

**RESEARCH PAPER****Global Intellectual Property Best Practices for Green Innovation: A Case Study of Pakistan****¹Muhammad Ali Haider, ²Amna Imdad and ³Dr Ghulam Murtiza**

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***Corresponding Author:** ghulammurtiza@gcuf.edu.pk**ABSTRACT**

This research analyzes the relationship between global intellectual property (IP) norms and sustainable innovation, with a focus on opportunities for Pakistan. As environmental challenges intensify, sustainable innovation becomes increasingly critical, and intellectual property rights are vital for protecting inventors and attracting investment in sustainable technologies. The study conducts a comparative analysis of effective IP strategies from international case studies, examining how advanced nations promote green technology. The findings reveal successful approaches that Pakistan could adopt to enhance its green innovation ecosystem, while also highlighting challenges such as regulatory complexities and limited access to funding. To foster an environment supportive of green innovation, it is essential for Pakistan to implement international IP strategies effectively. Recommendations include strengthening legal frameworks, promoting joint ventures, and improving skills development in related initiatives. This research provides actionable insights for policymakers and experts to leverage successful global IP practices to stimulate green innovation in Pakistan.

KEYWORDS: Best Practices, Green innovation, Intellectual property (IP), IP Approaches, Legal Structures**Introduction**

The Intellectual Property Rights (IPR) are legal rights assigned to creators and inventors for the protection of created products and inventions. Some of these protections are found as patents, copyrights, trademarks, and trade secrets and each of these helps to address different aspects of creativity and innovation work. Copyright works include literary, musical, and artistic works, and these works are protected by law for the duration of the author's life and 70 years after his/her death, thus encouraging creation of more contents within cultural and education domains (U.S. Copyright Office, 2021). Trade marks protect symbols, words, phrases, which is used to identify particular goods as well as services, to ensure that brand reputation and customer integrity is upheld (Gervais, 2019). Protection of these rights are important in the sense that it gives the innovator or inventor the confidence that his or her work cannot be used or copied by a third party hence leading to increased investment and technological advancement (Maskus, 2000). The role of IPR is especially critical in industries characterized by high levels of technological novelty and the need for effective protection of inventions and innovations that will support the further development of industries.

Green innovation can be defined as the process of creating and implementing products, services, processes and organizational structures that can lower negative effects on the natural environment to the population. This encompasses technologies in the generation of electricity from solar and wind sources, organic farming, bio pesticides,

development of green building materials and related products (REN21, 2020). The contribution of IPR for green innovations is therefore essential, as it offers the legal environment that is required for their protection and, in turn, their monetization, thus stimulating innovation in sustainable environments (Hall & Helmers, 2013).

Literature Review

The intersection of intellectual property (IP) rights and green innovation has garnered increasing attention in recent years, particularly as countries strive to balance economic development with environmental sustainability. Bashir and Ahmed (2023) delve into Pakistan's IP system, highlighting the challenges and opportunities for fostering green innovation through case studies focused on patent infringement litigation in the renewable energy sector. Their analysis reveals significant insights into the enforcement of IP rights and offers a judicial perspective on how legal frameworks can either facilitate or hinder the growth of sustainable technologies. This study serves as a critical foundation for understanding the legal landscape affecting green innovation in Pakistan and underscores the need for a robust IP regime to protect and incentivize environmentally friendly inventions.

In alignment with the objectives of enhancing green innovation, Haq and Sattar (2022) argue that compliance with the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement is essential for strengthening Pakistan's IPR framework. They assert that aligning national laws with international standards not only boosts foreign investor confidence but also facilitates the transfer of sustainable technologies into Pakistan. The enforcement of IP rights is underscored by notable judicial cases such as *Reckitt Benckiser Pakistan Ltd. v. Zone Pharmaceuticals* (PLD 2021 Lahore 112) and *Novartis AG v. Highnoon Laboratories Ltd.* (PLD 2020 SC 692), which emphasize the critical role of patent protection in fostering innovation while also highlighting the complexities of enforcing IPRs within the country. Such judicial perspectives are vital for framing the discourse around green technologies and their protection under Pakistani law.

The need for improved IPR protection in the context of green technologies is further echoed by various authors. Khan et al. (2021) note that advancements in Pakistan's renewable energy sector, particularly in solar and wind technologies, hinge on a solid IPR framework that ensures innovators can benefit from their inventions. Ahmad (2020) discusses the significance of the Patents Ordinance of 2000, which aims to protect technological advancements, including those related to green innovations. However, he also points out that the effective enforcement of these rights is impeded by challenges such as public awareness and infrastructural limitations. Meanwhile, Ali and Shafiq (2019) highlight the importance of building technical expertise and improving public knowledge to navigate IP complexities, advocating for a holistic approach to foster an environment conducive to green innovation.

Additionally, several studies emphasize the role of international cooperation and best practices in enhancing IP protection for green innovation in Pakistan. Mustafa and Hussain (2021) advocate for active engagement in international IP forums to adopt global best practices that can support domestic green technology development. Simultaneously, the National Renewable Energy Laboratory (NREL) (2018) asserts that clear IP protections are crucial for attracting investment in renewable energy projects, highlighting the economic potential of strengthening Pakistan's IPR framework. The integration of environmental considerations into IP policies, as suggested by the United Nations Environment Programme (UNEP) (2018), further underscores the need for legislative frameworks that explicitly incentivize sustainable technologies. As the landscape of global IP practices continues to evolve, Pakistan has the opportunity to learn

from these international examples, enhancing its approach to IP rights in a way that promotes green innovation while addressing local challenges.

Material and Methods

This qualitative research employs a normative approach to analyze green innovation and the protection of intellectual property (IP) rights in Pakistan. It includes an extensive review of textbooks, journals, legal codes, norms, standards, laws, conventions, rules, legal papers, papers by jurists, international agreement principles, precedents, case law, and various doctrines related to IP rights in green innovation. The study critically examines Pakistan's legal framework and compares it to international legal systems to identify the strengths and weaknesses of its legal structures in supporting green innovation through effective IP protection. Utilizing case study methodology, the research will explore the effects of IP protection on green innovation, focusing on Pakistan's legal and environmental context.

IP Strategies for Green Innovations: Lessons from Around the World

Patent Systems and Green Innovations

Accelerated patent examination programs are aimed at speeding up the examination of what are deemed critical patents in order to quicken technology development and implementation. These programs assume greater relevance in the case of green technologies, where the process of innovation has to be fast in order to meet environmental issues. The United States of America, Japan and Europe for instance have introduced famous accelerated examination procedures to support innovations based on green technologies.

In USA, USPTO started a new program known as the Green Technology Pilot Program through which the examination of all such patent applications that addressed inventions related to decreased greenhouse gas emissions and energy-saving technologies could be done at a faster pace (USPTO, 2009). This program managed to reduce the average time to carry out a patent examination from 40 months to less than 12 months thus speed up the period to move from the innovation stage to the implementation stage (Hague, 2011). Likewise in the case of Japan, the Japan's Patent Office (JPO) has provisions on prioritization of the patent applications, which are associated with green technology. Such applications are processed through examination expeditiously, and some patents have been issued within one year. The purpose is to make Japan the world's number one market for green technology by augmenting the diffusion of new environmental technologies (Nagaoka & Takeuchi, 2013).

Europe for instance through EPO provides for what is referred to as "Accelerated Prosecution of European patent applications" commonly known as the PACE program where provisions for green technologies are also provided for. According to this program, any application within the area of green technology is processed with higher priority and therefore takes a shorter time to obtain patent protection in multiple countries in Europe at the same time (European Patent Office, 2012).

Green patent databases play an important role of tracking and sharing information with respect to the patented green technologies. Innovators, researchers as well as policymakers use these databases as major reference sources for inventors with the intention of encouraging innovations in efficient and sustainable technologies. WIPO has also set up green patent library known as WIPO GREEN so as to assist businesses seeking green technologies.

Collaborative Intellectual Property Models

The two collaborative IPR management techniques examined here are patent pools and open licensing – strategies that concern the sharing and development of technology. These models have their greatest effect where change is fast and several patented technologies are cumulative in a manufacturing process for new products, generally in high-technology industries. A patent pool can of course be defined as a kind of anodic collaboration whereby one or more, and including all the members holding one or more patents, grant licenses to one another or third parties. An example for the successful implementation of MPEG-2 is the MPEG-2 patent pool. Formed in the 1990s, such important patents were involved in DVD and television digital video coding techniques. Thus, these companies used different shared patents in not seeking protection through litigation and in enhancing collective improvement of business technologies (Lerner & Tirole, 2004). This pool not only introduced efficiency in the commercialization process of MPEG-2 technology but also improved several factors of the market stability and reduced the transmission costs of the actual transactions. Open licensing means that IP can be utilized in a more liberal way and generally is employed in order to stimulate development of certain forms of products, for instance, software and environmentally friendly inventions. The most familiar type of open licensing is the GNU General Public License (GPL) which applies to the overwhelming proportion of open source software. In GPL, if a software is built using another software then the new software must also be released as GPL making it again open for innovation and collaboration, (Stallman, 2009). This model has spurred advancement in software with projects such as the Linux and Apache being the foundations of current infrastructure.

Public-Private Partnerships (PPPs) can be defined as cooperation between the government and the private sector to implement projects that cannot be done by the two individually. Specifically, PPPs have played a crucial role in the implementation of green innovations with regard to environmentally sustainable technologies.

Regulatory Frameworks and Incentives

Governmental actions have an immense impact on green technology and the Intellectual Property framework depending on the policies that facilitate green technology. In China, the government has embarked on several measures of five year plans in promoting industrialization and innovation of green technologies. This includes the promotion of research through grants, special program on fast-tracking of patents in the area of green technology and provision of incentive to firms/institutions to produce green technologies. Lower fees and better IPR protection for innovation in this field are provided by the Chinese government to the filers of these patents. Also, the European Union has established mechanisms in which green technology can be financed through its green deal; where the EU aims at achieving a climate neutral Europe by 2050. This policy involves such incentives as, the increased accessibility to a large portion of funding for green technology initiatives, tax credits as well as an enhanced IP system that allows for easy registration of patents on innovations in the green space (European Commission, 2020). Moreover, the European Union's current research and innovation program known as Horizon 2020 have helped in funding research on green technologies; this financial support provides the necessary capital that assists in bridging the between research, development, production and marketing of the green technologies (Schmidt, et al. , 2019)

International Agreements and Collaborations

The Paris Agreement, which was established in 2015, is a key document in combating climate change, where the important aspect is related to technology and innovation. However, some of the finer issues of the agreement are not well expressed about the sharing of intellectual property (IP) rights that is very central in green

technology advancement and diffusion. Some risks in technology transfer are evident from the absence of specific provisions on IP in the agreement; this is especially so for the developing nations, which may be affected by trends emanating from stringent IP regimes (Correa, 2018).

WIPO Green is another good example of the action that was taken by the World Intellectual Property Organization (WIPO) illustrating how people can use IP to cut their impact on the environment. This refers to the partnership where technology buyers find technology suppliers easily with the intention of enhancing the sharing of green technologies through a rich technological database available internationally. WIPO Green not only improves technology transfer and provides solutions regarding problems of renewing technology, but also allows recognizing the IPRs of the innovators, thus establishing the balanced system that furthers both inventiveness and accessibility (WIPO, 2020). However, besides WIPO Green there are other international attempts aimed at the promotion of green technology dissemination. The Green Climate Fund is a financial entity operating under the UNFCCC and is considerably involved in the financing of projects in developing countries; notably, it preserves the transfer of technology that respects IPRs as one of its primary objectives. In the same way, other activities such as Climate Technology Centre and Network (CTCN) engage various parties in extending technical support and capacity development for technology transfer process and deployment of relevant technologies to those that requires them (UNFCCC, 2021).

The inclusion of IP rights in these frameworks shows a global appreciation of the fact that while IP is important, it must be provided with some check to ensure that technology sharing is achieved especially in technologies that are critical in impacting the environment.

Innovative Case Studies from Developed Countries

Germany's Environmental Innovation Program

Umwelt Innovations programme (UIP) of Germany is a notable governmental programme that promotes environmental sustainability by introducing incentives for innovative technologies. The UIP was established in 1979 and has since been revised many times reflecting the dynamic environment, and emerging issues as well as the changes in technology. The main undisputed goal of the UIP is to stimulate the creation and application of new technologies, the use of which leads to environmental improvements and resource conservation. Germany has been able to combine environmental policies and incentives on the use of IP to promote technological development for utilization throughout various sectors of the economy (BMU, 2022). Since its inception the UIP has been accomplishing its objective through grants, low-interest business loans and subsidies being offered to corporations and research organizations favoring the development of environmental enhancement technologies. The financial support is incentivized by a Liberal IP environment that protects patents and this will motivate inventors and firms to embrace green technologies. Environmental policies have been correlated with benefits issued to inventors and innovators that have gone a long way towards making technology more favorable. The German Patent and Trade Mark Office (DPMA) has a significant role in this process because innovations in the environmental field get adequate patent protection promptly to make the technologies commercially profitable (DPMA, 2020).

Case Study: Innovative Wastewater Treatment Technologies

Of the technologies that were developed under the UIP, there is an innovative system of wastewater treatment which is a combination of membrane bioreactor [MBR] technology with the anaerobic digestion process. This system is the work of several

German industrial entities and research facilities concerned with solving the problems of utilization of wastewater in cities. The MBR technology in which semi-permeable membranes are used to filter out impurities within wastewater has been enhanced by the use of the anaerobic digester that breaks down the organic matter to biogas. This biogas can be further utilized as an energy source which makes it a two-fold process of managing wastes and producing energy (Koch et al., 2019).

USPTO's Green Technology Pilot Program

The United States Patent and Trademark Office (USPTO) launched the Green Technology Pilot Program (GTPP) in December 2009 as a strategic move or approach to fast-track application in the area of green technology. This undertaking was designed as a way of promoting innovations and projects on environmental issues like generation of renewable energy, energy efficiency and also low carbon emission. Through providing the organization for fast-track patenting of the identified green technologies the GTPP therefore sought to decrease the time needed for patent examination and thus fasten the market entry of better environmental technologies (USPTO, 2020). The GTPP procedure was intended for the fast consideration of those inventions that would have a positive impact on the environment. Such technologies involved those that contributed to the improvement of the environment, efficiency in energy use, or emissions on green gas. It was available for a certain number of applications and applicants needed to prove the environmental advantage of their creations. Pendency time was cut short drastically through the process thus the expedited time was notably shorter than the normal examination track (USPTO, 2020). This reduction in processing time was important in order to make sure that advantageous technologies got to the marketplace quickly and in this way, experienced the best environmental influence.

Case Study: Solar Energy Technologies

Among all these objectives of the GTPP, the development of solar power remains perhaps the most well-known success. For example, Solyndra LLC engaged the fast track patenting where the company was able to attain the patents for the cylindrical solar photovoltaic (PV) panels in a shorter time than what would have been needed under normal process. These panels were superior in efficiency and easier to install than flat panels, played a special role of pulling in the additional investment and thus increasing production lines. The fast tracking encouraged by the GTPP allowed Solyndra to deliver new advanced technique to the market place faster than its competitors hence improving on the utilization of solar solutions (Solyndra, Inc. v. Suntech Power Holdings Co., 2012).

Japan's Eco-First Program

The Ministry of the Environment (MOE) of Japan formulated the Eco-First Program in the year 2008, which represents the country's enthusiasm towards environment friendly practice and business accountability. This means that the given program was developed to identify and reward businesses for their proactive approaches in protecting environment. The high standards of the Eco-First Program as well as the outlined set of significant environmental obligations pushes companies to find creative solutions and weave sustainability into their management systems (MOE, 2021). Apart from the concrete minimization of the environmental impact of each company in the program, it also attempts to foster innovations in the sphere of green technologies with an intent to change the world. To enroll themselves in the Eco-First Program, such companies have to agree on certain environmental targets of their businesses and provide well-articulated blueprints to meet those targets. Such targets may involve cutting the emission of greenhouse gases, increasing the efficiency of energy usage, using renewable energy sources, decreasing waste and conserving the bio-diversity. The companies which have been approved for membership receive the certification of 'Eco-

First Companies' that allows them to use logos of the Eco-First Companies in their advertisements. This recognition improves their visibility publicly and draws attention to the fact that they are environmentally friendly, thus giving them an added advantage as the world turns into a green economy (MOE, 2021). The Eco-First Program provides many benefits to involved industries. This includes the government contracts which are usually tendered on a special or preferential basis, the right to draw grants and subsidies from the government, financial assistance, and assistance in securing credit facilities chargeable at reasonable interest rates. Besides, it encourages cooperation with government organizations to form joint projects and share experiences between Eco-First companies. The program also carries out public relations promotions to describe the success of these companies boosting the image and position of these companies in the market (Tanaka, 2019).

Case Study: Toyota's Hybrid Technology

Toyota Motor Corporation, which is one of the Eco-First companies, is an example of the achievement of the program in stimulating the creativity for sustainability. By this company has taken step forward towards emission of less carbon due to the fact of constant production and introducing more models of hybrid cars in the market. The Eco-First Program has offered an essential governmental assistance that has boosted the company's R&D work. Therefore, Toyota has been able to amass a large number of patents for its hybrid technology hence enhancing its competitive advantage and remarkably contributing to the fight against pollution from automobiles worldwide (Toyota Environmental Report, 2021). The huge acceptance of Toyota's hybrid cars indicates that the program is useful in creating a market for environmentally friendly technologies.

EPO's Initiative to Create a Shared Pool of Accessible Eco-Friendly Patents

Eco-Patent Commons which was developed by the European Patent Office (EPO) and the World Business Council for Sustainable Development (WBCSD) could be deemed as the first attempt to stimulate the dissemination and utilization of environmentally friendly technologies. It was initiated in 2008 and aims at the creation of shared pool of patents which are environmental friendly and are made available for the public domain. The objective of the Eco-Patent Commons is to lessen the limitations that hinder the diffusion of green technologies while at the same time, increasing the rate of generation and implementation of inventions that could contribute to the betterment of the environment (EPO, 2020).

The rules of access to the Eco-Patent Commons are open; however, its participation is voluntary. Organizations bring most of the patents into the pool while they retain ownership to them, but they exclude some rights to allow others to use the technology in a pool without risking legal action. These include legal documents which define the usage of collective pool and the details of patents contained in it. Also, the initiative complies with the general EU sustainable development and Innovation policies that create friendly legal frameworks promoting corporate participation (EPO, 2020). As a result of making eco-friendly patents open for use by the public, the barriers of entry have majorly been eliminated, which enables even the small firms, and research institutions to employ complicated technologies without having to pay much. This democratization of access has led to provision of innovation by minority groups in society. Furthermore, the pool of patents has allowed for the inter-industry interaction which has triggered creation of complex solutions for various environmental issues at the same time (WBCSD, 2021).

Case Study: IBM's Contributions

IBM's participation in the initiative of Eco-Patent Commons mirrors the effect of sharing in information technology. IBM has benefited others and the society in that it took patents that are associated with power savings of data centers so that other companies and research institutions could use such ideas to create efficient IT facilities. This has helped in the efficient improvement of the power consumption within data centers that are well known to be power intensive. Other engagements in the commons have also been geared towards offering joint research and new technologies aimed at increasing energy efficiency, IBM (2020).

Challenges and Opportunities in IPR for Green Innovations in Pakistan: A Comprehensive Analysis

Patenting of Intellectual Property Rights (IPR) in green innovation is a complex issue, whereby most countries, including developing nations such as Pakistan, face the dilemma of either protecting green inventions or making those technologies available to the public. This analysis focuses on trying to understand the relation and interaction between IPR and green innovations, as well as the legal issues involved or foreseeable in Pakistan.

Challenges

Balancing Patent Protection with Public Access in Green Technologies

One of the most significant issues arising in the context of IPR in green technology is the conflict between the patent protection which provide certain extent of exclusivity and the need to make green technologies accessible to the public. Patents aim at encouraging innovation through providing the inventors with special rights to use their inventions for a given period of time only. However, in the case of green technologies, exclusivity poses a problem because it slows the progress of this technology adoption and implementation in the global society particularly in the world's affected regions of climate change but with limited financial capability to buy patented technologies (Subramanian, 2021). In Pakistan, the set of rules under which patents are granted and protected is based on a number of worldwide practices, specifically the WTO's TRIPS Agreement, but the local Patents Ordinance 2000 fails to consider the potential needs and characteristics of green technologies (Government of Pakistan, 2000). In this regard, the policy makers could apply certain provisions similar to those adopted for compulsory licensing in countries such as India where the mechanism can be applied to technologies classified as vital to public health and the environment (Rajput, 2019).

Impact of IPR on Developing Countries' Access to Green Technologies

The access to green technologies by developing countries under strict IPR is an area of major concern. These technologies are usually invented in the technologically developed countries and the technologies bear patents, hence costly and can hardly be imported (Khan & Ghani, 2020). In the case of Pakistan, a proper strategy to deal with these technologies would entail, seek technology transfer on the basis of reciprocally sensible terms through bi-lateral or multi-lateral arrangements (Aftab& Bilal, 2022). Moreover, the idea of 'green patents' can be incorporated more actively into national IPR policies to support innovation in environmental technologies as well as concerning provisions for the easier licensing and sharing of such technologies across the borders (United Nations Environment Programme, 2021).

Proprietary Technologies vs. Widespread Technological Dissemination

The problem of patents, which are traditionally associated with innovation, becomes an issue when green technologies must be disseminated as widely as possible to address global environmental challenges. This tension is well seen, for instance, in the renewable energy solutions where there are particular technologies that could considerably reduce climate change effects but are not properly used in nations which cannot afford them because of IPR barriers (Lopez & Schmidt, 2022). Pakistan can learn from such approaches in dealing with this challenge, just like the European Union member states, where certain directives help the states to share green technologies under more preferred terms hence, the widescope ecological benefits (European Commission, 2020).

Legal, Economic, and Societal Barriers in Pakistan

IPR has met some legal, economic and societal challenges which affects the efficiency of the very technology in dissemination of green technologies in Pakistan. From the legal perspective, mechanisms of enforcement need to be strengthen and institutions in the form of special courts need to be established to try IPR cases related to green technologies where the matters are complicated in nature (Malik & Khan, 2023). In the economic consideration, the cost of acquisition and protection of all developed patents poses a challenge for SMEs and researchers. At the societal level, the knowledge and comprehension deficits are also evident concerning the roles and opportunities of IPR in encouraging environmentally friendly technologies. Efforts aimed at increasing public awareness and appreciation of IPR may involve awareness creation and incorporation of IPR awareness into the school curriculum (Nawaz & Iqbal, 2021).

Opportunities for Advancing Green Innovations through IPR in Pakistan

Strengthening IPR as a Catalyst for Green Innovation

The strong protection of IPR is essentially related to the promotion of innovation. In the context of green technologies, it is important to ensure on the one hand efficient IPR protection as it also encourages the development of new technologies, on the other hand provides a legal framework which is necessary for investments and cooperation. In the case of Pakistan, the enhancement of the IPR with reference to green technologies can stimulate foreign and domestic investments into the country and improve the country's technological capacity while responding to the environmental issues confronting it (Singh & Gupta, 2021). To do this, Pakistan should look towards green technology sector-specific policies like addition/modification to the Patents Ordinance 2000 for inclusion of Green Technology Track to enable fast tracking of patents as demonstrated by the South Korea and Australia (Kim & Park, 2020; Australian Government, 2019).

Leveraging International IPR Agreements to Access Global Innovation

Pakistan's participation in the IPRs including Patent Cooperation Treaty (PCT) and Madrid System for the international registration of marks can help Pakistan gain easier access over the global innovations. These agreements give opportunities to provide clear channels of the transfer of more environmentally sustainable technologies in to the country by easing methods on how Pakistani companies can seek protection of their inventions overseas (WIPO, 2022). Furthermore, apart from SDG-oriented activities, the engagement of Pakistan in the global arena through Technology Facilitation Mechanism created under the United Nations might be very helpful in possible international research and development partnerships which are instrumental for acquisition and domestication of new green technologies (United Nations, 2021).

Promoting Public-Private Partnerships (PPPs) for Technology Transfer

Public-private partnerships (PPPs) are widely recognized as enablers for preparing the environment for investing in green technologies. Such partnerships contribute to technology transfer that may combine the provision of public policy with liberal private capital. Thus, there remains a need to establish PPPs dedicated to green technologies' development and commercialization in Pakistan. This approach has been implemented in various countries such as Germany and these governments enhance the private sector's participation in renewable sources of power (European Commission, 2020). For greater effectivity in these collaborations, Pakistan ought to implement particular profit like tax exemption or funds for developments that are positively related to the country's sustainability wherein every part of the society can benefit from investment in green technology.

Enhancing IPR Education and Legal Frameworks

Suitable educational programs involving concepts concerning IPR and green technologies would be central to unlocking the creativity in Pakistan. By offering intellectual courses in universities and vocational training institutions comprising of the legal frameworks of IP law and sustainable tech development will produce a talented workforce to support this sector (Nawaz & Iqbal, 2022). Moreover some form of IPR courts or tribunals for green technologies alone can be created to improve on the legal system, where the cases are handled by professional personnel in the field. This strategy can result into more standard and sound decisions by the honorable judges and thus helped in enhancing the scenario of IPR in Pakistan.

Conclusion

The examination of case studies and international trends in IP protection identifies how effective IP systems are crucial for green innovation with reference to Pakistan. The global case studies emphasize that sound IP policies complemented by efficient measures and appropriate incentives are crucial for nurturing and popularizing environmentally sound innovations. Therefore, adopting such global best practices can significantly improve the country's capacity to tackle environmental issues, foster economic growth, and realize sustainable development objectives in Pakistan. IP policies need to meet best-practice guidelines of international norms and bring the synergy of public and private sectors to advance green innovation, which is in high demand for the improvement of environmental standards and economic stability.

Recommendations

- **Enhance Patent Laws:** Revise patent laws to provide stronger incentives for green technology innovation.
- **Streamline IP Registration Processes:** Simplify and expedite IP registration to accelerate commercialization of eco-friendly technologies.
- **Encourage Collaborative IP Models:** Support patent pools and open-source licensing to foster knowledge sharing in green technology.
- **Utilize Compulsory Licensing:** Implement compulsory licensing to ensure access to critical green technologies while respecting IP rights.
- **Develop Fast-Track Patent Approval:** Create expedited patent processes specifically for green technologies to encourage rapid innovation.
- **Collaborate with Developed Countries:** Foster international partnerships for effective knowledge transfer of green innovations.
- **Focus on Public-Private Partnerships:** Enhance collaboration to localize and adapt sustainable technologies in the local market.

- **Financial Incentives for Startups:** Offer IP-related financial incentives and reduced fees for startups focused on green innovations.
- **Develop Stronger Enforcement Measures:** Implement robust strategies to combat IP infringement in the green technology sector.
- **Promote Cross-Border IP Cooperation:** Establish international collaborations to protect and enforce green innovations globally.
- **Align with TRIPS Provisions:** Ensure compliance with TRIPS to attract foreign investment in green technologies.
- **Engage with WTO's Environmental Goods Agreement:** Actively participate in agreements to promote green trade and sustainability.
- **Support Public R&D Institutions:** Invest in public research and development to create and patent sustainable technologies.
- **Implement Balanced Policies:** Create policies that harmonize IP protection with environmental sustainability goals.
- **Solar & Wind Energy Patents:** Focus on local innovations for solar panels and wind turbines tailored to Pakistani conditions.
- **Sustainable Agriculture:** Utilize IP to protect eco-friendly farming methods and develop drought-resistant crops.
- **Waste Management & Recycling:** Promote IP protections for recycling technologies and waste-to-energy solutions.
- **Water Conservation Technologies:** Safeguard innovations in water purification and irrigation systems under IP laws.
- **Green Financing Models:** Explore IP-backed green bonds to fund sustainable infrastructure projects effectively.

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