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Implementation of Advanced Technology Transformation in Automobile Innovation System of India

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ABSTRACT

Developed and emerging countries income joints on their ability to stand reasonable gain through nonstop innovation. Advanced technologies are an important component of such strategies, but there are conditions for successful policies supporting the rapid transformation. The automobile industry sustaining the high level standards in high income countries will depend on a strong presence in knowledge-intensive, cutting edge of industries. The national and regional governments are actively facilitating the development, production and application of advanced technologies. However, advanced technology industries are more complicated. The technology information flow among the industry, enterprises, and institutions are a main player of the process of innovative technology. This paper aims to focus the complexity of automobile innovation system in India. Mostly emerging countries have not advanced technology capabilities, the solution is going through the international technology transfer, R&D, and relationship with academia. The technological capabilities hired from developed nations to produce the advanced technologies in the emerging countries. To explore the relationship between automobile industry's actors in the system that is involved in the universities, research institutions and government, with the help of the theoretical framework national innovation system.

1. Introduction

The automobile industry is a leader in driving innovation worldwide technological advancement. Presently the industry characterizes the most developed high technology kept by consumers, and automobile manufacturers constantly offer the innovative technology in the vehicles. The primary stage of automobile manufacturers advanced the novel technology in the vehicles, which is delivering the customer's needs. Nowadays automobile industry using the high tech materials in the automobile and advanced processes of the manufacturing. As globally known as automobile industry is using the advanced technology and most innovative sector. The automakers are recognizing the highest expenditure in research and development (R&D), both internationally and in the India. At present, industry registered the various patents every year their innovative, new automobile technologies, and well skilled personnel workforce in design and manufacturing the vehicles (Kale, 2017).

The basic advantages delivered by India in industry include, advanced technology and cost-effectiveness. The rules and regulation for overseas investment and import of technology also continuously reform itself and gripping newer technologies (Jacob & Kattokaran, 2017). In involves of more industrial technologies such as institutions, sources of innovation, technology capability in Indian growth of industry structure, but the multinational companies dominated (Kale, 2017). The Japanese automobile industry success in positioning constant technological advance with a stable reduction in costs. The industrial production and exports has been narrowly connected with advanced vehicle design and their capability to attain successfully fit in state-of-the-art technology (Gwynne, 2017). The automobile resource planning assists the continuous flow of knowledge through an institutional organization which participate as control whole manufacturing processes (Rajan et al., 2017). The companies are continuing to adopt automobile resources planning such as emerging and advanced manufacturing technologies (Bauer et al., 2012).

However, the Indian automobile sector concentrated capital and technology an advanced level of economy linkages with leading industry to making the industrial economy (Bhasker, 2013). According to Saxenian (2007), high tech activities have become internationally automobile emerging economies. A rising number of businesspersons from Silicon Valley and others centers are a leading power of technological innovation. For example, repatriating to their nations of origin, with India, Taiwan, China and Israel. These are changed global circumstances, in addition to challenges of advance innovation in industries. Government advanced industrial countries and emerging economies have a broad spectrum of policies to support the innovation, some are ambitious and risky. Whereas some innovation are succeeding, and some innovations are not bringing the expected outcomes.

The mass-producing countries purchase the novel technologies from the advanced nations with the collaboration, joint venture and licensing agreements. In this paper to explore the how automobile innovation driving the manufacturer. In this order to identify who are the technology adopter form developed nations. The research paper is carried out through the Tata Motors of India, which is playing the prominent role in the domestic and international level. This research is based on

quantitative and qualitative analysis. The data collected from the secondary sources which are in the public domain, such as annual report and published research papers from the respective automobile industry. In this research used an exploratory analysis, which is denoted the statistical analysis and data sets are using the summaries their main characteristic.

2. Theoretical framework National Innovation System (NIS) and definitions

A NIS has been defined as follows "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987). "The elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and are either located within or rooted inside the borders of a nation state." (Lundvall, 1992). "A set of institutions whose interactions determine the innovative performance of national firms." (Nelson, 1993). "The national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country." (Patel and Pavitt, 1994). "That set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies." (Metcalfe, 1995).

Among the socioeconomic innovation studies with an institutional orientation, those focusing on NIS particularly. Fowling Porter's (1990) groundbreaking investigation into the (particularly technology) competitiveness of leading industrialized countries, this study show that innovative capabilities of automobile firm such as Tata motors. At the center of the analysis products and process of technology based on the firms (Carlsson et al., 2002).

Nelson and his colleagues define NIS as "the cluster of the institution, policies, and practices that determine and industry's or nation's capacity to generate and apply innovations" (Steil et al., 2002). An early stage and in collaboration with Perez, Freeman also developed a classification for innovation. Their distinction between incremental and radical innovations is used particularly frequently. Incremental innovations are seen as a relatively continuous improvement of technology within one line of development. Radical innovation occurs discontinuity, often as a result of strategic research and development activities, and lie outside given technological trajectories (Freeman & Perez, 1988).

3. Technological changes in the Automobile Industry

The automobile industry is the largest manufacturing sector in the world, and this is considered a as a big competition in the automobile sector (Clark & Fujimoto, 1991). The history of automobiles started in the late 18th century with the creation of steam engine vehicles. At the beginning of the 19th century, cars with internal combustion engines were produced, and the ubiquitous modern petrol-fueled internal combustion engine was introduced to power automobiles in 1885. After the First World War, modern manufacturing operations were established in the Ford factory. From then on, the center of the industry shifted from Europe to the United States, and the global manufacturer of automobiles evolved from craft production to mass production (Womack et al., 1990).

After this, the automobile industry was dominated by a few North American firms, i.e. the Big Three (General Motors, Ford, and Chrysler) for over half a century. In the late 1950s, the automobile industry in the United States was dominated by General Motors, followed by Ford and Chrysler; the last two companies lagged behind General Motors in terms of product content and vehicle design. Subsequently, foreign manufacturers put little pressure on these companies: Volkswagen and Japanese automobile companies, were struggling in the surviving and growing, and provided inadequate competition (Clark & Fujimoto, 1991).

More importantly, the features of the industry changed from Clark & Fujimoto (1991) clarified that three driving forces transformed the global automobile industry. The first is the intense international competition, which stemmed from the capability of an increasing number of manufacturers to compete on a global scale. Dosi (1982) discussed the two mechanisms that determined the direction and extent of the technological change: demand-pull, which pertains to the requirements of the market; and technology-push, which suggests that new technology is generated from old technologies.

Technological change can be viewed as a pattern of knowledge recombination, i.e. knowledge components (existing knowledge elements) are integrated to generate new knowledge. The knowledge recombination process is associated with the fabrication of new products, processes, or markets by combining existing knowledge (Kogut & Zander, 1992). Thus, researchers regard the inventions involved in technological change as recombinant processes that deal with the use of various knowledge streams (Galunic & Rodan, 1998; Hargadon & Douglas, 2001; Fleming, 2001; Nickerson & Zenger, 2004).

4. Automobile Industry of India

In India have several automobile companies such as domestic and international automobile industries. These are coming from the different nations such as US, Germany, Japan, Korea, etc. In India, structured like all other industries and stockholders wanted to get licenses. That industry has many restriction late 1970s, various reforms are happening, but the major breakthrough got in the 1990s. That was great development various automobile companies are established the manufacturing setups in India. During the 1991, Indian government liberalised in their strategies and policies in the respect of automobile industry, one of the important factor foreign direct investment (FDI) interested in the automobile market. In the 1993, FDI invested in the passenger car automobile industry. The FDI norms of investment and import of technology liberalised during the time for manufacture of automobiles. Nowadays, 100% FDI is allowed under the automatic route in automobile sector (Bhasker, 2013).

5. Advanced Technology

During the 1990s lack of interest in the innovation policy undergoing with a transformation, as point out by the domestic and international initiatives to design of automobile and forward looking and wide-ranging policy programme (OECD, 2010b). According to OECD policy put into practices this is going slowly it more responsive of the complex task of innovation policy. While all countries are not succeeding in the emerging workable method (OECD, 2005). Primary attempts backup innovation depends on a linear model supposing the assist for simple research was satisfactory and need to apply into applied R&D, and sooner or later innovation will be surviving in the market (Braun, 2008; OECD, 2005).

Although internationally incorporated production and sales networks already developed between the 1960s-1980s, mostly R&D run by MNCs. Keep on domestic centralized various stages of the driving the innovation (Patel & Pavitt, 1992). If see from globalisation 1990s, changes in the organization, geography of the multinational company's innovation processes of automobile industries and most important of the processes of R&D. The transformation of new phase multinational companies is supported R&D from home to different geography. However, the process of R&D the multinational companies become more open and collaborative with the different emerging knowledge and well skillful employ in the firm in the international market (Bruche, 2009; Chesbrough, 2006; OECD, 2008d; Pittaway et al., 2004).

6. Technological Advancement

The automobile industry continuously developing in the advanced technologies, the mostly incremental innovation happening in the industries. The technological advancement is mainly known as reforming the industry. Such as including the automobile and automotive industry are going through driverless technologies, electric vehicles, happening in the worldwide. In India government supporting to the electric vehicles. The new technologies have brought the new automobile competition, the existing automobile industries make collaboration with new technology startups in Indian automobile industry.

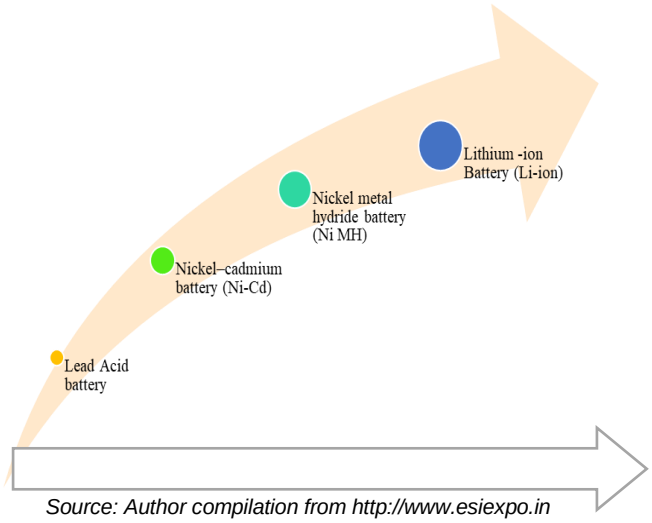
1. Charging Infrastructure

The Indian government plans to establish per three kilometers charging stations in the cities for electric vehicles. The automobile charging station on highway install every 50 kilometer. The land is provided by the municipal administration. The government expected to install the 30,000 slow charging and 15,000 fast charging stations. The plan works on the phase wise in the further years install the two high and one is fast charging stations. The public sector NTPC provides the power Grid Corporation and Indian Oil Corporation new comer the process in the installs the charging stations. Government of India is also providing the subsidies on manufacturing the electric vehicle batteries, the public sector undertaking to roll out the programme. NTPC previously install the charging infrastructures in Mumbai. The power grid corporation signed the agreement with the L&T for the developing charging infrastructure. The Indian automobile maker such as Tata Motors, Mahindra and Mahindra, Ola, and Uber these companies are interested to establish the charging infrastructure (Economic times, 2018).

2. Storage of Energy Technology in Electric Vehicles

The comparison of electric vehicle and batteries, the Li Ion batteries are small size and they have light weight and it is suited for electric vehicles, but this technology needs effective battery management system controls the battery cell balancing. A valve-regulated lead-acid battery (VRLA) have a heavy weight and small life, but the emerging technologies such as Lithium Metal batteries is not safe for the electric vehicles use (see the figure. 1. battery technology).

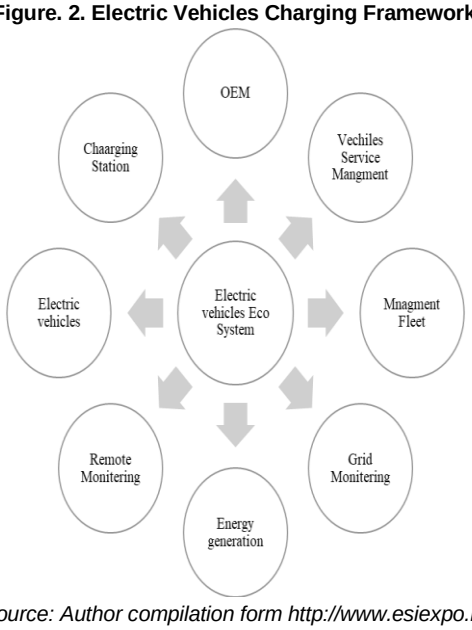
Figure. 1. Batteries Comparison of Electric Vehicles



Source: Author compilation from http://www.esiexpo.in

The clear trend of the higher range using the big storage capacity batteries (22 Kilowatts in 2010 to over 60 kilowatt in 2020), therefore growing demand of battery, and extreme increase in battery energy density follow-on in higher collection with the same footprint (see the figure 2 vehicle charging management, and see the table I subsidies on the electric vehicles) (energy storage, 2018).

Figure. 2. Electric Vehicles Charging Framework



Source: Author compilation form http://www.esiexpo.in

Table I: FASTER ADOPTION AND MANUFACTURE OF ELECTRIC VEHICLES (FAME) INCENTIVE SCHEME IN INDIA

Sr. No.	Vehicle Segment	Minimum incentive (INR)	Maximum incentive (INR)
1.	2 wheeler scooter	1800	22,000
2.	Motorcycle	3500	29,000
3.	3 wheeler Autorikshaw	3300	61,000
4.	4 wheeler cars	11,000	1,38,000
5.	LCVs	17,000	1,87,000
6.	Bus	30,00,000	66,00,000

Source: FAME India

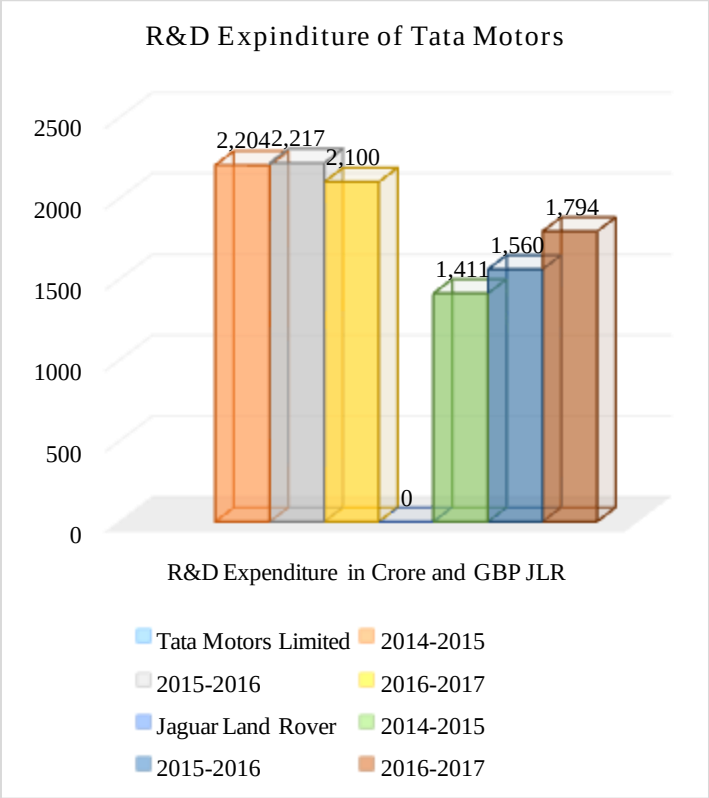
7. Innovation R&D

The automobile manufacturers leading worldwide the most innovative industry is the automobile companies a global management consulting firm functioning in 43 nations, it is found that the world's highest 20 "Most Innovative Companies" are automobile manufacturers. Top 20 automobile manufacturers included in technology companies. And 14 automakers are involved in Boston consulting group (BCG's) top 50 innovative industry, BCG keeps the eight automobile firms on its list. According to BCG various factors are driving the wave of automobile manufacturer innovation. The automobile companies are working to enlarge the conventional vehicle systems such as fuel-efficiency, hybrid and electric models, efficient power of vehicles. 3D, lighter weight of car bodies. The manufacturer is focusing on the safer vehicles with the cutting-edge of technologies for example, self-breaking system and vehicles communicate with one vehicle to other vehicles.

I. Automakers R&D Spending

The automobile manufacturer is working on the customer demands, the demands are the consumers such as sophisticated advanced technologies. According to study find that automakers invested more than on $100 billion yearly on the R&D. Indian automobile industry R&D expenditure R&D, innovation, design and engineering which form the basis of our product development. Tata Motors Limited (TML) spends on R&D 2,100 crores, Jaguar Land Rover (JLR) Great Britain Pound (GBP) 1,794 million, and file the patent applications, TML 80 patent applications, JLR 528 design applications, TML 52 design applications, and JLR 367. The new innovation of vehicles developed TML commercial vehicles is 9, passenger vehicles is 3, and JLR is11, the main innovation of the R&D highlights the TML for example, Tata Starbus Hybrid, Tata Ultra Electric, Fuel cell bus and India's first LNG bus. The JLR innovation is Jaguar I-pace included the first 5-seater battery electric crossover, plug-in hybrids on Range Rover and Range Rover Sports. The patents granted to TML 22, patents granted JLR 292, designs registered TML is 26, designs registered of JLR 412 (Tata Motors annual report) (see figure. 3 more details R&D expenditure of Tata).

Figure 3. R&D Expenditure of Tata Motors



Source: Author Compilation from Tata Motors Annual Report

II. The Export of Tata Motors and International Footprint

The Tata exported 64,221 vehicles 58,058 vehicles in 2016 fiscal involving 60,184 units of commercial vehicles and 4,037 units of passenger vehicles in 2017. The percentage of the commercial vehicles export of raised by 11.3 percent in 2017 by 60,184 units shipped related to 54,052 in 2016, crossing 60,000 deliveries first time highest volumes ever till now. The traditional markets is the South Asian Association for Regional Cooperation (SAARC) continued stronger than the previous year, rising by 21.5 percent with Sri Lanka, Nepal and Bangladesh contribute to the development. In the 2017 Tata successfully taken and completed many prestigious orders with 553 units Xenon pickups for point of scale, Malaysia 537 units of buses to Ivory Coast for the public transportation system, 25 units exported Prima to Oman at Al Tasneem, 25 units of Ultra trucks in Bangladesh to Pran RFL, 32 units of Ultra trucks in Malaysia to point of scale and 39 units of ultra-buses in Nepal for the Mahanagar Yatayat. Around the point in 2017 introduced Tata ultra-trucks in overseas nations such as Kenya and Tanzania; ultra-buses in Tanzania, Tata Prima in Saudi Arabia and Bhutan. This is the part of the strategy to expand the business at worldwide footprint, the industry also introduced the commercial vehicle brand in the Vietnam and Bolivia. During the 2017, the industry achieved the milestone of 1000 ultra-exported in the market. During the time 2017, the industry exports the passenger vehicles raised at 4,037 units, related to 4,006 units in 2016. In the 2017, JLR achieved highest sales 604,009 units in 2017, the development is 15.8 percent as compared to 2016, the mainly driven by the introduction of the Jaguar F-PACE and sustained strong demand for the Land Rover Discovery Sport. The sales were higher each year in the China by 32 percent, in North America 24 percent, in the UK 16 percent and in the Europe 13 percent in 2017.

III. Import of Tata Motors

The Tata motors import the investment, equipment, such as raw resources and mechanisms from, the manufacture automobiles in, and trade automobiles interested in the many nations. Therefore, Tata motors revenues and prices have important experience to the comparative movements of moneys of various nations. Defence Solutions the Government of India drive for 'Make in India' programme Technology Acquisition Fund Programme (TAFP), emphasis to focus on import replacement for the Defence apparatus and the inaugural of the defence sector in the private sector involvement. There is a big chance to tap in Defence sector. Tata goals to set up the full range of Defence solution provider. In the 2017 export of passenger vehicles raised the 4,037 unit's vehicles, which compares to 4,006 units in 2016. The trades in Sri Lanka dropped significantly due to rise in import duties and tightening of trade financing. Conversely, this was remunerated by the better trades in Nepal and South Africa with a development of 120% and 30% separately. The issues like continuously low-slung of oil prices, native currency reduction beside the US dollar. Enduring the constitutional guidelines to decrease the imports, the go-slow in Chinese economy impacting product trading countries and enlarged dealer inventory. Poorly impacted typical domestic consumption value (TDCV's) exports in main markets, for example, the Gulf Corporation Council, Vietnam, Algeria, Russia, and South Africa. The trade deficit declined for the majority of the period. In the 2017 reduction in imports that was far sharper than the drop in exports, but after that both exports and imports happening a long-awaited repossession (see the table 2 major technologies implemented by Tata).

TABLE II: MAJOR TECHNOLOGIES IMPORTS

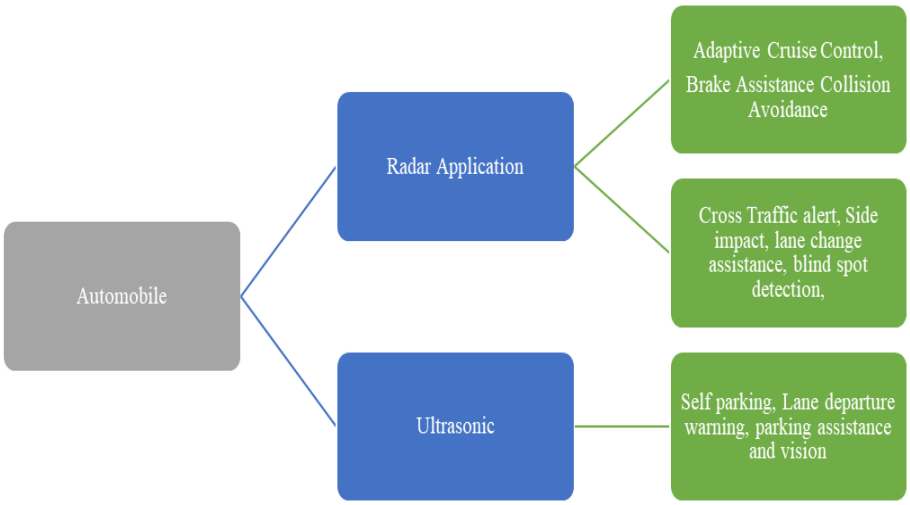
Sr. No.	Technology	Years	Status
1.	ESP (Electronic Stability Programme) for Xenon Euro V vehicle	2012-2013	Implemented
2.	Average Fuel Economy Display for HCV and LCV platform	2012-2013	Implemented
3.	A door seal pressure measurement rig	2014-2015	Commissioned and being used for new passenger vehicles
4.	Synthetic road shells on a chassis dynamometer	2015-2016	Implemented
5.	A Noise Test Cell for engine and drivelines	2015-2016	Implemented
6.	Combustion analyzer and knock sensors	2015-2016	Implemented
7.	Miniature shakers [from USA]—needed for Accurate Transfer Path Analysis of vibrations of engine To vehicle-body	2016-2017	Implemented
8.	Master air flow calibration rig	2016-2017	Implemented
9.	Climatic chamber with gasoline emission facility	2016-2017	Implemented

Source: Tata Motors Annual Reports

IV. Adaptation of Technologies in Vehicles

The Tata Motors architectural method will be to decrease the difficulty, adopt the emerging technologies and implement in the vehicles and safeguard worldwide relevance. Company's commercial vehicles sustainability fuels innovation programme. Rigorous work is ongoing on alternate fuels. Tata developed hydrogen fuel cell technology that controls both passenger and commercial vehicles to decrease necessity on fossil fuels. This innovative technology was industrialized with backing by the Government of India such as the Department of Scientific and Industrial Research. Tata developed the innovation next-gen clean, the new idea of green fuel based commercial vehicles, for example, 'Magic Iris Electric', and this is the zero-emission commercial passenger vehicle, this technology can use the solar energy for the additional charging the vehicle. The efforts to improve Tata manufacturing method permit the delivery of cleverer vehicles and autonomous vehicles (see the figure.4. advance technology in vehicles) (Tata Motors Annual Report 2017).

Figure. 4: Advance Technologies of Vehicles



Source: Author Compilation from auto alliance driving innovation

8. Conclusion

This research has been increasingly concerned with the technical innovations. In contrast to NIS approaches, that treated automobile innovations export and import from the native and foreign nations. Tata motors, one of the India's leading automobile industry, which emphasis on the indigenous innovation. Tata motors work with the various multifold intuitions that are delivering the new ideas and knowledge for the company. The Indian automobile structure is beaten in the worldwide the capitalist nation states exactly control both method speeds of technological change and progress. The finding of the paper the adopted of automobile industries from foreign countries. India export and import of Tata is doing very well from past years. The manufacturing processes of domestic industries R&D capabilities and expenditure are developing from the earlier decades. The Indian government must provide for subsidies to industry for the enlarging their business at a national and international level. Industry should be follows the NIS perspective which delivers the great opportunities to develop their technological capacity in the era of fourth industrial revolution based on artificial technology. Currently the Indian sates are too much lacking in various fields such as education, technology, hospitality, health sector automobile this is the current scenario to more focus on the development agenda. Need to use advanced technology in the vehicles that is protecting our environment and human.

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