Business Model Framework for Electric Vehicles in India

MOT 2910

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Summary

Sustainable energy sources are becoming an increasingly important part of the global economy. As a result, governments all around the world are attempting to implement these sustainable technologies fully. This research focuses on one such sustainable technology of Electric vehicles (EVs). The study is for the Indian market, with an emphasis on the country's urban areas. In recent years, the vehicle industry has been overgrowing due to revolutionary developments in information technology and higher living standards established by Indian citizens. The rising market puts a lot of strain on the available replenishable resources, like oil, gas, and fossil fuels. The supply and demand curves have crossed their limit, and the situation could deteriorate if a solution is not found to replace the current scenario. Electric vehicles are one of the versatile options available that can help India to overcome this crisis. But the EVs market in India is at a very nascent stage as compared to other developed economies. Many factors affect the growth of EVs in India. This research aims to discover these barriers and create a framework to help EVs flourish in the Indian market. For this, the main research question to be answered is:

*" **What can be a business model framework for EVs to help them succeed in the Indian market?"***

To answer this research question, a qualitative approach is adopted. This qualitative research was carried out in two steps: the literature study approach and the second interview approach. In the first step, a thorough literature review to understand the market situation and requirements of the Indian automobile market was done. Along with that, the significant challenges faced by EVs were also studied. As the research is for the urban region of India, challenges relating to this region are taken into consideration. Some of the challenges faced by EVs in the Indian urban market were lack of charging infrastructure, high initial costs, and heavy competition from the IC engine vehicles. The next step in the literature study was to analyze the global business models and the models in the EVs space. Various models are implemented globally, including luxury specific-purpose, luxury multi-purpose, economic specific-purpose, economic multi-purpose, better place, and the energy saving companies (ESCO) model. The crux of all the stated models, along with their advantages and shortcomings, were analyzed.

The second phase of the research involves interviewing the stakeholders involved in the EVs space in India. A total of ten interviews are taken. The interviewees are the automobile experts from incumbent and entrepreneurial companies, commercial experts, and charging or battery infrastructure experts working in India for years. The research done from the literature review was used to formulate the

questions. Since there are many ways in which the market requirements can be fulfilled, tools such as morphological boxes are used to get the best possible solution to the requirements. Three morphological boxes are created to determine the best-suited options for infrastructural needs, financial needs, and ownership perspectives.

Further, the insights on the various global models and their feasibility in the Indian context are also discussed. After discussion with the interviewees, each model's benefits and shortcomings when applied to the Indian market are determined. Most interviewees suggested going with the Better place and ESCO model, but they had few drawbacks. From the suggestions of the interviewees, both the models were combined according to the Indian market context. The better place model provides us with complete battery infrastructure for EVs, reducing the initial cost, which is the primary barrier for EV adoption, also has some financial shortcomings. The financial structure provided by ESCO helped in overcoming these financial shortcomings.

Thorough feedback on the framework developed was taken from the interviewees. This framework satisfies all the needs of the Indian urban market and thus answers the main research question of this study—the findings of this study aided in developing a scientific and practical strategy for EVs to gain Indian market share. The interview procedure provided an opportunity to have a better knowledge of stakeholders perspectives from other disciplines. And the incorporation of these insights helped to get the realistic framework for EVs in the Indian market. Though, there are some limitations to this study. This research focuses mainly on the metropolitan region of India; it does not focus on the other parts or the rural part of the Indian market, which also has a significant automobile market share. The framework developed is for the metropolitan regions of India only.

There are few recommendations that can help to lead the direction of future research. First, as the framework developed is just for the urban region, researchers can further widen the scope of the study and can develop a business framework for the other areas. Second, research in this report is done only based on the qualitative approach; it could be further elaborated by quantitative analysis to get better insights into the framework developed. Third, Indian policymakers can establish some policies for creating awareness and encourage people to use EVs. Fourth, policies on using standardized batteries by all the companies should be done. The same infrastructure developed for charging the batteries can be used by all vehicles available. Further, to curb the use of IC engine vehicles, restrictions are needed to be implemented strategically. Some recommendations are also provided to automobile manufacturers and businesses. As competition between the incumbent and the entrepreneurial firm ia high, they need to take a collaborative work approach to help the EVs penetrate the market. Companies should also agree on the standardization of the components such as batteries. The essential part that businesses can do is enable or convince their customers to shift to EVs and simultaneously stop promoting IC engine vehicles.

Chapter 1: Introduction

1.1.Introduction

Innovations in technology and business models are closely related. A successful business model aims at earning profits, building a strong customer base and consumer-supplier relations (*How to Design a Winning Business Model*, 2012.). No matter how advanced or innovative the technology is, it will fail if it does not possess a winning business model. One such revolutionary innovation is taking place is in the sector of sustainable technologies. These technologies promise to reduce harmful emissions, be environmentally friendly, and be more efficient. Climate change and fossil fuel shortages have led this sector to emerge rapidly. Businesses involving fossil fuels are leaning towards more sustainable options. As a result, sustainable technologies are slowly adapting to the current markets. These technologies include solar power, wind power and hydropower. Therefore, businesses need a sustainability and circularity model, enabling them to penetrate the current market and generate great economic values. But despite all the benefits, sustainable resources find it challenging to create their base in the mainstream markets. One such domain that is facing this problem is the Electric Vehicles (EVs) space. The following report focuses on this emerging market of electric vehicles in India.

IC engine vehicles are highly inefficient as most fuel is wasted (Digalwar & Giridhar, 2015). This fuel can never be recycled or reused. On the other hand, EVs are highly efficient, and batteries can be reused by recharging. EVs work on the electric-powered motor instead of the fossil fuel-based engines as used in conventional vehicles. It uses the batteries to supply electricity to the motor for generating power. They run on electricity; thus, they do not have exhaust and fuel pumps but need charging stations. It consists of the components such as battery packs, charging ports, motor, cooling system, electrical transmission, and electronic controller. EVs were first developed in the mid-19th century and have improved and updated since then. However, its market has sky-rocketed only in the last two decades. Electricity from these batteries is further passed to a motor, which generates the necessary power for its transmission. EVs convert almost 59-62% of the supplied energy than IC cars, converting 17-21% (*All-Electric Vehicles*, 2018.). Thus, EVs are highly efficient as compared to their predecessors. Over time, the major problem faced by EVs is that of the power source. Lately, with lithium-ion batteries' innovation, the power source's issue is tending to reduce. There are many types of EVs available (Mcfadden, 2020):

- Hybrid Electric Vehicles (HEV) – These vehicles cannot be charged by the external device or the source. The primary source of energy is still liquid fuel

- Plug-in Hybrid (PHEV) – These vehicles are charged from the source available outside and can use power from both batteries and liquid fuel

- All-Electric Vehicles (AEV) – All the power is generated from the electric source only, and batteries are charged externally

- Plug-in Electric Vehicles (PEV) – In this type, batteries are recharged from household output or the charging stations. These are the most recent type of EVs

EVs have evolved tremendously over time though it has not been able to compete with conventional vehicles. The development of EVs aimed to reduce the carbon emissions from conventional vehicles, though it has never been wholly achieved. Also, the EV's segment choices are significantly less than Internal Combustion (IC) engine vehicles. The high cost and the lack of infrastructure have been the reason behind the slow shift to this space (Morris, 2021.). On the other hand, Governments have started providing various subsidies on EVs to promote their use. Many public transport buses and trams have also been converted to their electric variant.

IC engine vehicles have dominated over the last century. But nowadays, climate change issues and global resource shortages have triggered the demand for EVs. Unfortunately, EVs have never outperformed or even matched the demand as that of IC engine vehicles. Thus, being environment friendly is not enough for EVs to increase their market adoption. The primary reason behind EVs' lack of market penetration is that there is no proper business ecosystem or framework for challenging IC engine vehicles. Thus, there is a need to create a comprehensive framework for EVs adaptability that will compete with IC engine-based vehicles to succeed in the market.

The Indian automobile market has peaked its curve(*Automobile Industry in India, Indian Automobile Industry, Sector, Trends, Statistics*, n.d.). This has led to massive traffic congestion and has affected the environmental situation severely. The primary dominant vehicles in this automobile sector are IC engine vehicles. The demand for these vehicles is ever rising in the Indian markets(*Automobile Industry in India, Indian Automobile Industry, Sector, Trends, Statistics*, 2021.). Due to this rise in demand, a large amount of crude oil is imported from different countries. This is hampering the country's economy in return. The government of India is trying hard to replace IC engine vehicles with EV's. They have also started providing subsidies and incentives for this ("'Revised Subsidies to Spur EV Demand,'" 2021). But since India is a large country with varying dynamics, stakeholders find it hard to develop a successful business framework to help the EVs penetrate the market. Many barriers affect the implementation of EVs in India. Some of them lack battery infrastructure, consumer awareness and policies, lack of electricity sourcing, high initial costs of EVs and severe competition from the incumbent vehicles(*Automobile Industry in India, Indian Automobile Industry, Sector, Trends, Statistics*, n.d.). This report studies the varied challenges faced by EVs in India. Further qualitative research has been done to develop a business framework to help EVs acquire and penetrate the Indian automobile market.

1.2. Research Problem

India's vehicle market is the 5th largest in the world. More than 300 million IC engine vehicles are present, increasing to 60000 vehicles each day. To cater for these vehicles, more than 70000 fuel stations are present across the country. However, out of all vehicles present, approximately only 354000 units of EVs are present on the Indian roads ("Ushering In An Age Of Smart Transport," 2018). At the same time, India plans to sell 30 million EVs by 2040 and ensure that all public vehicles and 30% of self-owned cars are electric by 2030 (Senthil et al., 2018).

At present, the EVs presence in the Indian market is significantly less, and its development is also in its nascent stages. The market share will increase with the development of the overall infrastructure required by the EVs. To encourage and boost this segment government of India has come up with various initiatives. They are providing heavy subsidies to sustainable technologies, including EVs. The

Automotive research association of India (ARAI), the regulatory body responsible for developing any vehicle and the government, has established various technical standards for EVs and has laid down its plan to develop its charging infrastructure. Along with that, many National mission plans for electric mobility (NEMMP) type of schemes have been funded by the government to formulate the EVs space, which is expected to generate 25% of India's manufacturing GDP (Pandey, 2020).

Many entrepreneurial and incumbent companies have started providing EVs in India. The country's vehicle manufacturing giants such as Tata Motors, Mahindra and Hyundai already entered the market of EVs(Gujarathi, Department of Electrical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat-395007, India, et al., 2018). Along with that, startup companies like Calamus, Ather energy has entered the two-wheeler EVs segment. But despite these products in the market, the overall share of EVs is significantly marginal.

It is projected that the EVs market will grow at a constant CAGR of more than 37% by 2023 (Pandey, 2020). At present, firms face problems establishing a business framework to overcome the challenges faced by EVs, as depicted in the literature search (see chapter 3). This type of strong market growth is expected because of the government's commitment to develop EVs space. However, to achieve this goal and compensate for the high initial costs of the EVs, a specific business framework has to be developed, catering to the need of the Indian market.

Through my thesis, I aim to develop a business framework for EVs for the Indian market**.** As India needs to import most of its fuel requirements, it is hampering its economic growth. Moreover, India aims to reduce its carbon emissions as it increasing rapidly, subsequently affecting the environment. Therefore, India seeks to reduce these carbon emissions by replacing the high polluting conventional vehicle with EVs(*Electric Vehicles: Why the Future of Electric Vehicles Appears Bright in India - The Economic Times*, n.d.)**.** The concept of sustainability has been prevalent in the urban regions of India. Moreover, the infrastructure present to incorporate the EVs is achievable in the urban areas, and also, the urban region accounts for the significant usage of vehicles. Therefore, I would target the Indian metropolitan area to formulate my business framework.

1.3. Research questions

As stated earlier, EVs have not been able to compete with conventional vehicles to gain a market share. This issue is highly observed in the Indian market (see chapter 3). This seems to be an apt knowledge gap that I aim to address in my thesis. I aim to study the Indian market and determine its exact needs thoroughly. In addition to this, a literature review on global business regarding EVs would be used to develop a business framework addressing the needs of the Indian EVs market.

The main research question of my thesis is:

*" **What can be a business model framework for EVs to help them succeed in the Indian market?"***

To come up with a suitable business framework following sub-research questions must be answered:

1. *What are the current market needs for the EV space in India?*

   To develop a business framework for EVs in India, it is essential first to understand the situation and needs of the Indian market. The answer to this question will help us understand the Indian market and help us determine our target segment for which there is the scope for EVs to succeed and impact the market.

2. *What kind of EVs business model exists globally?*

   Since EVs have become successful in many countries around the globe, it becomes necessary to study the business model adopted by these countries. Furthermore, the advantages and disadvantages of these models will also be explored.

3. *Based on the reviewed global models and the Indian market requirements, what framework can EVs develop to help them penetrate the Indian market?*

   Further, the feasibility of these models in the Indian market is to be checked by analyzing them with the Indian market needs as answered in the previous question. Various sustainable models such as ESCO used in solar and wind technologies are pretty successful in the Indian market. So it becomes necessary to check where these models could help in the EVs segment or not.

4. *How effectively can the developed business framework contribute to the Indian electric vehicle market, especially the urban region?*

   As the research mainly focuses on the urban region of India, the effectiveness of the model developed in the metropolitan area is to be validated.

1.4. Research approach

There are three ways to address any research problem: exploratory, descriptive, and causal. The exploratory study provides various possibilities and alternative options to address the problem. At the same time, descriptive research involves data collection. On the other hand, a causal study is used when the research objective is to find the relationship between the various parameters (Sekaran, 2016). To answer the above-mentioned research question of EVs, exploratory research will be used. An exploratory study is flexible, which allows the researcher to change the direction of the study when required (Dudovskiy, n.d.). Data collection will be done to answer sub-research questions 1 and 2, and this data will be analyzed to answer the following research questions mentioned. Exploratory research focuses highly on a qualitative study. The research is more about studying the Indian market and then incorporating the existing or developing a business framework for EVs according to market demands. Thus the research will be highly focused on qualitative aspects.

Verschuren et al., 2010 has mentioned that research is carried out by following specific guidelines, and objectives are met step by step in a definite manner. Therefore, the research methodology to answer the questions will be carried out in the following steps:

- The first step will be to carry out a thorough literature review on the topic. A comprehensive idea about the requirements and conditions of the Indian EVs market will be known. It also involves a detailed study of different sustainable business models and also models involving EVs. Further, this literature provides the base to the next step in the research consisting of interviews with the stakeholders

- The second step would be to carry out qualitative research by conducting interviews with various stakeholders. The interview helps to get detailed information on the Indian EVs market and check the feasibility of multiple models. Semi-structured interviews are taken with all the stakeholders and also with the existing market players. Interviews are conducted based on the literature review. For interviews, the stakeholders were approached via email and calls. The research questions were mentioned to the interviewers. All ten interviews are conducted via the online zoom platform. The stakeholders interviewed include people from automobile companies (both incumbent and entrepreneurial companies), policymakers, and industrial experts. Few discussions with commercial people were also conducted to analyze the commercial aspects of the market. These interviews will helps to get an idea of the current market and the stakeholders' expectations.

- The third step involves the analysis of the data gathered. This data collected from the interviews and the literature review was used to develop the new business framework of EVs for the Indian market. Along with that, the feasibility of sustainable models such as ESCO is also analyzed. Tools such as morphological boxes are used to get the precise requirements of the market. The morphological box is a creative way of illustrating all possible solutions for a problem. It gives the structured format in which all the available options are represented. Finally, these options are narrowed down using the logical combination to develop the best solution(Zwicky & Wilson, 1967).

- Feedback on the newly developed business framework is taken by proposing that to all the stakeholders and then taking the feedback to improvise it.

- The last step involves the conclusion of the research outcomes and providing specific future recommendations.

1.5.Research Framework

The research structure or framework serves as a link to the research question and the research goal. To showcase this, a schematic representation has been made. This diagram depicts the steps that are to be followed throughout the study. This aids the readers in comprehending the research gap which is to be addressed (Verschuren et al., 2010). A pictorial format for this is shown below.

Chapter 1 tells us about the introduction of the research and also addresses the knowledge gap. Further, the objectives and the research questions are also addressed

Chapter 2 gives detailed information on how the literature review and the interview approach is carried out. It also tells us more about the steps involved in the qualitative research process followed.

Chapter 3 starts with a detailed literature review of the current status and requirements of the Indian market. It also mentions the different challenges faced by the EVs space in India. Following that, various business models of EVs which are implemented globally are studied.

Chapter 4 involves taking the various stakeholders' interviews and checking the feasibility of different models in the Indian EVs space by discussing with them. These findings are used to develop a business framework that can help EVs succeed in the Indian market. Then, further another set of the interview is taken to get the feedback on the developed model.

Chapter 5 is the conclusion of the research along with the future recommendation regarding the findings.

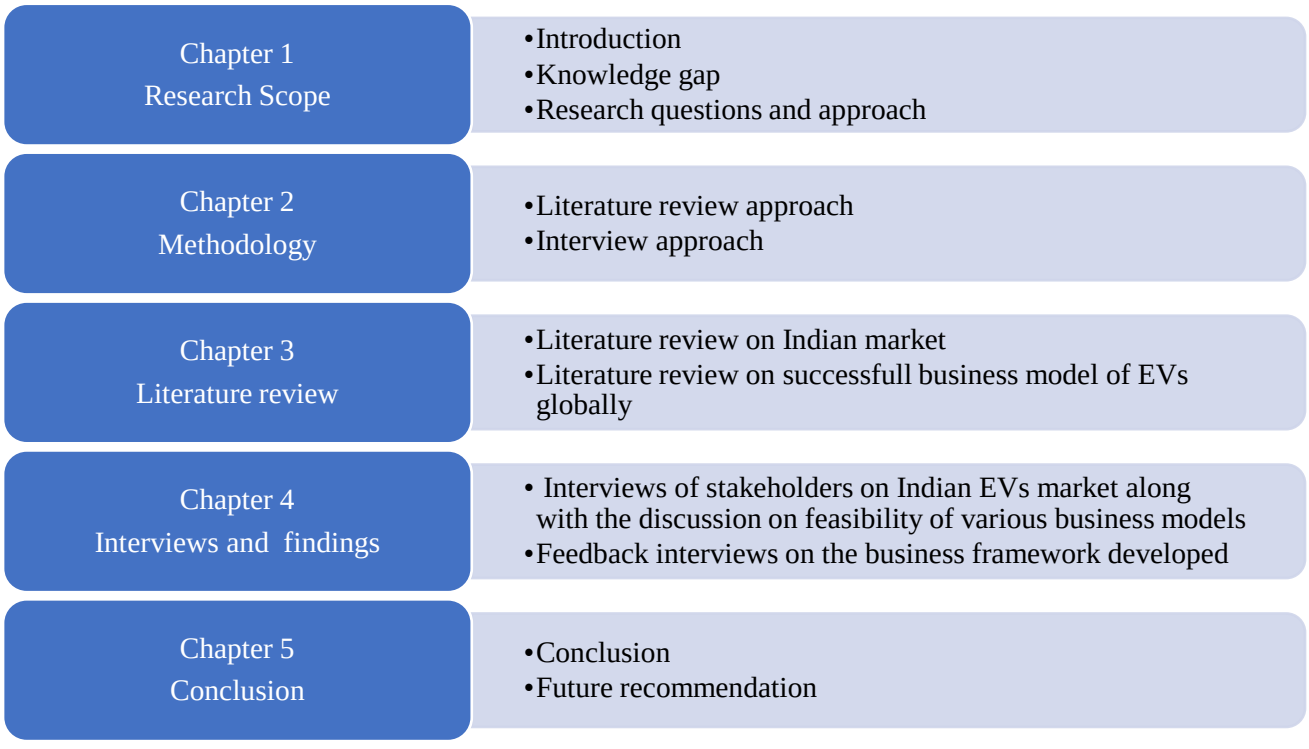

Figure 1. Research framework

Chapter 2. Research Methodology

This section indicates thorough details of how the literature study was carried during the research. First, the literature review was done, followed by the interviews of the stakeholders involved. This was done to gather detailed information and to understand the requirements of the Indian market. Further, this data was used to carry out analysis to develop the framework. Thus, the first section is about the literature review approach and the second section is on the interview approach is mentioned in detail below.

2.1. Literature review approach

The literature review was carried out to study the details of the Indian EVs market and its requirements. It was also done to explore the different successful business models followed across the globe. To do this following procedure was followed:

The initial search was done using the 'Scopus' database. The initial search terms were "Electric Vehicles" and "Electric Mobility". No restriction was placed on the timeline of articles at this stage because I wanted to know the history and emergence of EVs space. This search resulted in a total of 109488 results. Then, I filtered these results by subject area, which is 'Engineering.' This resulted in 83111 articles. Further, I sorted the papers based on citations (highest to lowest) to narrow this search. Additionally, I searched for documents that had 'Review' in the title. This further shortened the number of articles to 1400. Then I selected the first five articles from the search (articles with most citations).

After reading these five articles that were basically reviewed papers, I had a reasonably clear idea about how EVs have emerged over time, how have their definitions have changed, and a rough idea of challenges faced by EVs. Further, I came across similar notations given to EVs, i.e. 'Sustainable Vehicles' and 'Urban Mobility.'. Then I was curious about the challenges faced by the EV space. Then I searched for the articles cited in the above five articles for the challenges faced by EVs to get a detailed knowledge of these barriers. For this, I shortlisted nine papers. After going through them, I realized that EVs' significant challenges are missing battery infrastructure and consumer awareness and the lack of a business model framework to succeed. So, being from a business background, I decided to focus on the business model framework available for EV.

A fresh search was done to find literature on the business model framework in the 'Scopus' database. The terms used were the following:

- 'Business Model Framework' AND 'Electric Vehicles' – 159 articles
- 'Business Model Framework' AND 'Electric Mobility – 43 articles
- 'Business Model Framework' AND 'Sustainable Vehicles'- 76 articles
- 'Business Model Framework' AND 'Urban Mobility' – 84 articles

The filter used was a subject area - 'Business, Management and Accounting' in all the previous searches. Also, the repetitive documents in the above search were excluded. In addition to this, only those articles were selected, which had more than 50 citations. In the search procedure mentioned above, I tried to find articles that could give information about the models in the Indian market for EVs. These resulted in 10 articles that covered the requirement of the Indian market and provided some information on the prevalent business models in India. The next task was to get thorough knowledge

of the business model used globally. A total of 27 research articles were studied to gain insights into the global business models. The relevant data on the successful models from these articles is used further in the report.

2.2. Interview approach

As mentioned earlier, the second part of this section involves a detailed layout of the interview approach. The main objective of conducting the interviews was to get the details about the requirements of the Indian market. Interviewees were also asked to answer few questions related to morphological boxes to get better insights into the Indian market requirements. The morphological box is a creative way of illustrating all possible solutions for a problem. The second part of the interview is conducted to get feedback on the developed framework. The following procedure was used to conduct semi-structured interviews.

In any research project, interviews are the more prevalent way of conducting research and collecting data. Interviews are usually conducted in three forms; structured, unstructured and semi-structured (Alshenqeeti, 2014). Structured interviews consist of the fixed questions which are planned and created in advance. Since everyone is asked the same questions, it gets easier for the interviewer to compare the results. A semi-structured interview is a flexible form of an interview. In this few questions are fixed, but several relevant questions are asked spontaneously. Thus it gives thorough insights on the particular issue. It also provides the flexibility to ask any random questions. Unstructured interviews are the type of open-ended interviews. Different interviewers are asked other questions; therefore, it becomes difficult to analyze and compare the outcomes. Therefore, considering gathering in-depth knowledge on the topic and providing flexibility to the interviewers, the semi-structured interview is chosen as it is the best appropriate option for data collection. The interviews helped to analyse the needs of the Indian market in the EVs space. Further, these results and the data obtained from the literature review are combined to determine the exact market needs of Indian EVs space. A tool named morphological boxes is used, which is explained in detail later in the report.

2.2.1. Interview structure and process

The process the semi-structured interviews conducted is mentioned below:

1. Detailed data about the Indian market was collected from the literature study. Further, this data was incorporated in morphological boxes so that the interviewers can answer on every parameter of EVs space.

2. Interview questions were prepared based on the literature review.

3. The next task was to find the right interviewers. Different stakeholders from the various automobile companies in India working in the EVs domain were chosen. People from commercial backgrounds were also approached to get insights into the policymaking aspects.

4. Next, the interviewers were sent an email requesting the interview. In the email, a summary of the research was mentioned to give them the background on the topic. Finally, a full ten interviews were conducted via Zoom. Most of the interviews are recorded.

5. Further, the minutes of these interviews were created and were sent to the interviewers via email. The interviewers approved these minutes to give consent to use the data in the report.

A standard interview protocol was followed during every interview. In addition, interviewers were asked for the consent of few things mentioned below:

- A summary of the research was sent to the interviewers via email or was explained over a call during the invitation for the interview. This helped the interviewers to have a clear idea about the knowledge gap and research questions.

- At the start of the conducting interview, interviewees were asked to give their consent to use their identity and the information discussed in the interview

- Initially, before the recording of the interview, interviewees were asked for their permission for recording

- The interviewees were also told that if they feel like discontinuing the interview at any point, they are free to do so

- In the end, interviewers were asked if they had any questions and were asked to give their opinion on the research

Figure 2. Interview process

2.2.2. Selection of the Interviewees

It is necessary to select the right individuals for the interview to get an accurate response and information on the particular parameter. Proper sampling of people leads to real data and information. First, target groups of stakeholders belonging to one specific domain were created and then a few of them were chosen for the interviews based on their expertise and availability.

Stakeholders from the three domains were selected; automobile industry expert, commercial expert and people belonging to the charging infrastructure development domain. Few people were from entrepreneurial companies, and few from the incumbent automobile firms were chosen. This helped to get insights from both aspects. People from the commercial domain were selected to discuss the policies by the government and check the commercial feasibility of the new models developed. As charging infrastructure is the backbone for EVs to succeed, many interviews were conducted with experts in this domain.

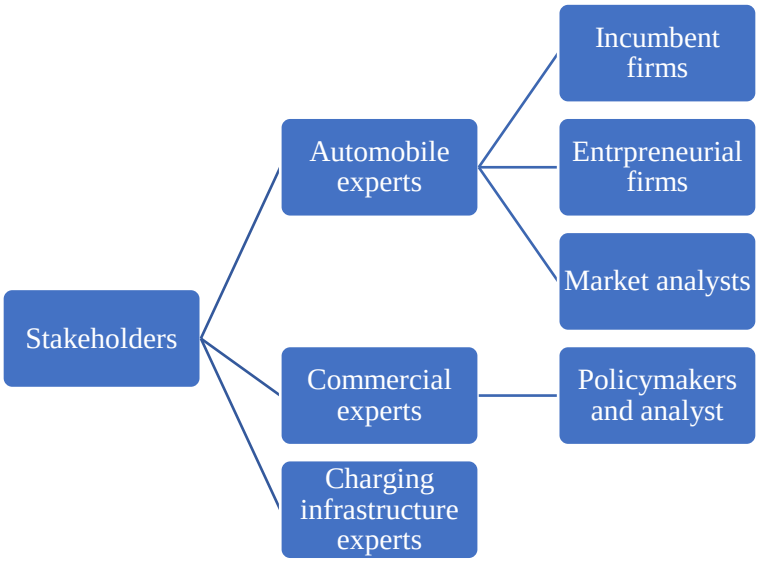

Figure 3. Selection of Interviewees

The following table gives the overview of the Interviewees selected for interviews:

Interviewee	Expertise / Designation	Date of interview
Interviewee A	Battery technology expert. Ex-employee of a battery manufacturing company	17th May 2021 & 20th June 2021
Interviewee B	Grid electricity infrastructure expert	18th May 2021 & 18th June 2021
Interviewee C	Experienced in policymaking and banking analyst	14th June 2021
Interviewee D	CEO of automobile components manufacturing ancillary	23rd May 2021 & 20th June 2021
Interviewee E	CEO of EVs startup company	12th June 2021
Interviewee F	An employee of an incumbent automobile company. Part of the EVs development team	28th May 2021 & 23rd June 2021
Interviewee G	An employee of the incumbent automobile company. Part of the product development team	4th June 2021 & 22nd June 2021
Interviewee H	Charging infrastructure expert	27th May 2021 & 19th June 2021
Interviewee I	Worked as a design engineer at EVs startup company	28th May 2021 & 13th June 2021
Interviewee J	Industrial finance and supply chain expert	21st June 2021

Table 1. List of interviewees with their expertise

2.2.3. Interview questions

Interview questions were framed by studying the literature review. The goal set while preparing the questions was to find answers to the research questions. The interview questions were distributed in two parts.

Part A: These questions were mainly based on finding the market needs and requirements of the Indian market. Various business models are also discussed. Further, the questions on the morphological boxes were also asked. These interviews were conducted immediately after the literature study to get more insights into the Indian market requirements

	Part A	
1.	What do you think about the automobile sector of India?	The answer to this question gives a thorough idea about the current situation in the Indian automobile market
2.	Where does the EVs stand in this automobile sector?	As EVs are a tiny part of the Indian market, their current status and plans to expand it are to be discussed
3.	What are the challenges for EVs in India?	As new technology has been developed, it has to face a lot of challenges. This question will help to analyze the challenges faced by EVs
3.	What segment of the market are you focusing on for the EVs to succeed?	This question tells us more about the company's ambitions and the consumers they are targeting for their EVs to succeed
4.	Nowadays, heavy investment is made by the Indian government to boost the EV sector; what do you think about it? And how do you think these steps will help EVs to gain market share?	Since EVs are very novel in the Indian markets, the government provides many incentives and subsidies. Thus it is necessary to study whether these steps are sufficient enough for the EVs to dominate the market
5.	Questions on the morphological boxes and the options available?	Various parameters regarding the EVs in the Indian market are discussed, which are represented in the form of morphological boxes.
6.	Discussion on the various models and their feasibility in the Indian market?	The EVs business models which are successful globally are discussed. The feasibility of these models in the Indian market is the primary concern that is discussed
7.	What are your views on a sustainable model like ESCO? And is this model suitable for the Indian EVs market?	ESCO model is very successful in the sustainability domain. Its feasibility for the EVs market is discussed
8.	What is your feedback on the research topic?	Discussion on the overall research project

Table 2. Part A interview questions

Part B: These questions were mainly designed to get the stakeholders' feedback on the framework developed to be further improvised. These interviews were conducted after the development of the new framework to get feedback on it.

	Part B
1.	What is your feedback on the model developed? (Better Place and ESCO combination)
2.	Does this model fulfil all the needs of the Indian market?
3.	How hard is it to implement this model considering the market and the industrial situation?
4.	What do you think are the shortcomings of this model?
5.	Any suggestion on the model developed?

Table 3. Part B interview questions

The data from the interviews were recorded in a structured manner using the morphological boxes. The interviewees were asked to comment and select their choice amongst the options available. As it was a semi-structured interview, the interviewees were asked about their suggestions for each topic discussed. The data from the interviewees were very directly represented through the use of morphological boxes shown in chapter 4. And further, this data was used to develop the framework.

Chapter 3. Literature review

Sustainable technologies are the future for the survival of this rapidly growing modernized world. But it has been observed that not all sectors provide an easy pathway for them to dominate or take their place in the potential market. One such segment is the EVs segment. The ever-increasing emissions of greenhouse gases, loss of natural resources are pushing economies worldwide to adapt the EVs. As a result, they have emerged as an alternative to conventional vehicles but have not created a solid market base. As a result, despite making numerous policies and efforts, EVs find it hard to penetrate the market. Lately, many countries have developed few business models that have helped EVs succeed, discussed further. But the EVs in the Indian market are struggling a lot to find space. This literature review covers the detailed analysis of EVs in the Indian and global markets.

3.1. Global business models used in electric vehicle space

EVs are said to be a significant contributor to the future of sustainability that can help countries achieve their sustainable targets. However, the initial costs involved in its development and deployment are very high compared to conventional vehicles. To compensate for this, EVs can develop a product service-based model (Nian et al., 2019). Different types of models are created to attract consumers and attain a more significant market share. Models are based on the two main dimensions of the value proposition (Bohnsack, 2014). First, models are based on target consumers. Specific vehicles are offered to cater to the particular segment of the consumers. Second, the value proposition is based on the purpose of the vehicle. Different models existing in the current market are mentioned below:

1. **Luxury specific-purpose business model**

In this model, the EVs provided are just for luxury or for particular purposes. Vehicles of these types are costly but at the same time offers salient luxury features such as good acceleration. These vehicles' travelling range is less, but it is sufficient for the consumers of this segment. (Guilford, 2017). Moreover, consumers of this segment have different vehicles for day to day usage. Thus, the lack of charging infrastructure is not an issue for them. This business model is very service-oriented. Companies usually have fancy showrooms and also provides salient after-sales services such as home maintenance and others. Since manufacturing costs are high and they have to manufacture cars in significantly less number, most companies outsource the components.

As most of the vehicle in this segment is prototype-based, it does not require substantial manufacturing resources. Thus, this model fits perfectly for both incumbent and entrepreneurial firms too. Incumbent firms such as Audi and BMW already exist in this segment. At the same time, an entrepreneurial firm such as Tesla has also entered this segment. This model is entirely successful, but the problem is that this segment accounts for a significantly less amount of the total vehicle market.

2. Luxury multi-purpose business model

The vehicles in this model aim at providing luxury multi-purpose targets such as efficient pricing, high efficiency, and less charging times. These vehicles are multi-purpose since they enable more than two travellers to travel long distances (Orsato & Wells, 2007). The complete manufacturing and assembling process is different from the previous model. Since these vehicles are used for travel purposes and are heavy too, they need larger batteries. These features add complexity to the manufacturing system and also increases production costs which disturbs the cost-revenue model.

Because of the production complexity and cost issues, most companies do not tend to use this model. However, US-based company Fisker tried to use this model with its vehicle 'karma' (Voelcker, 2013). The Fisker did the complete design and the production of the karma. But the batteries and the charging technologies were purchased from others. This made the vehicle very expensive, and its development was highly dependent on outside collaborations. As a result, the model has very little to offer to the consumers and the manufacturing firms. In addition, the vehicle produced becomes heavy and becomes costly too. Moreover, the overall model includes many complexities.

3. Economy specific-purpose business model

The model aims to cater to the economically focused consumer who uses the vehicles for specific reasons. In this model, firms try to cater to urban regions (Bohnsack, 2014). The urban crowd's major problem is that they tend to be sustainable but are not ready to make additional initial investments. To overcome this challenge, firms try to give some additional service options to their consumers. Services such as rental batteries vehicles are offered. In this way, consumers get the car batteries in the rented form, saving their initial investments. The other services provided by this model are various as compared to conventional vehicle businesses. Some firms have introduced the concept of car sharing as their primary service. They believe that people in the urban region want mobility comfort rather than owning their vehicle.

Both incumbent and entrepreneurial firms use this model. Since the market to cater to is the specific urban region, entrepreneurial firms also do that. They tend to provide the various components in this model. For example, one of the companies offers battery-less cars; the other offers rental battery services. In this way, entrepreneurial firms also use this model. Moreover, incumbent firms such as Toyota, under the name of Zipcar, also use sharing car concept.

4. Economy multi-purpose business model

The model aims to provide the most efficient and economical vehicle to its consumers. Since it's a multi-purpose utility, the vehicle tends to be heavy and requires more batteries to overcome its range issues. Incumbents highly focus on this model since this model's consumer segment has the largest automobile market share. Since the market share is substantial, firms require massive infrastructure to cater to them, requiring high investments(Ceschin & Vezzoli, 2010).

Moreover, firms need to face competition from conventional vehicle manufacturers in this segment. Thus, to overcome it, firms came up with the idea of creating additional revenues by lowering the vehicles' initial costs and providing the batteries on a rental basis. Along with that, firms started licensing their technology to other firms, thus gaining extra revenues. Furthermore, to tackle the range anxiety of the consumer's, firms came up with the infrastructure of fast-charging batteries and battery swap stations. Also, it provided a gasoline source to the vehicle as a backup option (Bohnsack, 2014).

This model is highly suitable for the incumbent firms as compared to the entrepreneurial firms. This is because incumbent firms have the infrastructure needed to cater to the complete market segment. Simultaneously, innovative, entrepreneurial firms could not scale them to such a massive market since they lack resources and monetary investments. Therefore, even though the market segment is significant, very few entrepreneurial firms are keen on using this model and catering to its consumers.

5. Better Place concept

Better Place concept rests on the business model used by an entrepreneurial company that created the battery infrastructure. In this business concept, the company provides battery and charging related solutions. Better Place owned the battery infrastructure, battery ownership, and charging stations (Budde Christensen et al., 2012). The consumer had to purchase the electric vehicles and sign the contract with Better Place, which provides the batteries on lease and sets the annual mileage limit. They provide the option of charging the batteries and also swapping batteries. Better Place coordinates with the intelligence system, which tells them the battery range based on the user driving. Initially, Better Place implemented its concept in Denmark and part of Israel. But after some time, this model failed. The model's success was solely based on the adoption of battery infrastructure provided by Better Place. Moreover, the car manufacturers used no standardized batteries, making it difficult for Better Place to cope with the manufacturers and customers demands (Strickland, 2020). Along with that, no specific leasing structure was designed, which led to the financial fiasco (“Why Better Place Is in a Better Place…,” 2020.).

Better Place can be well implemented when the car manufacturer itself uses this model and, along with that, provided complimentary services. Thus, a complete ecosystem must be developed for the model to succeed(*The Epic Failure Of Better Place, As Covered By Fast Company*, n.d.).

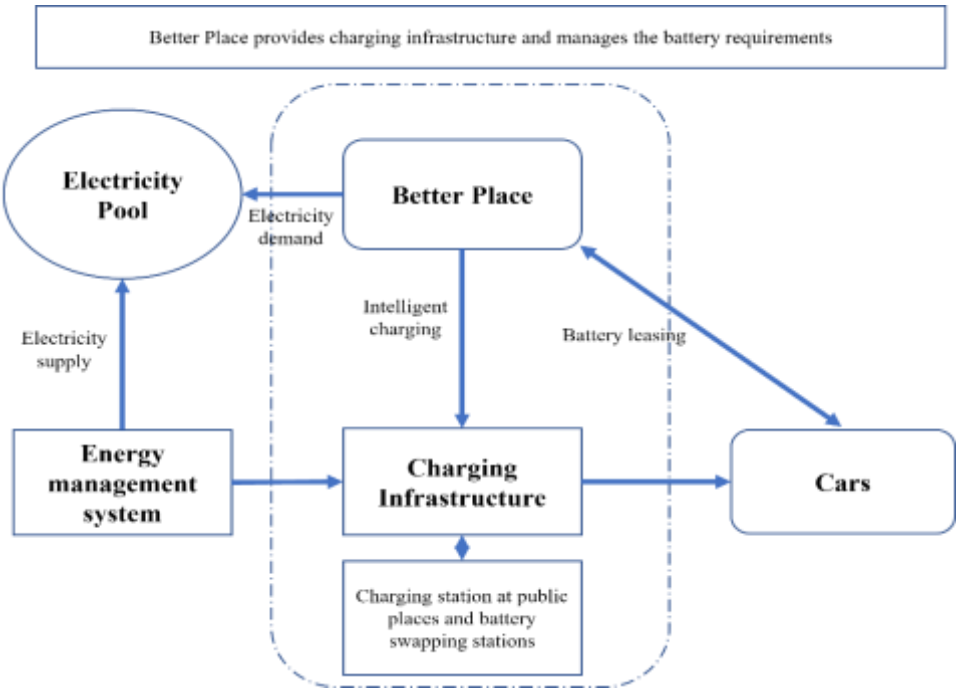

Figure 4. Working infrastructure of Better Place (Bohnsack, 2014)

6. Energy Service Companies (ESCO) model

The energy service companies (ESCO) model is widely used across solar technologies to make them more efficient. ESCO guarantees a particular amount of savings compared to conventional business models and technologies (Langlois & Hansen, 2020). An ESCO assesses the efficiency opportunities and then suggests the measures to make a system more efficient. The complete model works in the following manner. Initially, consumers need to pay only a minimal amount for adopting a renewable energy source; this amount is less than initial investments made in conventional business models. Then, the banks pay the remaining amount. Finally, customers try to pay off the remaining amount to the banks by using the savings generated from sustainable technology. If they fail to do so or cannot save from the technology, ESCO is responsible for paying back to the banks (*ESCO Contracts – Energy Service Companies (ESCOs) – Analysis*, n.d.). The model's main benefit is that the owner has to invest significantly less initially and encourages the consumer to buy a sustainable option. Generally, ESCO model success is based on output risk: ESCO does not benefit if no energy is saved (*ESCO Contracts – Energy Service Companies (ESCOs) – Analysis*, n.d.). ESCO model possesses some challenges too, which are:

- The sector where the ESCO model is applied is to be assessed thoroughly to find the exact savings to be obtained
- Large scale projects may take very long to implement the ESCO model

Figure 5. ESCO business model (Findley, 2019)

3.2. Case of the Indian market

In the last few decades, the automobile curve of India is rising quickly. At present majority of vehicles are based on fossil fuels. These damage the atmosphere and contribute to global warming by emitting greenhouse gases. The Indian transportation sector is rapidly expanding. As a result, the disparity between crude oil output and consumption is increasing. India imports almost 70% of the oil it requires each year (Gujarathi, Department of Electrical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat-395007, India, et al., 2018). As a result, there is a pressing need to look at the elements and obstacles preventing sustainable and green systems like EVs. Electric vehicles are one of the most aspiring, cleaner, and long-term modes of transportation. Compared globally, the vehicle to person ratio is relatively more; yet, the demand is highly significant, and more elevated emissions. India accounts for 1.726 billion Mt of CO2 emissions(Gujarathi, Shah, et al., 2018). Thus, there is a need for urgency for the Indian automobile market to adapt cleaner options in EVs.

The market value of the Indian EVs is accounted to rise (*Electric Vehicle Market in India | Share, Size, Growth 2021 to 2026 With COVID Impact - Mordor Intelligence*,). The COVID-19 pandemic has influenced the Indian electric vehicle market, causing the closure of factory units due to ongoing lockdowns and travel restrictions across the country. The electric vehicle (EV) sector in India is still in its infancy. Due to different government policies, it is predicted to develop substantially quicker during the forecast period. These governmental policies are mentioned further in the literature. To lower their carbon footprint, e-commerce companies (such as Amazon) are starting programs to deploy e-Mobility for last-mile delivery (*Electric Vehicle Market in India | Share, Size, Growth 2021 to 2026 With COVID Impact - Mordor Intelligence*, n.d.). Furthermore, state governments are actively involved

in implementing legislation that encourages the use of electric vehicles. Despite taking all these efforts, the market share of EVs is very marginal.

There are many challenges that EVs face in the Indian market and globally. However, a few of them are highlighted below

3.2. Challenges and barriers faced by EVs globally and in the Indian market

This part mentions the challenges faced by EVs because they have not created their market base. The main challenges faced by EVs are discussed below:

1. **Battery Technology:**

   Batteries are the backbone of EVs. Developing a battery for EVs requires a substantial amount of resources and investments for its R&D. The high cost of EVs is comprised of the battery price per usable kilowatt-hour (Haddadian et al., 2015). Even after investing so much in battery technology, the EVs' driving range remains a significant concern. High costs, less driving range, long charging times are the main drawbacks of the batteries. Moreover, batteries have a lower energy density and weigh significantly high. At the same time, petrol and other gasoline are cheaper. Currently, lithium-ion batteries are widely used considering their long-range, but at the same time, lithium-ion batteries are costly. At present majority of the lithium-ion batteries are imported from various countries to India. It mainly imports from countries like the USA and Denmark (Sarkar et al., 2018). India is heavily dependent on imports since lithium is highly scarce in the region. Thus it increases the overall costs of the batteries and further cost of the vehicle.
   Along with that, sufficient R&D still has to be done to reduce the costs to increase the range of these batteries. Therefore, the government role in developing the infrastructure to help the manufacturers produce these batteries in India is essential (Sarkar et al., 2018).

2. **Charging Infrastructure:**

   As mentioned earlier, the range of the batteries is the primary concern for EVs. Due to the shorter range, batteries are to be charged frequently(Asghar et al., 2021; Haddadian et al., 2015). But to provide this, the nationwide charging infrastructure has to be developed and doing this could require the energy sector to rethink the power capacity available in the country. Thus, a colossal infrastructure is needed to overcome this challenge of battery charging in India, considering geographical dynamics. Furthermore, to reduce the user's driving range anxiety, it is recommended to have charging stations approximately every 100 km (Biresselioglu et al., 2018)

   Moreover, significant research has been carried out to integrate the grid power available at users' houses, shopping complexes and highways with the charging infrastructure. However, since the Indian EVs market is very marginal, manufacturers are yet to develop this infrastructure. Moreover, the demographics of India does are so huge that creating a uniform charging infrastructure throughout the country is very difficult and time-consuming. In addition

to this, there is a lack of electricity available in all parts of the country, making it more difficult for EVs penetration (Berkeley et al., 2018).

3. **Load Balancing at Grids:**

One significant obstacle to EVs adoption is the power balance at grids since EV charging stations require high power. The energy generated cannot be accumulated in large amounts; thus, balanced electricity demand (Asghar et al., 2021). Since the batteries used in EVs are rapidly charged, they consume twice the average household load, thus creating an imbalance at the grid. Plus, the lack of electricity availability in India causes severe issues on the grid. Therefore, alternative ways of charging the batteries have to be found to overcome this challenge.

4. **Consumer awareness and policies:**

Consumer awareness about the EVs' efficiency in comparison to the IC engine vehicles has to be created. Moreover, to convince the users to shift to EVs, the Indian government should plan building and promoting a separate network infrastructure to cater to the EVs' charging needs (Kester et al., 2018). This infrastructure should address the behavioural barriers faced by the users (Haddadian et al., 2015). It has been observed that the Indian consumer sometimes does not know the subsidies offered by the government. Therefore, awareness of such policies has to be carried out.

5. **Path dependent nature of the market (A hampering factor for EVs):**

According to Bohnsack,(2014), the automotive firms can be divided into two sections, i.e. the incumbent firms and entrepreneurial firms. These firms follow a path-dependent nature which poses the biggest challenge for EVs. Incumbent firms are used to exploiting the existing business model based on the current internal combustion technology. As a result, they are not ready to invest and explore a sector that demands a lot of funding-based research (*Driving the Electric Bandwagon: The Dynamics of Incumbents' Sustainable Innovation - Bohnsack - 2020 - Business Strategy and the Environment - Wiley Online Library*, n.d.). This presents a classic example of incumbent inertia.

On the other hand, the entrepreneurial firms are open to EVs related ideas and are ready to iterate different business models, but they lack the infrastructure (Chesbrough, 2010; Chesbrough & Rosenbloom, 2002). Thus, incumbent businesses do not eagerly promote the concept of EVs. However, recently a lot of entrepreneurial companies are facing these problems.

Even though EVs can reduce environmental degradation and increase efficiency, they find it challenging to develop the standard business model (Abdelkafi et al., 2013). Firms aim to establish the value-creating model by using various components based on their innovations. Incumbent firms have been spending a lot exploring new market segments for conventional engines (Kester et al., 2018). They would not take this intrusion from the entrepreneurial organizations promoting cleaner technology. It could wipe out their business model and, most

importantly, the investments they have put in. The main path dependency parameters applying to both the firms are dominant business model logic, complementary assets, and flexibility to adapt changes according to the contingent events. Thus, to maintain their status quo, the incumbent firm would offer complementary services, bundle new technologies from the existing products, and serve the current model's customers (Amit & Zott, 2001). Entrepreneurial firm lacks sufficient investments as compared to incumbents. Though they are very flexible and innovative with their models, they do not have enough resources to make a noticeable impact (*The Entrepreneur's Business Model: Toward a Unified Perspective - ScienceDirect*, n.d.). They have to stick to only one structure at any given time. They mainly depend on the sources of values generation to attract consumers and make them shift from the incumbents. The similar dynamics of incumbent and entrepreneurial firms is observed in India.

6. Lack of standardized business model

Any business framework can be distinguished in three major parts: the value proposition, value network, and the cost-revenue model (Abdelkafi et al., 2013; *How Information Gives You Competitive Advantage*, n.d.). Value proposition involves product type and the service content which the firm offers. Value network consists of developing and producing the components and the sales strategy, and its after-sales services. The Cost-revenue model is about the pricing strategy and governmental aids provided to support them (Bohnsack, 2014). In conventional vehicles, these parameters are so well incorporated in their business framework that they target mainstream customers globally (Ammar & Ouakouak, 2015). However, most of the vehicles developed in India are multi-purpose, thus attracting a huge customer base. EVs lack here the most. Their major problem is finding the appropriate value proposition and fitting it into the best framework possible for the Indian market. Many options are available to provide an efficient cost-revenue model. But due to the high initial investment made by a consumer, firms feel responsible for delivering some value-adding facilities, leasing the batteries that provide the after-sales advantages. All these services revolve around the value proposition they offer (Nian et al., 2019). Thus, entrepreneurial firms should benefit from the governments' new sustainable schemes, such as subsidies on the vehicle, to compete with the incumbent firms (Orsato & Wells, 2007). Unfortunately, the Indian market lacks such a standardized framework that can help EVs flourish.

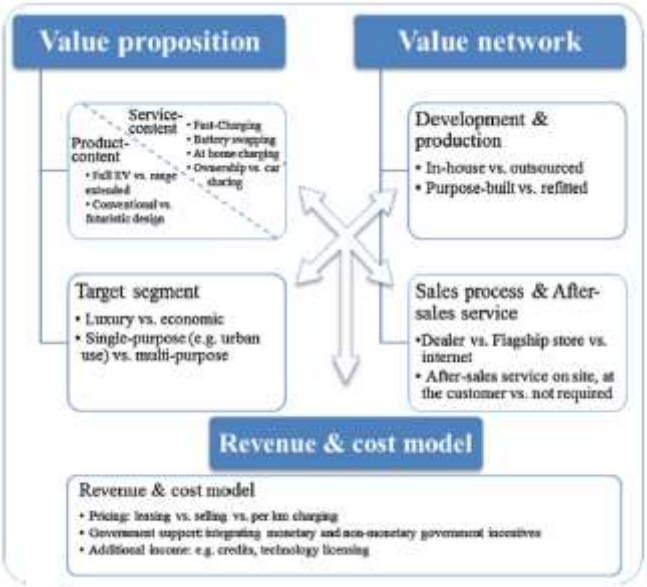

Figure 6. Electric vehicles essential business model components (Bohnsack, 2014)

3.3. Steps taken by the government to boost EVs market:

In the preceding, the Government of India has announced the National Mission for Electric Mobility (NMEM2020) (*FAMEDepository: National Automotive Board (NAB)*, 2020.). They aim to make every vehicle, including the public transport hybrid. The National Mission for Electric Mobility (NMEM) includes two primary aims that are intertwined:

1. Energy security at the national level

2. Development of domestic manufacturing capabilities across the whole spectrum of electric vehicle technologies (for example, batteries and their infrastructure)

The Ministry of Industries released its plans for Electric Mobility 2020 in January 2012, with many vehicles on the streets of India by 2020. To encourage consumers to buy dependable, economical, and efficient XEVs (all types of electric cars) that fulfil their pricing criteria and outcomes. The significant schemes provided by the Indian government with its time frame is given in the table below:

Sr No.	Scheme Name	Scheme details	Start date of scheme
1.	Alternate fuel for the surface transportation program	The Ministry of New and Renewable Energy (MNRE) in 2010 decided to give a 20 per cent subsidy on EVs for two, three and four-seater vehicles. Implementation of this scheme led to a massive leap in the sales of EVs	2010-2012
2.	National electric mobility mission plan 2020 (NEMMP)	The heavy industry department laid a plan of 14000 crore Indian rupees to develop the overall EVs infrastructure throughout the country. Various sub-plans such as FAME are developed under this mission to help EVs to succeed	2013
3.	Faster adoption and manufacturing of electric vehicles (FAME-I)	This program was developed to promote hybrid vehicles consisting of both gasoline and electric power trains. The main was to create demand creation by giving generous subsidies on using hybrid vehicles	2015
4.	Faster adoption and manufacturing of electric vehicles (FAME- II)	Under this scheme, the Indian government has allocated a budget of 10,000 crore Indian rupees. The scheme is planned for three years. It mainly aims at the vehicles using Li-ion batteries to promote it. Moreover, the government aims at setting up more than 2700 charging stations in the urban regions of the country	2019-2022

Table 4. Various schemes by the Government of India (*FAMEDepository: National Automotive Board (NAB)*, 2021.)

3.4 Literature conclusion

In this section, various global business models were studied. These models gave a brief idea about its implementation in EVs space globally. It also provided an idea about the critical parameter that should be considered while designing the successful framework. Further, the Indian market requirements were studied to get a brief idea about the Indian market needs and expectations. It also gave us an idea about the significant challenges present in the Indian market concerning EVs. This data is used further in chapter 4 to conduct interviews and get insights from the interviewees. This helped us check the feasibility of various models in the Indian EVs market and help formulate the framework discussed in the next chapter.

Chapter 4. Findings

4.1. Indian market requirements on EVs

This section discusses the insights gained from the interviews on Indian market requirements (see chapter 3). The morphological box concept will match these requirements and provide the reasoning behind selecting particular characteristics for the Indian market.

The concept of the morphological box (see chapter 1.4) is used here to gain insights into the Indian EVs market. It is evident in the literature review that various parameters are to be considered to develop a feasible framework for EVs. In addition to that, they have multiple solutions available for each of the parameters like battery infrastructure, financial services, and others. Thus, it is necessary to use morphological boxes to narrow down this wide selection to few relevant solutions. Further to finalize the selected options, interviewees were asked to opt for solutions based on their expertise and market knowledge. Thus, three morphological boxes are created to determine infrastructural needs, financial needs, and ownership perspectives.

4.1.1. Infrastructural and design needs

The first morphological box tells us about the infrastructure and design possibilities required for EVs in the Indian market. The important factors regarding the infrastructural needs of the EVs are taken from the literature review and specified as “characteristics” in fig 7 shown below. Next, the interviewees were given a brief idea about these “characteristics” and were asked to suggest the options that could be chosen for that particular characteristic. For example, in fig 7 shown below, the first “characteristic” is “Type of power supply”, for which an explanation was provided to the interviewee. Then they were given three options which are “ wired”, “wireless”, and “exchangeable batteries”. Now the interviewee was asked to comment on the feasibility of each option available. They could also suggest if there are any other options available other than these. A similar procedure was followed for each of the characteristics. In table 5, shown below, the most prominent option chosen for each of the characteristics by the corresponding interviews have been mapped. Also, the most prominent options have been highlighted in fig 7.

Characteristics	Parameters opted by each Interviewees		
Type of power supply	Wired (A, B, D, E, H, I, J)	Wireless (C, F)	Exchangeable batteries (G, J, A, F, D, I, B, H,)
Charging provider location	Private (A, B, C, E, G, I, J,F)	Semi-public (A, C, D, E, F, G, J)	Public (A, B, C, E, F, H, J)
Power connection	Single-phase (A, B, E, F, G, H, J)	Three-phase (A, C, D, E, G, I, J)	High voltage None
Grid information planning	Day-ahead (I, D)	Intra-day (I, B)	Real-time (A, C, E, F, G, H, J)
Power provider	Private Companies All interviewers	State companies (C, J)	Energy utility None
Type of bill	No bill (free) (D, J)	Fixed-rate (A, B, G)	Pay as usage (C, F, H, I, J, D, G)
Metering	No metering (D, J)	At charging facility (A, B, E, F, I, G)	Prepaid services (A, B, C, E, G, H, F, I)

Table 5. Parameters opted by Interviewees for infrastructure and design possibilities

The figure below illustrates the morphological box for infrastructure and design possibilities. And the highlighted boxes give us the most prominent option, which the interviewees chose according to table 5.

Characteristics	Infrastructural and design possibilities		
Type of power supply	Wired	Wireless	Exchangeable batteries
Charging provider location	Private	Semi-public (e.g., work place)	Public
Power connection	Single phase	Three phase	High voltage
Grid information planning	Day-ahead	Intra-day	Real-time
Power provider	Private companies	State companies	Energy utility	Independent provider
Type of bill	No bill (free)	Fixed rate	Pay as usage
Metering	No metering	At charging facility	Pre-paid services

Figure 7. Morphological boxes for Infrastructural and design possibilities

The detailed discussion with the interviewee on each characteristic chosen for the Indian market are given below:

- **Type of power supply**:
  In India, the wired power supply would dominate the EV market for the short term. The reason behind the prevalence of wired power supply is that most of the power lines in urban regions of India are wired, and thus, it becomes easy to incorporate wired charging. Also, it is a cheaper option as compared to wireless. The majority of the interviewees touted the exchangeable batteries option as a futuristic approach which we could most likely see in the longer term

  " India already has the wired power supply setup, so in my opinion, it is wise to use that option" – Interviewee A

- **Charging provider**:
  In these characteristics, the private option refers to the private company's charging station. The semi-public option refers to the situation where corporate companies will provide the required infrastructure for their employees. Finally, according to the stakeholders, the public infrastructure also seems necessary to facilitate the diffusion of EVs in the market.

- **Power connection**:
  In India, most households work on the single-phase power supply, whereas the public infrastructure supported by the government works on a three-phase supply. Thus both of them are necessary to support EVs.

  " It is necessary to provide both single-phase and three-phase power supply as majority household has single-phase supply" – Interviewee F

- **Grid information**:
  As grid balancing is one of the significant barriers when implementing the EV infrastructure, the interviewees believed that real-time grid planning would be helpful

- **Power provider**:
  In the urban regions of India, like in the city of Mumbai, the government has privatized the complete electricity transmission and distribution. Therefore private power provider is the only option available

  " Electricity pool by the private companies is the only source of electricity in the urban regions of India" – Interviewee D

- **Type of bill**:
  The vehicle usage is not defined for any consumer, and it varies from person to person; thus, we cannot opt for fixed-rate billing. Also, EVs' initial investment and operating expenditures and infrastructure are high, so free usage is not an option. So the best option available is of pay per usage option

  "I think India has a very price-sensitive market, so it is better to charge as per usage" - Interviewee C

- **Metering**:
  In a developing economy like India, offering free charging is not an option from a financial perspective. The interviewees suggested that a metering system should be installed at the charging station. Few interviewees said that to keep up with the digital revolution, pre-paid app-based metering services could be provided

For each of the characteristics discussed above, the set of options chosen best describes the infrastructural and design requirements of the Indian market for EVs. Hence, any framework developed should fulfil these.

4.1.2. Vehicle and battery ownership requirements

The second morphological box tells us about EVs' vehicle and battery ownership requirements in the Indian market. The factors that are important regarding the battery needs of the EVs are taken from the literature review and specified as “characteristics” in fig 8 shown below. Next, the interviewees were given a brief idea about these “characteristics” and were asked to suggest the options that could be chosen for that particular characteristic. For example, in fig 8 shown below, the first “characteristic” is “Property for vehicle”, for which an explanation was provided to the interviewee. Then they were given three options which are “ Customer”, “Vehicle provider”, and “Vehicle manufacturer” Now, the interviewee were asked to comment on the feasibility of each option available and opt for the most appropriate option. They could also suggest if there are any other options available other than these. A similar procedure was followed for each of the characteristics. Table 6 shows the most prominent option chosen for each characteristic, and the corresponding interviewees have been mapped. Also, the most prominent options have been highlighted in fig 8.

Characteristics	**Parameters opted by each interviewee (Vehicle and battery ownership)**			
Property	**Vehicle**	Customer (A, B, D, E, F, G, H)	Vehicle provider (C, I, J)	Vehicle manufacturer (None)
	Battery	Customer (B, D, H, A)	Battery provider (A, C, E, F, G, H, J, I)	Battery manufacturer (None)
Types of payment	**Vehicle**	Pay for equipment (A, B, D, E, F, G, H)	Monthly lease (C)	Fixed rental (I, J)
	Battery	Pay for equipment (B, D, H, A)	Monthly lease (A, C, E, F, G, H, J, I)	Fixed rental (C, G, J, I, E, B)
After sales-service provider	**Vehicle**	Customer (None)	Vehicle provider (C, D))	Vehicle manufacturer (A, B, I, E, F, J, H, G)

	Battery	Customer	Battery provider (C, D))	Battery manufacturer (A, B, I, E, F, J, H, G)
Ownership	**Vehicle**	Individual ownership (A, B, D, E, F, G, H, J, I)	Multiple ownership (C, I)	
	Battery	Individual ownership (D, I)	Multiple ownership (A, B, C, E, G, H, J, I)	

Table 6. Parameters opted by Interviewees for vehicle and battery ownership

The figure below illustrates the morphological box for vehicle and battery ownership possibilities. The highlighted boxes give us the most prominent option chosen by the interviewees, according to table 6.

Characteristics		Vehicle and battery ownership			
Property	**Vehicle**	Customer	Vehicle provider	Battery manufacturer	Vehicle manufacturer
	Battery	Customer	Battery provider	Battery manufacturer	Vehicle manufacturer
Type of payment	**Vehicle**	Pay for equipment	Monthly lease	Fixed rental	
	Battery	Pay for equipment	Monthly lease	Fixed rental upon usage	
After-sales service provider	**Vehicle**	Customer	Vehicle provider	Battery manufacturer	Vehicle manufacturer
	Battery	Customer	Battery provider	Battery manufacturer	Vehicle manufacturer
Ownership	**Vehicle**	Individual ownership	Multiple ownership		
	Battery	Individual ownership	Multiple ownership		

Figure 8. Morphological boxes for vehicle and battery ownership

The detailed discussion with the interviewee on each characteristic chosen for the Indian market are given below:

- **Property**:
  The vehicle owner would be with the customer in any case. Whereas for battery ownership, the literature and the interviewees agreed on providing both customer and battery providers ownership possibility. Since the Indian market imports lithium-ion batteries, to reduce the costs to the customer, a leasing option from the battery provider would be a good option

  " Indian market very prices sensitive market, if the overall prices go down by leasing the batteries that will make an impact" – Interviewee C

- **Types of payment:**
  The sentiments of the Indian customers are towards having the ownership of their vehicle. Therefore buying the car is an option, whereas, in the case of batteries, its inclusion increases the vehicle cost; hence interviewees suggested a lease-based model or rental option

  "It always a dream of the individual to own their own vehicle" – Interviewee G

- **After-sales service provider:**
  For the vehicle, the vehicle manufacturer should provide the services. The same applies to batteries. Since EVs arrangement is very complex, it is suggested to get it serviced from the manufacturer itself

  " Since EVs have very complex arrangement the vehicle and battery services must be provided by the experts only" – Interviewee J

- **Ownership:**
  Incase of EVs, individual ownership would foster its diffusion very fast, whereas, for batteries, multiple ownership is possible because of the adoption of the lease model, rental arrangement and also the provision of swapping station

For each of the characteristics discussed above, the set of options chosen best describes the infrastructural and design requirements of the Indian market for EVs. Hence, any framework developed should fulfil these.

4.1.3. Financial perspective

The third morphological box tells us about the financial requirements for EVs in the Indian market. The factors that are important regarding the financial needs of the EVs are taken from the literature review and specified as "characteristics" in fig 9 shown below. Next, the interviewees were given a brief idea about these "characteristics" and were asked to suggest the options that could be chosen for that particular characteristic. For example, in fig 9 shown below, the first "characteristic" is "Initial cost for vehicles", for which an explanation was provided to the interviewee. Then they were given four options which are " Customer", "Vehicle provider", "Vehicle manufacturer" and "battery manufacturer". The interviewee was asked to comment on the feasibility of each option available and

opt for the most appropriate option. They could also suggest if there are any other options available other than these. A similar procedure was followed for each of the characteristics. Table 7 shows the most prominent option chosen for each of the characteristics, and the corresponding interviewees have been mapped. Also, the most prominent options have been highlighted in fig 9.

Characteristics	**Parameters opted by each interviewee (Financial perspective)**			
Initial costs	**Vehicle**	Customer (A, B, D, E, F, G, H)	Loans from banks (B, D, G)	Lease from company (C, I, J)
	Battery	Customer (B, D, H, A)	Loans from banks (B, H, A)	Lease from company (A, C, E, F, G, H, J, I)
Operating costs	**Vehicle**	Customer (A, B, D, E, F, G, H)	Vehicle manufacturer (None)	Leasing company (C, I, J)
	Battery	Customer (B, D, H, A)	Battery manufacturer (None)	Leasing company (A, C, E, F, G, H, J, I)
Maintenance and service costs	**Vehicle**	Customer (A, B, D, E, F, G, H)	Vehicle manufacturer (None)	Leasing company (C, I, J)
	Battery	Customer (B, D, H, A)	Battery manufacturer (None)	Leasing company (A, C, E, F, G, H, J, I)
Incentives and subsidies		State government (A, B, C, D ,E ,F ,G, H, I ,J)	Central government (A, B, C, D ,E ,F ,G, H, I ,J)	

Table 7. Parameters opted by Interviewees for the financial perspective

The figure below gives you the morphological box for financial perspective. From the frequency graph shown, the best-suited box is chosen

Characteristics		Financial perspective		
Initial cost	Vehicle	Customer	Loans from banks	Lease from company
	Battery	Customer	Loans from banks	Lease from company
Operating costs	Vehicle	Customer	Vehicle manufacturer	Leasing company
	Battery	Customer	Battery manufacturer	Leasing company
Maintenance and service costs	Vehicle	Customer	Vehicle manufacturer	Leasing company
	Battery	Customer	Battery manufacturer	Leasing company
Incentives and subsidies		State government	Central government	

Figure 9. Morphological boxes for the financial perspective

The detailed discussion with the interviewee on each characteristic chosen for the Indian market are given below:

- **Initial costs**:
  As the vehicle owners will be with the customer, they would have to pay the initial costs. For batteries, two options are highly suggested by the interviewees, i.e. the customer could lease a battery from its provider or can buy for themselves with help from the banks

- **Operating costs**:
  The operating costs for the vehicle would be beared by the customer as they have the ownership of the car. The leasing company would account for the usage and operating costs in the leasing costs for the batteries.

  " As consumers are the owners of the vehicle, they will have to bear the costs of its operations" – Interviewee E

- **Maintenance and service costs**:
  The maintenance and service costs for the vehicle would be beared by the customer as they have the ownership of the vehicle. In the case of batteries, the leasing company would take care of the maintenance and service costs, and these costs will be recovered from the consumers in the lease costs

- **Incentives and subsidies**:
  Interviewees were of the view that there should a central policy governing the EV infrastructure and usage. In addition to that, state governments should formulate the policies according to their regional needs and dynamics.

" Government is trying very hard to promote the use of EVs by providing various schemes such as FAME. Companies and consumers should make proper use of that" – Interviewee C

Thus the selected box in the morphological arrangement gives us the best possible option of the particular parameter. In this case, it gives us the needs and requirements of the Indian market. Further, such a framework is to be designed that it fulfils all the boxes.

4.2. Findings on the business models

This section talks about the global business models being used for promoting EVs. A detailed comparison has been made using the data from the interviews. It also checks whether the specified models fulfil the requirements stated in the previous section or not. Questions were posed to the respondents based on the theoretical framework, literature cited, and the ideas made in the last section. Each of the interviewees and the expert were asked questions on the feasibility of the models. The interview questions and the reasons for asking them were previously discussed in chapter 2.

1. **Luxury specific purpose business model**

   In this model, the EVs provided are just for luxury or for particular purposes. Vehicles of these types are costly but at the same time offers salient luxury features. With regards to the use of this model in the Indian market, the interviewees had mixed opinions. India, a developing and huge nation, has variable demographics in which the target consumers of this model account for a significantly less percentage of the population. Interviewee A, when asked about this model, emphasized this point by saying

   "I think this model would not impact the Indian market much. This is because the rich people are very marginal who can afford to buy these expensive cars."

   Interviewee D also provided a reasoning scheme behind this model's failure - even if a company tries to get into the market using this model, it will get challenging to scale at such a size that it can help EVs penetrate the Indian market. Moreover, even if the manufacturing company can sell this kind of vehicle to its target consumers, it won't be easy to sustain on the same model for a more extended period. This is because there is a lack of infrastructure regarding EVs in India to complement these vehicles.

   " Let's say a company sells 2000 cars a year, but this number is like a drop in the ocean where you are trying to gain a majority of market share. Plus the lack of infrastructure will make it difficult to sustain decent sales numbers" – Interviewee D

   Considering the requirements stated in the previous section, each interviewees selection on the usage of this model is shown in table 8:

Model	Yes	No	Maybe
Luxury specific-purpose business model	C, H	A, B, C, D, E, F, G, I, J	

Table 8. Selection of luxury specific purpose business model by interviewees

2. Luxury multi-purpose model

The vehicles of this type are designed to meet luxury multi-purpose goals such as cost-effective price, high efficiency, and quick charging. These vehicles are categorized as multi-purpose since they can transport more than two people over extended distances. Even though this model aims for multi-purpose use, the argument is still about infrastructure throughout the country. Therefore this model will also face similar barriers as compared to the previous model discussed.

"Even if you are incentivizing the customer by providing the benefits, but the main concern is about the lack of infrastructure." – Interviewee F

Model	Yes	No	Maybe
Luxury multi-purpose business model	D	A, B, C, D, E, F, I,	G, J

Table 9. Selection of luxury multi-purpose business model by interviewees

3. Economic specific-purpose business model

The model is designed to appeal to the budget-conscious consumer who utilizes the vehicles for specific purposes. Firms strive to cater to urban areas in this strategy. The main issue with the urban population is that they are generally sustainable yet unwilling to make any more initial investments. To address this issue, businesses attempt to provide other service options to their customers, such as rental car services and carpooling services. For this model, one of the most significant shortcomings is that the customer does not have ownership of the car, and thus they tend to be more dependent on the car service providers, which is dynamic. Interviewee D made this point clear by citing an example:

"As you know, Viraj, life here in Mumbai is very fast-paced. So why should I waste my time booking a car on the application and waiting for it to arrive. I prefer having my car even though it's not an EV."

This model could be applied by aiming to provide B2B service to private players in the form of EV fleets. But the problem of infrastructure development remains.

Model	Yes	No	Maybe
Economic specific-purpose business model	I	A, B, C, D, E, F, G, H	J

Table 10. Selection of economic specific-purpose business model by interviewees

4. Economic multi-purpose business model

The model's goal is to give consumers the most efficient and cost-effective vehicle possible. However, because it is a multi-purpose utility vehicle, it is typically heavy and requires more batteries to overcome its range of difficulties. Since the vehicles in this model are multi-purpose and require a large amount of power, the cost increases instead of bringing down the price. As stated earlier in the report, the Indian market demands low initial investment vehicles; this model defeats this purpose. Thus most of the interviewees did not support this model.

Model	Yes	No	Maybe
Economic multi-purpose business model	J	A, B, C, D, E, F, H, I	G

Table 11. Selection of economic multi-purpose business model by interviewees

5. Better place model

In this model, the company delivers battery and charging-related solutions to consumers in the urban region. The battery infrastructure, battery ownership, and charging stations are all owned by the service providing company. The customer has to buy the electric vehicles and enter into a contract with the service providing company, which leases the batteries and develops the required infrastructure throughout the region. In this model, the consumer gets the ownership of the vehicle, and they do not have to worry about the battery lease and the required

infrastructure. Moreover, interviewees stressed that this arrangement is an excellent option to bring down the overall initial costs.

"According to me, the model explained would be a great fit in the Indian market. Reduction in the initial costs and provision of charging infrastructure will be a game-changer." – Interviewee C

"I feel that this model will be a good start to cater for the diverse market like India. Metropolitan regions of India should be targeted first." – Interviewee F

But the counter questions asked by the interviewees were mainly related to the usage pattern of the individual customer. They wanted to know if there is an arrangement to calculate the exact amount of usage by an individual to optimize the lease amount catering to their needs. The discussion of the point mentioned above ended with some queries, which were :

- The model does not have transparency about the lease amount, which is to be charged to the consumer. Every individual has a different consumption pattern, so the fixed lease amount is out of the question and calculating the variable lease amount is not structured in the model. Interviewee B stated that

"Yes, I think this model is quite promising. But we need to think about it from B2B and B2C perspectives separately. As giants like uber have sophisticated algorithms to determine their usage. But for an individual user, the usage tracking and the lease to be charged should be formulated."

- The marginal section of the society wants to own the vehicle and the batteries, which is not possible in this model

Model	Yes	No	Maybe
Better Place	A, B, D, E, F, G, H		C, I, J

Table 12. Selection of Better Place business model by interviewees

6. ESCO model

ESCO guarantees a particular amount of savings as compared to conventional businesses. An ESCO assesses the efficiency opportunities and then suggests the measures to make a system more efficient. The significant advantage of this model lies in the fact that the consumer could

get financial help from the banks in getting sustainable technologies, bringing down the initial investments for them. In this case, ESCO acts like the governing body, which determines the savings that EVs will make per unit of electricity consumed compared to per unit of fuel consumed for driving the same distance. These savings will be used to pay back to the banks or the lease companies. ESCO highly concentrates on the financial perspective and does not take into account the infrastructural need for EVs. Interviewee F said

" ESCO's can be implemented in EVs. It can help to reduce the financial burden. However, before the scalability in EVs space, it should be combined with any of the other models in the EV space like Better place and others you mentioned before."

Model	Yes	No	Maybe
Energy-saving companies	A, C, J		B, D, E, F, G, H, I

Table 13. Selection of luxury specific purpose business model by interviewees

Section 4.1 describes the Indian market requirements as suggested by the interviewees and the literature. Section 4.2 discusses the business model that has been implemented globally and how the interviewees reacted to it. The data from these two sections would be combined to formulate the business framework that satisfies all the requirements mentioned in section 4.1.

4.3. The business framework developed for the Indian market (Better Place and ESCO combined)

Discussion with the interviewees on the morphological box based requirements and models that could be applied to the Indian market was done in the previous sections. It was observed that the Better place and ESCO model were highly opted by the interviewees (see table 11&12). But both the model has their own shortcomings. The perspective about the Indian market regarding both the model is discussed below

Better Place perspective:

The better place model was highly praised and preferred by most interviewees to cater to the Indian market. However, there were a few shortcomings associated with the Better place model, which are:

- No structured approach on how the customer will be able to pay back the lease
- Difficult to implicate it in the B2C segment
- The model does not talk about ownership. Instead, everything is based on the lease concept

"I said maybe for better place model because this model does not explain anything about the lease structure" – Interviewee C

"This model seems quite good for the big companies like user taxis, but it is difficult to implement this for the individual consumer level. It does not mention how the consumer will be charged for the services. Since the usage of the individual consumer is very varying, the lease structure should be specified" – Interviewee H

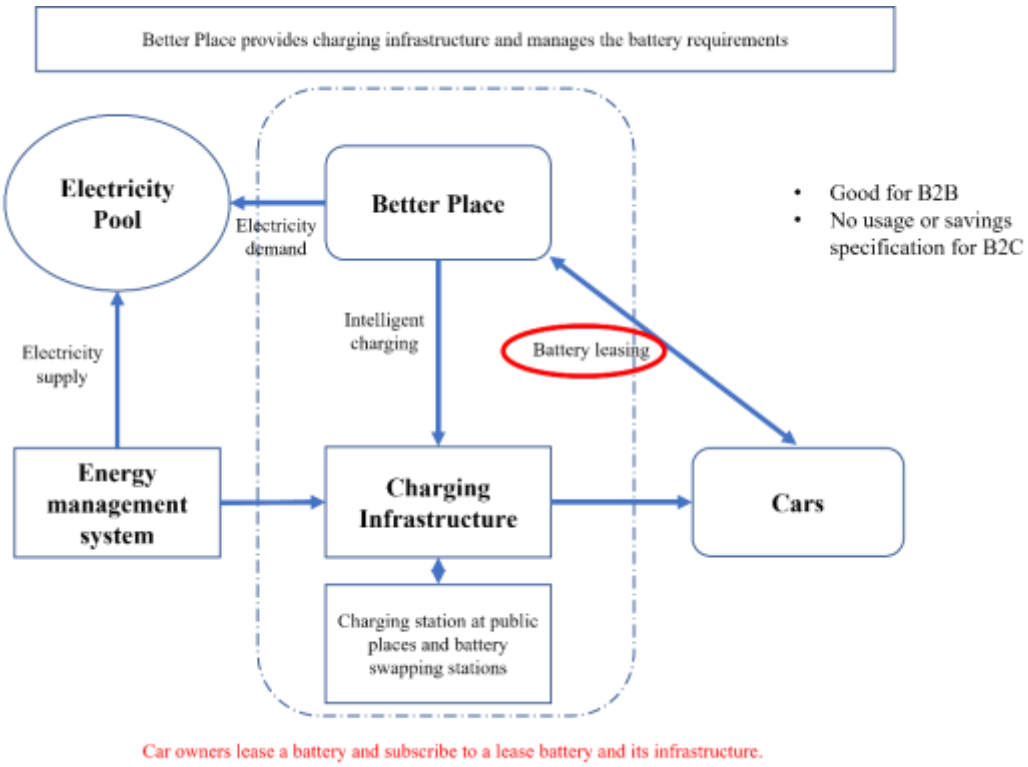

Figure 10. Better place model with its shortcomings highlighted

ESCO perspective:

After discussing with the interviewees on the ESCO model, many suggested (see table 12) to structure it in the automotive domain. For example, the ESCO would act as a governing body in the EVs market, ensuring that a specific amount of savings will be made depending on the charge usage and vehicle dynamics. For this, ESCO would work closely with the vehicle and the battery manufacturer to get accurate savings numbers. Interviewee G supported this by saying:

“ ESCO can work with battery and vehicle provider to calculate the actual savings generated by EVs.”

But the only shortcoming to this model is that it does not provide any plan to develop the infrastructure for EVs.

Combination of a Better place and ESCO model

Based on the feedback on both the models, a comprehensive business framework could be suggested for the Indian EVs market.

We know a better place model provides us with complete battery infrastructure for EVs. However, customers have to buy the vehicles and lease batteries reducing the initial cost, the primary barrier for EVs adoption. But the problem here lies in the financial perspective, i.e. there are no incentives provided to attract the consumers to buy EVs. Also, there is no leasing structure provided regarding the batteries. This problem could be easily solved if we incorporate the ESCO model. ESCO also acts as a guarantor where the consumer is given an assurity that a particular amount of savings compared to other IC vehicles is generated.

Moreover, ESCO tries to reduce the financial burden on the customers by providing two provisions. First, ESCO helps the consumer in getting financial aid from banks. Second, the interest amount is decided in such a manner that the savings generated by EVs per month are almost equivalent to the interest. Therefore, the lease charged by the Better place company will be similar to the savings generated by using EVs and as specified by ESCO.

If the savings promised by ESCO is not achieved, then the ESCO is liable to pay the difference to banks or the leasing company. The model also enables an individual to have complete ownership of the batteries by taking loans from banks. So, finally, we have a model where ESCO solves the financial lease problem. On the other hand, the better place model facilitates the consumers by providing the infrastructure needed for EVs to flourish. Thus the shortcomings of both the models are satisfied by combining the models. And this becomes the framework for the Indian market for EVs.

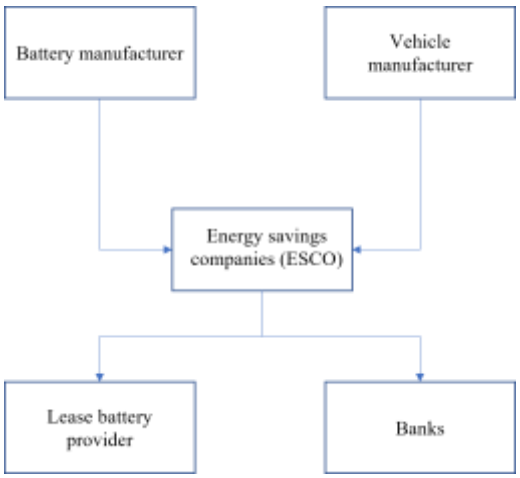

Figure 11. ESCO model formulated for EVs

The above figure shows that ESCO works closely with vehicle and battery manufacturers to determine the savings generated compared to the IC engine vehicles. Further, this savings would be used to pay the lease to the infrastructure and battery provider company. The following section has the final framework.

4.3.1 The Business Framework:

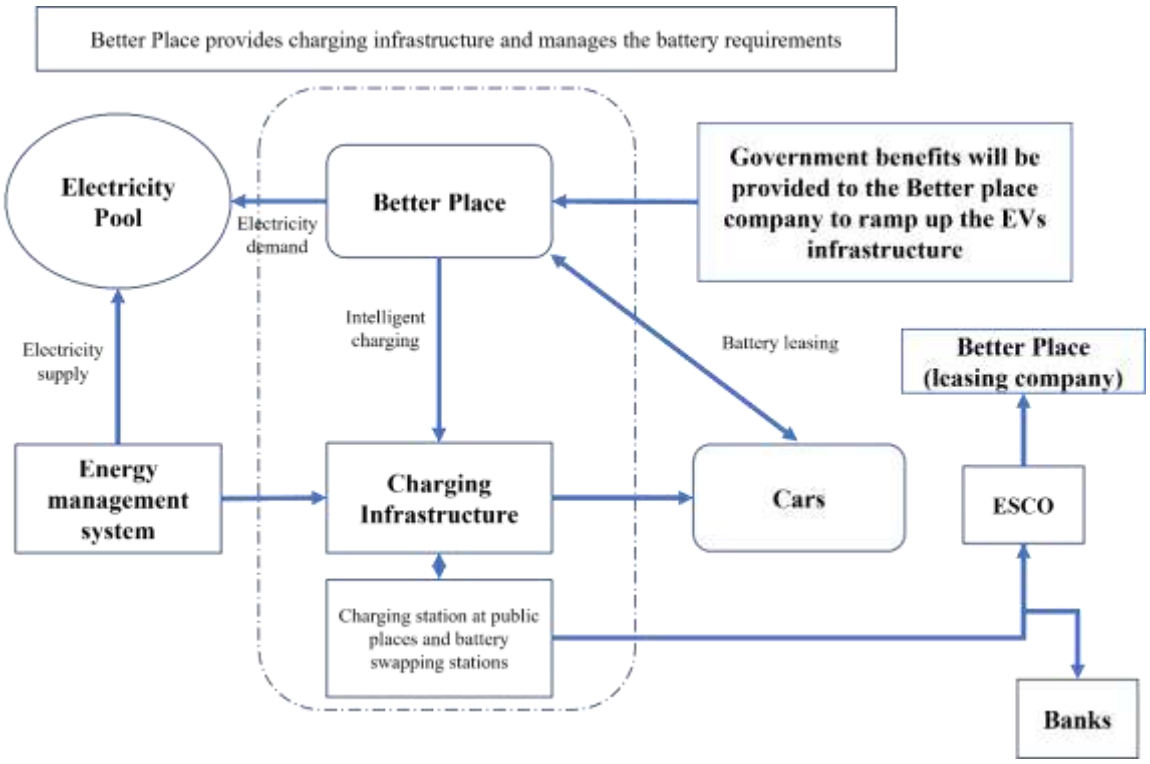

Figure 12. Framework for EVs in India

In this framework, both ESCO and Better place models are combined. The final implications of the framework, as drawn with the discussion with interviewees, are

1. Customers will have to buy the car from the vehicle manufacturer and lease batteries from a Better place type company. As batteries account for the high initial costs for EVs. This arrangement will help to bring down the initial costs of EVs. Customers will also have the option to buy their batteries from a better place type company.

2. Better place type company will be responsible for developing the complete charging infrastructure throughout the city:

The responsibility of developing the complete EVs infrastructure will be given to the better place type company. A better place type company will also provide the batteries to the consumers and its maintenance services. Charging infrastructure to these batteries and vehicles will be developed at the consumers home and workplaces. They will also come up with charging stations at public places like parks, shopping malls and will also create swapping station's for batteries

3. Electricity to this charging infrastructure will be provided by the private companies, i.e. from the electricity pool:
   As mentioned earlier in section 4.1, Fig 7., the electricity in India's urban regions is mainly provided by private companies. Thus the better place type company will procure electricity from the pool of these private companies. Moreover, electricity will be provided in both single-phase and three-phase connections, considering the Indian market demands.

4. Energy savings companies (ESCO) will work closely with the automobile and battery manufacturers to calculate and get the exact amount of savings that will be generated by using EVs as compared to the petrol vehicles

5. These savings will be equivalent to the lease charged for batteries or the interests to be paid to the banks if the consumer takes any loans to buy the batteries. This amount calculated and paid to the better place company will help them develop the overall battery infrastructure. ESCO can be any authorized governmental or private company. ESCO will act as a guarantor to the leasing companies and the banks too. If the promised savings are not generated, ESCO is liable to pay the difference to the leasing companies and the banks

6. Government benefits will be provided to a better place for setting up the infrastructure. For example, better place type companies can use schemes such as the National Electricity Mobility Mission Plan (NEMMP) and Faster adoption and manufacturing of EVs (FAME) schemes to set up the infrastructure for batteries around the country's urban regions. Details of all the schemes are provided in section 3.3.

"The combination ESCO model with Better place model suits relly well. ESCO fulfils the financial needs, and the better place looks after the infrastructural needs." – Interviewee A

"Combining better place and ESCO is a good idea. The model framed seems easy to implement and also impactful."- Interviewee C

"I think this model creates a win-win situation for all the stakeholders involved in the market, and it satisfies all the needs as discussed by us in the morphological boxes."- Interviewee F

" This model gives a perfect combination of models for the Indian market; it also utilizes the governmental supporting schemes for EVs effectively." – Interviewee H

The requirements of the needs of the Indian market, as stated in section 4.1, are completely fulfilled by this framework. Thus this framework seems to suit well for EVs to penetrate and make their market dominance in the urban region of India.

The development of this framework also answers the main and also the sub research questions of this project.

Chapter 5

5.1. Conclusion and discussion

The main objective of the research was to understand the Indian EVs market and suggest a feasible model that can help EVs penetrate the market. Therefore, the main research question was:

*" **What can be a business model framework for EVs to help them succeed in the Indian market?"***

Based on the interviews, the conclusion drawn was that for bringing EVs into the Indian market, the policymakers and the private companies would have to work together. In addition to it, the reduction in initial investment to buy EVs and the infrastructural development should go hand in hand. From the interviews, it was clear that for increasing the uptake of EVs in the Indian market, a lot of research is needed from the companies and government side to simultaneously reduce the cost and build the mega EVs infrastructure.

From the analysis of the interviewees regarding the infrastructure and design possibilities, few characteristics were prominent. The interviewees were confident in using a wired power supply in the short term for urban cities, and exchangeable batteries could replace as its development fosters. To increase consumer convenience, interviewees emphasized developing the charging infrastructure at both public and private places. Proper grid planning is also required to avoid variations in the power supply, which could be managed by developing a real-time grid balancing plan. In the urban regions, the power suppliers are primarily private companies for which the government has tendered. Therefore they are the only source of power provider for charging stations. The billing scheme for the usage of this infrastructure should be based on the 'pay as you use' scheme.

Interviewees pressed for the complete ownership of the vehicle by the consumer, where for batteries and consumer ownership, the battery leasing option could be more feasible. It will help reduce the initial costs. Since the cost of batteries is a significant expense for the consumer, it is better to lease them every month. The after sales-services for the vehicle and the batteries should be provided by their manufacturers.

A lot of discussions was done on the financial part of EVs, batteries and charging stations. It was decided from the discussion that the customer should bear the initial vehicle costs as they get complete ownership, whereas, for batteries, the lease model would be a good option. To boost the EVs segment, support from the government is of the utmost importance. Interviewees referred to of incentives and subsidies as the financial instrument. The grants in the Indian market are given on two levels; central and regional level. The central level subsidies would be fixed and unified throughout the country, and the state subsidies are formulated keeping in mind the needs at the regional level.

Following this study on Indian market requirements. A detailed discussion on the global business models on the EVs concluded that the prominent business models existing globally might meet the

requirements of the Indian EVs space. Still, it won't significantly impact if the models are not modified according to the market needs. In luxury specific-purpose, luxury multi-purpose, economic specific-purpose or multi-purpose economic interviewees, these models fulfil requirements on the consumer experience side. Still, they lack a concrete solution that can help create infrastructure and buzz about EVs in the Indian market. Most of the interviewees have positive views for a better place model. They said that it gives assurity about the complete development of the battery infrastructure for EVs, reducing the initial cost, which will ramp up the penetration of EVs in the market. But the only shortcoming mentioned was that the model lacks the leasing structure, which can be a threat to its implementation on a larger scale. Moreover, the ESCO model provides financial assurity by giving us the data on how EVs can make much savings compared to their predecessors. Interviewees mentioned that this model offers an excellent financial perspective, but it cannot develop the infrastructure for EVs.

A brief discussion was done on the selection of one of the models mentioned. But it was concluded that no global model could directly be implemented in the Indian market. Since the market requirements are very different from other countries, any model being used must be modified according to the Indian market needs. However, the better place and ESCO model were the best choices of the interviewees. Since the Better place model provides a complete solution to the infrastructural problem and ESCO provides the financial solution, it was suggested by the interviewees to try and come up with the framework combining these two models.

After the qualitative data analysis consisting of a literature study and interviews, a business framework was designed by combining the Better place and the ESCO model. This framework helped in creating a win-win situation for the urban market of India. The initial costs of the vehicle came down, and the infrastructural needs were also fulfilled. The ESCO solves the financial shortcoming of the better place model. ESCO guarantees a particular amount of savings generated by EVs as compared to conventional vehicles. These savings are further used to pay the lease amount to the battery lease company. The battery lease company develops the infrastructural requirements under a better place model. Interviewees were asked for feedback on this model, and most of them were satisfied with it.

Thus this combination gives us the framework that fulfils the needs of the Indian market need as stated in section 4.1. This framework developed also answers the main research question of the thesis. Moreover, it also answers all the sub-question mentioned in section 1.3. Thus this research is concluded with the development of this framework.

5.2 . Limitations of the research

As all the research has some limitations, limitations for this research are mentioned below:

- The complete research is done targeting just the urban region of the Indian market. The framework developed is also for urban areas. The requirements of the other parts like the rural region are not considered
- The framework is developed just by using the data gathered from the literature and the interviews of the stakeholders. There are many other factors to be considered for the implementation of this framework in real life
- Many huge incumbent companies were approached for scheduling the interviews for the research. The data from these companies could have helped a lot, but due to the company's privacy policies, the interviewees were not able to disclose the information
- The sample size of the interviews was limited to ten interviews. Due to and the lockdown imposed in India because of the COVID situation, many stakeholders refused interviews
- Only one framework has been developed. Other frameworks can also be studied and developed
- Because of the COVID-19 situation and target region being India, all the interviews were taken on via the zoom platform. Taking interviews face to face has many advantages. Moreover, many interviewees knew very little about this online setting (Abdelkafi et al., 2013)

5.3. Recommendation

There is future scope to this research. Recommendations for different domains are mentioned below:

5.3.1 Recommendations for scientific research work

- The thesis mainly focuses on the qualitative research part. To get more thorough insights into the developed framework, quantitative research can be done
- The sample size of the interviews is ten in this research. This sample size can be increased to get the better insights
- Only successful business models related to EVs are studied in this research. More models can be studied further

- The framework developed focuses just on the urban region. The feasibility of this framework on a nationwide scale can be checked

- The framework developed can be made more precise, indicating the specific needs for B2B and B2C market base

5.3.2 Recommendations for Indian automobile companies

- The Indian market has very steep competition between the incumbent and entrepreneurial firms. This competition hampers the penetration of EVs in the market. Collaborative work from both incumbent and entrepreneurial companies needed to be done

- Standardization of EVs components is needed to be done, so that charging of vehicles can be done at any place have a charging infrastructure

- The main competition to EVs is from the IC engine promoting companies. Instead, they to shift to EVs and enable them in public space

- Companies should also provide some incentives to the EVs buying consumer to promote it

5.3.3 Recommendations for Indian policymakers for EVs

- There is a great lack of awareness about EVs in the Indian market. The policy should be framed to create awareness about the EVs

- A stricter policy towards the standardization of components can be formulated. This will help to have one unified charging infrastructure for all types of EVs

- Some policies to start curbing the IC engine vehicle should be formulated. This will make people shift towards EVs

- As mega infrastructure has to be created throughout the country, policies helping the local workers for developing this infrastructure should be created

5.3.4 Management of Technology relevance

According to the course guidelines, any MoT thesis should have a scientific-analytical study and highlight many technical aspects such as technology, strategy, innovation, etc. Moreover, by doing this kind of study, the outcome of the thesis should be such that it helps stakeholders or the organization involved to improvise their technology or the process qualitatively.

This thesis, "Business model framework for electric vehicles in India," aims to develop a framework to help EVs penetrate the Indian market. The thesis uses scientific study and methodologies which are studied in the many courses of MoT. A detailed stakeholder analysis is also done in the thesis, along with the content analysis consisting of taking interviews of the stakeholders and then drawing relevant data through it. From all the data obtained, I finally developed a business framework with the help of many strategies studied during the course. To come up with the deductive conclusion, the main research question is parted into many sub-research questions to get the detailed answer to all the aspects. This was done following the research methodology course studied in the curriculum.

Thus the research represents a scientific study relevant to a particular technological domain representing the business perspective of that domain by using methods learned during the MoT courses. The complete scientific research is represented simply for every layperson to understand it.

5.3.5 Personal reflection and contribution towards science

The framework developed will be a good step to start the EVs penetration in the Indian market. In a country like India, which has vast geographical dynamics and a price sensitive market, any business model must develop a complete charging and battery infrastructure to kickstart the journey towards going electric. To overcome this geographical and demographical challenge, no single business model can be efficient as every region has its demands and varying dynamics. Therefore, I studied the urban areas of my framework since it is a good start towards the electric mobility vision. Moreover, we know that people in metropolitan India are more aware of the concept of sustainability and benefits of the EVs. So my framework should initially be applied in the urban region to check its feasibility so that modifications can be made if necessary.

The next step should be extending the use of this model by modifying it by understanding the dynamics of every region. All the stakeholders should come together to promote the use of EVs. The initiatives by the government in terms of subsidies should be used effectively. Moreover, policies should be implemented to curb the use of gasoline vehicles and promoting EVs. Many of such frameworks should be developed and implemented in the coming days so that the vision of EVs in the Indian market becomes a reality.

This research would provide a foundation to the science community by giving them a reference about the framework building in regards to EVs and also give them a thorough h idea about the Indian market and its dynamics

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