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FEASIBILITY OF ELECTRIC VEHICLES IN INDIA: AN INTERPRETIVE STRUCTURAL MODELLING APPROACH

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Abstract

Electric Vehicles (EVs) the current technological demand & yet advent in many countries is the modern-day demand. Currently, it practically exists in some European Countries nicely & yet to be implemented in a developing country like India. The objective of this research was to analyse the factors, & final sub-elements of the factors, for implementation of EVs in a developing country India using Interpretive Structural Modelling (ISM) approach. The major findings in this research are three folds. Electricity availability, which somehow was able to counter the demand for the year 2019-20 still with a 0.5% deficit. Infrastructure for charging stations in a large population-dense country. Appropriate Government Policies & Intervention required to tackle these situations were the three main driving factors for the successful implementation of EVs.

Keywords*: Electric Vehicles, interpretive structure modelling, feasibility of EV's, VAXO model, industrial engineering tools*

INTRODUCTION

"Any vehicle propelled by an electric drive-train taking power from a rechargeable battery or from a portable electrical energy source (like fuel cell [14], solar panels, etc.) which are manufactured to utilize on public roads is known as Electric Vehicles (EVs)" or in simple words we can say "A vehicle which works on electric traction using an electric motor as its propulsion source is called Electric Vehicle". EVs practical existence first came in the mid-nineteenth century, when electricity was the preferred methods over the rest of propulsion methods, giving a level of compatibility and ease in functionality that might not be achieved by the internal combustion engine cars at that time. Various ESS topologies including hybrid combination technologies such as a hybrid electric vehicle (HEV), plug-in HEV (PHEV) [1].

As the name EVs suggests, Electric vehicle does not use any combustible fuel like diesel, petrol or gasoline as is used in internal combustion engines& purely run on cleaner energy source using electric batteries & motor for its propulsion. Therefore electric vehicles can replace internal combustion engine automobile, and can help in minimizing the problem of air pollution, depletion of natural resources, reduced dependence on crude oils, global warming& possibly many health hazards due to bad air quality etc. The concept of electric vehicles has drawn a good amount of interest in peoples in few past decades due to rising carbon footprint and other environmental problems caused by fuel-based vehicles& the most common is global warming which generally takes place due to combustion of gasoline results in the emission of greenhouse gases.

Electric Vehicles (EVs) as an option for transportation policy is being considered by many countries across the world. But their efforts are affected by their stage of economic development, availability of energy resources, technological capabilities, and political will to solve climate change issues on a priority basis. The continuous growth of India's economy, population, and urbanization has changed the mobility of peoples in the past few decades. According to World Bank data, cited by NITIAayog**.** The demand for transports in India has increased by 8 times as compared to 1980 which is maximum among all Asian nations**.** Many countries have considered EVs as an element of transportation policy but their responses vary according to their stage of economic development, energy resource endowments, and infrastructural capabilities. There is a particular set of factors in India that are encouraging to the aim of sustainable mobility and have created a chance for fast adoption of EVs replacing ICE vehicles.

These are listed as:

1. A relatively good availability of reusable resources mainly renewable energy.
2. Good availability of technology and manpower for manufacturing purposes.
3. Consumers transition & transitional infrastructure that can afford opportunities to implement technologies at various rapid stages of development.
4. An Indian culture that encourages sharing of resources and assets for the overall familiar welfare.

These are the circumstances which support India to proceed on EV policy which carefully ensures the fast electrification of vehicles as globally many large economies seem to take significant steps towards the replacement of IC vehicles with EV. India's growth prospects produce tendencies for building leadership in EVs manufacturing. EV policy will promote a

path that will be particularly based on the characteristics of India and steps for building a global relevance in the automobile sector. The key points of the EV policy are:

1. Minimizing the fuel consumption of transports.
2. Increasing the adoption of electric and environment-friendly energy vehicles by the peoples.
3. Promoting modern technology through adoption, transformation, research, and development.
4. Improving transportation facility which is used by ordinary peoples for transportation of goods or personal use as EVs are a much efficient vehicle over IC engine vehicles.
5. Minimize pollution in cities.
6. Setting up EV manufacturing ability that can compete globally with other manufacturing nations.
7. Promoting an increase in employment in this rising sector.
8. Promoting environment friendly & sustainable technological development.

India has a unique mobility pattern as compared to other countries. An EV policy for India should be made particularly for Indian conditions. There is the rapid growth of vehicles in India, ownership of vehicle per 1000 of the population was 53 in 2001 and has increased to 167 in 2015, and the type of vehicles used in India is different from other countries. India's auto-segments are different from most other countries across the world and use a huge variety of motorized vehicles on roads. According to data of the last six-year sales, the vehicles on Indian roads are categorized as:

1. Buses and heavy-duty vehicles like trucks, which are 3% of the country's total vehicles.
2. Four-wheelers costing less than □1 million are 12% of the country's total vehicles.
3. Luxury four-wheelers which cost more than □1 million, which is 2% of total vehicles.
4. Three-wheelers, including tempos, which are 4% of the country's total vehicles.
5. Two-wheelers, which are 79% of the country's total vehicles.

Figure 1: An electric Vehicle charging from charging booth

IDENTIFICATION OF ELEMENTS

a) Infrastructure:

To successfully deploy EVs in urban areas, increase quality and access of charging booth infrastructure [15], and developing a supply chain for charged batteries is necessary. Charging infrastructure should include low speed charging facilities on workplaces and homes and fast charging stations located in public places especially in shopping malls & parking fields to make possible quick charging which hardly takes 10 - 15 minutes. A smart-grid environment promises to assist the addition of EVs into national grids by enabling both EV-charging and discharging (G2V and V2G) load. Globally, several countries have made policies and plans for improving infrastructure for EVs not only in a state or a town but to the entire regime were to implement this technology so to make electricity readily available which is its first fuel. Increasing battery capacities and the development of more widespread charging opportunities may reduce the peak demand from EV charging [8].EV coordination with the vehicle to grid (V2G) technology for the cost-benefit analysis [9].

b) Impact to economy:

Shifting of mobility to EV may launch new business opportunities. These opportunities will be generated in areas such as charging and swapping infrastructure, service, or integrated transport. In India, many energy players have entered the mobility industry and some traditional power companies are trying to enter in charging infrastructure business, and infrastructure companies are exploring possibilities in the battery business. Transformation and up-gradation of small & medium sub-system & auto-integrant industries is also an important task. Such a large number of small and medium companies are auto-component companies for diesel/petrol vehicles which provide large employment to peoples. Many of these small companies will face challenges in their survival as EV replaces fuel-based vehicles. It is important to develop a plan to save such industries and provides help to them during the transition to EV components manufacturing can be a saviour policy for these organizations or companies.

An increase in transport vehicles based on IC engines negatively impacts the economy considerably, apart from health issues caused by pollution. Unpredictable Crude oil price adds uncertainty to an already increasing import bill, while also needing huge expense on oil refineries and related distribution infrastructure. There are many studies that show's overall positive impact on GDP on the introduction of EVs in fuel importing service dominated economies. One study has estimated that shifting to electric vehicles would cause a 1% increase in EU GDP. Another study shows net social and private benefit, which is in the range of $300 and $400 per EV. The battery manufacturing industry in India with renewable power generation can become bigger than the total amount spent on the import of crude oil. This would provide a huge advantage to the Indian economy. The loss of revenue for governments from the taxes on the oil industries is expected to be replaced by higher tax revenues in other economic sectors & even though

in some European countries the amount at which the crude oil is available if electricity as a fuel for EVs is made available at the same price, then the tax gained by the government is comparatively higher then tax gained on crude oil. And hence we can say, it will impact directly to the economy positively as well as negatively.By overcoming the problem of EV, it can boost the economy and will enormously change towards National Economy. It will increase employment in the electrical industries of car accessories like batteries, charging booths, etc.

c) Cost of vehicle:

Currently, two-third of the cost of an EV is because of the battery and power electronics. The commonly used battery materials are Lithium-Ion (LiON) and nickel-metal hydride (NiMH). Several factors like a gap in demand and supply, low& uneconomical volumes, etc., makes the manufacturing of EVs are more expensive. Today, an EV's motor along with battery & its power electronics can become 6 to 7 times more expensive than an IC engine increasing the ex-showroom price. According to Source: BloombergNEF, Most of the Indian car buyers purchased vehicles priced below $10,000 in 2018 while the most economical electric car available in India is Tigor EV whose ex-showroom price is $12,433. That's why the cost of vehicles is an important factor especially in developing countries like India.

d) Electricity:

As India is a developing country the power the requirement is continuously increasing and generation also increasing with demand but growth is low which was 0.26 % in 2019-2020. In India, power generation is less than its requirement. Introducing electric vehicles will lead to an increase in demand of electricity, so to meet this demand there will be a huge requirement for an increase in power generation. And possibly electricity generation can be increased by working on various technological fronts to produce electricity either by renewable energy resources or on coal-fired power plants (which is currently producing a major portion of electricity requirement with a share of 59.3% of total electricity generation in 2017). The general topology of the electric vehicle is composed of three distributed energy resources, the proton exchange membrane Fuel Cell is the prime and important source and a hybrid energy storage system includes batteries and super capacitor devices as the alternate source [4]. The given below is a statistic which represents the past ten years of electric energy scenario & correspondingly reflects the essential need of electricity which is the only fuel of EVs.

Table (i): Energy generation and growth from conventional sources during

Year	Energy Generation from Conventional Sources (BU)	% of growth
2009-10	771.551	6.6
2010-11	811.143	5.56
2011-12	876.887	8.11
2012-13	912.056	4.01
2013-14	967.150	6.04
2014-15	1048.673	8.43
2015-16	1107.822	5.64
2016-17	1160.141	4.72
2017-18	1206.306	3.98
2018-19	1249.337	3.57
2019-20*	1252.611	0.26

Table (ii): Energy supply position of India

2009-10 to 2019-20 * Up to March 2020 (Provisional), Source: CEA	Energy				Peak			
Year	Requirement	Availability	Surplus(+)/Deficts(-)		Peak Demand	Peak Met	Surplus(+) / Deficts(-)	
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
2009-10	8,30,594	7,46,644	-83,950	-10.1	1,19,166	1,04,009	-15,157	-12.7
2010-11	8,61,591	7,88,355	-73,236	-8.5	1,22,287	1,10,256	-12,031	-9.8
2011-12	9,37,199	8,57,886	-79,313	-8.5	1,30,006	1,16,191	-13,815	-10.6
2012-13	9,95,557	9,08,652	-86,905	-8.7	1,35,453	1,23,294	-12,159	-9.0
2013-14	10,02,257	9,59,829	-42,428	-4.2	1,35,918	1,29,815	-6,103	-4.5
2014-15	10,68,923	10,30,785	-38,138	-3.6	1,48,166	1,41,160	-7,006	-4.7
2015-16	11,14,408	10,90,850	-23,558	-2.1	1,53,366	1,48,463	-4,903	-3.2
2016-17	11,42,929	11,35,334	-7,595	-0.7	1,59,542	1,56,934	-2,608	-1.6
2017-18	12,13,326	12,04,697	-8,629	-0.7	1,64,066	1,60,752	-3,314	-2.0
2018-19	12,74,595	12,67,526	-7,070	-0.6	1,77,022	1,75,528	-1,494	-0.8
2019-20*	12,90,247	12,83,690	-6,557	-0.5	1,83,804	1,82,533	-1,271	-0.7

from conventional sources during

e) Impact to Environment:

Internal Combustion engines are one of the main sources of pollution in India. They negatively affect the environment, metazoan, and human health. Emission from internal combustion engines of vehicles causes two-third of air pollution in urban areas& due to fuel-burning poisonous gases like carbon monoxide, nitrogen oxides, particulate matter of Sulphur & unburned hydrocarbons generally released. The current ban on older IC cars in some cities showed a positive influence on air quality. Electrification of vehicles will lead to a reduction in these emissions and it is quite possible that it may cause a positive impact on air quality index. In addition, private electric cars and taxis also provide the benefits of reducing CO, NO_x, NMHC, and PM_{10} emissions [3].

f) Raw material:

Batteries are the most important part of electric vehicles; availability of raw material like lithium can become a challenge for the production of batteries in India. The occurrences of Li ores (lepidolite, pegmatite, spodumene and hiddenite) in India are very small and found in only a few selective places. For instance, Bihar mica belt consists of Lepidolite and another ore of Li is pegmatite, which is found in the Chitalnar, Mundwal and Govindpalregions of south Chhattisgarh. The intention to prefer lithium-ion batteries over others are usually because of its higher energy density, high power density & longer life span. Apart from this, a lot of newer materials are used in EVs compared to their ICE vehicles counterpart. Components which are considered essential for examine the consumption of material in EVs are Glider (also known as the body), Power train system &Battery pack. Polymer electrolyte fuel cells are considered as a good alternative to remove the CO_2 emission in the transport sector [7].

g) Government Policies and intervention:

Government policies will play a vital role in promoting manufacturing as well as the adoption of EVs in India. This will lead to increased penetration of EVs in the Indian market. There are some crucial requirements for the fast adoption of EVs which are as appropriate infrastructure, themed-regulations, and policies. A framework can be made to encourage these policies and regulations. The government's purchase subsidy policy and limited travel policy can promote [2]. The themed-regulations and policies under this substructure can enable faster and smooth implementation of EVs in India. A good to go example is European countries whose Vice President of European Commission Maros Sefcovic announced a policy "European Battery Alliance" in 2017 to create a competitive manufacturing value chain in Europe with sustainable battery cells at its core. So, Government policies must be implemented from time to time to make India a clean energy transition hub.

h) Efficiency and sustainability:

The electricity source of EVs should be considered while determining overall vehicle efficiency, and while powering an EV by coal is not the same eco-friendly as using electricity from renewable sources, this doesn't mean coal-fired charged EVs are not as efficient as ice vehicles. EVs were still more efficient than ice vehicles. While converting energy from coal-fired plants to power the EV motor is about 85-90 percent efficient. The invention of electric vehicles can lead to a huge contribution to the movement to low-carbon regions, because of its capability of lower pollution feature [5]. The policy recommendations provide many insights for stakeholders to invest in electric mobility [10]. "EVs can convert more than 77% of the electrical energy from the grid supply to power at the axle or wheels. Whereas Conventional ICE vehicles can only convert about 12% to 30% of the energy present in fuel to power to the wheel," as per US Department of Energy". On similar notes, this technology is sustainable over bio-fuel technology because it won't lead to the cultivation of fuel crops & hence not to any food crops crisis as well.

i) Technical skills of engineers:

Probably there can be a huge requirement of skilled and talented engineers for the EV industry in India. Electric Vehicles (EV) makers in India are facing a difficult time finding the right talents for the future of mobility. According to a report, the current requirement for engineers in the field is more than 5,000 engineers, which will go up to 15,000 in the next couple of years. Around 1,000 engineers are only employed in the EV sector. And because of the technical skills of engineers EVs are concatenated with regenerative braking technology which currently 65% efficient but can be improved in the future through strong research and development work. Different types of renewable energy sources such as wind turbines, solar PV panels, and geothermal units are considered, and an energy scheduling model is deployed [6].

j) Attitude willingness and awareness to people:

In India peoples are not aware of electric vehicle capabilities, their attitude about EVs is not right, this can be because of range anxiety, non-availability of appropriate resources or price, etc. Lack of consumer interest is a challenge in replacing IC vehicles with EVs. Conversely, respondents were most concerned about vehicle safety, legal liability, and charging issues. Individuals' charging behaviours may change substantially and be different from what has been expected or observed to date.

METHODOLOGY

This paper used Interpretative Structural Modelling (ISM), which is among one of the modelling strategies to make and explain the formation of the system which is being studied. Analysis and find out the existing structure in a system is the highest participation to promote the system efficiently and make meaningful contributions in the decision-making process. ISM is a combine learning process where structural models are generated in order to show the difficult subject of a system via checking of the designed pattern by using pictures, flow charts and statements. *ISM* [11] is mainly based on examine partial coefficients for the different sub-elements and to find a relation among multiple sub-elements, avoiding the effect of irrelevant sub-elements, and eliminate the effect of subjective factors. ISM inspection is based on created upon data filtering and knowledge or sources from superiors in order to get the

same trendy matrix using the existing steps. With the help of ISM, a multiple level pecking order- structure model can be produced by inspecting the relationship matrix of sub-elements of a system.

The provisional association was prepared from opinion polls, using VAXO symbol model,

The superiors were allocated intentionally according to their experience in connection to the reach of the particular research.

The SSIM matrix then turned into Initial Reachability Matrix (RM) through small changes in, A, X, O symbols to the binary number, where V (1, 0), A (0, 1), X (1, 1) and O (0, 0).

The *RM*, then inspected to confirm its compliance with transitivity rule to develop a closed matrix., for example, if X affects Y and Y affects Z then X must affect Z. Cells with ZERO as its value need to be examined, whether the value is aligned with the transitivity rules, or not. Any cells without compliance with transitivity rule have to be reformed. The single interaction matrix that has to fulfil transitivity rule criteria in the binary format then returned back to VAXO symbols matrix and match with the original matrix to see its stability. The sub-elements were categorised on tiered levels, by applying iteration within reachability and antecedent, and classified at the same level as the correction level in the canonical matrix.

The next process is to form matrices and plot graph between driver and dependence power. The final step describes the interpretive structure modelling of "Scope of EVs in India". This step results in a classification of sub-elements of barriers, assign the driver power and giving the ranking from highest to the lowest factor interdependency with other sub-elements. Then, the plot curve of driver power-dependence element/ factors of the Electric vehicle's factors can be described. Finally, the interpretive structure model of the different categorisation of factors on a top-level with diagraphs measurement can be developed.

ISM is used to study the inter-relationships among recognized AMIs. In addition to it is more important for the organization to interpret how, and in what way each impediment influences other impediments in a specific environment [12].

The table shows 10 different factors, out of which some are related to manufacturing perspective and values or customer basis.

The expert respondents were determined by considering 3 criteria, namely,

1) Have the expertise and knowledge in the area of study,

2) Have a good profile, designation or control within its compliance in the area of the target study,

3) Have the reliability and unity as well as best information and understanding in the area of the topic.

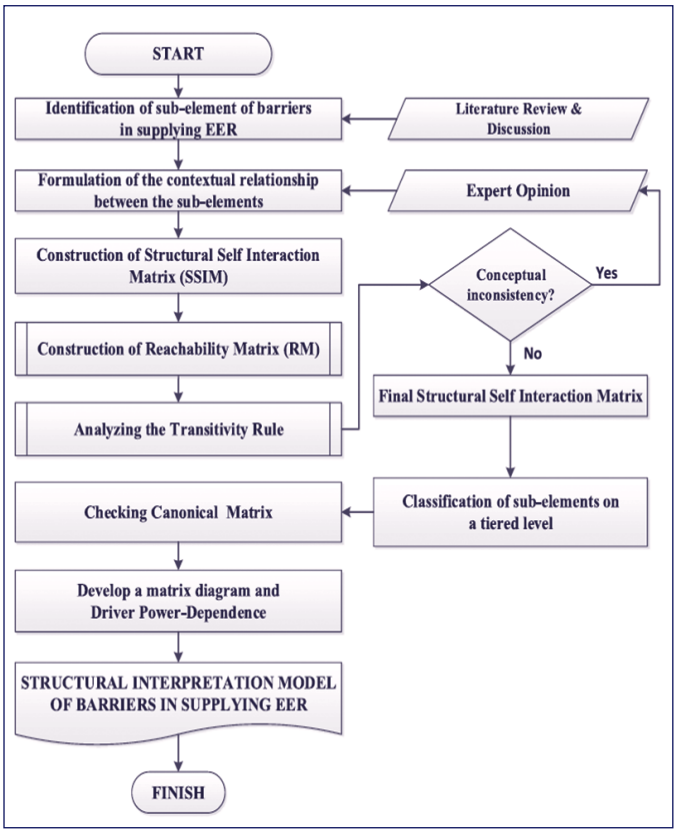
V = If the sub-element i leads to sub-element j, but the reverse of it does not apply.

A=If the sub-element j leads to sub-element i, but the reverse of it does not apply

X=If the sub-element i and j mutually leads to each other

O = If the sub-element i and j has no relationship and not in any direction either.

Figure 2: ISM flow chart



Structural Self-Interaction Matrix (SSIM):

Figure 3: SSIM Table

Criterion	10	9	8	7	6	5	4	3	2	1
1	O	V	O	O	V	O	O	V	O	X
2	O	O	O	O	O	X	O	O	X	
3	O	O	O	V	V	O	O	X		
4	V	O	A	X	O	O	X			
5	O	A	O	V	O	X				
6	O	O	O	V	X					
7	O	O	O	X						
8	V	O	X							
9	O	X								
10	X									

We can see clearly, Cell (1, 9) for V as electricity directly impacts attitude, willingness, and awareness to people. Similarly, cell (1, 6) & cell (1, 3) while other cells keep no impact towards each other relation i.e., O.As far as, only cell(2,5) is X which shows there is the impact in both directions for factor Raw materials with other factors & alongside with O of all cells (2,10) (2,9), (2,8), (2,7),(2,6),(2,4),(2,3).Cells(3,7), (3,6) are V

relation cells means infrastructure directly impacts the impact on economy and govt. policies & intervention respectively, while other factors keep O relation as there is no impact in any direction. Cell (4, 10) represents the direct impact of efficiency and sustainability towards a positive impact on the environment while cell (4, 8) represents the impact of technical skills of engineer on the efficiency &sustainability. Other factors keep as no relation i.e. O.

Cell (5, 9) shows attitude willingness & awareness to people impact cost of vehicle and cell (5, 7) represents there is a direct impact of the cost of vehicle on the economy. While other relations are kept as no relation i.e. O.

Cell (6, 7) shows Govt. policies & intervention on economy and while other factor's relations are kept as no relation i.e. O

Cells (7, 10), (7, 9), (7, 8) all have no impact relation.

Cell (8, 10) shows the relation of technical skills to the positive impact on the environment directly.

Cell (9, 10) no relation i.e., O.

Note:-All factors will have a direct relation in both directions with their own.

E.g. Factor 1 will have X relation with 1. Similarly for other factors from 2 to 10.

REACHABILITY MATRIX:

The SSIM had been turned into a binary matrix, called the Initial Reachability Matrix (Table 3) by putting1 at the place of V, A, X, & by 0at position of O in SSIM.

Then whole transitivity is examined. If the element *i* leads to element *j* & element *j* leads to element *g,* then element *i* should lead to element *g.*

By transitivity entry, the modified Reachability matrix called Final Reachability Matrix is obtained as shown in Table 4.

1 shows "Direct relation"

0 shows "No Relation"

1* shows transitivity as due to interdependency between factors and after removal of interdependencies, 0 replaces by 1*

Figure 4: Initial Reachability matrix

	1	2	3	4	5	6	7	8	9	10
1	1	0	1	0	0	1	0	0	1	0
2	0	1	0	0	1	0	0	0	0	0
3	0	0	1	0	0	1	1	0	0	0
4	0	0	0	1	0	0	1	0	0	1
5	0	1	0	0	1	0	1	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	1	0	0	1	0	0	0
8	0	0	0	1	0	0	0	1	0	1
9	0	0	0	0	1	0	0	0	1	0
10	0	0	0	0	0	0	0	0	0	1

Figure 5: Final Reachability Matrix after transitivity

	1	2	3	4	5	6	7	8	9	10
1	1	0	1	0	1*	1	1*	0	1	0
2	0	1	0	0	1	0	1*	0	0	0
3	0	0	1	1*	0	1	1	0	0	0
4	0	0	0	1	0	0	1	0	0	1
5	0	1	0	1*	1	0	1	0	0	0
6	0	0	0	1*	0	1	1	0	0	0
7	0	0	0	1	0	0	1	0	0	1*
8	0	0	0	1	0	0	1*	1	0	1
9	0	1*	0	0	1	0	1*	0	1	0
10	0	0	0	0	0	0	0	0	0	1

LEVEL PARTITION OR ITERATIVE MATRIX:

By the help of Final Reachability Matrix, the reachability set & antecedent set for each criterion is found. The reachability set contains itself element & other elements to which it may reach, whereas the antecedent set contains itself element& the other elements which may reach to it. Then the intersection of both the sets is obtained for all elements. The element for which the reachability & the intersection sets are the same is the top level element. Physically, the hierarchical topmost element will not reach to any other element above itsown level. Once the top-level element is identified, it is segregated from the other elements. Then by the same process, the next level of elements is found. Now, the elements are arranged according to their levels and reachability matrix was then converted into the lower triangular matrix.

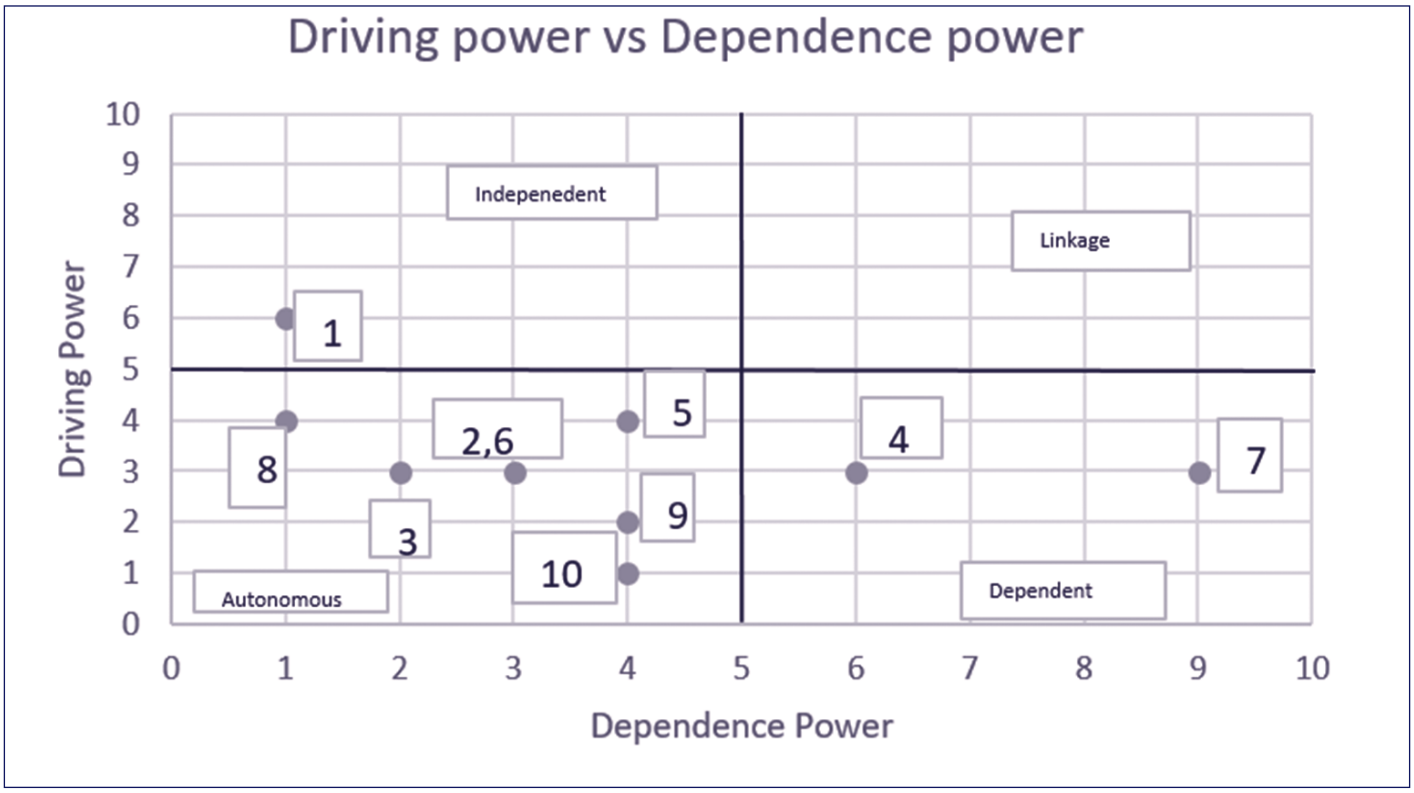
Figure 6: Iterative Matrix

Elements	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,3,5,6,7,9	1	1	V
2	2,5,7	2,5,9	2,5	III
3	3,4,6,7	1,3	3	IV
4	4,7,10	3,4,5,6,7,8	4,7	II
5	2,4,5,7	1,2,5,9	2,5	III
6	4,6,7	1,3,6	6	III
7	4,7,10	1,2,3,4,5,6,7,8,9	4,7	II
8	4,7,8,10	8	8	III
9	2,5,7,9	1,9	9	IV
10	10	4,7,8,10	10	I

Classification of Criteria:

Different criteria have been categorised into mainly four sectors, namely autonomous, dependent, linkage, &driver/ dependent, based on the criteria of driver power & dependence. It has been presented in Fig.7 as the driver power dependence matrix.

Figure 7: Driving Power vs Dependence Power

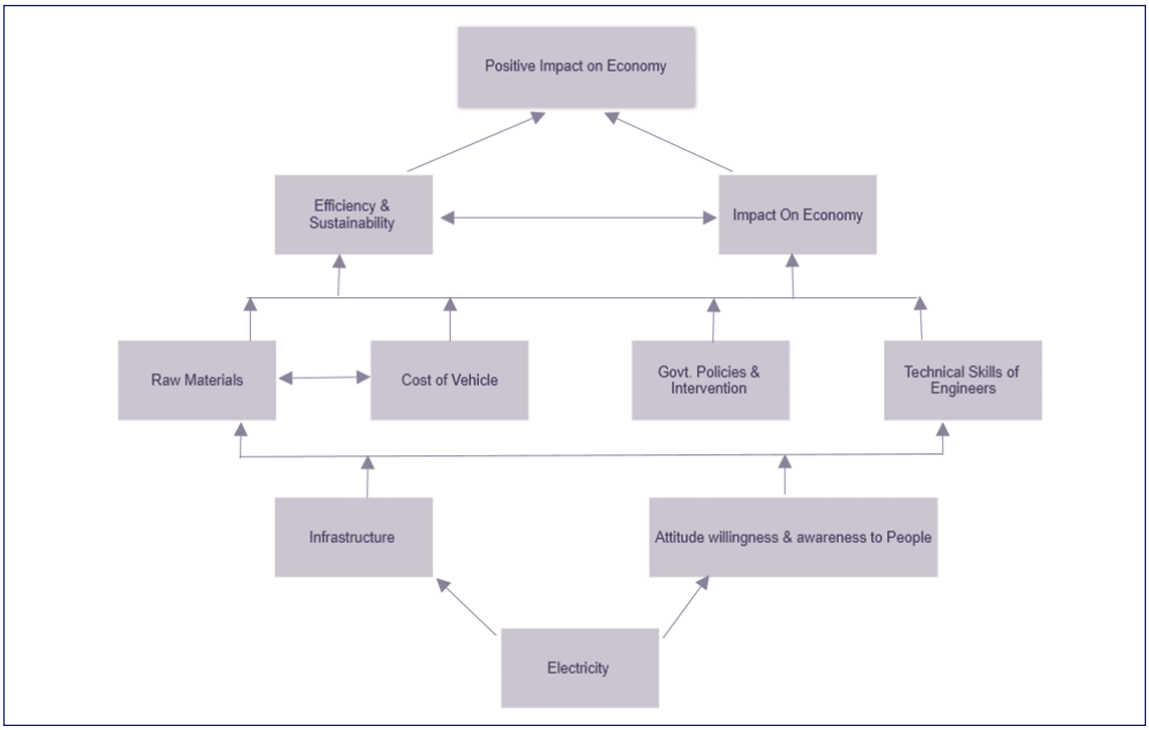


INTERPRETIVE STRUCTURE MODELLING (ISM):

With the help of the Lower triangular matrix, the structural model is formed followed by the help of nodes or vertices& lines of edges. If there is a connection between elements *i* & *j* this is easily represented through an arrow, which points from *i* to *j*. This graph is known as a directed graph or digraph. The elements details are written in the digraph to say it ISM as shown below.

The developed ISM has nothings like cycles or feedbacks. Elements are connected in a pure hierarchical sequence as shown below in Fig.3

Figure 8: Interpretive Structure Model



DISCUSSION

This paper is solely based on Indian conditions, not any other published papers discussed factors until now so much deeper. Many previous published paper-like [13] is only talked about US-based data and factors, But not for Indian Subregions. Consideration of Factors also makes it unique with new factors like Electricity Resources, Technical Skills of Engineers, and Impact on the economy. Factors are changing vigorously every year. In past years, a new factor added in the feasibility criteria domain.

In ISM, we considered Transitivity deeply, and one more thing, the closeness of factors with problem statements like technical skills also impact the economy, etc.

Interpretive Structure Modelling was practiced to found out the factors which are affecting the Electric Vehicle feasibility in India.

Some of the points can be concluded from the ISM:

1) Electricity (Sub element – 1) is the most driving powered factor and most critical to achieving feasibility of electric vehicle in India and at level V.
2) Attitude willingness & awareness to people (Sub element – 9) & infrastructure (sub-element- 3), both are high drive powered and independent in nature at the same level IV.
3) Raw materials (sub-element – 2) & Cost of Vehicles (sub-element- 5) both are dependent (showing with linkages) and at level III, while Govt. Policies &interventions (sub-element – 6) & Technical skills of Engineers (sub-element -8) both are dependent but at the same level i.e. level III.
4) Efficiency & Sustainability (sub-element-4) & Impact on economy (sub-element – 7) both are at the same level i.e. level II, dependent in nature showing with linkages.
5) Positive Impact on Environment (sub-element – 10) is the least powered factor and at the level I.

To overcome the problem of electricity which is a high powered factor, Govt. needs to take some actions on the production of electricity and hence boost the development of electric vehicle in India; this may be achieved by working on alternate resources like solar, nuclear energies, wind energy, tidal energy, wave energy & geothermal energy.

Some areas beautifully working on Wind energy like Gujarat, Kerala, &Tamil Nadu. And attitude willingness and awareness to people can be enhanced positively by arranging seminars, webinars, conferences on the topic of electric vehicle in different universities, societies, schools, workplaces, etc. Infrastructure is the vital player in the scope of EVs in India as infrastructure requires huge investment and henceforth it requires some investors as well. Hence this is a duty of Govt. to propose some good business plans, policies, & actions for them and enhance the same to work towards the development of required appropriate infrastructure.

Raw material & cost of vehicle is regulated by many authorities and assign some balance between all these because currently, this technology is expensive over ICE vehicles & it is required to make it economical according to India market. Investment in skills of engineers and make them learn new courses which are need of an hour, just grasp all obsolete technologies will not work for anyone& can't help to give some good innovations in this particular field. Efficiency and sustainability will lead the way of production and to make it possible for working Research and development is a must.

The economy is that which is regulated by the global market and effects globally as well, and economists need to work on some good plans& strategies to finance government policies so that appropriate action can be taken for driving factors. Positive impact on environment is that which must is for the current generation, that's what inclines thinking towards electric vehicles of people. Hence, to make it possible, collective measures need to be taken as many factors are interdependent with each other.

CONCLUSION:

This paper will give direction to all new future scope of studies researches based on Electric vehicle production industries. ISM is a great industrial tool that provides a qualitative approach for analyzing factors of the "Scope of EVs" in India.

In this paper, an effort has been made to approach & develop an integrated model using ISM. As the paper is primarily concerned about implications, feasibility, &scenario of EVs in India, so it reflects the possible consequences which can come across during its implications, in terms of different possible dependent & independent factors that have already discussed above. The good to go inference is that it highlights the positive impacts on environments, & reflects the reduced dependence on Crude oils which are costly not to obtain but to store as well. Apart from this, the study has recognized infrastructure, electricity, and attitude and willingness of people as key factors to promote electric vehicles in India. The study may provide important guidelines for government and organizations which are trying to replace ICE vehicles with electric vehicles.

ISM is an extremely subjective and judgmental process, treating all elements equally without a weighting factor assigned to the elements. Someone can do further analysis of ISM by adding new factors and can get new results and ISM with interesting aspects. We know that in upcoming years, new factors will come into the picture& it is quite possible that either these will not too much important for the scope of EVs in India or maybe those new factors will impact ISM vigorously.

Interdependencies we took, is best as per our thorough analysis of different journal papers, stats available. Hence, a person can do ISM by changing (add/remove) interdependencies. Govt. policies can be categorised furthermore and can be modelled with newborn factors. Hence, this ISM is just a base for any electric vehicle feasibility but new updates can be added comes with new year/decade. At last but not the least, the study has to reflect that all the factors listed in Paper & briefly discussed in preceding section of study can lead either directly or indirectly towards sustainable development, which is the important modern-day demand.

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