

Assessment of key International Environmental Agreements (IEAs) and its impact on Innovation & Competitiveness of Indian Automobile Sector

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Abstract: Vehicular Pollution is one of the major source of GHG emissions in the world. Various Environmental treaties and agreements have been ratified to fight pollution and reduce GHG emissions. The paper is a descriptive research aimed towards empirical analysis of these agreements on Indian Automobile Sector. With the help of Hypothesis testing, the study concluded that IEAs influence laws and regulations in India leading to innovation in Automobile Sector. Automobile companies need to invest in technologies that are environment friendly and are also streamlined to global standards

Index Terms - International Environmental Agreements, Pollution, Porter's Hypothesis, Regulation, Innovation

I. INTRODUCTION

Air Pollution as defined by OECD is given as, "the presence of contaminant or pollutant substances in the air that do not disperse properly and that interfere with human health or welfare, or produce other harmful environmental effects" [1] Air Pollution is a major problem in world leading to loss of human life as well as natural capital. There are two main sources of air pollution, namely, Anthropogenic Air Pollution (Increase in pollutants in air due to manmade sources) & Natural Air Pollution (Due to natural causes like Volcanic Activity)

Air pollution has seen a dramatic increase since 19th Century, as we know the industrial revolution led to setting up of carbon-intensive factories. These factories ran on fossil fuels and emitted huge greenhouse gases. These GHG gases are responsible for warming up of global mean temperature. Global temperatures have risen up by 0.8 °C in past century and if no intervention is taken, the temperatures will soon touch 2°C [2]. Some of the GHG gases existed naturally (CO₂, N₂O, and CH₄) but their respective concentrations have increased drastically in last three decades. Other GHG gases like HFCs, NF₃, PFCs, and SF₆ came into existence due to human interventions.

Air Pollution is mainly caused by these GHG gases and a major culprit is CO₂ emissions. We would keep our discussion focused on CO₂ emissions only. There exists a major gap between per capita CO₂ emissions and Annual CO₂ emissions per country. While major polluters are China, USA, and India in terms of Annual CO₂ Emissions, but Per capita emissions are high for developed countries like USA, Japan and UK. It clearly signifies that a person in USA has more carbon footprint than a person in India. [3] This calls for a 'differentiated responsibility' by different countries when it comes to reducing CO₂ emissions. Transportation is the second biggest contributor to world GHG emission levels after Energy sector. Transport sector includes Road, Rail, Air, Marine and other forms of transport. According to UN EDGAR, Transport contributed 5.53 Million Giga grams of CO₂ globally being second after energy sector (20.33 million Giga grams of CO₂) [4]

Indian Scenario

India being one of the largest polluters, annually emit 2236.55 Million ton of CO₂. This contributed to the rising economic prosperity of country with large population and increasing demand. The energy-intensive sectors like Energy & Transport sector use fossil fuels to fulfill the demand. Dependability on fossil fuels has led to increased CO₂ consumption. Petrol and Diesel is the main source of energy which drives Indian vehicles today. Use of sub-par technology and the less regulatory administration has further lead to complexity of the situation. Transport contributes 10-12% of India's GHG emissions (A.T. Kearney & CII, 2014). The figures are expected to rise as more vehicles are introduced each year.

International Environmental Agreements (IEAs)

The paper has discussed the impact of IEAs on Indian automobile sector. According to IEA Database project, "An intergovernmental document intended as legally binding with a primary stated the purpose of preventing or managing human impacts on natural resources" [5]. In the coming sections, we will discuss various IEAs which has directly/indirectly affected Automobile sector.

Stockholm Conference was held in Sweden on 5th-11th June 1972. It was the first remarkable event that united the world to come up with a solution to solve the problem of degrading environment and development. 114 countries participated which included Government heads, delegates, NGOs, Civil society, Executives from industries and common people. The conference was a result of catoptric events such as release of Rachel Carlson Book on Silent Springs which stirred discussion among public about the dangers of use of chemicals in agriculture, Acid rains in different parts of world, Minimata disease due to Mercury, Degradation of environment due to Atom Bomb explosion, Rising poverty, pollution and gap between developing and developed countries etc. All these factors triggered the need for a worldwide discussion on issues like climate change and development. Key outcomes of the conference were Creation of United Nations Environment Program (UNEP), Stockholm Declaration containing 26 Directive Principle on environment and development. Directive principles related to pollution was that Pollution must not increase more than nature's capacity to clean itself. Countries part of UNEP started monitoring air, water, and environment quality as per the declaration. [6][7]

World Commission on Environment and Development (1987), gave the concept of sustainable development. The report [8] published by the commission predicted that global warming would increase to very high levels by 2020 and energy demands would be huge. The report predicted that if most energy efficient technologies are used then a decent annual global per capita GDP of 3% can be achieved.

Convention on Long-Range Trans boundary Air Pollution and Volatile Organic Compounds Protocol (1991) held at Geneva, Switzerland aimed at reducing VOCs emissions. It gave some suggestions so as to reduce VOCs emissions from automobiles such as reducing Fuel Volatility, Use of catalytic convertors etc. [9]

Montreal Protocol intended a reduction in the use of CFCs and halons to 80% (1986 levels) by 1994 and 50% by 1999. After successive revisions, it has been amended to a complete phase-out of CFCs, HCFCs, HBFC and other. It is considered as the most successful treaties as it achieved universal ratification. It successfully phased out 98% ODS from the atmosphere, remaining 2% is HCFCs who's phasing out is starting by 2019. Montreal Protocol prevented a million cases of Skin cancer, cataract and other skin diseases. UV index of USA would have been a 30 if Montreal Protocol was not put into place. (11 is the maximum level of safe UV). It also reduced GHG emissions equivalent to 135 billion tons of CO₂. [10][11][12][13]

UN Framework Convention on Climate Change (UNFCCC). The ultimate objective of the Convention [14] is to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system." It states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner." Principles such as Precautionary Principle, Inter & Intra generational equity were adopted. It was concluded that due to the indiscriminate economic activity of developed countries the global temperatures are rising. Therefore, Annex I countries were expected to cut most of the emissions. [15][16][17]

Kyoto Protocol [18] was adopted at COP 3 in Kyoto, Japan 11th December 1997. It entered into force on 16th February 2005, signed by 192 countries. It set legally binding targets for Annex I countries for limiting GHG emissions (originally by at least 2% from 1990 levels and after Doha Agreement at least 18% of 1990 levels). It also provides mitigation & adaptation opportunities in developing countries. Regulated GHGs under Kyoto Protocol were CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, and NF₃ (added in Doha Agreement). Key Sectors of Emission Reductions were Energy (which includes Transport and Fugitive emissions from fuels), agriculture, waste etc.

Key outcomes of Kyoto Protocol are given here. According to UN, Emissions lowered by 22% in 2012[19]. But, data from OECD document suggest that global emissions increased instead of decreasing [20]. The difference in figures was due to world biggest emitters USA, China was not part of Kyoto Protocol. USA, China, Japan, Russia backed out of Kyoto – who are some of the largest emitters. India ratified Doha Agreement of Kyoto Protocol in 2017. Due to less participation, it is currently not in force.

COP19 Warsaw saw the implementation of INDCs i.e. Party members were required to submit INDCs (Intended Nationally Determined Targets) for more inclusive participation from Nations. India submitted NDC which had 8 goals. From GHG perspective, the goals aimed to reduce the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level, to build capacities, create a domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies [21]

COP 23, also known as Paris Agreement entered into force by 4th November 2016. It was ratified by 55 parties and has 195 countries as a signatory. [22]. It aimed at keeping global temperatures below 2 Degree Celsius w.r.t. pre-industrial levels. Countries who have ratified Paris Agreement accounts for world's 55% GHG emissions. The agreement is often criticized as the targets and provisions laid down in Paris Agreement are not legally binding. No clear indication is given on what action will be taken if a country fails to accomplish its target.

It is important to understand the evolution of vehicles laws and standards in India and how they changed due to above protocols. After Stockholm Conference of 1972, India enacted 42nd Amendment which stated, "The State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country," reads Article 48A, part of the Directive Principles of State. Reads Article 51A (g), part of the Fundamental Duties. [23]

The Air (Prevention and Control of Pollution) Act, 1981 was also a result of Stockholm Conference 1972. The law gave basic definitions of terminology related to air pollution. It formed CPCB, SPCB and laid rules for its functions. Penalties for non-compliance were also given in the law. [24]. Environment Protection Act, 1986 further strengthened the environmental law in India.

Motor Vehicles Act 1986 gave power to Central Government of India, under Ministry of Road Transport and Highways, to regulate emission norms of India. A draft of National Automobile Pollution and Fuel Authority has been submitted by SIAM (Society of Indian Automobile Manufacturers) also gives a future road map for India Fuel policy and emission norms.

After Montreal Protocol, India passed Ozone zone Depleting Substances (Regulation and Control) Rules, 2000. This act dealt with "with prohibition on new investments with ozone depleting substances, Regulation of import, export, and sale of products made with or containing ozone-depleting substances along amid Monitoring and reporting requirements for the same" [25]

The research work covers the different IEAs, their evolution and how it affected India. Further, the study explores various literature studied for the preparation of the paper. The paper then gives research methodology and provides an empirical analysis of primary data collected through a survey. Lastly, the study concludes with inferences and conclusions on the basis of primary and secondary data.

II. LITREATURE REVIEW

The research studies chosen for the paper focuses on studying various environmental treaties, protocols or standards, Triggering factors that led to the establishment of such IEAs. It also reviews topics dealing with the evolution of automobile industry Pollution norms etc. The database includes Research papers, Journals, Books, News articles from Google Scholar, Wiley, Research Gate and others. The literature chosen for review are mainly scientific works, research papers, journals, abstracts, and reports. The selection of literature was done in keeping to include more recent works to provide best possible knowledge and analysis. But to cover the overall aspect and impact of IEAs, it was essential to study some older works. Therefore, the range of studies ranges from 1995-2018. Majority of studies were from 2010-2018.

The research work analyzed for this paper included 21 studies. Out of these, 6 were Qualitative studies, 5 were Quantitative in nature and 9 were both Quantitative, Qualitative in nature. The author reviewed scope, limitations, and outcomes of each literature. The literatures reviewed came from Public and Private Institutions and renowned colleges.

The literatures contained overall same theme with common keywords such as ' IEA', 'Effectiveness', ' Porter Hypothesis', ' Regulation', ' Innovation' and ' Automobile'.

Two research works (Hirota, 2010) and (PWC, 2017) were similar in comparing countries on vehicles related policies and regulations. [26][27]. Hirota, 2010 compared 10 Asian countries namely China, Indonesia, Philippines, Singapore, Thailand, Korea, Japan, Malaysia, Vietnam and India. It analyses air quality data through Vehicles Kilometres Travelled to determine emission inventories and analyze policy effectiveness. It elaborates monitoring and Inspection/Monitoring, Fuel Quality Monitoring System (FQM) of the 10 major Asian countries. It identifies challenges like Non-Availability of data related to IM and FQM after sales. It also suggests some steps to reduce emissions like switching to Integrated Emission Standards which are established after ground research. Lowering the sulfur content (below 500 ppm), focus on introduction of stricter emission regulations. PWC report [26] Germany was successful in decreasing emissions from 1990-99 levels to 1999-04 in spite of increased competition, increase in weight, size, power of vehicles) by increasing fuel efficiency arising directly from the 1998 ACEA voluntary agreement

EU- EC has placed CO₂ Taxation, Eco-labeling and Eco-Driving as the integrated approach towards reducing emissions. Though, a consensus has not been made on how to apply the same standard to automakers of the different and varied portfolio. They have a target of 120g CO₂/km.

Japan has applied strict fuel economy standards with 13.6 km/l of fuel economy already achieved. They are setting targets for different vehicles based on weight.

China has also adopted a similar approach of weight-based standards.

One more approach has been discussed i.e. Differentiated approach where automobile manufacturers are required reduce emissions levels below previous year emissions levels. The problem arising is indecisiveness in choosing base year for comparison. Early actions taken before the base year would be of no value to automotive manufacturers whereas carmakers who made no efforts in the past to reduce CO₂ emission.

The report has suggested automakers to expand their product portfolio and focus on core competencies. Improvement such as new injection systems, tap potential out of all components, Downsizing and turbochargers are also suggested. Ignorance of new tech like hybrids, micro, EV would lead to significant costs in the future to catch up or buy the technology from competitors. Research and development should not be limited to a single technology. Also expand supplier early into the process of procurement of components while development of new technology. For ex. DaimlerChrysler, BMW, and GM can serve as an example for such a partnership. A healthy relationship with fuel companies is also important to build distribution companies. It is very important for companies to lower improvement cost by improving the image in market and advertising as “Environment-friendly car” For ex- Toyota Prius is sold as an environmentally friendly product with leading technology. Image building as a market leader in innovation, quality, and efficiency will enable automakers to develop a price premium and competitive advantage as providing environmentally friendly technologies will be a selling point in major markets globally. Although the report is extensive and gives great insights but since, the report is based on data from 1980 to 2007, major international agreement is missed out i.e. Paris Agreement.

Houde & Benthem 2010 in the article ‘How Attractive Are Fuel-Economy Standards?’ talks about CAFE Standards introduced in USA in 1975 after Arab Oil Embargo to reduce fuel consumption. It is calculated as a minimum sales-weighted average miles-per-gallon (MPG), US, India, China, Japan – all of these countries are aiming at a minimum of 55MPG by 2020. It has also suggested ways by which manufacturers can comply with CAFÉ- By using efficient manufacturing technologies, Increasing price of vehicles which pollute more and reduce the price of cleaner vehicles. The author also gives limitations of this standard. Rebound effect of driving more as cost per mile gets decreased, a consumer would psychologically want to drive more miles. Leakage effect- as new standards come in the picture, cost of developing new technology increases the cost of the vehicle which leads to increase in demand for used cars and their resale value. These used cars remain in operation and take away the 15% expected fuel savings by emitting the same amount of CO₂. It only applies to new vehicles. To tackle these limitations, a higher Fuel tax is suggested which further has socio-political implications. [28]

CAFE in India is also been implemented. We studied ARAI notification [29] which mentions the formula and other specifications. The regulation only covers Passenger Vehicles with weight under 3500kg, having maximum 9 seats. CV, Trucks are excluded unless mentioned.

To evaluate the concept of the impact of environmental agreements, we reviewed two works from same author Chenaz. (2005) and Chenaz (2014). Both of the works study the effectiveness of IEAs and gives methodology. In Chenaz (2005), the author analyzed the effectiveness of various treaties and performed trend analysis of associated environmental indicators. Major IEAs were selected for study (34), out of which 28 were contacted for the questionnaire based assessment. Only 20 were part of study since rest did not reply. Environmental parameters were calculated for five years and the total was plotted vs. time for establishing associated environmental parameters. The analysis showed that using time series analysis, we can show IEAs are effective and there is a positive change. Slow positive change showed that Treaty implantation is occurring at a slow rate which is undesirable. [30]

In Chenaz (2014), the paper elaborated on the concept of effectiveness of IEAs and gave out a methodology to assess the adequate implementation of these agreements. It stated that effectiveness of IEA is not a single outcome or result, rather it is more of a continuous process. It depended on various international – domestic factors such as Politics, Negotiations, Legal texts, Nature of issue, science etc. We reviewed that for short-term analysis, interim effectiveness indicators can be evaluated such as Establishment of National, regional focal points, Setting of financial mechanism, Enhancement and enforcement of domestic legislation (for ex. Emissions control; regulation of mining etc.), National Action Plans, Adoption of new technology or standards, MoUs, R&D, Stakeholder awareness, Compilation of baseline information etc. The long-term effectiveness indicators mentioned were Emissions on NMVOCs, SOX, NOX, CO₂, heavy metals, CFCs, HCFCs; Production and discharge POPs, Successful phasing out of leaded petrol, Deposition of pollutants in food chain etc. Chenaz provided only a starting point for evaluating IEAs, the literature does not give any methodology for quantitative evaluation. [30][31].

The research was majorly inspired by works of Porter and Linde (1995), where the authors introduced ‘Porters Hypothesis’. In the following section, we would mention literature reviewed related to Porters Hypothesis from different authors.

Porter and Linde (1995) in the famous paper titled ‘Toward a New Conception of the Environment-Competitiveness Relationship’ gave Porters Hypothesis which stated that, “Strict environmental regulations do not inevitably hinder competitive advantage against rivals; indeed, they often enhance it” and “properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them” [32].

They termed it as innovation offsets. It also lowered cost of meeting these regulations and lead to competitive advantage over other firms in other countries not having such regulations. The paper supports its claims by giving various examples of private companies which benefitted after innovated their process due to regulations. It also emphasizes on First mover advantage in green innovation and responds to criticism as well. Some of the limitations of the paper are that it assumes that firms and the general consumer has very less awareness about the negative effects of pollution and climate change and thus not invested to its full potential for innovation.

Porter and van der Linde gives out reasons to support their claims. [33]

- Regulations are a signal to a potential resource inefficacy and its improvement
- Regulations can reap benefits by raising corporate awareness
- Reduction in uncertainty of a profitable investment addressing environment
- Develops pressure to innovate
- Develops equal opportunities for all companies

Porters gave some ways for increasing innovation and competitiveness –

- Introducing market-based instruments such as emission tax, tradable allowances, and performance standards

- Training programs improve competitiveness and profitability by enhanced environmental conscience
- Regulations may help reduce organizational hindrances to adopt a sustainable process in companies [33]

Ambec, Cohen, Elgie and Lanoie (2013) reviewed the 'Porter Hypothesis' and theoretical and empirical findings for policy making and increasing competitiveness but don't provide appropriate methodology to fully understand the way by which regulation leads to innovation and leads to cost reduction.

Franckx (2014) mainly covers US and EU standards. The author has concluded that emission standards in cars have brought technological change in various supply chain levels. But there exists no evidence that it has led to increase in productivity (due to data unavailability). The author also concluded that countries are likely to have strict emission norms if they export to other countries. He concluded that weak form of Porter's Hypothesis is evident in the automobile market i.e. that emission standards in cars have brought technological change in various supply chain levels. The research had only covered on-road car also no empirical testing has been done to validate strong version of Porter's Hypothesis. [34]

Rexhäuser and Rammer [35] neither approves nor negates the Porter's hypothesis. The literature concluded that the validity depends on type of regulation-induced innovation. Environmental Regulations do not necessarily lead to increase in competitiveness in the sector unless companies reduce externalities from the environment by improving resource efficiency. Rexhäuser and Rammer do not look into long-term effects of policy and regulations on innovation & profitability

Blind (2012) categorized Environmental regulation under social regulation. In the automobile industry, the researcher cites various examples which mostly shows positive effects of regulations (while some mix responses are also present). For Example- Technology forcing regulations were most effective in inducing innovation (Lee et al. (2007)). The empirical evidence were also found to be mainly positive. The data studied mainly covered OECD countries. The extent of study can be increased to developing countries like India. [36]

Lanoie, Paul & Patry, Michel & Lajeunesse, Richard. (2008) analyzed Porters Hypothesis in Quebec Manufacturing Industry. They used Regression and Total Factor Productivity TFP for getting results. The results concluded that Productivity decreases due to regulation but increase in a four year cycle which validates Porters hypothesis. External competition is the main driver for using environmental regulations as gains, more important than improvement in efficiency due decreased emissions. The research is based on data of 1985-94 & based in Quebec City of Canada. Scope of research can be extended beyond Canada and employed for the current time period. [37]

Wagner (2003) did theoretical analysis showing Porter's hypothesis holds true for certain set of conditions such as favourable demand, type of pollutants etc. The results of Porter's hypothesis depends on level on which it is applied. The result varies on each level- country, regional & firm. The industry will enjoy first-mover advantage and competitive advantage due to increased innovation due to regulations. [38]

Stewart (2010) talks about two kinds of innovation that a regulation can bring. They are Compliance innovation (Change in technology to adhere by the norms, thus avoiding compliance cost), Circumventive innovation (When existing technology is non-complaint, leading to innovation to escape regulatory costs). Incremental innovation is when company makes minor improvements to existing technology while radical innovation is changing process or bringing entirely new product concept. Radical innovation gives higher benefits but they are risky to execute. [39]

One of the literature by Debnath 'Environmental Regulations Become Restriction or a Cause for Innovation – A Case Study of Toyota Prius and Nissan Leaf' used SWOT analysis to demonstrate how regulations in Automobile industry in Japan has led to increase in sales of cars- Toyota Prius and Nissan Leaf'. Debnath analyses Porters Hypothesis and showed shows how by bringing in innovative low emission car models, companies like Toyota and Nissan benefited in terms of increase in sales of these cars. This innovation was adopted in light of strict regulatory environment of Japan. As sales of electric and hybrid cars are increased, this led to company to re-invest in R&D for more fuel efficient technologies. Regulation leads to innovation which helps in further investment leading to more innovation. Only two cars and their success have been discussed in the literature reviewed, both of which are from Japan. Expanding the scope to other car models is a point for further research. [40]

By reviewing literature related to Porters Hypothesis, We have endeavored to determine the validity of Porters Hypothesis in Indian Automobile Sector by doing empirical analysis. This is the first attempt to study Indian Automobile industry in relation to Porter Hypothesis.

Other literatures were also reviewed related to World GHG emissions trend, Indian Automobile Sector and policies.

Taptich, Arpad Horvath, Mikhail V. Chester in the paper, "Worldwide Greenhouse Gas Reduction Potentials in Transportation by 2050" study explored the Greenhouse gas reduction potentials by the year 2050 in transport sector which is a major contributor to GHG worldwide. The authors studied the reduction by Mode switching and use of alternative fuel. Graphical data of various developing – developed countries is analysed for the same. LCA is used for get life cycle emission factors for vehicles. The GHG emissions from Wheel to Wheel life cycle assessment is a function of vehicle fuel efficacy and Ridership/ freight turnover (i.e. levels of service). The important inferences from the literature were-

Long distance vehicles (heavy duty trucks, rail, aircrafts OGVs) share 93% - 100% of W2W emissions. Future policies needs to be focused on these modes of transport

Developed countries are ahead of developing countries in terms of GHG reduction across all mode. This is due to slow penetration of Fuel efficient vehicles in these markets and slower decarbonization of electricity

Due to slower fleet turnover rates and different performance conditions than passenger vehicles, reduction in GHG intensity in Freight is slower than Passenger vehicles.

In comparison to North America, India would have 2.5 times more GHG footprint for a BEV, due to higher emissions from electricity generation.

BEV & Gasoline have same emissions in 2030 for India. This means that every country needs to apply different strategy depending on ridership, freight turnover, and supply chain process, finance available and supporting policies specific to that region

Overall, PV have larger fuel efficiency than freight vehicles- a 90% reduction from 2010 levels

Limitations of study were that Varied fuel rate over time was not considered in determination of life-cycle GHG estimates, Alternative fuels such as biogas, Natural gas was not included in the study. Economic, Political, Cultural factors were not analyzed which indirectly affect the implantation of policies and technologies. [41]

For assessing present situation of Indian Automobile Sector several kinds of literature were studied, HDFC Bank [42], KPMG report [43][44] was reviewed to get understanding about trends, barriers and drivers in Indian Automobile Sector. Challenges that OEMs and

suppliers were facing were also studied. Technological Regulations by SIAM, ARAI was assessed to review emission standards, fuel standards, and Safety standards in Indian Automobile sector. [45][46][47][48][49][50][51]

III. RESEARCH METHODOLOGY

The aim of this paper was to assess the current Indian Automobile sector regulations and how the International Environment Agreements has led to change in the same. The type of research we used for Descriptive in nature. The formulated hypothesis was based on Porters Hypothesis that strictly regulated regulations lead to innovation and competitive advantage. To analyze the same, we devised hypothesis and then further decided upon the population of research, type of sampling, sample.

Scope of our research

Indian Automobile Industry with respondents mainly coming from metropolitan cities of India, namely, Mumbai, Chennai, Bengaluru, Delhi and Kolkata

Hypothesis formulated

Ho_a: Regulations will not have any impact innovation in Automobile Industry in India

Hob: Respondents are not aware of environment

Hoc: Respondents do not feel that vehicular pollution is affecting them and their family

Hod: Respondents do not have knowledge about Kyoto Protocol

Hoe: Respondents do not agree that agreements like Kyoto and Paris lead to an increase in competitiveness and innovation in various industries, like automobile

Hof: Respondents do not agree that Indian Automobile sector is competitive in Green vehicle segment

Hog: Respondents do not feel that introduction of 'FAME' (Faster Adoption and Manufacturing of Hybrid and Electric vehicles) in India, to support the market development, infrastructure of Electric/ Hybrid Vehicles, is a good step by Indian Government with respect to business profitability

Population: Heterogeneous Population

Population selected was Heterogeneous in nature to maintain diversity and obtain assorted results.

Sample- Non-Probabilistic Sample/ Non- random sample

Type of Sampling Selected- Purposive sampling

The research used non-probabilistic sampling, more specifically purposive sampling, also known as subjective or selective sampling. Since, we were only addressing a certain section of population for responses. They included Teachers and students from environment background, Professionals working in Automobile sector, Environment or Sustainability professionals and finally Design Engineers directly involved in designing of Automobiles. Therefore, Non-Probabilistic Sampling was selected to address those audience only who are informed about Environmental regulation and industry's innovation and competitiveness level.

Method of data collection

For Primary data collection, we used Questionnaire Survey method since it was found apt for the descriptive research. [51]

The questionnaire included 14 Questions which assessed respondent's views. It included 6 demographic questions and then it was followed other questions. The option type used was 5 scale Likert Scale. The Questionnaire was pilot tested to check the validity of the instrument. Adequate changes were made after the recommendations and analysis of pilot test results. The Questionnaire used for research survey is attached in the Annexure A.

IV. SURVEY ANALYSIS

Hypothesis Testing: Survey results were evaluated to test the hypothesis formulated. T- Statistic Analysis was done to test the hypothesis. Confidence level was taken as 95% and Confidence Interval as 5%. T value for the infinite population was taken as 1.645. The responses on Likert scale were coded on the basis of influence. T test was used for analysing the data. The study used the formula $T_{cal} = (\text{Sample Mean} - \text{Scale Mean}) / \text{Standard Error}$

- Ho_a: Regulations will not have any impact innovation in Automobile Industry in India .is rejected as t_{cal} i.e 10.31156 is greater than t_{tab} i.e. 1.645. Therefore, the study says that Regulations will have impact innovation in Automobile sector of India.
- The survey results showed that the respondents were aware of the term 'Environment'. The Ho_b was also rejected since t_{cal} was greater than t_{tab} (28.716 > 1.645)
- T test also rejected Ho_c i.e. Respondents do not feel that vehicular pollution is affecting them and their family and accepted the alternate hypothesis that People surveyed strongly feel that vehicular pollution is affecting them. ($t_{cal} > t_{tab}$ i.e 27.6933 > 1.645)
- Null Hypothesis related to International Environment Agreements asking respondents about their knowledge about Kyoto Protocol was rejected. Null hypothesis was taken as Ho_d: Respondents do not have knowledge about Kyoto Protocol, which was rejected. T test showed $t_{cal} > t_{tabulated}$ (8.07 > 1.645)
- Ho_e: Respondents do not agree that agreements like Kyoto and Paris leads to an increase in competitiveness and innovation in various industries, like automobile, was also rejected as calculated t value(8.487405) was greater than tabulated t value(1.645)
- Respondents did not feel that Indian Automobile sector is competitive in Green vehicle segment which lead to acceptance of null hypothesis Ho_f ($t_{cal} < t_{tab}$ i.e -1.85 < 1.645)
- Ho_g was rejected since t value 14.388 was greater than 1.645. So, Respondents do not feel that introduction of 'FAME' (Faster Adoption and Manufacturing of Hybrid and Electric vehicles) in India, to support the market development, infrastructure of Electric/ Hybrid Vehicles, is a good step by Indian Government with respect to business profitability

V. RESPONDENTS DEMOGRAPHIC CHARACTERISTICS

The respondents were surveyed through online survey method. Survey Monkey was used as a platform for creating questionnaire and sending across the link. Targeted population was people with knowledge of environment/automobile sector residing in the vicinity of

metropolitan cities of India. Specific population was chosen to correctly assess the perception of people who come directly from background which frames or will frame future Indian Automobile Sector and associated regulatory environment. Nearly 75% of population was of 18-30 years. Rest 25% were distributed among age group- 31-40 years (7.95%), 41-50 years (10.80%) and 51-60 years (5.68). The majority of responses came from young population and working class who are potential customers for Indian Automobile Industry.

The occupational distribution of the responses consisted majorly of Professionals working in automobile sector (36.72%) followed by Students (32.77%). Responses had 24.29% share of Environment Professional, 3.95% of Design Engineers employed in designing of automobiles and of 2.26% Academician. 60% of people surveyed were employed were 23.73% had salary 6-10lakhs, 15.25% were from 16lakhs and above salary range, 11-15lakhs had 9% share, 11.86% respondents had 1-5 lakhs salary and rest were not earning. The responses came mostly from Mumbai (60.67%), followed by Delhi (20.22%), Kolkata (11.80%), Bengaluru (4.49%) and Chennai (2.81%)

VI. RESULTS AND INFERENCES

The respondents under study were asked about their awareness level about the term ‘environment’. This was asked to test the validity of the responses to the questions that followed this question. 92% of sample was very much aware of environment (56% - Fully aware and 36%- To a large extent). The results verify their responses as they are well aware of environment and threats associated with it.

As the study showed 92% of respondents were aware of environment, they also expressed their concerns about air pollution, specifically vehicular pollution. 89.33% felt that they were extremely affected by vehicular pollution.

Respondents were asked whether they have any knowledge about ‘Kyoto Protocol’ as to substantiate their response to vehicular pollution and other questions succeeding the question. 40% were fully aware, 28 were aware to a large extent, total of 68% respondents had knowledge about Kyoto Protocol. The succeeding question asked specifically the level of agreement the respondents had with the statement ‘Agreements like Kyoto and Paris leads to an increase in competitiveness and innovation in various industries, like automobile’. Majority of respondents agreed with statement (55% Agreed and 14% strongly agreed). This is an indicator that respondents who majorly comprises of people who directly – indirectly affect the innovation in Automobile industry feels that IEAs are helpful instrument in bringing regulatory innovation and competitiveness in industry. But respondents strongly felt that the Indian Automobile Industry is not competitive in Green Vehicle Segment. Statistically, 42.37% disagreed, 25.42% had neutral stance and only 32.10% agreed that complete level is decent in green vehicle segment in India.

Responses to the statement “Indian Government has introduced ‘FAME’ (Faster Adoption and Manufacturing of Hybrid and Electric vehicles) in India, to support the market development, infrastructure of Electric/ Hybrid Vehicles. Do you think it is a good move by Government with respect to profitability and business continuity of Automobile sector?” were more or less positive. 75.70% of respondents feel that it is a positive move by government when it comes to business sustainability. They feel it will be profitable to automobile industry in future.

Out of respondents who are fully aware of environment and feel IEAs increase the innovation and competitiveness of Indian Automobile Sector, 78.63% respondents believe regulatory move of government towards introduction of Electric Vehicles is a good move. Awareness increases the probability of an industry and society in general to accept regulatory reforms that changes regular operations of industry (For. Example Automobile) and push companies to adapt to reforms by bringing innovation.

VII. GRAPHS

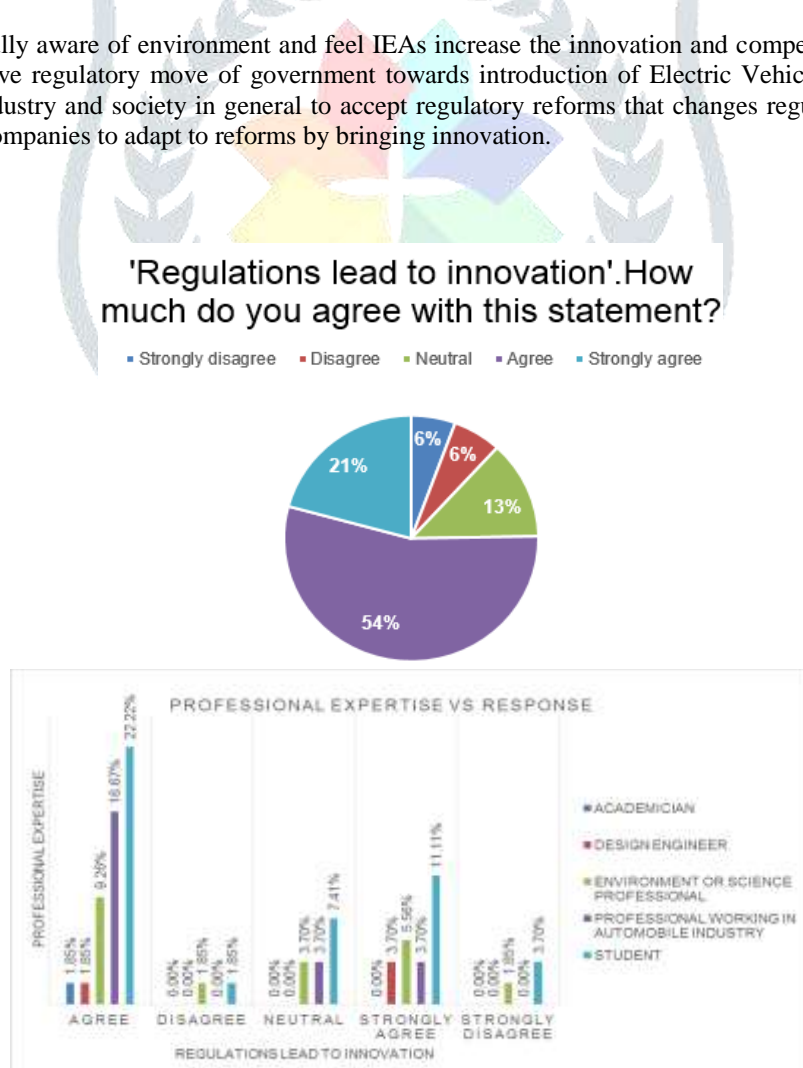


Fig. 1 & 2: Graph showing respondents agreed that regulations drive innovation. Bar chart shows the occupational distribution for the same. Students, automobile professionals, and environmental professionals are most convinced with the given statement

VIII. CONCLUSION

Porter and Van Linde said that “properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them.” This statement seems valid as per our study. As respondents firmly affirmed that rules and laws increase innovation (Figure 2). Survey also brought out the fact that International Environment Agreements and Protocols impact the automobile industry. The research clearly shows a linkage that International organizations like UN, UNFCCC etc. pressurizes countries to frame laws that are in line with IEAs. Countries as per their declarations design laws for industries. The effect trickles down to industries. Rules and regulations compel Automobile industries to invest in R&D to bring technology which is suitable for new regulatory environment. For example, Indian automakers are going to technological disruptions due to two biggest regulatory reforms i.e. leapfrogging to BS 6 norms and introduction of FAME

Regulations also reduce interference of reluctant organization department, to implement sustainable practices in the company. The regulation may lead to increased spending on pollution abatement technology but it will lead reduce uncertainty of the firm by making it ready for stricter compliance in future. The best way for an Indian Automobile Company is to stay ahead of the curve by investing in technologies that emit minimum carbon, use of direct injection, reducing weight and size of engines etc. Diversification of a portfolio is important to cater different customer needs. Having varied portfolio also reduces risk of technological change. Indian Automobile Companies should streamline itself with emission and technological standards of Germany/Japan. These are the countries having toughest automobile norms. This streamlining would reap two benefits- It will reduce future regulatory costs and it will also increase export of Indian cars as they would be already compliant with standards of the foreign market. Companies who will be first in bringing innovation in supply chain and products will enjoy a competitive advantage, also it will help in Green Marketing of the brand.

The study concluded that Indian Automobile Sector is impacted by treaties and protocols. With increased global consciousness over environment and pollution, the regulations are going to be tougher in future. It is an impediment for automobile companies to stay ready by investing in eco-friendly technology. Innovation will be only brought if such investments are made. With adequate Government and Market support, innovative environmental friendly vehicles will succeed in Indian Market. Though present, Indian Automobile Market is not competitive in this segment, future policies and industry steps should be taken on integrate technology, and improve competitiveness by creating customer demand and making efficient vehicles. Further research can be done on Pan-India level covering not just metro cities but also tier 2, tier 1 cities as they are potential buyers of vehicles in India.

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X. ANNEXURE

Questionnaire used for survey

1. Name
2. Gender
 - Male
 - Female
 - Others
3. What is your age?
 - 18-30Years
 - 31-40 Years
 - 41-50Years
 - 51-60Years
 - 61 Years and above
4. What is your salary per annum?
 - Not Earning
 - 1 lakh – 5 lakhs
 - 6-10lakhs
 - 11-15 lakhs
 - 16lakhs and above

5. What is your highest educational qualification/Professional Expertise?

- Student
- Academician
- Professional working in Automobile Industry
- Environment or Science Professional
- Design Engineer

6. Specify the nearest city to your place of living

- Mumbai
- Delhi
- Kolkata
- Chennai
- Bengaluru

7. Are you aware of the term 'Environment'?

- Fully aware
- To a large extent
- Somewhat
- Very Little
- Not at All

8. Do you feel vehicular pollution is affecting you and your family?

- Definitely
- To a great extent
- Somewhat
- Very Little
- Not at All

9. Do you know about Kyoto Protocol?

- Fully aware
- To a large extent
- Somewhat
- Very Little
- Not at All

10. 'Protocols like Kyoto and Paris Agreement leads to an increase in competitiveness and innovation in various industries, like automobile'. How much do you agree with this statement?

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

11. 'Regulations lead to innovation'. How much do you agree with this statement?

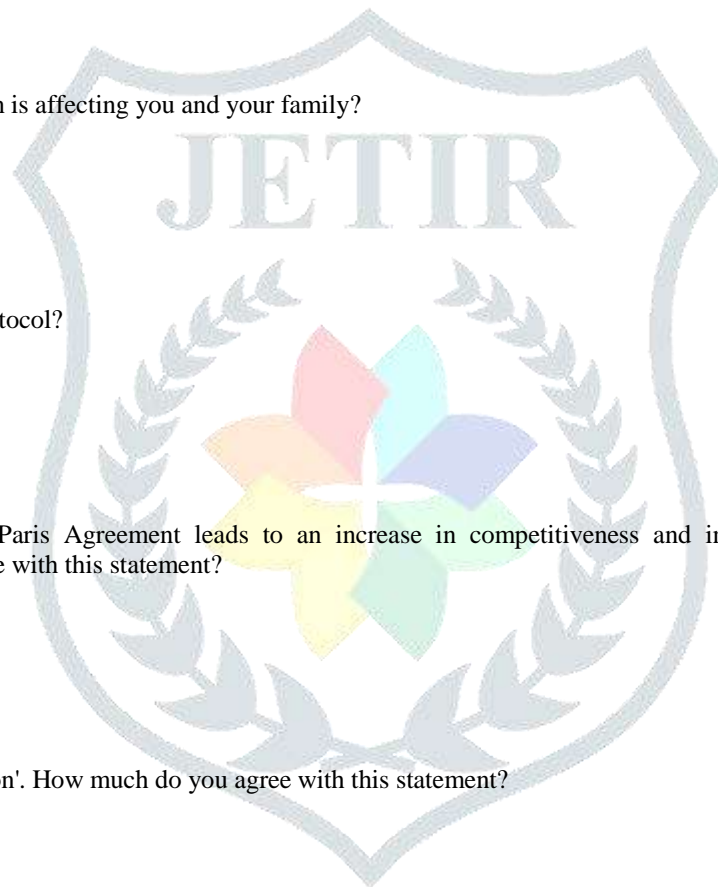
- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

12. 'Indian Automobile sector is competitive in Green vehicle segment'. How much do you agree with this statement?

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

13. Indian Government has introduced 'FAME' (Faster Adoption and Manufacturing of Hybrid and Electric vehicles) in India, to support the market development, infrastructure of Electric/ Hybrid Vehicles. Do you think it is a good move by Government with respect to profitability and business continuity of Automobile sector?

- Definitely
- To a great extent
- Somewhat
- Very Little
- Not at All



12. 'Indian Automobile sector is competitive in Green vehicle segment'. How much do you agree with this statement?

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

13. Indian Government has introduced 'FAME' (Faster Adoption and Manufacturing of Hybrid and Electric vehicles) in India, to support the market development, infrastructure of Electric/ Hybrid Vehicles. Do you think it is a good move by Government with respect to profitability and business continuity of Automobile sector?

- Definitely
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- Not at All

