra Reva India

It was also discovered that relationship exists between barriers. Mahindra Reva India considered that low demand of electric vehicles (demand barrier) as a result of lack of government subsidies (institutional barrier). In fact, government only provide subsidies as much as 10% for the sales of each electric vehicle. It was considered not interesting enough for Indian people to buy electric vehicles. Moreover, the case of range anxiety is also both affected by battery range (complementary technology barrier) and lack of public charging station (infrastructure barrier).

Table 5-8 provides further analysis to investigate whether the strategies implemented by Mahindra Reva are in accordance with strategies suggested by literature.

Table 5-8 Strategies implemented by Mahindra Reva in comparison with literature

#	Barriers	Strategies	Literature
1	Institutional	Explore multiple markets niche strategy	-
2	Demand	Explore multiple markets niche strategy	(Ortt et al., 2013)
3	Infrastructure	Explore multiple markets niche strategy	-
4	Social, cultural, behavioural,	Explore multiple markets niche	(Ortt et al., 2013)

#	Barriers	Strategies	Literature
	and psychological	strategy	
5	Complementary technology	Explore multiple markets niche strategy	-

No literature discussed in this research suggests overcoming institutional, infrastructure, and complementary technology barriers by penetrating multiple markets niche. This is possible due to the fact that Mahindra Reva India considered this as the company's main strategies even though there were other strategies implemented by Mahindra Reva. However, the expert articulated that other strategies were considered as supporting strategies, not the main strategies.

Furthermore, the importance of barriers is discussed to see if the expert was consistent in evaluating the importance of each barrier and ranking the barriers based on its importance (the five highest ranking of barriers are discussed). According to the expert, there were three barriers considered as extremely important barriers with scale of 7, which are: demand, institutional, and infrastructure barriers. There were also two barriers considered as very important with scale of 6, which are: social, cultural, behavioural, and psychological barrier as well as macro-economic barrier. Therefore, it is logical to assume that the five barriers assigned with scale 7 would be considered as the three most important barriers while barriers with scale of 6 would be considered as the fourth and fifth most important barriers (the barriers with importance scale of 7 and 6 can be seen in Table 5-9).

Table 5-9 Barriers with importance scale of 7 and 6 Mahindra Reva

Scale	Barriers
7	Demand
	Institutional
	Infrastructure
6	Social, cultural, behavioural, and psychological
	Macro-economic

Based on the questionnaire filled out by the expert, it is discovered that the assumption is in accordance with the expert's ranks. Therefore, it can be concluded that the expert was consistent in both assigning the importance scale and assigning the rank of each barrier.

Table 5-10 Rank of barriers with the importance scale of each strategy Mahindra Reva

Barrier	Rank	Importance Scale
Demand	1	7
Institutional	2	7
Infrastructure	3	7
Macro-economic	4	6
Social, cultural, behavioural, and psychological	5	6

The consistency between the importance of strategies and its rank is also investigated. Two strategies were considered extremely important with scale of 7, which were; explore multiple markets niche and development of infrastructure strategies. Moreover, there were three strategies considered as very important with scale of 6, which were; lobbying, knowledge development, and market research strategies. Therefore, it is logical to assume that two strategies with scale of 7 would be considered as the first and second most important barriers while the three strategies with scale of 6 would be positioned as the third, fourth, and fifth most important strategies (the strategies with importance scale of 7 and 6 can be seen in Table 5-11).

Table 5-11 Strategies with importance scale of 7 and 6 Mahindra Reva

Scale	Strategies
7	Explore multiple markets niche strategy
	Development of infrastructure strategy
6	Lobbying strategy
	Knowledge development strategy
	Market research strategy

Based on the questionnaire filled out by the expert, it is discovered that the assumption is in accordance with the expert's ranks. Therefore, it can be concluded that the expert was consistent in both assigning the importance scale and assigning the rank of each strategy.

Table 5-12 Rank of strategies with the importance scale of each strategy Mahindra Reva

Strategy	Rank	Importance scale
Explore multiple markets niche strategy	1	7
Development of infrastructure strategy	2	7
Lobbying strategy	3	6
Knowledge development strategy	4	6
Market research strategy	5	6

Since the expert can be considered consistent, the ranking of both barriers and strategies can be considered valid and can be used for further discussion in the research. Moreover, the interview also discussed the relation between barriers and strategies, including barriers and strategies that were not mentioned during open questions. As can be seen in Figure 4-2, Mahindra Reva India conducted several strategies to penetrate the market in India but the strategies were not directly related to the barriers discussed in open question. As mentioned by the expert, these strategies serve as supporting strategies while the focus of Mahindra Reva India is carrying out the main strategy of exploring multiple markets niche strategy.

5.1.3 Renault Brazil

Table 5-13 summarizes the barriers experienced by Renault Brazil, including the strategies implemented along with categorization of the barriers and strategies.

Table 5-13 Barriers and strategies Renault Brazil

#	Barriers	Categories of barriers	Strategies	Categories of strategies
1	High price of electric vehicles	Demand barrier	- Lobby the government - Tax exemption - Providing financial assistance to customers through Bank of Renault	Lobbying strategy, financial aid strategy, network creation strategy
2	Lack of infrastructure	Infrastructure barrier	- Cooperation with suppliers, governments, and federal (state) by participating in chamber of discussion to promote installation of public charging infrastructure	Network creation strategy, lobbying strategy
3	Battery range	Complementary technology barrier	R&D to improve the battery	Knowledge development strategy
4	Lack of government's incentives	Institutional barrier	Lobby the government	Lobbying strategy

The relationship between barriers and strategies are described as follow:

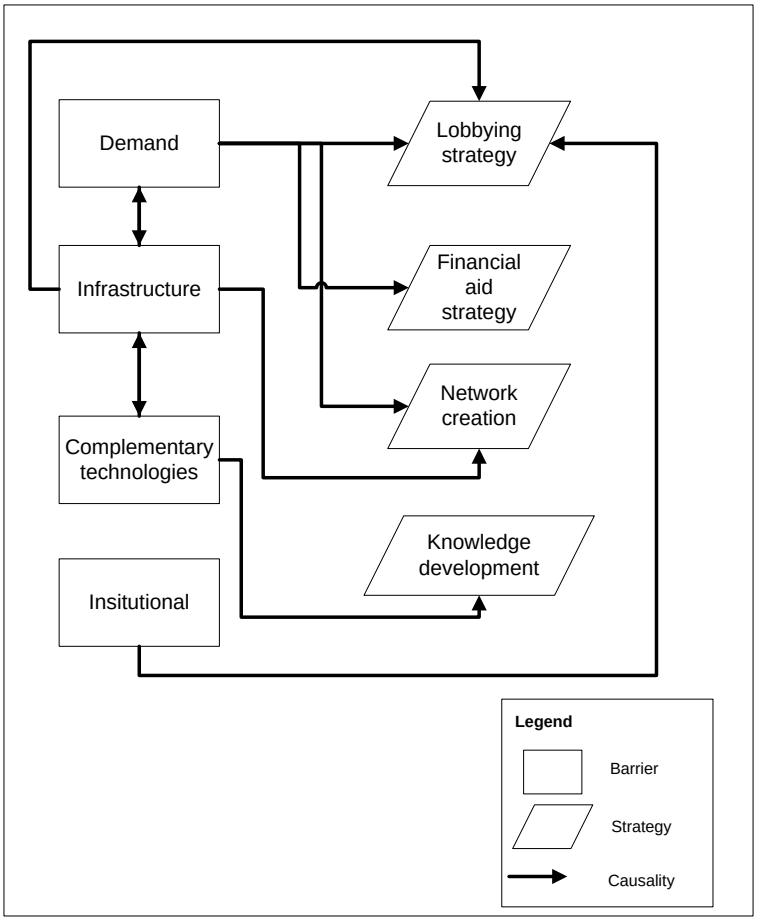

Figure 5-3 Relationship between barriers and strategies of Renault Brazil

From Figure 5-3, it can be seen that the demand barrier relates to infrastructure barrier, as explicitly mentioned by the expert during the interview, refer as 'chicken and egg' problem. No infrastructure of charging stations has led to low demand of electric vehicles, but low demand of electric vehicles also led to the reluctance to build charging stations. However, according to the expert, if charging stations are built, then electric vehicles can be perceived to be more viable in the market.

Moreover, the infrastructure barrier also relates to the complementary technology barrier. Complementary technology barrier represents the battery range (referred as autonomy by the expert). Since the battery range is limited, the dense network of charging stations is required to provide electric vehicles with sufficient electrical supply. This also leads to range anxiety, meaning that customers are afraid to be run out of battery before reaching their destinations or the next charging stations.

Furthermore, the relationships occur between barriers and strategies, in which specific strategies are implemented to circumvent specific barriers. Table 5-2 provides further analysis to investigate whether the strategies implemented by Renault are in accordance with strategies suggested by literature.

Table 5-14 Strategies implemented by Renault in comparison with literature

#	Barriers	Strategies	Literature
1	Demand	Lobbying	Added in this report, modified from (Ortt et al., 2013)
		Financial aids	-
		Network creation	(Kemp et al., 1998)
2	Infrastructure	Lobbying	-
		Network creation	(Painuly, 2001)
3	Complementary technology	Knowledge development	-
4	Institutional	Lobbying	Added in this report, modified from (Kemp et al., 1998; Painuly, 2001)

From Table 5-14, it can be seen that several strategies implemented by Renault are not in accordance with literature discussed previously in this research. This is possible due to the unique situation of Renault Brazil. Renault Brazil is a part of Renault group, originated in France. Other than engage in business of cars manufacturing, Renault Group also has an established bank, namely Bank of Renault. This situation makes it possible for Renault Brazil to cooperate with Bank of Renault in providing financial or leverage options for customers wishing to purchase electric vehicles. It is possible that the literature did not foresee the possibility of the companies providing financial aids to its customers as a solution for demand barrier since this unique situation of Renault Brazil might be limited.

In the infrastructure barrier, the focus is on the lack of public charging station in which Renault tries to overcome by participate actively lobby the government to promote electric vehicles by providing charging sations . However, it was not mentioned in the literature that the infrastructure barrier can possibly be overcome through lobbying strategies. This could happen due to the different situation or case discussed in the literature. In this research, it is really highlighted that specific barrier is treated with specific strategies that are perceived as most appropriate by the company.

In the complementary technology barrier, one strategy implemented by Renault was not discussed in literature, which is knowledge development. It is possible that cases discussed in the literature in regards with complementary technology were different than complementary technology referred in this research. In this case, the complementary technology discussed was the battery range or battery capacity. Renault is trying to improve their battery range by doing research and development (knowledge development). Furthermore, the insight of complementary technology barrier being circumvented by implementing knowledge development strategy could be considered by other companies as well as for further research.

Furthermore, the importance of barriers is discussed to see if the experts were consistent in evaluating the importance of each barrier and ranking the barriers based on its importance (the five highest ranking of barriers are discussed). According to the expert, macro-economic, infrastructure, and financial issue are considered as extremely important barriers with scale of 7. Moreover, network, demand, and institutional barriers are considered as very important barriers with scale of 6. Therefore, it is logical to assume that three barriers with scale 7 would be positioned as the three most important barriers while the two from three barriers with scale of and 6 would be positioned as fourth and fifth most important barriers (the barriers with importance scale of 7 and 6 can be seen in Table 5-15).

Table 5-15 Barriers with importance scale of 7 and 6 Renault

Scale	Barriers
7	Macro-economic
	Infrastructure
	Financial issue
6	Network
	Demand
	Institutional

Based on the questionnaire filled out by the experts, it is discovered that the assumption is in accordance with the expert's ranks. Therefore, it can be concluded that the experts were consistent in both assigning the importance scale and assigning the rank of each barrier.

Table 5-16 Rank of barriers with the importance scale of each barrier Renault

Barrier	Rank	Importance scale
Financial issue	1	7
Macro-economic	2	7

Infrastructure	3	7
Institutional	4	6
Demand	5	6

The consistency between the importance of strategies and its rank is also investigated. Three strategies were considered as extremely important with scale of 7, which are; lobbying, knowledge development, and financial aid strategies. Three other strategies were considered as very important with scale of 6, which are; demo, experiment, and develop niche, pilot project, and development of infrastructure strategies. Therefore, it is logical to assume that three strategies with scale of 7 would be positioned in the highest three rank while two of the three strategies with a scale of 6 would be positioned as fourth and fifth most important strategy (the strategies with importance scale of 7 and 6 can be seen in Table 5-17).

Table 5-17 Strategies with importance scale of 7 and 6 Renault

Scale	Strategies
7	Lobbying strategy
	Knowledge development
	Financial aid
6	Demo, experiment, and develop niche
	Pilot project
	Development of infrastructure

However, the ranking of the strategies were discovered to be different than the assumption. All three strategies with importance scale of 6 were ranked as first, second, and third most important strategies, while two of three strategies with importance scale of 7 were ranked as fourth and fifth most important strategies.

Table 5-18 Rank of strategies with the importance scale of each strategy Renault

Strategy	Rank	Importance Scale
Demo, experiment, and develop niche	1	6
Pilot project	2	6
Lobbying	3	6
Financial aid	4	7
Knowledge development	5	7

From Table 5-18, it can be seen that there is inconsistency between the importance scale with the ranking, proven three strategies with scale of 7 were not considered to be in the three most important strategies. Instead, two of them were considered to be the fourth and fifth most important strategies. The three strategies with importance scale of 6 were considered as first, second, and third most important strategies. This could indicate that the experts were indifferent toward the strategies, possibly considering all the strategies with the same level of importance, making it difficult to rank the strategies.

For further investigation, it is considered that the importance scale is more reliable than the ranking. This is because during assigning the importance scale, the experts only needed to focus on one barrier or strategy at a time and assess the importance of each, rather than assessing the relative important between one barrier/strategy to other barrier/strategy. Therefore, barriers and strategies with scale of 7 and 6 are considered as the most important barriers and strategies experienced by Renault Brazil.

Moreover, in the case of Renault Brazil, several strategies that were not related to the barriers discussed in open questions were implemented by Renault. This could indicate that during the open question, Renault did not foresee all the barriers that occurred as well as all the possible strategies that were implemented. It could also indicate that big company with worldwide market such as Renault implement all possible strategies to gain as much benefit as possible for the company.

5.2 Cross-Case Analysis

5.2.1 Similarities between the Three Cases

Nissan South Africa, Mahindra Reva India, and Renault Brazil experienced infrastructure, institutional, and complementary technology barriers (discussed during the open question session). For the case of institutional barrier, all mentioned the lack of government support to provide subsidies and incentives for the customers. All also discussed the lack of government support in providing public charging station. This result in a limited number of public charging stations that leads to range anxiety, especially in South Africa. Nissan explained that customers were worried they would run out of battery before getting to their destination with no nearby public charging station. Long distance travel in South Africa makes the dense network of public charging station very important to support the adoption of electric vehicle. Renault discussed mostly about the very limited number of public charging stations, only counts for 10-15 public charging stations in each big cities and also mentioned that since Brazil is a big country, more charging stations are require to support adoption to electric vehicles. Although Mahindra Reva did not discuss the long distance, Mahindra Reva also mentioned concern for range anxiety.

Nissan, Mahindra Reva, and Renault also discussed the lack of government incentives for electric vehicles' customers. The incentives are important to balance the high price of electric vehicles. Therefore, to make electric vehicles as a more interesting option, incentives should be given. A good example of government incentives to increase the demand of electric vehicles is in Norway (Hjorthol et al., 2014).

Furthermore, all three companies involve in cooperation with other companies, such as Nissan with BMW, Mahindra Reva with prospective companies that wish to enter electric vehicles market in India, and Renault with other car manufacturers in Brazil. Although the purpose of these cooperation differ from one another, it can be concluded that cooperation with other entities are important to help promote the adoption of electric vehicles in BRICS countries.

5.2.2 Differences between the Three Cases

Mahindra Reva manufactured their vehicles in India while Nissan imported the Nissan Leaf from other Nissan's plant and Renault from its plant in Europe. This difference might occur due to the differences in strategic planning of each company. One of Mahindra Reva's early visions is to provide Indian people with affordable electric vehicles and they have been focused in manufacturing and distributing electric vehicles in India. While for Nissan, electric vehicle is one of the many vehicles offered by them. Entering market in South Africa was decided as they wanted to become the first electric vehicles in that region. However, due to low demand of electric vehicles, Nissan decided to import the vehicles to avoid high production cost if the vehicles are manufactured in South Africa. As for Renault, they also decided to import the vehicles from Europe's plant. As mentioned during the first stage in interview with Renault, they manufactured the electric vehicles in France to be later distributed worldwide.

As in their method of selling electric vehicles, Nissan and Mahindra Reva utilized their current dealers as their selling point, even though it is only limited (seven outlets of Nissan South Africa and eight outlets of Mahindra Reva India) while Renault does not utilize the dealers. To acquire Renault's electric vehicles, the purchase must go through corporation purchase.

Moreover, other difference that can be spotted is the different approach to overcome the barriers by the two companies even though they experienced similar barriers. Nissan South Africa relied heavily in lobbying activities to obtain subsidies. Renault also participated actively in association and chamber of discussion to lobby and advocate the government in promoting electric vehicles. Moreover, Renault specifically target the business-to-business market and possibly enter customers' market (or business-to-customers) later when the infrastructure or charging station is considered sufficient to support the mobility of electric vehicles. In contrast, Mahindra Reva focuses its effort to penetrate multiple markets that are mature enough to adopt electric vehicles. However, the strategy of Mahindra Reva to explore multiple markets could lead to a more pressing issue of infrastructure barrier. This especially could happen if the increase in demand could not be followed by the increase of availability of public charging station.

To overcome the issue of the availability of public charging stations, Nissan engaged in collaboration with BMW to install public charging stations that can be used by both Nissan and BMW vehicles. However, this type of collaboration could not be implemented in India since Mahindra Reva is the only electric vehicles manufacturer India. However, Nissan emphasized the importance of this collaboration and it also occurred in Renault. The difference is that the collaboration in Brazil is through formal association in order to establish standard for electric vehicles in Brazil, especially for charging connection. Therefore, Mahindra Reva could adopt the collaboration strategy once other manufactures enter Indian market to provide the customer with dense network of public charging stations.

More differences in regards with the instalment of infrastructure or charging stations are that Nissan together with BMW in South Africa built their own charging infrastructure while Mahindra Reva and Renault did not build the charging infrastructure, In India, the charging stations are built by the government while in Brazil, the charging stations are built by third party, by cooperating with electrical charging point manufacturers.

Furthermore, the electricity supply in India and Brazil can be considered more stable compare to South Africa since there is no mention of power outage in India while this happen quite frequently in South Africa. Therefore, companies that wish to enter market in Sub Sahara region should be aware of this power outage situation since it could lead to customer being worried that would not be able to charge their vehicles before traveling.

5.2.3 Relative Importance of Barriers

The importance scale of each barrier assigned by Nissan, Mahindra Reva, and Renault are summed to discover the relative importance of the barrier.

Table 5-19 Relative importance of barriers

#	Barriers	Expert			Summed scale
		Nissan South Africa	Mahindra Reva India	Renault Brazil	
1	Production system	1	2	5	8
2	Complementary technology	3	4	4	11
3	Network	7	5	6	18
4	Demand	6	7	6	20
5	Institutional	7	7	6	20
6	Technological	1	4	4	9
7	Natural resources and labour	1	2	2	5
8	Social, cultural, behavioural, and psychological	5	6	2	13
9	Macro-economic	5	6	7	18
10	Accidents or events	4	1	2	7
11	Infrastructure	6	7	7	20
12	Financial issue	1	5	7	13
13	Undesirable societal and environmental effect	1	2	2	5

From Table 5-19, it is discovered that demand, institutional, and infrastructure barriers can be considered as the most important barriers with total relative importance of 20. During the interviews, all the three barriers were discussed in depth. These three barriers were considered to affect the adoption of electric vehicles greatly. As discussed during the interview, demand barrier relates to the unwillingness to buy due to high price of electric vehicles, leading to low demand of electric vehicles. The lack of government's support (institutional barrier) in forms of incentives for customers as well as support to build public charging stations also considered to hamper the adoption of electric vehicles. Lastly, the lack of available public charging infrastructure leads to range anxiety, making the customers feel safer to use combustion-engine vehicles for long distance travel.

Moreover, two barriers were considered as the least important barriers; natural resources and labour and undesirable societal and environmental affect barriers. During the interviews, the only undesirable societal and environmental effect that was discussed was the waste management of battery. However, the battery could be recycled or use for storage for big building; therefore the waste management of battery is considered as a non-issue. As for natural resources and labour, both Nissan and Renault rated it with scale 1, not important at all, because currently, they imported the cars from outside BRICS countries; therefore they have no issue with natural resources or labour. However, Renault mentioned that if the production system were to be set up in Brazil, probably in the future, then natural resources could be a barrier to achieve mass market. As for Mahindra, they had an issue with natural resource to produce battery; therefore they decided to import the battery. Since this barrier can still be managed by Mahindra Reva, the expert rated this barrier with 2, low important.

5.2.4 Relative Importance of Strategies

The importance scale of each strategy assigned by both Nissan and Mahindra Reva is summed to discover the relative importance of the strategies.

Table 5-20 Relative importance of strategies

#	Category	Expert			Summed scale
		Nissan South Africa	Mahindra Reva India	Renault Brazil	
1	Demo, experiment, and develop niche	6	1	6	13
2	Top niche market	2	1	NA	3
3	Pilot project	3	5	6	14
4	Lobbying	7	6	7	20
5	Redesign niche	5	1	5	11
6	Dedicated system or stand-alone niche	6	3	NA	9
7	Hybridization or adaptor	2	1	NA	3
8	Knowledge development	6	6	7	19
9	Geographic niche	6	4	NA	10
10	Market research	1	6	NA	7
11	Explore multiple markets niche	7	7	5	19
12	Financial aid	7	5	7	19
13	Establishment of standard	2	4	5	11
14	Network creation	5	5	5	15
15	Development of infrastructure	7	7	6	20

From Table 5-20, it is discovered that lobbying and development of infrastructure strategies are considered to be the most important strategies. Those two strategies were discussed in depth during the interview. Lobbying is conducted to get more government's supports as part of strategy to circumvent the institutional barrier while development of infrastructure is conducted to have more public charging stations available for the customers. Moreover, hybridization or adaptor strategy is considered as the least important strategy. This is possible since the focus of this research is pure electric vehicles, resulting in discussion on hybrid electric vehicles to be limited.

5.2.5 Relationship between Barriers and Strategies with Insight from the Interview

As explained in section 5.1.1, 5.1.2, and 5.1.3, there are several strategies implemented by companies that were not discussed in literature review in this research. Table 5-21 summarizes the barriers and strategies linkage with additional insight from interview result. The coloured rows highlight the strategies implemented by the company for respective barrier. It can be seen that even though both companies experienced similar barriers, the strategies implemented to circumvent these barriers were different.

Table 5-21 Barriers and strategies according to literature and interviews

#	Barriers	Strategies	Literature	Company
1	Production system	Top niche market strategy	(Ortt et al., 2013)	
		Pilot project strategy	(Kemp et al., 1998)	
		Redesign niche strategy	(Ortt et al., 2013)	
		Network creation	(Kemp et al., 1998; Painuly, 2001)	
		Establishment of standard	(Painuly, 2001)	
		Lobbying strategy	Added in this report, modified from (Ortt et al., 2013)	
2	Complementary technologies	Dedicated system or stand-alone niche strategy	(Ortt et al., 2013)	Nissan
		Hybridization or adaptor niche strategy	(Ortt et al., 2013)	
		Geographic niche strategy	(Ortt et al., 2013)	
		Knowledge development		Nissan, Renault
		Explore multiple markets niche		Mahindra Reva
3	Network	Redesign niche strategy	(Ortt et al., 2013)	
		Knowledge development	(Ortt et al., 2013)	
		Lobbying strategies	Added in this report, modified from (Painuly, 2001)	
		Market research	(Ortt et al., 2013)	
		Geographic niche strategy	(Ortt et al., 2013)	
4	Demand	Top niche market strategy	(Ortt et al., 2013)	
		Pilot project strategy	(Kemp et al., 1998)	
		Lobbying strategy	Added in this report, modified from (Ortt et al., 2013; Painuly, 2001)	Renault
		Redesign niche strategy	(Ortt et al., 2013)	
		Geographic niche strategy	(Ortt et al., 2013)	
		Knowledge development	(Bhat, 2015; Freitas et al., 2012; Ortt et al., 2013; Painuly, 2001)	
		Market research	(Kemp et al., 1998; Ortt et al., 2013)	
		Explore multiple markets niche	(Ortt et al., 2013)	Mahindra Reva
		Network creation	(Kemp et al., 1998)	Renault
		Financial aid		Renault
5	Institutional	Lobbying strategy	Added in this report, modified from (Kemp et al., 1998; Painuly, 2001)	Nissan, Renault
		Redesign niche strategy	(Ortt et al., 2013)	
		Knowledge development	(Painuly, 2001)	
		Geographic niche strategy	(Ortt et al., 2013)	
		Network creation		Nissan
		Development of infrastructure		Nissan

#	Barriers	Strategies	Literature	Company
		Explore multiple markets niche		Mahindra Reva
6	Technological	Demo, experiment, and develop niche strategy	(Ortt et al., 2013)	
		Top niche market strategy	(Ortt et al., 2013)	
		Pilot project strategy	(Kemp et al., 1998)	
		Redesign niche strategy	(Ortt et al., 2013)	
		Hybridization or adaptor niche strategy	(Ortt et al., 2013)	
		Knowledge development	(Ortt et al., 2013)	
		Geographic niche strategy	(Ortt et al., 2013)	
		Market research	(Kemp et al., 1998; Ortt et al., 2013)	
		Establishment of standard	(Painuly, 2001)	
		Lobbying strategy	(Ortt et al., 2013)	
		Dedicated system or stand-alone niche strategy	(Ortt et al., 2013)	
		Financial aid	(Painuly, 2001)	
7	Natural resources and labour	Top niche market strategy	(Ortt et al., 2013)	
		Lobbying strategy	Added in this report, modified from (Ortt et al., 2013)	
		Redesign niche strategy	(Ortt et al., 2013)	
		Hybridization or adaptor niche strategy	(Ortt et al., 2013)	
		Knowledge development	(Ortt et al., 2013)	
		Geographic niche strategy	(Ortt et al., 2013)	
		Network creation	(Painuly, 2001)	
8	Social, cultural, behavioural, and psychological	Redesign niche strategy	(Ortt et al., 2013)	
		Geographic niche strategy	(Ortt et al., 2013)	
		Market research	(Ortt et al., 2013)	
		Explore multiple markets niche	(Ortt et al., 2013)	Mahindra Reva
		Knowledge development	(Painuly, 2001)	
9	Macro-economic	Geographic niche strategy	(Ortt et al., 2013)	
		Market research	(Ortt et al., 2013)	
10	Accidents or events	Geographic niche strategy	(Ortt et al., 2013)	
		Market research	(Ortt et al., 2013)	
11	Infrastructure	Development of infrastructure	(Bhat, 2015; Kemp et al., 1998)	Nissan
		Network creation	(Painuly, 2001)	Nissan, Renault
		Pilot project strategy	(Kemp et al., 1998)	
		Lobbying strategy		Nissan, Renault
		Explore multiple markets niche		Mahindra Reva
12	Financial	Lobbying strategy	Added in this report, modified from (Ortt et al., 2013; Painuly, 2001)	
		Financial aid	(Bhat, 2015; Freitas et al., 2012; Painuly, 2001)	
		Network creation	(Painuly, 2001)	
13	Undesirable societal and environmental effect	Network creation	(Kemp et al., 1998)	

6. Concluding Remarks

This section gives conclusion of this research, by answering the sub questions and the main research question. Moreover, this section also provides discussion for related things gained during the research activities. Reflection and limitation of the research are discussed subsequently. This section is then closed by providing both managerial and academic recommendation.

6.1 Conclusion

This research has a main objective to identify barriers that can hamper the transition to electric vehicles in BRICS countries as well as strategies implemented by companies in BRICS to overcome those barriers. This section answers five sub question as well as answer the main research question, based on the sub questions.

6.1.1 Sub Question 1

What are the barriers based on current literatures that can hamper the transition to new technologies?

Based on the literature studied in this research, barriers were categorized in thirteen categories. Table 6-1 summarizes the categorization of barriers along with explanation for each barrier.

Table 6-1 Barrier categories

#	Barrier Category	Explanation
1	Production system	The unavailability of a good production system to support the transition to large scale diffusion
2	Complementary technologies	The unavailability of complementary products and/or services that support the product
3	Network	The absent of actors or organizations that are involved to supply the necessary product as well as coordination between the actors, including lack of international cooperation
4	Demand	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product or when the price of the product is considered too high.
5	Institutional	Laws and regulations that hamper the large scale diffusion of the product, lack of supporting laws and regulations, as well as lack of competition and information sharing between the producers and customers
6	Technological	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product, as well as lack of standardization of the product
7	Natural resources and labour	The unavailable natural resources and labour that are required to support production system, for example lack competent labour
8	Social, cultural, behavioural, and	Different perspectives norms and culture in regards to the use of the

#	Barrier Category	Explanation
	psychological	product, lack of social acceptance of the product
9	Macro-economic	Issues related to economic situation
10	Accident or events	Occurrence of events that cannot be foreseen beforehand that affect the companies
11	Infrastructure	The unavailability of technology or infrastructure that are required for the distribution and usage of the technology
12	Financial Issue	The absent of financing sources or lack of financial capabilities
13	Undesirable societal and environmental effect	Negative side effect from the new technology

6.1.2 Sub Question 2

What are the strategies implemented based on current literatures that can overcome the barriers of transition to new technologies?

Based on the literature studied in this research, strategies were categorized in fifteen categories. Table 6-2 summarizes the categorization of strategies along with explanation for each strategy.

Table 6-2 Strategy categories

#	Strategy Category	Explanation
1	Demo, experiment, and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem
2	Top niche market strategy	Targeting the high-end market by providing tailored product
3	Pilot project strategy	Conducting pilot project to see how the product would be accepted by the market and how the customers would behave towards the product
4	Lobbying strategies	Involve lobbying activities to the government to provide subsidies and other supports for the product
5	Redesign niche strategy	A simpler version of the product is introduced by using current knowledge, fewer resources, leading to reduced price
6	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology
7	Hybridization or adaptor niche strategy	The new product is combined with the existing product to make the new product compatible with existing system
8	Knowledge development	The knowledge about the product is transferred to both suppliers and customers, campaign to increase awareness of the importance of the product, enhancement of the R&D system of the company
9	Geographic niche strategy	The new product targets specific geographical area

#	Strategy Category	Explanation
10	Market research	Conducting an in-depth market research to explore the market needs, for example by involving lead user
11	Explore multiple markets niche strategy	The new product is introduced to multiple markets
12	Financial aid	Collaboration with other institutions (for example international organization) to get financial support, both for producers or customers
13	Establishment of standard	Standard is imposed to the product
14	Network creation	Establishment of cooperation between institutions, both locally and internationally
15	Development of infrastructure	Creation of infrastructure to support the distribution and usage of the product

6.1.3 Sub Question 3

What are the barriers of transition to electric vehicles in BRICS countries?

Three countries were investigated during the research: South Africa (Nissan), India (Mahindra Reva), and Brazil (Renault). In South Africa, Nissan experienced complementary technologies, demand, institutional, accidents or events, infrastructure, network, social, cultural, behavioural, and psychological, macro-economic, and financial issue barriers. In India, Mahindra Reva experienced complementary technologies, network, demand, institutional, social, cultural, behavioural, and psychological, natural resources and labour, macro-economic, infrastructure, financial issue, and undesirable societal and environmental barriers. Lastly, Renault in Brazil experienced production system, complementary technologies, network, demand, institutional, macro-economic, and infrastructure barriers. Table 6-3 presents the barriers that are experienced by the three companies.

Table 6-3 Barriers experienced by Nissan, Mahindra Reva, and Renault

#	Barrier category	Nissan	Mahindra Reva	Renault
1	Production system			X
2	Complementary technologies	X	X	X
3	Network	X	X	X
4	Demand	X	X	X
5	Institutional	X	X	X
6	Technological			
7	Natural resources and labour		X	
8	Social, cultural, behavioural, and psychological	X	X	
9	Macro-economic	X	X	X
10	Accidents or events	X		
11	Infrastructure	X	X	X
12	Financial Issue	X	X	
13	Undesirable societal and environmental effect		X	

All three companies explicitly mentioned that government support in the form of incentives for the electric vehicles' customers is very important in promoting the adoption of electric vehicles. Although there is no law or regulation that hamper the adoption to electric vehicles, the absent of supporting law and regulations happen to be the institutional barrier that greatly affect the customers' decision in purchasing electric vehicles. Moreover, infrastructure barrier also pose as a prominent challenge. The unavailability of sufficient charging stations is perceived to trigger range anxiety, due to long distance travel and limited battery range (mileage).

Moreover, natural resources and labour and undesirable societal and environmental effect barriers are considered as the least important barriers. This is due to the well-established waste management of battery; hence there is no issue in regards to undesirable societal and environmental effect. As for natural resources and labour, the issue is less of a concern since the electric vehicles of Nissan and Renault are imported from countries with sufficient natural resources as well as capable labour while for Mahindra Reva, the issue of unavailable natural resource for battery is solved by importing the battery from other countries. Therefore, these barriers are considered as not important.

6.1.4 Sub Question 4

What are the current strategies implemented to overcome the barriers of transition to electric vehicles in BRICS countries? What are the results of these strategies?

Nissan South Africa implemented lobbying strategy, dedicated system or stand-alone niche strategy, knowledge development strategy, network creation strategy, development of infrastructure strategy, demo, experiment, and develop niche strategy, top niche market strategy, pilot project strategy, knowledge development strategy, redesign niche strategy, geographic niche strategy, market research strategy, explore multiple market strategy, financial aid strategy, establishment of standard strategy. In India, Mahindra Reva implemented explore multiple markets niche strategy, pilot project strategy, lobbying strategy, dedicated system or stand-alone strategy, knowledge development strategy, geographic niche strategy, market research strategy, financial aid strategy, establishment of standard strategy, network creation strategy, development of infrastructure strategy. Meanwhile, Renault Brazil implemented Lobbying, financial aid, network creation, knowledge development, demo, experiment, and develop niche, pilot project, knowledge development, explore multiple markets niche, establishment of standard, and network creation strategies. Table 6-4 presents the strategies that are implemented by the three companies.

Table 6-4 Strategies implemented by Nissan, Mahindra Reva, and Renault

#	Strategy category	Nissan	Mahindra Reva	Renault
1	Demo, experiment, and develop niche strategy	X		X
2	Top niche market strategy	X		
3	Pilot project strategy	X	X	X
4	Lobbying strategy	X	X	X
5	Redesign niche strategy	X		

#	Strategy category	Nissan	Mahindra Reva	Renault
6	Dedicated system or stand-alone niche strategy	X	X	
7	Hybridization or adaptor niche strategy			
8	Knowledge development	X	X	X
9	Geographic niche strategy	X	X	
10	Market research	X	X	
11	Explore multiple markets niche strategy	X	X	X
12	Financial aid	X	X	X
13	Establishment of standard	X	X	X
14	Network creation	X	X	X
15	Development of infrastructure	X	X	

Lobbying and development of infrastructure strategies are considered to be the most important strategies. Most lobbying is conducted to advice the government to support the adoption of electric vehicles by offering incentives to the customers. These incentives could be adopted from incentives given in Europe, such as Norway. One of the incentives that can be given is discount in purchasing the electric vehicles (advice by Mahindra Reva). It is advised that the government should subsidize the purchasing of electric vehicles. Tax exemption is also implemented to make the electric vehicles imported (in the case of Nissan and Renault) more competitive. However, even with tax exemption, the price of electric vehicles could count to five times higher than combustion-engine vehicles. Therefore, more incentives are important to make electric vehicles more attractive.

In contrast, top niche market strategy and hybridization or adaptor niche strategy as the least important strategy. All the companies targeted their cars to be used by mass market; hence they did not offer the cars only to top niche market. Moreover, they only focus on pure electric vehicles. Therefore, the hybridization strategy is considered to be not important compare to other strategies.

As a result, the strategies in all three countries can be considered to have good influence in promoting the adoption of electric vehicles in the countries. However, those strategies cannot yet drive for large scale market of electric vehicles. This is possible due to the fact that electric vehicles only enter the market since around 2012. Therefore, it can be concluded that it will require more time for electric vehicles to achieve mass market. Renault considers that in Brazil, all electric vehicles could possibly be achieved at 2030 at the earliest. This is an indication that electric vehicles in BRICS countries can be categorized as a technology with long market adaptation phase.

6.1.5 Sub Question 5

What are the differences in barriers and strategies in BRICS countries, as well as the results of the strategies?

Differences can be seen in different level of lobbying activities conducted by the companies. Both Nissan and Renault are involved in committee that regularly discuss and advocate the government to give more attention to electric vehicles in the country. However, even though Mahindra Reva also lobbies and advocates the government, the level of intensity is quite lower. Instead of advocating the government, Mahindra Reva decided to put its effort into multiple markets that have high potential of acceptance of electric vehicles.

Furthermore, difference can be identified in the issue of infrastructure. Nissan with collaboration with BMW installed their charging stations, while Mahindra Reva and Renault do not built their own charging stations. At first, Mahindra Reva built the charging stations but currently, this activity falls as the government's responsibility. As for Renault, there is a third party, the electrical charging station manufacturers that are responsible for the installation of charging station.

However, despite the different approach of strategies taken by firms, no significant differences of result can be identified. As explained in 6.1.4, the strategies have helped to promote the electric vehicles, but it still requires longer period of time to achieve mass market. Government incentives such as implemented in Europe (in developed countries like Norway) can also be a catalyst of adoption to electric vehicles.

6.1.6 Main Research Question

How do firms in BRICS countries overcome barriers of adoption electric vehicles?

As explained in section 6.1.3 and 6.1.4, companies in BRICS countries experience various barriers and implement various strategies to overcome the barrier.

Moreover, from the interview, it was discovered that there are several barrier that specifically occur in specific country, such as the power outage in South Africa (categorized as accidents or events barrier) and lack of natural resources to produce electric vehicles' battery in India (categorized as natural resources and labour barrier). This also resulted in different approach or different strategy to overcome the barriers.

It is concluded that to tackle specific barriers, specific strategies need to be implemented. However, it does not limit the other strategies to be implemented as well. As stated by Mahindra Reva, other strategies are implemented to support the specific strategies. However, the amount of effort dedicated for these supporting strategies might not be as high as the specific strategies. As long as the companies have the resource to implement supporting strategies, then it should be implemented to achieve more benefit in order to smoothened the adoption of electric vehicles.

Reflecting from the interview, it is also discovered that companies implemented strategies that have not yet discussed in previous literature studied for this research. Currently, there are three strategies to overcome complementary technologies barrier from literature (Ortt et al., 2013); dedicated system or stand-alone niche

strategy, hybridization or adaptor niche strategy, and geographic niche strategy. However, from the interview, it was discovered that knowledge development strategy implemented by Nissan and Renault as well as explore multiple markets niche strategy implemented by Mahindra Reva can be alternatives to overcome the complementary technologies barrier. Nissan and Renault are doing research and development to improve their complementary technology, the battery range.

Moreover, while Mahindra Reva implemented explore multiple markets niche strategy to overcome demand barrier (in accordance with (Ortt et al., 2013)), Renault implemented network creation strategy (in accordance with (Kemp et al., 1998)) and financial aid strategy which was not discussed in previous literature. This is possible due to the unique situation of Renault as a company. Other than focus as a manufacture company, Renault group also active in banking industry by establishing Bank of Renault. Therefore, Renault had the opportunity to offer financial leverage for potential customers through Bank of Renault.

As for institutional barrier, Nissan implemented network creation and development of infrastructure strategies. In the other hand, Mahindra Reva focused in multiple markets niche that could overlook the institutional barrier, such as targeting market with high awareness of electric vehicles; hence reducing the concern for institutional support. Mahindra Reva also implemented this strategy to overcome the barrier of social, cultural, behavioural, and psychological. By targeting market with high awareness of electric vehicles, Mahindra Reva aimed to gain higher market acceptance.

Lobbying strategy is also implemented by Nissan and Renault in the effort of overcoming the infrastructure barrier. Quite a lot of public charging stations are required to support which also require large amount of funding. Therefore, government support is required to help providing the customers with sufficient public charging stations. Government can serve as the source of financial while the company installs the charging stations or government can hire third party to install the charging stations. Either way, government should participate in providing funding for development of infrastructure. Different with Mahindra Reva, they decided to focus on high density of population area (or urban area) with high support of electricity; hence minimizing the issue of insufficient public charging stations.

6.2 Discussion

This section explores things that are discovered during the research but were not part of the research objectives.

6.2.1 Electric Vehicles Companies in BRICS Countries

Electric vehicles companies in BRICS countries can be categorized as big companies. In South Africa and Brazil, both companies discussed in this research are part of larger corporation, which are Nissan (originated from Japan) and Renault (originated from France). They previously already have good images in combustion-engine vehicles and then decided to expand their companies by manufacturing electric vehicles. As for Mahindra Reva

in India, it was also a part of a larger corporation, Mahindra Group. This large corporation does not only focus on manufacturing vehicles, but can be categorized as one of the biggest conglomerate holding company in India. It has business in aerospace, agribusiness, aftermarket, automotive, components, construction equipment, defence, energy, farm equipment, finance and insurance, industrial equipment, information technology, leisure and hospitality, logistics, real estate, retail, and two wheelers. Mahindra Reva was established specifically to cater the market of electric vehicles.

Since the companies are part of larger corporations, it can be concluded that the companies penetrating the electric vehicles market are not small or medium enterprise (or categorized as SME), but it is an established corporation with large financial capabilities. This is understandable since manufacturing electric vehicles require large capital, which might not available for SMEs. The knowledge to manufacture electric vehicles could also be categorized to be unique knowledge, with limited distribution of knowledge. This is proven by the fact that Mahindra Reva still requires to import several part of the electric vehicles, such as battery due to limited resources and knowledge. Moreover, Renault also considered Brazil to be lacked of knowledge to manufacture the electric vehicles, leading to them importing the electric vehicles from Europe. According to the expert from Europe, if Renault decides to manufacture the electric vehicles in Brazil, then technological barrier related to the knowledge to produce the electric vehicles will occur.

Moreover, since electric vehicles can be categorized as new technology, cooperation between manufacturers is very important. In all three countries, collaboration and cooperation between companies occur. Nissan and BMW as the players in electric vehicles market in South Africa have been collaborating to provide charging stations with connectivity for both Nissan and BMW cars. Together, they are also active in lobbying activities. In Brazil, Renault also participates in associations with other manufacturers to discuss standardization for electric vehicles as well as lobbying activities to the government to promote electric vehicles in the country. Renault emphasized that they always tries to actively involve and participate in cooperation with other companies. Different case occurs in India. Mahindra Reva is the only company in electric vehicles in India. However, it does not stop them to involve in cooperation with prospective companies that wish to enter the market. This cooperation is to determine the standard charging connectivity in India.

6.2.2 Types of Market Conditions

There are at least three types of conditions that can be experienced by companies, which are:

1. No-barriers exist

   In this condition, companies can freely enter the market and grow in the market, meaning that companies can achieve large scale production or mass market without experiencing any difficulties.

2. Existence of barriers that partially block the companies to enter and grow in the market

   In this condition, companies experience barriers that could hamper their penetration to the market as well their growth within the market (to achieve mass market). These barriers exist but companies can deal with

the barriers by implementing the appropriate strategies to overcome the barriers. Once the strategies are successfully implemented, companies can achieve large scale market.

3. Existence of barriers that entirely block the companies to enter the market

   In this condition, companies cannot enter the market completely. This could happen the technology is very radical and cannot be accepted by the market. Other possibility is that there are rules that make the technology unacceptable, for example, the case of Facebook in China. Facebook cannot enter the market in China due to government regulation. Therefore, the government regulation serves as the barrier that completely blocks the companies to enter the market.

This research focuses on the second condition, aims to investigate types of strategies implemented by companies to overcome the barrier, therefore allowing the companies to enter and achieve the mass market in the future. However, the barriers that block the entry to market were not discussed in depth, most discussion are concentrated in barriers to achieve mass market. Nevertheless, it can be concluded that the third condition did not occur in South Africa, India, and Brazil since the companies already exist there, even though with small market share compare to combustion-engine vehicles.

6.2.3 Types of Strategies

During the research, it was discovered that there are four types of strategies that can be implemented. Those four types of strategies can be mapped into the following matrix:

Strategies / Actors	Market entry	Other
Government	A	B
Private companies	C	D

Figure 6-1 Types of strategies

Those strategies are divided based on the actors implementing the strategies as well as the types of strategies itself. In this research, the actors being investigated are private companies; Nissan in South Africa, Mahindra Reva in India, and Renault in Brazil. Moreover, the strategies discussed are other strategies, which are the strategies to achieve mass markets. Therefore, it is concluded that this research focus on the D area of the matrix. Nevertheless, during the interview, the experts emphasized the importance of government's involvement in promoting the adoption of electric vehicles, which are the B area of the matrix. It is believed that government support in providing incentives as well as infrastructure of electric vehicles can have great impact in adoption of electric vehicles in BRICS countries. Further discussion in regards to strategies implemented by companies investigated in this research can be seen in Section 6.2.6.1, by comparing the strategies proposed by (Ortt et al., 2013) with new categorization of strategies proposed in this research.

6.2.4 Dynamic Barriers and Volatility of Growth of BRICS Countries

During the research, it was discovered that barriers are bound to change overtime; hence adjustment for strategies are required to overcome the new arising barriers. The change of barriers could also lead to different perspective of the importance of barrier. Currently, demand, institutional, and infrastructure barriers are considered as the most important barriers and should be dealt with immediately in order to achieve large scale market. Based on the interview, these barriers can be overcome through lobbying in order to get incentives for customers, installation of dense network of public charging stations, and limiting the market to dense urban area in which electricity is easy to acquire.

However, according to Renault, this could lead to increased demand then natural resources barrier would arise, since more electric vehicles (due to increased demand) will lead to more demand of electricity. It possible that in next twenty years, lack of electricity due to lack of natural resources to produce electricity would become a very important barrier. Although it was not discussed further in regards to possible strategy in order to overcome this natural resource barrier, the implemented strategy is most definitely different than the strategy to overcome early barriers such as demand and infrastructure. Installation of more solar panel or optimization of hydropower would be one possible strategy.

Mahindra Reva also hinted that when the demand increases, production system barrier might pose as an important barrier. Currently, the production system is sufficient to cater all the demand. However, once the demand increases, more capital is required to upgrade the production capacity in order to cater all future demand. In this case, production system and financial issue barriers become more important than demand barrier. Therefore, Mahindra Reva should implemented new strategies to overcome these new arising barriers. Financial aid strategy can be implemented, by trying to identify funding options from international organizations that support electric vehicles or soft loans from banks.

Therefore, for the case of transition to electric vehicles in BRICS countries, it can be concluded that at first, demand barrier would pose as a very prominent barriers as well as the infrastructure and institutional barrier. Those barriers can be overcome by implementing development of infrastructure to increase the density of infrastructure, knowledge development to the customers to increase awareness and acceptance of electric vehicles, and lobbying to get government's support. By implementing those strategies, it is expected that demand would increase. However, once the demand increases, it is possible that other barriers would arise, such as financial, production system, even natural resources and labour barriers. Additional funding would require to expand the production capacity and this could be overcome by identifying possible outsource of funding other than companies' internal funding. Moreover, knowledge development could also be conducted for employee in order to achieve large scale production and reducing the labour barrier.

Macro-economic situation can also change overtime; hence different strategy might need to be implemented in different macro-economic situation. BRICS's economic growth has exceeded the economic growth of industrialized countries (Biggemann & Fam, 2011). However, in the last year, the economic growth of Brazil has decreased into negative growth; it declined 5.4% in the first quarter of 2016 compare to the previous year (Instituto Brasileiro de Geografia e Estatística (IBGE), 2016). South Africa also experiences this negative growth, the economic growth declined 1.2% in the first quarter of 2016 (Statistics South Africa, 2016). Moreover, Russia also experienced the same decline of 1.2% in the first quarter of 2016 (Federal State Statistics Service, 2016). Due to transformation of growth model implemented by China, it is expected that the Chinese's economic growth might be lower than in the previous decade, though it would not reach negative growth (BRICS Magazine, 2016). It seems that from all five countries, India emerges with the better macro-economic situation with expanded growth of 7.9% in the first quarter of 2016 (Taborda, 2016).

This macro-economic situation has significant effect on government's strategies and priorities. As mentioned by Nissan, Mahindra Reva, and Renault, government has not yet put transition to electric vehicles as one of their priorities. It is considered that stabilizing macro-economic situation is more important than transition to electric vehicles. Therefore, unstable or difficult macro-economic situation can pose as an important barrier for adoption to electric vehicles as well as other sustainable technologies. During this condition, company cannot simply rely on government's assistance. As explained by Mahindra Reva, India's government currently give subsidy for electric vehicles but it is not attractive enough. Mahindra Reva perceives bigger portion of subsidy should be implemented, but government is more focused with macro-economic situation; hence only limited subsidy is provided for electric vehicles. To deal with the situation, Mahindra Reva then focuses on specific market in which awareness of environmental situation is high and it leads to high level acceptance and willingness to buy of electric vehicles. By targeting such market, it is expected that the presence of subsidy is not going to be considered in decision to buy electric vehicles.

Difficult macro-economic situation also leads to lack of government support in providing public charging station in South Africa. Therefore, in order to reach bigger marker, Nissan cannot wait for the government to provide the public charging station. Nissan then cooperates with BMW to install public charging stations that can cater both Nissan's and BMW's vehicles. However, the issue of insufficient public charging station still persists. Therefore, Nissan continue lobbying activities to advise government in installation of public charging stations. When the macro-economic situation is getting better, it is expected that government will have more resources to be deployed in order to achieve large scale market of electric vehicles.

Renault also expressed their concern in regards to current macro-economic situation in Brazil. Renaults briefly mentioned that Brazil is currently in its worst situation in terms of macro-economic. This affect government's priority; electric vehicles are not the top priority for the government. Government of Brazil is now prioritizes to stabilize macro-economic situation in Brazil rather than providing various supports for electric vehicles.

However, if the macro-economic situation is highly volatile, then it can be expected that government regulation can be changed according to the current macro-economic situation; hence affecting the institutional barrier. Therefore, in countries with high volatility of macro-economic situation, company should have more strategies to balance government support. Strategies should be adjusted from time to time to match government's priority in regards of support for electric vehicles (or other sustainable technologies). This also means that the company should be more flexible in implementing various strategies.

6.2.5 Relationship between Barriers and Strategies

During the interview, it was discovered that companies implemented most of the strategies, regardless of its relation to the barriers (categorized as strategy A and strategy B in Section 4.1.5, 4.2.5, and 4.3.5). Strategy A refers to strategies implemented by companies to overcome specific barriers discussed during the open questions while strategy B were discussed during the closed question in stage 3 of the interview (discussion of pre-specified list of strategies proposed in this research).

Mahindra Reva treats strategy B as supporting strategies (Gopal, 2016) while their main strategy is 'explore multiple markets niche strategy'. Mahindra Reva believe that explore multiple markets niche strategy should be supported with other strategies in order to get the best result in increasing demand of Mahindra e2o electric vehicles. However, the other two interviews did not discuss further about these strategies due to time constraints. Even so, Nissan was mentioned that pilot project strategy (one of Nissan's strategy B) was not intended to overcome any barrier. Pilot project strategy was conducted as part of introduction of electric vehicles and to see customers' perspective in regards to electric vehicles. Nissan emphasized that customers do not know what they want in the future; hence low acceptance of electric vehicles could be predicted from the pilot project. However, Nissan still went through the plan to introduce electric vehicles in South Africa and implement other strategies in order to attract the market. It is possible that pilot project strategy is part of standard operation procedures before launching any new Nissan's vehicles as well as to serve as early introduction of the vehicles. Therefore, even though the result of pilot project could already be predicted, Nissan continued to implement the pilot project strategy.

Furthermore, since electric vehicles market is still considered new, it is possible that companies might not have enough knowledge on what kind of strategies that would work in the market to achieve large scale market. Therefore, it is possible for big companies such as Nissan, Mahindra Reva, and Renault to have more resources to implement various strategies to see different result of different strategies and adapt the strategies to fit current market situation. This adaptation of strategies could work best in situation which the technologies are new and companies have little knowledge on how the market would behave in regards of adoption of the technologies. This adaptation could also add into the dynamic nature of both barriers and strategies. It is possible that

implementation of strategies could trigger new barrier to arise, then requires the strategies to be adapted in order to overcome new barriers.

Moreover, adaptive strategies such these could give companies more options as how to attract the market of new sustainable technologies. The implementation of various strategies regardless of the barriers also shows that strategies could be implemented without first proceeded by barriers. Strategies can be a part of larger vision of the companies that could also help companies in realizing their long term strategy. However, the classification of strategy A and strategy B during the interview might also occur due the interview method which include the close question section. More explanation on this is discussed in Section 6.3.

It was also discovered that implementation of one strategy can eliminate more than one barrier. It is very apparent in the case of Mahindra Reva. Mahindra Reva intensively implemented explore multiple markets niche strategy to overcome all the barriers that it encountered. Other strategies are implemented as supporting strategy, but Mahindra Reva perceived explore multiple markets niche strategy as the most appropriate strategy to overcome the barriers. Lobbying strategy is also implemented by Nissan and Renault to overcome institutional and infrastructure barriers. This shows the importance of government's role in promoting electric vehicles in South Africa and Brazil.

6.2.6 Relation to Previous Theory

6.2.6.1 Relation to (Ortt et al., 2013)

This research was built up based on the barriers and strategies proposed by (Ortt et al., 2013) to commercialize new high-tech products. By combining this literature with (Kemp et al., 1998; Painuly, 2001), and various literature regarding BRICS countries, this research propose more categorization for both barriers and strategies, as well as elimination of irrelevant barrier in regards to adoption of electric vehicles. This section discusses in details the adaptation of (Ortt et al., 2013)'s barriers and strategies throughout the research.

(Ortt et al., 2013) proposes twelve barriers, in which the barriers are divided into two categories with the first category includes barriers that are prerequisite for one or more of the barriers in second category. However, for the purpose of this research, the barriers were evaluated to see if it is relevant for the case of adoption of electric vehicles. Figure 6-2 gives general relationship of barriers. Barriers on the left side serve as predecessors of barriers on the right side of the figure. However, direct relationship between each of the barrier was not further discussed in the literature. It could only be said the set of six barriers affect the occurrence of the next six set of barriers.

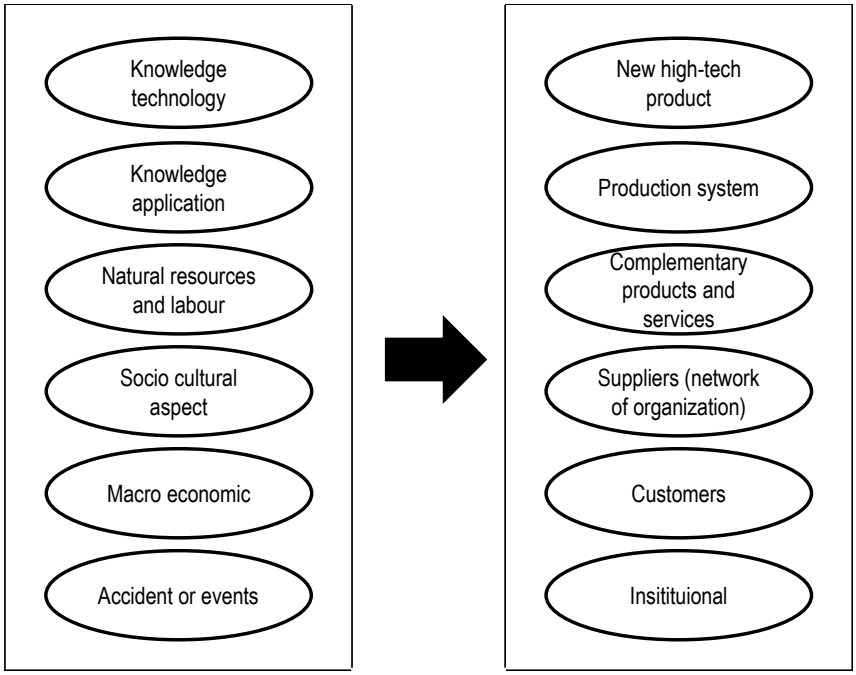

Figure 6-2 Barriers as explained by(Ortt et al., 2013)

For the purpose of this research, knowledge of application barrier was removed. It is possible that (Ortt et al., 2013) included the knowledge of application since in most cases, the practical application of the new and radical technologies are still unknown, or unfamiliar to the customers. However, in the case of electric vehicles, there is no different practical application of electric vehicles, compare to combustion-engine vehicles. The fundamental difference lies in the power system of the cars. In combustion-engine vehicles, the power is generated from fossil fuel while in electric vehicles the power comes from electricity stored in the battery. However, the different power source between electric vehicles and combustion-engine vehicles could lead to lack of knowledge of maintenance, battery range, and other knowledge of the product. This could also be considered as a barrier, specifically customers barrier. Therefore, the practical application of the two vehicles is still the same, which is as a mode of transportation. This consideration results in the exclusion of knowledge of application barrier in this research. Therefore, from twelve barriers proposed, only eleven barriers are suitable for this research.

Combining the literature of (Kemp et al., 1998; Ortt et al., 2013; Painuly, 2001) as well as various literature of BRICS countries also result in new categorization of both barriers and strategies. These new categorization was done to better grouped the barriers and strategies from all the literature. The new categorization of barriers is possible, considering the specific nature of the countries investigated, BRICS countries, as well as the technology itself, the electric vehicles. Moreover, the different categorization of strategies is also a result of more strategies discussed in this research, which cover the introduction strategy as well as the strategy to achieve large scale market, with deeper focus on the strategies to achieve large scale market.

During the interview, it was discovered that barriers could affect each other. As also described by (Ortt et al., 2013), several barriers precede other barriers. Reflecting from the three cases, institutional barrier influences demand barrier greatly. The lack of incentives for customers has impact on low demand of electric vehicles. Since the price of electric vehicles is high, the absent of incentives make electric vehicles even less attractive than combustion-engine vehicles. Therefore, by implementing strategies to overcome the institutional barrier, the demand barrier can also be tackled.

Moreover, both infrastructure and complementary technologies barriers lead to range anxiety, which could lead to unwillingness to buy electric vehicles. Since battery range is limited, the dense network of public charging stations is necessary to support the customers with sufficient electricity required in order to reach the destination. However, the unavailability of public charging stations can be perceived as the result of lack of government support (institutional barrier). This shows us that the barriers are interrelated with each other, causing complex situation for adoption of electric vehicles.

Figure 6-3 pictures the new modified relationship between barriers based on the new categorization of barriers. As can be seen in Figure 6-3, knowledge of application barrier has been removed while other barriers along with new categories emerged. There are also three new categories of barrier, which all are considered as barrier group 1; infrastructure, financial, and undesirable societal and environmental effect. According to (Painuly, 2001), if the access to technology is restricted due to insufficient infrastructure, it will affect the market size. The size of market size is one of the components in demand barriers (previously address as customers barrier by (Ortt et al., 2013)); therefore infrastructure barrier can be considered as barrier group 1. Furthermore, financial barrier related to the financial issues faced by firm, including the high cost of capital as well as high up-front investment, leading to high price of price. High price of product can affect the demand (Kemp et al., 1998); Therefore, financial barrier then can also be categorized as barrier group 1. Lastly, according to (Kemp et al., 1998), undesirable societal and environmental effect barrier could affect the image of the new technology, in which also affecting the demand. If the technology is perceived to be environmentally harming due to negative side effect to the technology, it is possible that the market size would be reduced. Therefore, this barrier can be included in barrier group 1 because this barrier affects demand barrier.

Furthermore, institutional barrier is also moved to barrier group 1 since based on the interview, institutional barriers greatly affect the demand barrier. Lack of government incentives have proven to be a challenge in attracting the demand. Complementary technology barrier is also moved to barrier group 1 due to its affect to demand barrier. Therefore, it can be concluded that most barriers proceeded demand barrier. This could emphasized why demand barrier become one of the most important barriers considered by experts during the interview. Moreover, to point out the new categorization, technological barrier was previously addressed as new high tech product barrier while network barrier was previously addressed as suppliers barrier.

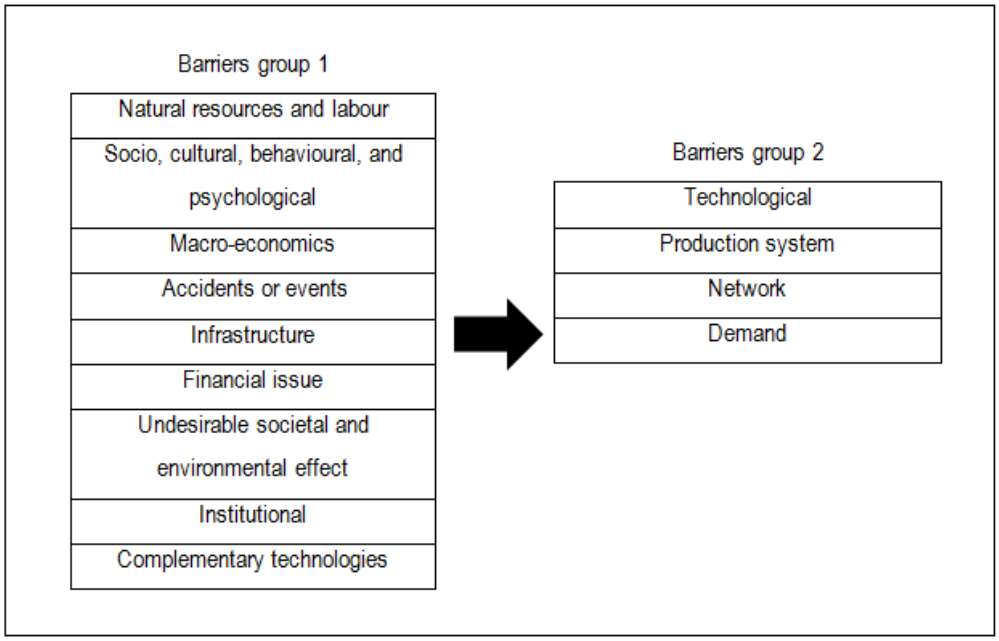

Figure 6-3 Modified relationship between barriers

As for the strategies, this research comes up with five new strategies, which are pilot project, financial aid, establishment of standard, network creation, and development of infrastructure. These new strategies were categorized based on additional literature of (Kemp et al., 1998; Painuly, 2001), and various BRICS literature. This research also modified several strategies related to government's act and categorized it as lobbying strategy. This was done under the consideration that company would not be able to exercise government's act; hence leaving the company with option to lobby the government in order to carrying the acts, such as to provide incentives, to waive import tax on electric vehicles, and other advice that will benefit the transition to electric vehicles.

Moreover, the new strategies can be done earlier in innovation phase, in order to create an appropriate environment for the launch of new technology. These strategies can help in increasing the level of awareness and acceptance of the new technology. Through pilot project, customers can have early experience with the technology while lobbying and network creation can help ensure that the technology would have full government support as well as suppliers or other actors require for the adoption of new technology. Financial aid could also be achieved or implemented even before the launch of the product, such as to fulfill investment for production. However, financial aid could also be achieved in later phase, for example to expand production long after the product is launched. In the case of transition to electric vehicles, development of infrastructure strategy should be well implemented even before the cars are launched, because once the cars is launched, the need of public charging stations is going to increase; hence emphasizing the importance of having all the infrastructure ready before the cars go into the street.

6.2.6.2 Relation to Other Theories

In investigating the adoption of electric vehicles in BRICS countries, we can relate to the notion of technology cycle. This technology cycle consist of four phases, the technological discontinuity, era of ferment, dominant design, and era of incremental change, before it goes back to the technological discontinuity. Technological discontinuity occurs when technologies with very different nature with previous technology appear in the market. This will then lead to competition between the technologies, which called era of ferment. The winning technology then becomes the dominant design. From there, era of incremental change occurs by continuous improvement of the dominant design, before new technologies come and the cycle goes back to technological discontinuity.

In the case of electric vehicles, the combustion-engine vehicle is the dominant design in the market. This dominant design is described by (Schilling, 2013) as product that dominates the product category. The combustion-engine vehicles have been the dominant design for quite some period. Electric vehicles came in to challenge the status quo of combustion-engine vehicles and lead to the standard battle. According to (Shapiro & Varian, 1999), standard battle or standard wars refer to battle between incompatible technologies. The companies aim to lead the electric vehicles to be the future dominant design of vehicles since electric vehicles are perceived as a more sustainable technology, with more benefit than combustion-engine vehicles. The transition to electric vehicles can also help to reduce the carbon emission significantly.

It can be seen that combustion-engine vehicles have an effect to transition to electric vehicles as the combustion engine vehicles can be seen as the direct competition for electric vehicles. It relates to demand barrier; customers most likely will compare the price of electric vehicles with the price of combustion-engine vehicles. Since electric vehicles are more expensive (can be up to five times the combustion-engine vehicles), it could lead to unwillingness to buy; customers would prefer the cheaper vehicles. Lack of public charging stations also contribute to the customers' choice, leading them to prefer combustion-engine vehicles with sufficient charging station for gasoline. Therefore, to compete with combustion-engine vehicles, company should focus on how to make the vehicles more attractive, by advising the government to give more incentives and provide sufficient public charging stations for electric vehicles.

Furthermore, to establish the electric vehicles as dominant design, companies should concern themselves with factors that affect the creation of dominant design. (Schilling, 2013) emphasizes three factor that affect the selection of dominant design; learning effects, network externalities, and government regulation. Learning effect in production system will help the companies to achieve economic of scale, in which the production can be more effective and efficient with lower production cost. This would help the companies to achieve large scale market once they are ready to produce the vehicles in large scale. With experience in manufacturing combustion-engine vehicles, Nissan and Renault might be able to utilize the learning effect faster than other new player in manufacture industry. However, due to current low demand of electric vehicles, large scale production might not be the priority in order to avoid oversupply of electric vehicles.

Then, the other two factors can be seen as pre-requisite in order for companies to establish large scale production. Network externalities refer to the installed base and complementary goods for the technologies. The installed base or the number of customers as well as the good complementary technologies can increase the value of the technology. More users of electric vehicles can push the level of urgency of the public charging stations. However, due to high price of electric vehicles, the growth of demand is slow, resulting in small installed base of electric vehicles in BRICS countries.

Therefore, in the context of BRICS countries, government regulation becomes the most important factor in selection of dominant design for this case. As discussed with all three companies, government has a very significant role in promoting the adoption to electric vehicles. Tax exemption becomes one of the government's regulations that can help to attract customers in adopting electric vehicles. However, even though tax exemption is implemented, the price of electric vehicles is still higher than combustion-engine vehicles. Therefore, as suggested by the experts during the interview, more government intervention should be applied in order to achieve large scale market of electric vehicles.

However, apart from relying to the government support, it is possible that companies can seek other financial aid from other organization (private organizations within the countries or even international organization). There is high awareness of global warming around the world. Companies can approach organization with concern to environment and seek funding from them; hence reducing the level of dependencies to the government. This type of funding could also come from developed countries, with the aim to help developing countries to reduce its carbon emission through transition to electric vehicles.

The notion of the importance of triple helix of university – industry – government relationship (Etzkowitz & Leydesdorff, 2000) emphasizes the importance of alignment and collaboration between the three actors in innovation; university, industry, and government. From the interview, it can be seen that the collaboration between government and industry has been established through discussion activities. Intensive collaboration within the industry (the manufacturers of electric vehicles) is also perceived to be very important for the companies. This collaboration aims to better provide the customers as well as to achieve standardization related to electric vehicles. However the notion of collaboration with university has not yet been discussed.

The following summarizes the findings of this research that are aligned with previous theory:

1. The notion of barriers affecting each other as proposed by (Ortt et al., 2013) can be seen in how institutional and infrastructure barriers ignite the demand barrier. Moreover, complementary technology barrier also raise the urgency of infrastructure barrier. These proved that the barriers are related to each other and overcoming one barrier can also eliminate others.

2. The importance of government regulation (Schilling, 2013) in order to achieve large scale market of electric vehicles and to establish electric vehicles as the dominant design in the market.
3. The importance of collaboration between university, industry, and government as depicted in triple helix (Etzkowitz & Leydesdorff, 2000).

6.3 Reflection and Limitation of the Research

This section explicates the experiences gained during the research as well as the limitation of the research. Further, section 6.4.2 discusses the possible further research correlated with the limitation of the research.

This research is divided into two different parts of approach, first through literature review to get a first glance in regards to existing literature about barriers and strategies in general as well in BRICS countries and second through interviews (case study method) to gain more perspective about current situations in BRICS countries in regards to the specific case, transition to electric vehicles. While the first approach of literature study was proven to be challenging in terms of finding suitable literature to cover all the possible barriers and strategies, the biggest challenge come from in case study method. Since the research focuses on five countries (Brazil, Russia, India, China, and South Africa), it makes sense to have case from each country. However, contacting the electric vehicles manufacturers in those countries came as quite a struggle. Language barriers became the most prominent challenge to make the first contact with the company, mainly because the first contact that can be access is through customer services, in which English might not be quite familiar. Therefore, the research could not cover the five countries. In fact, only three countries could be investigated in this research, with one firm from each country.

Moreover, due to difficulties in contacting the firms as well as limited electric vehicles manufacturers within the countries, this research only managed to investigate different brands in those three countries. However, the effects of the different brands were not being investigated further even though there is a possibility that customer decision or behavior towards electric vehicles is affected by the image of the brands.

The interview method with combination of open question and closed question for barriers and strategies could also be the cause of the classification of strategy A and strategy B. Strategy A refers to strategies that implemented directly to overcome specific barriers while strategy B refers to supporting strategies that are not directly linked to the barriers. During the open question section, experts have already explained barriers that they considered relevant for adoption of electric vehicles and those barriers are currently being experienced by the companies. Experts also explained specific strategies to overcome those barriers. However, during the closed questions, experts were provided with pre-specified list of barriers and strategies and were asked to identify whether the barriers and strategies in the list also applied to the companies. It is possible that by looking at the list, the experts were reminded of other barriers and strategies that previously were not considered during open question. However, due to limited interview duration, the barriers and strategies from closed questions could not

be discussed further. Due to the busy schedule of the experts in the companies, the interview could only be conducted in limited time and more time is allocated for open questions stage. Therefore, it is also possible that the interview cannot really represent the real condition of the companies due to limited time in discussion. For further research, a better interview method should be proposed in order to avoid such situation. This research advises that pre-specified list of barriers and strategies could be provided before the interview time; hence the expert could have more time in reflecting to the barriers and strategies. However, this type of method could also arise challenge that the expert will get too focus on the list and limiting the possibility of new category of barrier to emerge from the interview. This would not be a problem if the researcher is sure that the list have covered all the possible barriers and strategies.

The strategies discussed in this research are limited to the strategies implemented by firms. However, the government strategies might serve as the most influential strategy that can lead to mass adoption of electric vehicles (Barcik, 2016; Castro, 2016; Ebeling, 2016; Gopal, 2016). This type of strategies was discussed briefly during the interview.

Furthermore, this research did not take into consideration that the countries that were being investigated might be in a different stage, in terms of economic condition or the understanding of electric vehicles. Therefore, the effects of those differences cannot be articulated explicitly. It is possible that the different stages of the countries could result in different barriers as well as strategies.

Lastly, this research did not intend to create a generalization for sustainable technologies in all developing countries. Different barriers and strategies categories might arise for different sustainable technology. It is possible that specific technology could trigger unique barrier or companies could implemented very unique and new strategies, apart from the strategies discussed in this research.

However, if similar situation is encountered in other countries, then similar barriers can be expected. For example, if the countries are experiencing unstable macro-economic issue, which can be seen assessed by companies, then macro-economic barrier with its impact should be expected to occur in the country. One of the outcomes of unstable macro-economic situation is that the sustainable technology, not limited to electric vehicles becomes less of a priority than stabilizing the issues related to macro-economic situation. This condition is experienced by all three companies in three different countries, lead to lack of government support for transition to electric vehicles.

The framework of thirteen barriers and fifteen strategies can be further implemented to different case. However, several barriers and strategies that were previously exempted for the purpose of this research should first be investigated to determine whether those exempted barriers and strategies can occur for another case.

Knowledge of application barrier could probably be included if the technology investigated is very novel that the application of the product is still unknown, those resulting in fourteen barriers to be address during the research.

6.4 Recommendation

This section offers managerial and academic recommendation. The managerial recommendation focuses on practical insights that could be implemented by companies. Academic recommendation focuses on recommendation for further research in order to enhance the result of this research.

6.4.1 Managerial Recommendation

This section provides recommendations for companies wishing to participate actively in electric vehicles market in BRICS countries. If a company wishes to enter electric vehicles market in the three countries discussed in this research, it should be aware of the prominent barriers occurring within the countries:

1. Infrastructure barrier: BRICS countries are still experiencing the lack of infrastructure needed to support the adoption of electric vehicles. This leads to range anxiety, due to long travel distance.
2. Institutional barrier: this relate more to the lack of supporting regulation, such as incentives for customers rather than the presence of regulation that hamper the adoption of electric vehicles.
3. Demand barrier: relate to high price of electric vehicles and lack of knowledge of the benefit of electric vehicles, leading to low demand of electric vehicles.
4. Specific barrier occurring in specific country, such as frequent power outage in South Africa and the absence of natural resource to manufacture battery in India.

From those expected barriers, company can consider several strategies to overcome the barrier. The company can enter the market while the barrier still persists. If so, then the company should consider the following strategy:

1. It should be noted that collaboration (network creation strategy) with other manufacturers are well established in the three countries studied in this research. Therefore, it is logical to join the collaboration, instead of pure competition.
2. Companies can decide to import the vehicles from Europe or build a factory within the countries. However, if the company has been manufacturing cars for quite some time, importing should be considered as a better option, reducing initial capital to build the factory in BRICS countries. Building the factory could be considered later once the growth of demand is accelerated.
3. Introduce the vehicles with the same charging connectivity available in the country. This emphasizes the importance of establishment of standard strategy. With the same connector, the cars can be charged at the current public charging stations. This is possible once the company join the collaboration.
4. Build additional public charging station (development of infrastructure strategy) to increase the density of public charging station. Thus, reducing range anxiety from customers' perspective.

5. Approach the government for possible incentives, such as government subsidy for each electric vehicle sold in the country (lobbying strategy) and tax exemption.
6. Awareness campaign, seminar, workshop, and other form of knowledge development strategy for the potential customers to further emphasize the importance and benefit of electric vehicles in the hope to increase demand.
7. The electric vehicles could be offered to different market, such as private citizens or government institutions (explore multiple markets niche strategy). Different models of electric vehicles could also be offered to different market (explore multiple markets niche strategy.

Once the company is active in the market, company needs to consider the dynamic barriers, meaning that the barriers would change overtime, depend on the situation in the countries. Setting up production plant in BRICS country, for example, would result in different barriers, such as production barriers and natural resources and labour barriers. Financial issue barrier could also occur if more capital is required for setting up the production plant. Therefore, company should consider other strategies to overcome the new occurring barriers.

On the other hand, company can also decide to wait until the barriers are eliminated and become the late entrants to the market. However, this poses great risk that most of the potential customers have been taken over by the first movers on the market. Moreover, it could also take a very long time for the infrastructure barrier to vanish; hence it is suggested to enter the market soon while also applying strategies to overcome the barriers.

6.4.2 Academic Recommendation

This section refers to further research that can be conducted to explore more about adoption of electric vehicles in BRICS countries or other researches which relates to this research. Firstly, taking a case in Russia and China should be considered to have broader view of BRICS countries. It is possible that different findings will occur if Russia and China are included in the research.

Moreover, the questionnaire of importance and rank of barriers and strategies can be spread not only to the expert interviewed, but also to more people involve in electric vehicles in the countries. The questionnaire could also be taken by senior management in the companies to see how the senior management views the barriers and strategies in the adoption of electric vehicles. The senior management refers to the people with high management rank in the company, accompanied with extensive experience in strategic management field. Moreover, different questionnaire or even interview could be conducted specifically for the senior managers. This questionnaire or interview should be intended to identify the company's priorities set by the senior managers within the company, especially if the company has a lot of range of cars. By identifying the priorities, researcher can identify whether company has utilized all its resources in order to achieve large scale market in the country. It is possible that slow adoption is a result of minimum effort from the company due to different priority. It is possible that the company's current priority is to make electric vehicles more familiar to the customers rather than

focusing on achieving large scale sales. This would give broader view on the importance of implementation of strategies.

It was discovered that government plays important roles in transition to sustainable technology; hence it could be interesting to see the government's point of view in regards to this issue and what type of strategies implemented by the government. It could also be interesting to investigate how the government identifies barriers to transition to sustainable technology. Alignment of strategies between government and companies could have significant impact to achieve mass market in sustainable technology. The following research questioned can be posed:

"How does the government deal with barriers in adoption of electric vehicles, taking into consideration other issues within the country"?

This research also discovered that barriers and strategies could change overtime. For example, in the case of Mahindra Reva and Renault, the production system and technological barrier can be greatly of challenge once they acquire high demand of electric vehicles. However, as of now, both barriers are considered to be less significant compared to other barriers such as demand and infrastructure barriers. Therefore, research in regards of the dynamic barriers and strategies can be interesting to be conducted. It could also be taken into consideration to conduct such research in a longer period to really investigate the effect of strategies to the barriers and company's success, as well as to investigate the dynamic change of the barriers. The dynamic change of barriers could also result in new categorization of barriers. It means, during the long duration of adoption of electric vehicles, new barriers can arise, leading to different strategic plan implemented by companies. The changes of the barriers could also be a result of dynamic situation within the countries. Therefore, the follow up research with the same companies (Nissan South Africa, Mahindra Reva India, and Renault Brazil) could be conducted in the next few years to investigate whether the barriers have changed, and if yes, how it affects the strategies. This follow up research could also be conducted to further see the impact of strategies discussed in this research. It will be interesting to see if the companies have successfully achieved their target by implementing the strategies. The result of the follow up research could also further improve the understanding of relation or linkage between barriers and strategies. The possible research question for such investigation can be:

"How does the dynamic change of barriers affect the implementation of strategies?"
"How does dynamic situation of the countries affect the barriers?"

The importance of collaboration, instead of pure competition between the companies could also be investigated further. This collaboration can be within the industry, or involving other stakeholders such as university and government. As mentioned in 6.2.4, possible collaboration with other organizations as financial sources can also be achieved. Such collaboration is intended to reduce dependencies to the government, since in these cases;

government has more pressing issues to be considered than mass adoption of electric vehicles in the countries. Possible research question as follow:

"How does collaboration within the industry can help to achieve large scale market of electric vehicles?"

"How does the involvement of university affect the adoption process of electric vehicles?"

A comparison study with developed countries could also be conducted, to possibly adopt strategies in developed countries to further accelerate the adoption of electric vehicles in BRICS countries. Companies in developing countries can learn from companies in developed countries in how to promote electric vehicles. Such knowledge could also be gained for the government, by possibly adopting government's actions in developed countries to developing countries. Most definitely, developed countries face different barriers than developing countries. These differences occur from the different situation of the countries, such as macro-economic, customers' awareness, and the access to the electric vehicles. Since demand is one of the most important barriers found during the research, then investigating different customers' behavior in developed and developing countries towards electric vehicles could be an interesting further research. Such researches could be investigated to answer the following research question:

"How should companies in BRICS countries learn from companies in develop countries in order to achieve large scale market in BRICS?"

"How does the customers' behaviour affect the adoption of electric vehicles in both developed and developing countries?"

At last, those proposed research questions are not limited only to electric vehicles. Other sustainable technologies adoption can be investigated with similar manner. In term of generalization, it is possible to implement the framework used in this research to investigate implementation of other sustainable technologies in developing countries.

References

Acker, R. H., & Kammen, D. M. (1996). The quiet (energy) revolution. *Energy Policy*, *24*(1), 81–111. doi:10.1016/0301-4215(95)00112-3

Ackerman, F., & Finlayson, I. J. (2006). The economics of inaction on climate change: a sensitivity analysis. *Climate Policy*, *6*(5), 509–526. doi:10.1080/14693062.2006.9685617

Aidis, R., & Adachi, Y. (2007). Russia: Firm entry and survival barriers. *Economic Systems*, *31*(4), 391–411. doi:10.1016/j.ecosys.2007.08.003

Ali-Oettinger, S. (2015, August). India: First solar-powered airport in Cochin. *PV Magazine*. Retrieved from http://www.pv-magazine.com/news/details/beitrag/india--first-solar-powered-airport-in-cochin_100020628/

Automotive World. (2014, January). Nissan LEAF global sales reach 100,000 units. *Www.automotiveworld.com*. Retrieved from http://www.automotiveworld.com/news-releases/nissan-leaf-global-sales-reach-100000-units/

Bär, H. (2013). *Lead Markets for electric vehicles – China ' s and Germany ' s strategies compared*. *Working Paper No. 12 within the project: Lead Markets*.

Barcik, S. (2016). Personal Interview.

Baron, J., Ménière, Y., & Pohlmann, T. (2014). Standards, consortia, and innovation. *International Journal of Industrial Organization*, *36*, 22–35. doi:10.1016/j.ijindorg.2014.05.004

Bazenkova, A. (2015, September 6). Russian Gas Stations Ordered to Provide Chargers for Electric Cars. *The Moscow Times*. Retrieved from http://www.themoscowtimes.com/business/article/russian-gas-stations-ordered-to-provide-chargers-for-electric-cars/529411.html

Bhat, V. (2015). Trade and Investment in Renewable Energy Technologies: A Study of BRICS. In B. S. Reddy & S. Ulgiati (Eds.), *Energy Security and Development* (pp. 423–436). New Delhi: Springer India. doi:10.1007/978-81-322-2065-7

Bhatti, Y. A. (2012). What is Frugal, What is Innovation? Towards a Theory of Frugal Innovation. *SSRN Electronic Journal*, 1–45. doi:10.2139/ssrn.2005910

Biggemann, S., & Fam, K. S. (2011). Business marketing in BRIC countries. *Industrial Marketing Management*, *40*(1), 5–7. doi:10.1016/j.indmarman.2010.09.004

Brain, M. (2002). How Electric Cars Work. *HowStuffWorks.com*. Retrieved January 25, 2016, from http://auto.howstuffworks.com/electric-car.htm

BRICS Magazine. (2016). How Will China's Next Steps Affect Brazil? *Bricsmagazine.com*. Retrieved from http://bricsmagazine.com/en/articles/how-will-china-s-next-steps-affect-brazil

Campos, N. F., & Iootty, M. (2007). Institutional barriers to firm entry and exit: Case-study evidence from the Brazilian textiles and electronics industries. *Economic Systems*, *31*(4), 346–363. doi:10.1016/j.ecosys.2007.08.001

Castro, A. (2016). Personal Interview.

Cheng, H. F., Gutierrez, M., Mahajan, A., Shachmurove, Y., & Shahrokhi, M. (2007). A future global economy to be built by BRICs. *Global Finance Journal*, *18*(2), 143–156. doi:10.1016/j.gfj.2006.04.003

China Association of Automobile Manufacturers (CAAM). (2015). New energy vehicles keeped a high-speed growth. *China Association of Automobile Manufacturers (CAAM)*. Retrieved January 16, 2016, from http://www.caam.org.cn/AutomotivesStatistics/20151022/1005175995.html

Clark, W. (2015, September). Russian Resources Start to Flow Into Renewable Energy. *Huffington Post*. Retrieved from http://www.huffingtonpost.com/woodrow-clark/russian-resources-start-t_b_8215902.html

Ebeling, T. (2016). Personal Interview.

Edelstein, S. (2014, October). Brazil's Green-Car Incentive Surprise: Electrics, Plug-In Hybrids Omitted. *Green Card Reports*. Retrieved from http://www.greencarreports.com/news/1095107_brazils-green-car-incentive-surprise-electrics-plug-in-hybrids-omitted

Enerdata. (2015). CO2 Emissions from Fuel Combustion. *Enerdata*. Retrieved November 20, 2015, from https://yearbook.enerdata.net/CO2-emissions-data-from-fuel-combustion.html

Estrin, S., & Prevezer, M. (2010). A survey on institutions and new firm entry: How and why do entry rates differ in emerging markets? *Economic Systems*, *34*(3), 289–308. doi:10.1016/j.ecosys.2010.01.003

Etzkowitz, H., & Leydesdorff, L. (2000). The Dynamics of Innovation: from National Systems and "Mode 2" to a Triple Helix of University–Industry–Government relations. *Research Policy*, *29*(2), 109–123.

doi:10.1016/S0048-7333(99)00055-4
Eurostat. (2015). *Greenhouse gas emission statistics*. Retrieved from http://ec.europa.eu/eurostat/statistics-explained/index.php/Greenhouse_gas_emission_statistics
Fast Company. (2013). MAHINDRA REVA in "MOST INNOVATIVE COMPANIES 2013 by FAST COMPANY." *www.woorlor.com*. Retrieved February 10, 2016, from http://www.woolor.com/thetechbook/mahindra-reva-in-most-innovative-companies-2013-by-fast-company/
Federal State Statistics Service. (2016). *Russia's GDP Contraction Confirmed at -1.2% in Q1*.
Freitas, I. M. B., Dantas, E., & Iizuka, M. (2012). The Kyoto mechanisms and the diffusion of renewable energy technologies in the BRICS. *Energy Policy*, *42*(2012), 118–128. doi:10.1016/j.enpol.2011.11.055
Gopal, K. (2016). Personal Interview.
Hekkert, M. P., Suurs, R. a a, Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M. (2007). Functions of Innovation Systems: A New Approach for Analysing Technological Change. *Technological Forecasting and Social Change*, *74*(4), 413–432. doi:10.1016/j.techfore.2006.03.002
Hjorthol, R., Vågane, L., Foller, J., & Emmerling, B. (2014). *Everyday Mobility and Potential Use of Electric Vehicles*.
Holtbrugge, D., & Baron, A. (2013). Market entry strategies in emerging markets: An institutional study in the BRICS Countries. *Thunderbird International Business Review*, *55*(3). doi:10.1002/tie
Instituto Brasileiro de Geografia e Estatística (IBGE). (2016). *Contas Nacionais Trimestrais: Indicadores de Volume e Valores Correntes*. *Instituto Brasileiro de Geografia e Estatística (IBGE)*. doi:10.1017/CBO9781107415324.004
Islam, A. K. M. S., Islam, M., & Rahman, T. (2006). Effective renewable energy activities in Bangladesh. *Renewable Energy*, *31*(5), 677–688. doi:10.1016/j.renene.2005.08.004
Johnson, J., & Tellis, G. J. (2008). Drivers of Success for Market Entry into China and India. *Journal of Marketing*, *72*(3), 1–13.
Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Technology Analysis & Strategic Management*, *10*(2), 175–198. doi:10.1080/09537329808524310
Kjærland, F. (2007). A real option analysis of investments in hydropower-The case of Norway. *Energy Policy*, *35*(11), 5901–5908. doi:10.1016/j.enpol.2007.07.021
Koskas, T., & Thormann, D. (2016). *Renault Group Q1 2016*.
La Rovere, E. L., Pereira, A. S., & Simões, A. F. (2011). Biofuels and Sustainable Energy Development in Brazil. *World Development*, *39*(6), 1026–1036. doi:10.1016/j.worlddev.2010.01.004
Lamprecht, I. (2013, October). SA's First Electric Car Goes on Sale. *Moneyweb*. Retrieved from http://www.moneyweb.co.za/archive/sas-first-electric-car-goes-on-sale/
Lund, H., & Mathiesen, B. V. (2009). Energy system analysis of 100% renewable energy systems-The case of Denmark in years 2030 and 2050. *Energy*, *34*(5), 524–531. doi:10.1016/j.energy.2008.04.003
McKinsey & Company. (2009). *China' s green revolution*. *McKinsey & Company*. doi:10.14452/MR-026-05-1974-09_2
Murphy, A. (2015, May). The Largeest Auto Companies in The World 2015. *Www.forbes.com*. Retrieved from http://www.forbes.com/pictures/eggh45eiki/8-nissan-motor/#6f05e3b14cd1
Nissan Motor Corporation. (2016). Our Company. Retrieved January 15, 2016, from http://www.nissan-global.com/EN/COMPANY/PROFILE/
Ortt, J. R., & Delgoshaie, N. (2008). Why Does it Take So Long Before the Diffusion of New High-Tech Products Take Off? *International Association for Management of Technology*.
Ortt, J. R., Kamp, L. M., & Doe, M. F. A. (2015). Niche strategy selection to introduce radically new systems: The case of kite-based airborne wind energy. In *2015 IEEE International Conference on Engineering, Technology and Innovation/International Technology Management Conference (ICE/ITMC) IEEE* (pp. 1–8). doi:10.1017/CBO9781107415324.004
Ortt, J. R., Langley, D. J., & Pals, N. (2013). Ten Niche Strategies To Commercialize New High-Tech Products. In *2013 IEEE International Technology Management Conference & 19th ICE Conference 24-26 June 2013*. Den Haag.
Ortt, J. R., & Schoormans, J. P. L. (2004). The Pattern of Development and Diffusion of Breakthrough Communication Technologies. *European Journal of Innovation Management*, *7*(4), 292–302. doi:10.1108/14601060410565047
Painuly, J. P. (2001). Barriers to renewable energy penetration: A framework for analysis. *Renewable Energy*,

24(1), 73–89. doi:10.1016/S0960-1481(00)00186-5
Parker, S., Don, B., & McLoughlin, K. (2010). Exploring market barriers. *International Journal of Market Research*, *52*(6), 731–756. doi:10.2501/S147078530920
Pegels, A. (2009). Renewable energy in South Africa : Potentials , barriers and options for support. *Energy Policy*, *38*(9), 4945–4954. doi:10.1016/j.enpol.2010.03.077
Perkowski, J. (2014, December). Electric Cars: A Review Of 2014. *Forbes*. Retrieved from http://www.forbes.com/sites/rosatrieu/2016/01/21/inside-hitachi-how-an-hr-revolution-transformed-the-100-year-old-company/#70b7a3a0363f
Phat, N. T. (2012). Motivations and Barriers of the Model of Non-Traditional Market Economy: A Case to Study in BRICS. *Modern Economy*, *03*(08), 920–925. doi:10.4236/me.2012.38115
Renault Group. (2016a). Renault in Three Figures. *Renault Group*. Retrieved May 17, 2016, from https://group.renault.com/en/our-company/our-brands/brands/
Renault Group. (2016b). Top Fifteen Markets. *Renault Group*. Retrieved May 17, 2016, from https://rapport-annuel.group.renault.com/#/en/les-chiffres-cle
Research and Market. (2012). *Strategic Analysis of Brazil Electric Vehicle Market - Era of Electric Vehicles in Brazil , With Market Growing to More than 80 , 000 Units by 2020*.
Schilling, M. A. (2013). *Strategic Management of Technological Innovation* (4th ed.). New York: McGraw-Hill.
Shapiro, C., & Varian, H. R. (1999). The Art of Standards Wars. *California Management Review*, *41*(2), 8–32.
Statistics South Africa. (2016). *The economy slides in the first quarter*. Retrieved from http://www.statssa.gov.za/?p=7824
Taborda, J. (2016). *India GDP Growth at 1-1/2-Year High of 7.9%*.
The Times of India. (2015, December 29). India Looks to Put Hybrid and Electric Vehicles on the Fast Track in 2016. *The Times of India*. New Delhi. Retrieved from http://www.brics-info.org/india-looks-to-put-hybrid-and-electric-vehicles-on-the-fast-track-in-2016/
Ulrich, A. M. D., Hollensen, S., & Boyd, B. (2014). Entry Mode Strategies into the Brazil, Russia, India and China (BRIC) Markets. *Global Business Review*, *15*(3), 423–445. doi:10.1177/0972150914535066
Wirth, H. (2015). *Recent facts about photovoltaics in Germany*. *Fraunhofer ISE*. Retrieved from http://pschuetzenduebe.webclient5.de/wp-content/uploads/130912-Recent-Facts-PV-Germany.pdf
Yin, R. K. (2009). *Case Study Research: Design and Methods* (4th ed.). Los Angeles: Sage Publication.
Zhang, H., Li, L., Cao, J., Zhao, M., & Wu, Q. (2011). Comparison of renewable energy policy evolution among the BRICs. *Renewable and Sustainable Energy Reviews*, *15*(9), 4904–4909. doi:10.1016/j.rser.2011.07.063

Appendix

Appendix A: The Importance of Barriers by Thomas Ebeling, Nissan

Please indicate your answer by giving an 'X' mark on the coloumn

Appendix A - The importance of barriers by Thomas Ebeling, Nissan

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
1	Production system	The unavailability of a good production system to support the transition to large scale diffusion	X						
2	Complementary technologies	The unavailability of complementary products and/or services that support the product			X				
3	Network	The absent of actors or organizations that are involved to supply the necessary product as well as coordination between the actors, including lack of international cooperation							X
4	Demand	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product or when the price of the product is considered too high.						X	
5	Institutional	Laws and regulations that hamper the large scale diffusion of the product, lack of supporting laws and regulations, as well as lack of							X

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
		competition and information sharing between the producers and customers							
6	Technological	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product, as well as lack of standardization of the product	X						
7	Natural resources and labour	The unavailable natural resources and labour that are required to support production system, for example lack competent labour	X						
8	Social, cultural, behavioural, and psychological	Different perspectives norms and culture in regards to the use of the product, lack of social acceptance of the product					X		
9	Macro-economic	Issues related to economic situation					X		
10	Accident or events	Occurrence of events that cannot be foreseen beforehand that affect the companies				X			
11	Infrastructure	The unavailability of technology or infrastructure that are required for the distribution and usage of the technology						X	
12	Financial Issue	The absent of financing sources or lack of financial capabilities	X						
13	Undesirable societal and environmental effect	Negative side effect from the new technology	X						

Appendix B: The Rank of Barriers by Thomas Ebeling, Nissan

Please rank the following list with 1 as the most important, and 13 as the least important

Appendix B - The rank of barriers by Thomas Ebeling, Nissan

#	Category	Explanation	Rank
1	Production system	The unavailability of a good production system to support the transition to large scale diffusion	13
2	Complementary technologies	The unavailability of complementary products and/or services that support the product	8
3	Network	The absent of actors or organizations that are involved to supply the necessary product as well as coordination between the actors, including lack of international cooperation	3
4	Demand	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product or when the price of the product is considered too high.	5
5	Institutional	Laws and regulations that hamper the large scale diffusion of the product, lack of supporting laws and regulations, as well as lack of competition and information sharing between the producers and customers	2
6	Technological	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product, as well as lack of standardization of the product	12
7	Natural resources and labour	The unavailable natural resources and labour that are required to support production system, for example lack competent labour	11
8	Social, cultural, behavioural, and psychological	Different perspectives norms and culture in regards to the use of the product, lack of social acceptance of the product	6
9	Macro-economic	Issues related to economic situation	4
10	Accident or events	Occurrence of events that cannot be foreseen beforehand that affect the companies	7
11	Infrastructure	The unavailability of technology or infrastructure that are required for the distribution and usage of the technology	1
12	Financial Issue	The absent of financing sources or lack of financial capabilities	9
13	Undesirable societal and environmental effect	Negative side effect from the new technology	10

Appendix C: The Importance of Strategies by Thomas Ebeling, Nissan

Please indicate your answer by giving an 'X' mark on the coloumn

Appendix C - The importance of strategies by Thomas Ebeling, Nissan

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
1	Demo, experiment, and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem						X	
2	Top niche market strategy	Targeting the high-end market by providing tailored product		X					
3	Pilot project strategy	Conducting pilot project to see how the product would be accepted by the market and how the customers would behave towards the product			X				
4	Lobbying strategy	Involve lobbying activities to the government to provide subsidies and other supports for the product							X
5	Redesign niche strategy	A simpler version of the product is introduced by using current knowledge, fewer resources, leading to reduced price					X		
6	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology						X	
7	Hybridization or adaptor niche strategy	The new product is combined with the existing product to make the new product compatible with existing system		X					

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
8	Knowledge development	The knowledge about the product is transferred to both suppliers and customers, campaign to increase awareness of the importance of the product, enhancement of the R&D system of the company						X	
9	Geographic niche strategy	The new product targets specific geographical area						X	
10	Market research	Conducting an in-depth market research to explore the market needs, for example by involving lead user	X						
11	Explore multiple markets niche strategy	The new product is introduced to multiple markets							X
12	Financial aid	Collaboration with other institutions (for example international organization) to get financial support, both for producers or customers							X
13	Establishment of standard	Standard is imposed to the product		X					
14	Network creation	Establishment of cooperation between institutions, both locally and internationally					X		
15	Development of infrastructure	Creation of infrastructure to support the distribution and usage of the product							X

Appendix D: The Rank of Strategies by Thomas Ebeling, Nissan

Please rank the following list with 1 as the most important, and 15 as the least important

Appendix D - The rank of strategies by Thomas Ebeling, Nissan

#	Category	Explanation	Rank
1	Demo, experiment, and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem	4
2	Top niche market strategy	Targeting the high-end market by providing tailored product	14
3	Pilot project strategy	Conducting pilot project to see how the product would be accepted by the market and how the customers would behave towards the product	13
4	Lobbying strategy	Involve lobbying activities to the government to provide subsidies and other supports for the product	3
5	Redesign niche strategy	A simpler version of the product is introduced by using current knowledge, fewer resources, leading to reduced price	8
6	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology	10
7	Hybridization or adaptor niche strategy	The new product is combined with the existing product to make the new product compatible with existing system	15
8	Knowledge development	The knowledge about the product is transferred to both suppliers and customers, campaign to increase awareness of the importance of the product, enhancement of the R&D system of the company	6
9	Geographic niche strategy	The new product targets specific geographical area	7
10	Market research	Conducting an in-depth market research to explore the market needs, for example by involving lead user	9
11	Explore multiple markets niche strategy	The new product is introduced to multiple markets	11
12	Financial aid	Collaboration with other institutions (for example international organization) to get financial support, both for producers or customers	1
13	Establishment of standard	Standard is imposed to the product	12
14	Network creation	Establishment of cooperation between institutions, both locally and internationally	5
15	Development of infrastructure	Creation of infrastructure to support the distribution and usage of the product	2

Appendix E: The Importance of Barriers by Kartik Gopal, Mahindra Reva

Please indicate your answer by giving an 'X' mark on the coloumn

Appendix E - The importance of barriers by Kartik Gopal, Mahindra Reva

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
1	Production system	The unavailability of a good production system to support the transition to large scale diffusion		X					
2	Complementary technologies	The unavailability of complementary products and/or services that support the product				X			
3	Network	The absent of actors or organizations that are involved to supply the necessary product as well as coordination between the actors, including lack of international cooperation					X		
4	Demand	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product or when the price of the product is considered too high.							X
5	Institutional	Laws and regulations that hamper the large scale diffusion of the product, lack of supporting laws and regulations, as well as lack of competition and information sharing between the producers and customers							X
6	Technological	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product, as well as lack of				X			

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
		standardization of the product							
7	Natural resources and labour	The unavailable natural resources and labour that are required to support production system, for example lack competent labour		X					
8	Social, cultural, behavioural, and psychological	Different perspectives norms and culture in regards to the use of the product, lack of social acceptance of the product						X	
9	Macro-economic	Issues related to economic situation						X	
10	Accident or events	Occurrence of events that cannot be foreseen beforehand that affect the companies	X						
11	Infrastructure	The unavailability of technology or infrastructure that are required for the distribution and usage of the technology							X
12	Financial Issue	The absent of financing sources or lack of financial capabilities					X		
13	Undesirable societal and environmental effect	Negative side effect from the new technology		X					

Appendix F: The Rank of Barriers by Kartik Gopal, Mahindra Reva

Please rank the following list with 1 as the most important, and 13 as the least important

Appendix F - The rank of barriers by Kartik Gopal, Mahindra Reva

#	Category	Explanation	Rank
1	Production system	The unavailability of a good production system to support the transition to large scale diffusion	9
2	Complementary technologies	The unavailability of complementary products and/or services that support the product	10
3	Network	The absent of actors or organizations that are involved to supply the necessary product as well as coordination between the actors, including lack of international cooperation	6
4	Demand	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product or when the price of the product is considered too high.	1
5	Institutional	Laws and regulations that hamper the large scale diffusion of the product, lack of supporting laws and regulations, as well as lack of competition and information sharing between the producers and customers	2
6	Technological	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product, as well as lack of standardization of the product	8
7	Natural resources and labour	The unavailable natural resources and labour that are required to support production system, for example lack competent labour	12
8	Social, cultural, behavioural, and psychological	Different perspectives norms and culture in regards to the use of the product, lack of social acceptance of the product	5
9	Macro-economic	Issues related to economic situation	4
10	Accident or events	Occurrence of events that cannot be foreseen beforehand that affect the companies	13
11	Infrastructure	The unavailability of technology or infrastructure that are required for the distribution and usage of the technology	3
12	Financial Issue	The absent of financing sources or lack of financial capabilities	7
13	Undesirable societal and environmental effect	Negative side effect from the new technology	11

Appendix G: The Importance of Strategies by Kartik Gopal, Mahindra Reva

Please indicate your answer by giving an 'X' mark on the coloumn

Appendix G - The Importance of strategies by Kartik Gopal, Mahindra Reva

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
1	Demo, experiment, and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem	X						
2	Top niche market strategy	Targeting the high-end market by providing tailored product	X						
3	Pilot project strategy	Conducting pilot project to see how the product would be accepted by the market and how the customers would behave towards the product					X		
4	Lobbying strategy	Involve lobbying activities to the government to provide subsidies and other supports for the product						X	
5	Redesign niche strategy	A simpler version of the product is introduced by using current knowledge, fewer resources, leading to reduced price	X						
6	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology			X				
7	Hybridization or adaptor niche strategy	The new product is combined with the existing product to make the new product compatible with existing system	X						
8	Knowledge development	The knowledge about the product is transferred to both						X	

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
		suppliers and customers, campaign to increase awareness of the importance of the product, enhancement of the R&D system of the company							
9	Geographic niche strategy	The new product targets specific geographical area				X			
10	Market research	Conducting an in-depth market research to explore the market needs, for example by involving lead user						X	
11	Explore multiple markets niche strategy	The new product is introduced to multiple markets							X
12	Financial aid	Collaboration with other institutions (for example international organization) to get financial support, both for producers or customers					X		
13	Establishment of standard	Standard is imposed to the product				X			
14	Network creation	Establishment of cooperation between institutions, both locally and internationally					X		
15	Development of infrastructure	Creation of infrastructure to support the distribution and usage of the product							X

Appendix H: The Rank of Strategies by Kartik Gopal, Mahindra Reva

Please rank the following list with 1 as the most important, and 15 as the least important

Appendix H - The rank of strategies by Kartik Gopal, Mahindra Reva

#	Category	Explanation	Rank
1	Demo, experiment, and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem	14
2	Top niche market strategy	Targeting the high-end market by providing tailored product	15
3	Pilot project strategy	Conducting pilot project to see how the product would be accepted by the market and how the customers would behave towards the product	6
4	Lobbying strategy	Involve lobbying activities to the government to provide subsidies and other supports for the product	3
5	Redesign niche strategy	A simpler version of the product is introduced by using current knowledge, fewer resources, leading to reduced price	13
6	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology	9
7	Hybridization or adaptor niche strategy	The new product is combined with the existing product to make the new product compatible with existing system	11
8	Knowledge development	The knowledge about the product is transferred to both suppliers and customers, campaign to increase awareness of the importance of the product, enhancement of the R&D system of the company	4
9	Geographic niche strategy	The new product targets specific geographical area	10
10	Market research	Conducting an in-depth market research to explore the market needs, for example by involving lead user	5
11	Explore multiple markets niche strategy	The new product is introduced to multiple markets	1
12	Financial aid	Collaboration with other institutions (for example international organization) to get financial support, both for producers or customers	7
13	Establishment of standard	Standard is imposed to the product	12
14	Network creation	Establishment of cooperation between institutions, both locally and internationally	8
15	Development of infrastructure	Creation of infrastructure to support the distribution and usage of the product	2

Appendix I: The Importance of Barriers by Renault Brazil

Please indicate your answer by giving an 'X' mark on the coloumn

Appendix I - The importance of barriers by Renault Brazil

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
1	Production system	The unavailability of a good production system to support the transition to large scale diffusion					X		
2	Complementary technologies	The unavailability of complementary products and/or services that support the product				X			
3	Network	The absent of actors or organizations that are involved to supply the necessary product as well as coordination between the actors, including lack of international cooperation						X	
4	Demand	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product or when the price of the product is considered too high.						X	
5	Institutional	Laws and regulations that hamper the large scale diffusion of the product, lack of supporting laws and regulations, as well as lack of competition and information sharing between the producers and customers						X	
6	Technological	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product, as well as lack of				X			

xxx

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
		standardization of the product							
7	Natural resources and labour	The unavailable natural resources and labour that are required to support production system, for example lack competent labour		X					
8	Social, cultural, behavioural, and psychological	Different perspectives norms and culture in regards to the use of the product, lack of social acceptance of the product		X					
9	Macro-economic	Issues related to economic situation							X
10	Accident or events	Occurrence of events that cannot be foreseen beforehand that affect the companies		X					
11	Infrastructure	The unavailability of technology or infrastructure that are required for the distribution and usage of the technology							X
12	Financial Issue	The absent of financing sources or lack of financial capabilities							X
13	Undesirable societal and environmental effect	Negative side effect from the new technology		X					

Appendix J: The Rank of Barriers by Renault Brazil

Please rank the following list with 1 as the most important, and 13 as the least important

Appendix J - The rank of barriers by Renault Brazil

#	Category	Explanation	Rank
1	Production system	The unavailability of a good production system to support the transition to large scale diffusion	6
2	Complementary technologies	The unavailability of complementary products and/or services that support the product	9
3	Network	The absent of actors or organizations that are involved to supply the necessary product as well as coordination between the actors, including lack of international cooperation	7
4	Demand	The unavailability of potential customers for the product. This could occur due to the situation where the customers do not have knowledge about the product, leading to unwillingness to buy the product or when the price of the product is considered too high.	5
5	Institutional	Laws and regulations that hamper the large scale diffusion of the product, lack of supporting laws and regulations, as well as lack of competition and information sharing between the producers and customers	4
6	Technological	The lack of knowledge that is required to develop, produce, replicate and control the technological principles in a product, as well as lack of standardization of the product	8
7	Natural resources and labour	The unavailable natural resources and labour that are required to support production system, for example lack competent labour	10
8	Social, cultural, behavioural, and psychological	Different perspectives norms and culture in regards to the use of the product, lack of social acceptance of the product	11
9	Macro-economic	Issues related to economic situation	2
10	Accident or events	Occurrence of events that cannot be foreseen beforehand that affect the companies	12
11	Infrastructure	The unavailability of technology or infrastructure that are required for the distribution and usage of the technology	3
12	Financial Issue	The absent of financing sources or lack of financial capabilities	1
13	Undesirable societal and environmental effect	Negative side effect from the new technology	13

Appendix K: The Importance of Strategies by Renault Brazil

Please indicate your answer by giving an 'X' mark on the coloumn

Appendix K - The Importance of strategies by Renault Brazil

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
1	Demo, experiment, and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem						X	
2	Top niche market strategy	Targeting the high-end market by providing tailored product	NA						
3	Pilot project strategy	Conducting pilot project to see how the product would be accepted by the market and how the customers would behave towards the product						X	
4	Lobbying strategy	Involve lobbying activities to the government to provide subsidies and other supports for the product							X
5	Redesign niche strategy	A simpler version of the product is introduced by using current knowledge, fewer resources, leading to reduced price					X		
6	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology	NA						
7	Hybridization or adaptor niche strategy	The new product is combined with the existing product to make the new product compatible with existing system	NA						
8	Knowledge development	The knowledge about the product is transferred to both							X

#	Category	Explanation	Not at all important	Low important	Slightly important	Neutral	Moderately important	Very important	Extremely important
			1	2	3	4	5	6	7
		suppliers and customers, campaign to increase awareness of the importance of the product, enhancement of the R&D system of the company							
9	Geographic niche strategy	The new product targets specific geographical area	NA						
10	Market research	Conducting an in-depth market research to explore the market needs, for example by involving lead user	NA						
11	Explore multiple markets niche strategy	The new product is introduced to multiple markets					X		
12	Financial aid	Collaboration with other institutions (for example international organization) to get financial support, both for producers or customers							X
13	Establishment of standard	Standard is imposed to the product					X		
14	Network creation	Establishment of cooperation between institutions, both locally and internationally					X		
15	Development of infrastructure	Creation of infrastructure to support the distribution and usage of the product						X	

Appendix L: The Rank of Strategies by Renault Brazil

Please rank the following list with 1 as the most important, and 15 as the least important

Appendix L - The rank of strategies by Renault Brazil

#	Category	Explanation	Rank
1	Demo, experiment, and develop niche strategy	Demonstration of the product in public in a controlled way so the limited quality of performance is not a problem	1
2	Top niche market strategy	Targeting the high-end market by providing tailored product	NA
3	Pilot project strategy	Conducting pilot project to see how the product would be accepted by the market and how the customers would behave towards the product	2
4	Lobbying strategy	Involve lobbying activities to the government to provide subsidies and other supports for the product	3
5	Redesign niche strategy	A simpler version of the product is introduced by using current knowledge, fewer resources, leading to reduced price	8
6	Dedicated system or stand-alone niche strategy	Complementary technology is designed to support the new technology	NA
7	Hybridization or adaptor niche strategy	The new product is combined with the existing product to make the new product compatible with existing system	NA
8	Knowledge development	The knowledge about the product is transferred to both suppliers and customers, campaign to increase awareness of the importance of the product, enhancement of the R&D system of the company	5
9	Geographic niche strategy	The new product targets specific geographical area	NA
10	Market research	Conducting an in-depth market research to explore the market needs, for example by involving lead user	NA
11	Explore multiple markets niche strategy	The new product is introduced to multiple markets	9
12	Financial aid	Collaboration with other institutions (for example international organization) to get financial support, both for producers or customers	4
13	Establishment of standard	Standard is imposed to the product	10
14	Network creation	Establishment of cooperation between institutions, both locally and internationally	7
15	Development of infrastructure	Creation of infrastructure to support the distribution and usage of the product	6

Note: NA refers that the strategy is not implemented; hence the Renault does not put a rank on it. However, it could also be concluded that the five strategies are considered to be the five least important strategies, rank from 11 to 15.