

PATENT MANAGEMENT FOR SUSTAINABLE DEVELOPMENT: ANALYSIS OF ELECTRIC VEHICLE PATENTABILITY

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ABSTRACT:

The present study employs patent management activity to elucidate the innovation trends in India's electric vehicle sector. The authors conducted an analysis utilising the patent publication database to examine the emergence of Indian business automobile houses in electric vehicle technology. The Indian market is seeking to adopt this technology to achieve various economic objectives, including gaining a competitive advantage through innovation and enjoying monopoly rents resulting from technological advancements. It will be followed by the section that will entail a "Critical Analysis" in order to examine and contemplate the Competition and Patent Protection in the Automobile Industry, in conjunction with the Management structures, utilising the database collection. The Critical Analysis will facilitate a discussion which will be summarised in the Conclusion, with the aim of pursuing the opening up of patenting policy.

Keywords: *Electric Vehicles, Automotive industry, automobiles, Patent Management, Patent Diffusion.*

INTRODUCTION:

India took a long way route to make Electric vehicles mainstream and reflect the growing trend. Depletion of resources is commonplace, and the future of climate change is striving for its survival. It is expected that by 2023, the Indian government will emerge as a global leader in support of schemes and incentives to invest in R&D strategies for electric vehicles. As environmental awareness prevails, several developing countries have observed a trajectory in the automotive sector and implemented electric mobility as a more accessible and simpler viable alternative. Being new and emerging in such technological developmental structures, it distinctly stands crucial because it has impacted the global economy. Big automotive businesses are enjoying patent management strategies to protect Intellectual Property and gain a competitive advantage. Furthermore, thus, we see automobile enterprises have entered into an arrangement of patent applications.

It is an undeniable fact that electric vehicles are cost-effective and environmentally friendly, owing to the utilisation of advanced battery technology. These factors have led to greater competition among the biggest names in the electric vehicle market.

Under such an atmosphere and policy, Automakers like Ford and Honda have recently made it to the headlines about their plans for fossil fuel vehicles in stages over the next decade. At the same time, India and Germany have vowed to ban fossil fuel vehicles entirely by 2030. However, there is still a significant amount of progress that needs to be made.

The segment of this research will deal with Patent Management in the automotive industry, with due emphasis laid on striking a balance between Competition and Patent Protection. This research is an attempt to highlight various facets with regard to safeguarding their innovations through patent disclosure to constitute the outcome of Patent Management acting upon the future of electric vehicles.

Firstly, the study would deliberate on the emergence of Electric Vehicles in India. Thus, to draw the inference that Electric vehicles are in consonance with Climate change technology development.

Secondly, the study seeks to analyse Patent Management so as to sustain the objective of this study after assessing the pros and cons in the interest of Patent Protection and Competition.

Thirdly, the study also highlights various facets of critics and makes a critical analysis of Patent policies and electric vehicle innovations.

In our Critical Analysis, we compare the innovation responses to the product market across automobile companies indulged in electric vehicles that are prevalent globally. The study will address, by far, leading the technology development in such a niche sector, and how India will be progressing ahead in EVs Patentable actions and finally concludes with a note in favour of striking a balance.

METHODOLOGY:

The proposed methodology for this study involves the utilisation of mixed-methods research synthesis to identify, examine, and integrate pertinent empirical research in a systematic review. Our methodology involves conducting a comprehensive search for pertinent research in electronic databases and other relevant sources. The methodology will convert the outcomes of quantitative syntheses into narrative accounts characterised by qualitative themes. The

integration of textual descriptions and results from the initial qualitative syntheses that are mutually compatible is a common practice in mixed-methods syntheses.

LIMITATIONS OF THE STUDY:

The paper has some limitations, which include:

1. The study only focuses on the Indian electric vehicle market, and the findings may not be generalizable to other countries or regions.
2. The analysis is based on patent publication data, which may not provide a complete picture of innovation trends in the electric vehicle sector.
3. The authors do not provide a detailed analysis of the legal and policy implications of open-source patents in the electric vehicle sector.
4. The paper does not provide a comprehensive review of the existing literature on electric vehicles and patenting policy.

ELECTRIC VEHICLES IN INDIA?

Electric Vehicles have come a long way road to India. However, the concept is familiar to the world. In creating Electric vehicles, England called it first around 1897 to build Electric taxis. Subsequently, France and the United Kingdom stepped into the shoes of implementing comprehensive electric vehicle policy during the same era. However, several concerns were cornered in terms of efficiency, pricing, battery, speed, Etc.ⁱ Although there was some floating interest in electric vehicles, it was not until the later 2000s that the efforts of Elon Musk in developing the lithium-ion battery and the introduction of the "Tesla Roadster" vehicle that shed light and shaped the future of the Electric Vehicles Industry.

1. The History and Its Emergence:

The market for electric cars is one of the most active in the field of renewable energy. In 2021, the number of electric vehicle (EV) sales doubled from the previous years to reach a new peak of 6.6 million. Only 120,000 electric vehicles were sold globally in 2012. Each week in 2021, sales average out to be higher than that. By 2021, the percentage of electric vehicle sales in the world will be close to 10%, up from just 4% in 2019. With this, there are now over 16.5 million electric vehicles on the road worldwide, which is nearly three times more than there were in 2018. With 2 million sold in the first quarter of 2022, a 75% increase from the same period in 2021, electric car sales have been expanding steadily worldwide.

India, being home to 1.3 billion or the most populous country, confronts intricate challenges with respect to infrastructure, transportation, oil and gas production and environmental pollution. In 2021, provided by IQAIR, three cities out of 10 were reported to be the most polluted cities in the world.ⁱⁱ Thus, to combat such plight, India has adopted some targets in consonance with Sustainable Development Goals. Since it aims to decrease carbon emissions by 1 billion tonnes and increase the renewable energy production capacity to 500 GW by the year 2030, and net zero carbon emission by 2070.

Thus, with the intent to achieve these targets, choosing electric vehicles over conventional fuel-powered vehicles is a viable option for India.ⁱⁱⁱ Moreover, in light of this, such advent features of electric vehicles call for regulations and standards and strict compliance. It can be inferred from the market data and patent application filing data that the future of electric vehicles in the

automotive sector is uprising. The next segment discusses how patent applications are fuelled with competition among applicants in order to protect innovation and yet sustain green technology.

The automotive industry has been predominantly dominated by gasoline engines for more than a century. Electric vehicles gained traction in the late 2000s because of increasing public interest and awareness and Government incentives. A vehicle that uses an electric motor for propulsion and a battery as a source of energy is referred to as an electric vehicle. It can also be run on electricity from extravehicular sources or a collector system. Road and rail vehicles, surface and underwater watercraft, electric aeroplanes, and electric spacecraft are all examples of EVs.

2. Current Scenario and Expectations of electric vehicles in India

As of August 2022, almost 14 Lakh EVs were running on Indian roads. 3 Wheelers hold the most significant share, with around 57%. The total percentage of two-wheelers accounted for over 39%. At the same time, four-wheelers and above stood at 4%. With the possibility of 100% FDI, new manufacturing centres, and intensified efforts to improve charging infrastructure, the electric car industry in India is gaining momentum. Other growth factors for the Indian EV industry include federal subsidies, a regulation that favours deeper discounts for electric two-wheelers made in India, and a boost for locally produced advanced carbon composite batteries. With yearly sales forecast to reach 10 million by 2030 and an estimated increase in the number of EVs on the road to half a million, sales of EVs will grow at a compound annual growth rate (CAGR) of around 50% between 2022 and 2030. By 2025, the value of the Indian EV market is predicted to be \$7.09 billion.

The EV30 project aims to achieve a 30 per cent market share for EVs by 2030 and represents a potential investment opportunity worth up to INR 20 lakh crore. In order to do this, there has recently been a rise in both corporate and state budgetary investments in EVs. Financial benefits for EVs, charging stations, and manufacturing that have been granted by the federal and state governments are assisting in achieving ICE (internal combustion engine) vehicle parity in terms of the total cost of ownership for a number of market segments and use cases. OEMs and component producers are making investments in domestic manufacturing and supply networks.

THE NEXUS BETWEEN PATENT MANAGEMENT AND AUTOMOBILE SECTOR

A patent is a legal instrument that deploys a set of exclusive rights to its owner.^{iv} It is a social bargain.^v Furthermore, the management of patents within the automobile industry pertains to the systematic approach of obtaining, safeguarding, and utilising patents that are associated with novel ideas and advancements in the realm of automotive technology. The process begins with the identification and assessment of patents that have the potential to be licenced, sold, or leveraged for the purpose of generating revenue via royalty payments.

Effective patent management is essential for companies operating in the automobile industry to maintain their competitiveness and safeguard their intellectual property. The implementation of intellectual property protection enables companies to sustain their competitive edge by restricting unauthorised usage of their technology by competitors.^{+vi} Additionally, it facilitates the possibility of collaborative ventures with other organisations. Given the intensifying

competition in the high-tech industries, the significance of patent management expertise surpasses that of a firm's patent portfolio.^{vii} Nevertheless, the availability of such proficiencies remains limited. However, the important question is the role of Patent in light of the ongoing discussion on whether Patent hinders the development and transfer of green technologies.

According to the patterns of patent applications in Germany, the US, and China, the number of patents relating to EVs is rising more than before, and the majority of those applications are for energy storage, batteries supercapacitors, fuel cell systems, range extenders, power electronics and electric machines. India can be new and, somehow, a delayed and reluctant party to the concept of Electric Vehicles. However, it has also seen many changes made by automobile companies to bring and involve Electric vehicles in the conventional automotive market. Businesses may set up their own matching patent strategies at various R&D stages to address the current development trends of EVs and patent applications in order to successfully protect their R&D findings and prevent infringing on the patent rights of other businesses.

Nissan stood to be one of the strong competitors since the launch of Nissan LEAF in 2010 which is known for all electric, zero emission car.^{viii} Currently, several startups are building their way to the development of EV space, such as. Sakti3 has 69 patents in their own name, while NovaTorque with approximately 36 patents and Wireless Advanced Vehicle Electrification (WAVE) has about 25 patents.^{ix} The majority of these nascent companies were procured by prominent entities such as Dyson and Ideanomics. The primary emphasis in the industry is on battery charging systems, with Dcbel Inc., Ze Way SAS, and Fermata LLC at the forefront of this development.

Figure No. 1 - Trends in Patent Applications in Electric Vehicles:

IPR Technology Category (Indicative)

Based on automated segmentation - It is possible to have deviation from the category

| Category | Publication numbers ▾ |
|------------------------|-----------------------|
| Battery | 4,715 |
| Design | 2,573 |
| Miscellaneous | 2,572 |
| BMS | 1,401 |
| Charging System/method | 1,368 |
| EV Powertrain | 1,038 |
| CONVERTOR (AC/DC) | 929 |
| Battery swapping | 748 |
| Charging Station | 360 |
| Wireless Charging | 315 |

A) BATTERY:

Batteries certainly serves one of the core parts in any Automobile which is inclusive of Electric Vehicle. Since the government rolled out the Product Linked Incentive scheme for advanced chemistry cell battery manufacturing, Toshiba, DENSO and Suzuki Motor Coporation had set up Lithium – iOns Battery manufactory in Gujarat.^x The commercial fleet for EV deployment is taking stakes due to inventions in battery components and management systems, resultant from the policy. In the case of energy utilisation in electric vehicles, the core technologies in the market are the lithium-ion battery so to replace lead acid and metal hydride batteries due to lower storage capacity. Electric vehicles commonly rely on rechargeable chemical batteries as their conventional energy storage solutions.

In summary, the transformation could be sensed in the following manner:

- (a) Lead Batteries: These batteries are highly accessible due to their widespread use and affordability, resulting from their well-established manufacturing process and dependable performance. Despite their widespread use and affordability, concerns exist about the disposal of these batteries due to the inadequacy of lead-acid battery recycling in supporting portability and the need for efficient pollution control systems to reduce emissions.
- (b) Nickel metal hydride batteries: These gives higher energy density when compared to lead-acid batteries. The energy density of nickel metal hydride batteries is estimated to be around 69.4 Wh/kg. The batteries in question have been widely employed in fully electric plug-in automobiles, including but not limited to the Toyota RAV4 EV, General Motors EV1, and Honda EV Plus. Furthermore, they have been utilized in hybrid automobiles such as the Toyota Prius and Honda Civic Hybrid. The environmental impact of this type of battery is comparatively lower than that of nickel-cadmium batteries, owing to the lack of toxic cadmium. The recycling of industrial nickel is a prevalent practice owing to its significant economic worth.
- (c) Lithium Ion batteries: In the context of electric vehicle application, lithium-ion batteries are commonly favored owing to their exceptional range per charge. Furthermore, they are comparatively more cost-effective than nickel and demonstrate a discharge rate of around five percent per month. In contrast, it can be observed that nickel-metal hydride batteries exhibit a discharge rate of 30% per month. It is recommended to periodically charge lithium-ion batteries during their initial stages in order to extend their longevity. In addition, it is imperative to ensure that the batteries are not discharged below their minimum voltage and that their thermal management is properly maintained.^{xi}

B) DESGINS:

Initially, batteries of a moderate size are incompatible with traditional internal combustion engine (ICE) vehicles, resulting in battery size and efficiency being significant factors in the current design of electric vehicles (EVs). The observation has been made that the primary objective behind the development of inventions has been to optimize fuel efficiency. One hand it had to entailed minimizing aerodynamic drag and rolling resistance, and on the other hand maximizing the efficiency of the engine/motor and transmission. It is noteworthy that the development of battery electric vehicles with high efficiencies has been aimed at mitigating the need for costly battery mass reduction. Such structural designs are intended to optimize vehicle design, including increased flexibility in component placement for electric vehicles.^{xii}

C) CHARGING SYSTEMS:

Charging Time Optimization: This technology The charging duration of an electric vehicle (EV) can be optimized by considering various factors including the battery's condition, the availability of charging infrastructure, and energy tariffs. It's worth noting that Tata Motors and Ather Energy have secured patents for this technology. Utilizing solar panels for EV charging not only promotes sustainability but also decreases grid dependency. SUN Mobility and Tata Motors have also filed patents for this solar charging technology.

Plug In Charging: A Plug-in Electric Vehicle (PEV) is a motor vehicle that can be charged from an external source of electricity, such as a wall socket. The energy contained within the rechargeable battery packs is harnessed to propel the wheels of the automobile. These are portable charging stations that can be moved around to different locations, providing a convenient and flexible charging solution. This technology has been patented by companies like Tata Power and SUN Mobility.^{xiii}

Wireless Charging: During the period of 2019-2020, the State Grid Corp of China was identified as the leading innovator in wireless electric vehicle charging (WEVC) on a global scale, having secured 31 patent families. The rate of technological advancement in this field is noteworthy, with China (CN) being the primary source of patents, trailed by the United States (US) and Korea (KR). In Japan, the ownership of most wireless electric vehicle charging (WEVC) patents is concentrated among prominent automobile corporations like Toyota, Nissan, and Hyundai, in contrast to China where research and development endeavors are dispersed among numerous small groups and startups. In the United States, WEVC technology was being developed by Qualcomm and WiTricity, a spinout of the Massachusetts Institute of Technology, in parallel.

Corollary, Wireless charging technology is still in the early stages of development, and there are several technical and regulatory challenges that need to be addressed before it can become a mainstream charging solution for EVs. However, companies like Hero Electric and SUN Mobility are leading the way in developing innovative and sustainable charging solutions for the future of mobility.^{xiv}

Hero Electric, which is one of the leading manufacturers of electric two-wheelers in India, has filed a patent for a wireless charging system that uses an array of charging pads embedded in the ground. The charging pads are connected to a charging station, and the EV can be parked over the charging pads to begin charging wirelessly. According to Hero Electric, this technology will make charging more convenient and will also reduce the risk of cable theft and damage.

SUN Mobility, on the other hand, has developed a modular battery-swapping system for EVs that includes a wireless charging pad. The wireless charging pad is used to charge the batteries while they are being swapped, ensuring that the batteries are always fully charged and ready to use. SUN Mobility's technology has been designed to be compatible with a wide range of EVs, making it a flexible and convenient solution for fleet operators.

The below diagram provides the list of top assignees for granted and alive patents in the field of EV Charging.

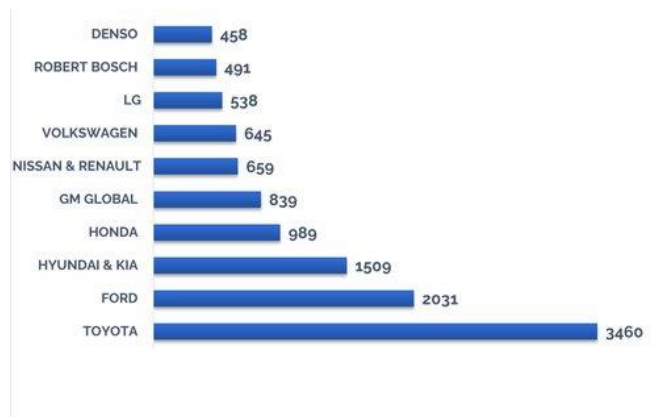


Figure no. 2 - The list of top assignees for granted and alive patents in the field of EV charging observed Globally (Source : Lumenci)

- (I) Static Wireless Charging: The technology of wireless charging has experienced a significant surge in popularity due to its multifaceted applications, which span from the charging of mobile phones to the charging of electric vehicles (EVs). The existence of considerable air gaps within current wireless charging systems for electric vehicles (EVs) presents a notable hindrance to their extensive implementation. The presence of air gaps poses several challenges such as efficiency-related concerns, power transfer-related complexities, and electromagnetic compatibility (EMC) leakage issues.^{xv}
- (II) Dynamic Wireless Charging: The practice of dynamically charging electric vehicles (EVs) wirelessly is gaining popularity as the favored approach for transferring energy between the grid and the vehicle while it is in transit. The Dynamic Wireless Electric Vehicle Charging System (D-WEVCS) is a technology that shows great potential in mitigating the challenges associated with the range and cost of Electric Vehicles (EVs). Indeed, it represents the only viable resolution for forthcoming automated electric vehicles.^{xvi}

D) **Figure No. 3** - EV Powertrain technologies:

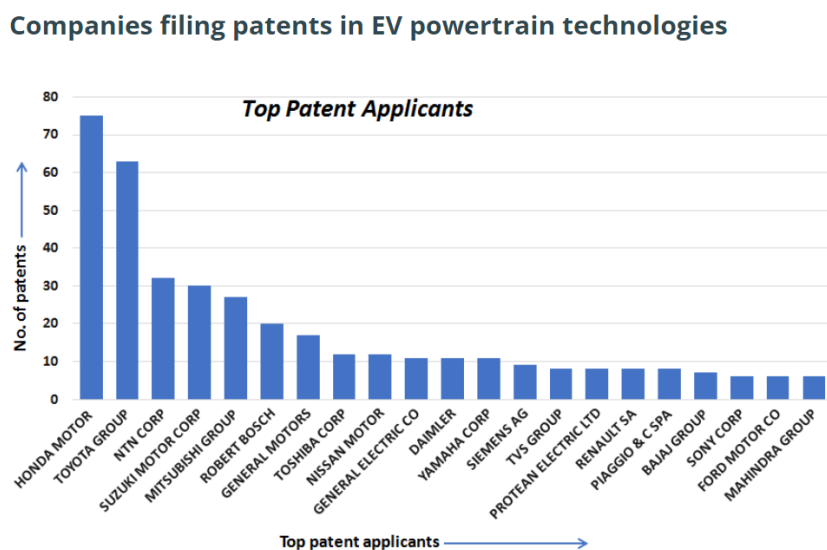


Fig. 3 Bar graph showing the number of patents filed by top patent applicants in the EV powertrain segment to date.

1. **Regenerative Braking System:** This system captures the energy released during braking and stores it in the battery, thereby increasing the overall efficiency of the EV. This technology has been patented by companies like Mahindra and Tata Motors.
2. **Battery Management System:** This system manages the charging and discharging of the EV battery and ensures that it operates within safe limits. It has been patented by companies like Mahindra and Ashok Leyland.

Tata Motors and Mahindra are two of the leading Indian automotive companies that have patented innovations in the field of electric vehicle (EV) powertrain.^{xvii}

Tata Motors has filed several patents related to EV powertrain technology, including a system for monitoring and controlling the temperature of the battery pack, a method for regenerative braking control, and an algorithm for optimizing the powertrain efficiency. Tata Motors has also developed a fast-charging system for EVs that can charge a vehicle to 80% in just 60 minutes.

Mahindra, on the other hand, has patented several innovations related to EV powertrain components, such as an electric motor with a two-speed transmission, an integrated electric powertrain module, and a battery pack cooling system. Mahindra has also developed an EV powertrain system called MESMA, which stands for Mahindra Electric Scalable Modular Architecture, that can be customized for various types of EVs.^{xviii} These patented innovations in EV powertrain technology demonstrate the commitment of Indian automotive companies like Tata Motors and Mahindra towards the development of sustainable and efficient mobility solutions. As the demand for EVs continues to grow, we can expect to see many more innovative and sustainable solutions being developed in the field of EV powertrain technology. These are just a few examples of the many innovations that have been patented in the field of EV powertrain in India. As the adoption of EVs continues to grow, we can expect to see many more such innovations in the future.

Opening up of Patent Policy:

In the segment of climate change technology development, Patent holds power to provide substantial benefit to the environment as they provide an incentive for the commercialisation of technologies. However, there might be a market failure in environmental innovations in lieu of minimal resources.

Open-source patents are designed to create a cooperative environment where businesses can cooperate on shared goals and ideas that advance both society and technology. This idea supports the axiom that better outcomes come from teamwork. It lowers research and development costs for businesses while also boosting their capacity for innovation. The process of opening up patents may result in the adoption of global standards within emerging or quickly developing industries.

The development of electric vehicles is greatly dependent on fossil fuels because of the depreciation of air quality. However, the relationship between fossil fuels and its consumption is difficult to be laid down in precise figures due to the shortage of resources and raw materials required to manufacture batteries for electric vehicles. It has been set out in the Parliamentary Standing Committee report that India was reliant on the international market for EV equipment and spent around 1% on R&D of technological developments.^{xix} Furthermore, the restrictions

imposed by the patent holder on licensing and use of technology can act as a barrier to sustainable development and in producing cheaper electric vehicles with infrastructures.

In the pursuit of novel patenting technologies, a general approach is to submit excessively comprehensive patent applications. A patent with broad claims is formulated in a manner that is intentionally imprecise, with the aim of obtaining more extensive legal protection. The aforementioned statements exhibit intentional ambiguity regarding the particulars, exhibit a dearth of technical intricacies pertaining to the innovation, and as a result, may fall short in offering resolutions. The court, in the case of Charge Point Inc vs. Sema Connect, Inc (2019) determined that the claims pertaining to a wireless vehicle charging station were deemed ineligible for patent protection due to their abstract and indeterminate nature.^{xx} Likewise, numerous patent applications exhibit this flaw as the imperative to pursue broader protection assumes significance in this competition.

Though there are many emerging players in the electric vehicles market, there are only a few when it comes to the segment of Patent pledging for the advancement of electric vehicle technology. The basic energy utilisation by far is going on a large scale in India, which is categorised to be an emerging country that has taken a shift in patents between 2000-2022. When compared to China, it is worth noting that investors are hugely contributing to R & D and account for 8% of patents and when in terms of climate change-related technology, patenting is less concentrated than patenting as a whole.^{xxi}

Achieving a sustainable development that involves the use of electric vehicles necessitates a balance between competition and protection, which can be effectively attained through the diffusion of patents. The preceding discourse is pursued due to the presence of exclusionary motives, while the diffusion motives hold a prominent position immediately subsequent to the exclusionary ones. A viable alternative for a patent pool is a patent pledge, which refers to the voluntary relinquishment of intellectual property rights. Elon Musk, when he made it to the headlines for his commitment to Patent Pledging in the context of electric vehicle technology, there was a spur of the patent pool.^{xxii} The objective of the worldwide initiative to decrease global emissions and attain climate stabilisation involves the implementation of existing environmentally-friendly technologies, as well as the ongoing advancement and commercialisation of such innovations. That does not qualify that patents no longer be equated with incentives or transactions. It is noteworthy that entities can employ Tesla's technology without divulging their own Intellectual Property portfolios through the execution of a licensing agreement with Tesla. Nevertheless, it is evident that Tesla is deriving advantages from the transaction, potentially via the acquisition of licensing fees, royalties, or cross-licensing agreements.^{xxiii}

The Patent Pledge framework possesses the capability to create a hindering patent system, whereby a company enhances the pledged technology, secures a patent for said enhancement, and subsequently blocks any coming utilisation of the enhancement as well as any future extension of improvements. Problems are likely to arise whereby a patent owner declines to license his technology for environmental application. This becomes implied for the coordination of environment laws and intellectual property laws, there will be the achievement of the much required balance and harmony assuring progress and protection.

The Eco-Patent Commons was instituted in 2008 as a patent commitment structure with the aim of promoting the adoption of environmentally friendly technologies and enhancing the

likelihood of subsequent innovation. The Eco-Patent Commons had a specific focus on five distinct areas of green technology, namely energy conservation, pollution control, environmentally sustainable materials, water, and materials. Therefore, considering the act of making patent pledges, it is associated with both incentives and significant risks.

Does Patent Pledging Accelerate Innovation?

Recent literature on knowledge diffusion has demonstrated that information in patent documents can enhance technological advancement compared to scenarios where inventors do not have access to such information. It highlighted that the presence of a solid patent right impedes advances in technology when compared to scenarios where the patent right is voluntarily relinquished, such as in the case of pledged patents.^{xxiv} Promoting patent pledges for technologies aimed at mitigating climate change and other technologies related to significant challenges and indeed suggested with bold lines. While initial efforts were unsuccessful, the research professed that patent pledges possess the capability to stimulate subsequent innovations given the appropriate circumstances.^{xxv}

The website provided a static display of patent listings without any active recommendations for potential applications of these technologies, either individually or together.^{xxvi} The findings in a study proposed that successful dissemination of technology necessitates additional measures beyond patent non-assertion, particularly in developing nations. The provision of technical support and transfer of technology and expertise are crucial for the successful implementation of environmental technologies, surpassing the requirements for software or pharmaceuticals. At this juncture, it is essential to note that patent disclosures alone are often inadequate in facilitating effective technology implementation.^{xxvii}

Regarding the acceleration of technology, considering patent commitments as a means to achieve such a goal is a simplistic viewpoint. Contreras and Jorge argue that the act of pledging patents has a positive impact on society beyond the interests of the corporation, a phenomenon they attribute to the philanthropic nature of the practice. The assertion put forth by the author – Chien is corroborated by argument that the act of sharing intellectual property rights (IPRs) could fulfill humanitarian objectives.^{xxviii} The authors highlight that a majority of pledges are not philanthropic in nature, and instead, the pledgers' primary motives are to gain favourable public perception or enhance their market standing. Contreas, Hall, & Helmers, have reported that patent pledges are seldom motivated by PR.^{xxix}

Patenting Option in India:

At the outset, disclosure of technical knowledge is a strong foot for patentability. In consonance with TRIPS Agreement, disclosure of information stands as a pre-requisite for standard protection. Several works after exorbitant research suggest that patent disclosure may avoid the flurry of lawsuits and infringement claims.^{xxx} In congruence with the bargain theory of patent protection, so that the patent system shall be constructed in a way that the rewards are beneficial for future generations efficiently. Thus, the results imply that knowledge diffusion increases as the time frame between the invention and its disclosure decreases, emphasising more on the importance of disclosure to the usefulness of the disclosed information for future inventions.^{xxxi}

India is a prominent destination for numerous multinational automobile corporations seeking to broaden their operations in the Asian region. In recent years, Indian automobile industry

leaders have undertaken significant efforts towards upgrading their operations. These efforts include the implementation of advanced modular platforms, the utilisation of new materials, and the practice of platform sharing within India. The notion of upgrading pertains to the ability of enterprises to enhance the quality of their products, optimise production processes, and venture into more sophisticated domains. The technological advancements made by Toyota and Tesla hold the potential to offer a competitive advantage in the domain of research and development, serving as a preliminary framework upon which to build. Through their assistance to prospective rivals, Toyota and Tesla are expediting the innovation process and augmenting consumer options, ultimately yielding enduring advantages for the purchaser.^{xxxiii} Consequently, the open-source patent pledges possess significant utility for both fledgling and established enterprises that operate within the Electric Vehicle industry. A few years ago, Mahindra and Mahindra, an Indian automotive company, appraised Tesla's patents, intending to incorporate them into their own electric vehicle technology. However, after a two-year duration, they revised their position and decided against leveraging Tesla's patents, citing their possession of a considerable number of patents that could be monetised. Nevertheless, suppliers or vendors are commonly classified as small and medium enterprises (SMEs) face restrictions in terms of opportunities and resources for augmenting their operations. Usually, there is a paucity of investments designated for research and development, as well as the safeguarding of intellectual property rights. The idea of 'Free Patents' can be interpreted as advantageous for Indian automotive SMEs, irrespective of the manufacturer's primary motive.

CONCLUDING REMARKS:

We need science and law to sustain a greener world. Currently, Electric Vehicles are hitting on the roads of India; however, in the longer run, sustainability should be carried forward and not revert back to conventional vehicles. In this paper, we analysed Electric Vehicles are rapidly involved and, thus, observed the trends and the pace of innovation in the EV sector, intersecting with patent alignment. The open-sourcing policy is a novel idea to facilitate the inclination to adopt Electric vehicles, and thus, due emphasis is laid down on Patent Disclosure. Automotive Industry is a targeted sector in the space of Electric Vehicles and relies upon climate change technology, the appropriate manner of selection for open-source patents raises several questions, and this research bridges the vacuum in order to strike a balance for a sustainable environment.

It is, of course, an open question about the extent to which the technology development involves patent pledging or would apply more generally for the lapse of the patent system. There are, however, reasons to ponder for choosing sustainable environmental development and overcasting the shadows of litigation on technological advances. It comes to no doubt that the patent system will face new challenges in the future with emerging technology, the increasing importance of a sustainable environment, the growing role of markets and the arrival of new entrants, the convergence of evolved technological systems (e.g. Electric Vehicles in the automotive sector), fostered by the emergence of lithium-ion batteries which generates the patent pool and promotion of patent applications in the changing age of the world. In this context, the patents will not decline, but the conditions for patent innovation choose to be used and suffice can be handled.

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