

Utilizing the Potential of Intellectual Property Protection Rights to Build Business Models in Developing Countries

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Abstract

The Internet of Things (IoT) and other smart systems are revolutionizing emerging countries. IoT prototypes have been created in Botswana in fields like environmental monitoring, mining, and healthcare. However, their commercialization is hampered by a lack of intellectual property (IP) protection. Innovations are susceptible to infringement in the absence of patents, copyrights, or trademarks, which discourages investors and impedes advancement. This report emphasizes how crucial IP protection is to transforming IoT breakthroughs into successful business endeavors. It investigates relevant IP rights and encourages the early incorporation of IP tactics in research. It illustrates how robust IP frameworks can establish Botswana as a Southern African technology powerhouse using examples from both domestic and international contexts. To promote an inclusive innovation culture, this paper promotes capacity-building programs and stakeholder collaboration, including between academia, entrepreneurs, and the government; regulators. In addition to safeguarding inventions, efficient IP enforcement promotes economic expansion and technological development.

Keywords:

Copyrights, Innovation Protection, Intellectual Property, Internet of Things, Patents, Trade Secrets

1. Introduction

The Internet of Things is transforming businesses and fostering more creativity and efficiency by allowing networked objects to gather and share data. IoT offers enormous potential for both technological and economic development in developing nations. It is essential to comprehend and

put into practice strong intellectual property protection measures in order to fully take advantage of these prospects (Chen and Puttitanun 2005).

Even though Botswana's IoT development is expanding quickly, developers, academics, and startups are not well-informed on intellectual property protection. Innovative IoT inventions are vulnerable to copying or appropriation without adequate intellectual property protection, which keeps creators from reaping the full rewards of their labor (Reichman 2009). Long-term technical advancement is discouraged and Botswana's standing as a regional tech hub is weakened by the lack of a proactive IP culture.

In Botswana, a lot of research is being done to find IoT-based solutions to local problems. Projects include healthcare monitoring, smart agriculture, environmental management, and more. Academic journals, conference proceedings, and technical reports contain the development and documentation of many of these initiatives (Sheikh 2024; Sheikh and Matlotse 2023; Mahatlane, Sheikh, and Molefhi 2021; Abdulmalek et al. 2022). The fact that projects are rarely finished or turned into workable business models, despite the creation of useful systems and the publication of information, is a persistent problem. As a result, these innovations' full economic and social potential has not yet been realized. It is crucial to think about IP strategies early in the research and development process because IP protections, like patents, cannot be obtained after public disclosure (Flores-Cortez, Cortez, and Rosa 2019; Sheikh and Ngebani 2019; Sheikh, Mokgwathi, and Matlotse 2022; Sheikh et al. 2024; Sheikh et al. 2023).

The University of Botswana, for example, has developed and proposed a number of IoT-based solutions, as reported in recent publications, including An IoT Livestock Health Monitoring System (Sheikh, Seloiso, and Raiyo 2023), An IoT Based Health Monitoring System for Cancer Treatment (Kavitha et al. 2023), An Internet of Things Tap WaterUsage Monitoring Device (Sain, Sheikh, and Molefhi 2021), Design of a Microcontroller Based Internet of Things Based weather Station (Ngebani et al. 2018), Addressing Agri-Business Challenges using Internet of Things Technologies (Sheikh and Ben Halima 2024) and Building Internet of Things projects for Real World Problems in developing Countries (Sheikh 2024). Even though these projects demonstrate the technical prowess of regional researchers, their commercialization potential is still constrained in the absence of sufficient intellectual property protection.

IP rights can be secured for a wide range of components of IoT systems, including the physical hardware, firmware, software algorithms, data analytics models, communication protocols, mobile or web interfaces, and even branding elements. For instance, a custom-designed sensor board for environmental monitoring can be patented, while the software controlling data processing or device behavior may be protected under copyright or trade secrets. In an interdisciplinary field like IoT, where engineering meets data science and user experience, almost every layer of the system has IP potential.

Raising awareness of IoT patenting and other IP protections through university workshops, public seminars, and partnerships with regulatory organizations like the Companies and Intellectual Property Authority is crucial to closing this gap. Botswana can foster a flourishing innovation ecosystem where creators are protected and incentivized by teaching innovators about the value of patents, copyrights, trademarks, and trade secrets. Local inventors will be able to obtain ownership of their creations, draw in investors, and expand their ideas into long-term business models if intellectual property considerations are incorporated into research and development procedures.

The many forms of intellectual property protection; patents, trademarks, copyrights, trade secrets, and utility models, are further explained in the next section. The use of these safeguards particularly in the context of IoT projects is then covered in Section 3. The expanding IoT scene in Botswana is examined in Section 4, along with IP enforcement methods, regulatory authorities in Botswana and abroad, IP protection tactics, and the function of IP in international trade. Examples of IoT technologies that have been successfully protected locally and internationally are shown in Section 5. The paper's last section offers thoughts on how Botswana's status as a developing center of technological innovation might be supported by a robust intellectual property regime.

2. Understanding Intellectual Property (IP)

Intellectual Property is a broad and essential area of law that helps creators and businesses protect their innovations, ideas, and creations from unauthorized use (Hernández-Chea et al. 2020). By granting exclusive rights to creators, IP encourages innovation and creativity while allowing them to capitalize on their work. The five main types of IP are:

2.1. Patents

According to the U.S. Patent and Trademark Office, new, useful, and non-obvious discoveries or innovations are legally protected by patents (U.S. Patent and Trademark Office n.d.). They cover a wide spectrum of breakthroughs, including materials compositions, technological devices like cellphones and electronics, processes like innovative production methods, goods like pharmaceutical medications, and improvements in already-existing technology. A patent gives the owner the sole right to stop unauthorized production, use, sale, or distribution of the protected innovation. Utility patents normally endure for 20 years from the date of filing, though the length of patent protection varies by nation.

An invention needs to fulfill three essential requirements in order to be eligible for a patent. It must, first and foremost, be novel; that is, brand-new and unreported before. It must also be beneficial, exhibiting a real-world application or usefulness. Lastly, it must be non-obvious, which

means that an expert in the field shouldn't be able to tell that the invention has been improved or modified (Burstein 2011). These specifications guarantee that patents give innovators legal protection for their works while promoting true innovation.

2.2. Trademarks

Names, words, logos, and other distinguishing marks that set one party's products or services apart from another are protected by trademarks. In essence, a trademark is a way to identify a brand and can be anything from phrases to graphics, sounds, or even particular colors that are connected to a company or product as argued by World Intellectual Property Organization (WIPO n.d.). Businesses need trademark protection to preserve their brand's reputation and avoid consumer confusion in the marketplace.

Logos like Nike's "swoosh," brand names like Apple or Coca-Cola, and slogans like McDonald's "I'm Lovin' It" are all well-known examples of trademarks. Trademarks are important for brand recognition in the technology and Internet of Things industries. Examples of legally protected trademarks are IBM Watson, Tesla's Autopilot, Google's Android, and Amazon Alexa.

A mark needs to fulfill certain criteria in order to be eligible for trademark protection. It needs to be distinctive, which means it is one-of-a-kind and able to pinpoint the origin of products or services. It must not be deceptive, which means that customers cannot be misled or confused. It must also be actively linked to products or services in the market, which means it must be employed in commerce (Diamond 1962). Businesses can create powerful brand identities with trademarks, which also keep rivals from using them without permission.

2.3. Copyrights

Original works of authorship, such as software, films, architecture, literature, art, music, and theater, are safeguarded by copyrights as stated by the U.S. Copyright Office (2021). In order to avoid unauthorized use, copyright gives the creator the sole authority to reproduce, distribute, perform, and exhibit their work. Although there are certain exceptions and variances, copyright protection usually lasts for the author's lifetime plus 70 years in many nations.

Novels, articles, poetry, music compositions, recordings, software programs, visual art like paintings and sculptures, and digital content like photos and graphic designs are all common examples of works that are protected by copyright. To safeguard innovation and intellectual property, software applications, AI-generated content, IoT firmware, and smart device user interfaces are commonly copyrighted in the technology and Internet of Things sectors.

A work must fulfill three essential conditions in order to be eligible for copyright protection. Being original guarantees that the work was produced on its own and wasn't plagiarized. Fixation necessitates that the work be preserved in a material form, like writing, recording, or digital

storage. Last but not least, copyright protects expression rather than ideas (Hughes 2021). This means that while a written novel or a computer program that has been developed is protected, the idea itself is not. In many domains, including technology and digital innovation, copyright is essential for promoting creativity and protecting intellectual endeavors.

2.4. Trade Secrets

Exclusive commercial knowledge that gives a corporation a competitive edge is known as a trade secret. According to the U.S. Department of Justice (1996), as long as they are kept hidden, trade secrets are protected and stay confidential, in contrast to patents, which are made public. Formulas, processes, designs, methods, algorithms, and any other important knowledge that is not generally recognized or readily available might all be considered trade secrets. Trade secret protection lasts forever as long as a business takes the necessary precautions to keep the information private.

The Coca-Cola recipe, Google's search algorithm, and proprietary manufacturing techniques are a few well-known examples of trade secrets that businesses employ to stay ahead of the competition. Trade secrets are essential for safeguarding unique AI models, machine learning algorithms, encryption techniques, and IoT device security protocols in the technology and Internet of Things industries that businesses do not want to patent or make public.

Information must fulfill certain criteria in order to be considered a trade secret. Businesses must use non-disclosure agreements (NDAs) or restricted access, among other reasonable measures, to ensure the confidentiality of the information. Additionally, the information must be economically valuable, which means that because it is not widely known, it gives a competitive advantage. Last but not least, confidentiality is the most crucial component of trade secret protection since once a trade secret is made public, its protection may be lost (Varadarajan 2018).

2.5.

Utility

Models

According to the German Patent and Trade Mark Office (n.d.), utility models, which typically have a lower bar for invention than patents, are a type of intellectual property rights that safeguard innovative and useful technical advancements. Utility models, sometimes known as "innovation patents" or "petty patents" in some nations, offer a quicker and easier path to protection for modest ideas or gradual advancements of already-existing technologies. Utility models are simpler to acquire and provide a shorter protection duration, typically ranging from six to ten years, depending on the country, in contrast to patents, which may demand a high degree of invention.

A redesigned bottle cap, an enhanced door locking system, and a tool handle that has been altered for improved grip are a few examples of utility models. Utility models can safeguard improved sensor enclosures, circuit board layouts for increased energy efficiency, and antenna designs for wireless IoT devices in the technology and Internet of Things industries. Even though these

inventions might not be eligible for complete patent protection, they nevertheless offer technological and useful advancements.

An invention needs to fulfill three essential conditions in order to be eligible for a utility model. Novelty guarantees that the concept is fresh and hasn't been revealed to the public. For an invention to be considered useful, it must be useful and offer a useful advantage. Last but not least, the originality criterion is lower than for patents, thus the invention only needs to show a technical advance over pre-existing methods rather than being revolutionary (Schoemaker 1982). Startups, small companies, and innovators seeking to protect their technological innovations at a reasonable cost will find utility models very helpful.

3. IP Protection for IoT Projects

IoT is a complex field combining hardware, software, and data analytics. Protecting the IP of IoT projects requires a comprehensive strategy involving patents, copyrights, trademarks, trade secrets, and utility models (K.K.C. and M.G. 2018).

3.1.1. Patents

Innovative hardware, communication protocols, and integrated IoT systems are among the new inventions that are protected by patents. A novel sensor or a novel way for devices to communicate with one another, for instance, can be patented to stop technology piracy.

3.1.2. Copyrights

Original software code, user interfaces, and documentation are safeguarded by copyrights. IoT projects frequently utilize proprietary software that manages data or controls devices; this software can be protected to stop illegal usage or duplication.

3.1.3. Trademarks

By protecting brand names, logos, and slogans, trademarks make it possible for customers to identify IoT items in the marketplace. For example, a business can prevent misunderstanding with rivals by trademarking the name and logo of its IoT devices.

3.1.4. Trade Secrets

Trade secrets safeguard proprietary algorithms, data analytics techniques, and manufacturing procedures, among other sensitive information that provides a company with a competitive advantage. For instance, in order to preserve exclusivity, special predictive algorithms for industrial IoT might be protected as trade secrets.

3.1.5. Utility Models

Technical advancements in IoT hardware, including improved sensors or device architectures, are safeguarded by utility models. They provide less protection than patents but are quicker and easier to obtain. They are helpful for small-scale developments.

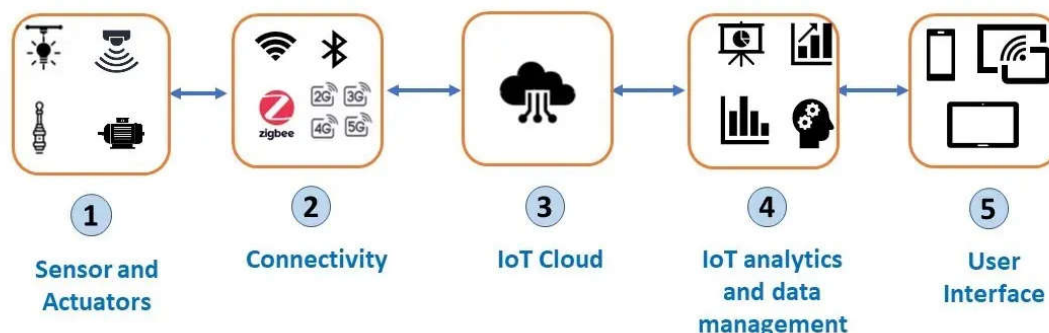


Figure 1: IoT System Diagram, Source: Harmon 2023

Multiple components must be integrated in order for IoT systems to gather, send, and act upon data. As seen in Figure 1, these elements consist of sensors, actuators, data processing units, connectivity modules, and cloud or edge platforms. An outline of a typical IoT architecture and the interactions between its components is given in this diagram (Harmon 2023).

Key IoT components; more especially, sensors, actuators, and connectivity modules, are examined from the standpoint of intellectual property protection in the ensuing subsections. To protect innovation, we find opportunities for each component where utility models, trade secrets, or patents might be useful.

3.2.1. Sensors and Actuators

- **Patents:** New sensor designs, distinctive actuator systems, and advancements in data collection techniques are all worthy of patent protection. This includes improvements in sensing capabilities, energy efficiency, and miniaturization.
- **Trade Secrets:** To preserve technological uniqueness, proprietary algorithms that maximize sensor accuracy, noise reduction strategies, and specific calibration processes are best safeguarded as trade secrets.

- **Utility Models:** Utility models can be used to obtain special physical arrangements that promote resilience to environmental factors, durability, or flexibility.

3.2.2. Connectivity

- **Patents:** New techniques for lowering latency, dynamic frequency management, or energy-efficient variations of Bluetooth or Zigbee are examples of wireless communication protocol innovations that can be protected by patents.
- **Trade secrets:** can include proprietary methods for signal optimization, specially designed firmware for connectivity modules, or special encryption methods for safe device communication.

3.2.3. IoT Cloud Infrastructure

- **Patents:** New developments in edge-cloud orchestration, distributed computing, or real-time data processing methods can be protected by patents.
- **Copyright:** Software systems that oversee device coordination, cloud-based data storage, and security features may be covered by copyright laws.
- **Trade secrets:** May include proprietary data compression algorithms, server optimization techniques, and internal configurations that improve system performance.

3.2.4. IoT Analytics and Data Management

- **Patents:** Specialized machine learning models, automated anomaly detection methods, or predictive analytics algorithms designed for Internet of Things data may be protected by patents.
- **Copyright:** Analytics dashboards, data aggregation interfaces, and custom applications for data visualization are all protected by copyright laws.
- **Trade secrets:** May include proprietary decision-making frameworks and other techniques for organizing, cleaning, and analyzing massive amounts of sensor data.

3.2.5. User Interface (UI)

- **Copyright:** The layout, iconography, and interactive components of the graphical user interface design are all protected by copyright.
- **Utility Models:** Utility models may be justified by unique control panel, smart device screen, or interactive hardware interface physical designs.
- **Trademarks:** Trademarks can be used to protect product names, logos, and other branding components that set the IoT system apart in the marketplace.

Additional Considerations

- **Firmware and Embedded Software:** While source code is protected by copyright law, firmware design advances that improve device security, power management, or performance may be eligible for patent protection.
- **Security Protocols:** While trade secrets may cover proprietary intrusion detection or threat mitigation strategies, patents can protect innovative encryption algorithms or secure authentication approaches.
- **Documentation and Instructional Materials:** The copyright protection of user guides, whitepapers, and training materials strengthens the IoT system's overall security.

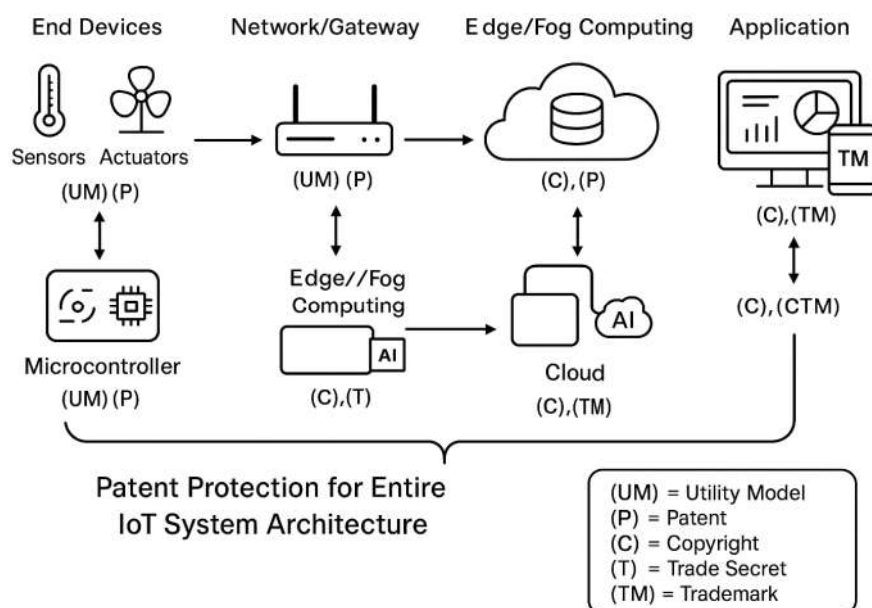


Figure 2: IoT System Possible Protections

Figure 2 illustrates the different components of an IoT system architecture and the types of IP protection that can be applied to each part.

- End Devices such as sensors and actuators, as well as the microcontroller, can be protected by patents (P) and utility models (UM) due to their hardware and embedded technology.
- Patents and utility models are also available for the network or gateway hardware, which reflects advancements in communication protocols and interfaces.
- The data is processed using cloud and edge/fog computing systems; the platforms themselves may be patentable, and the software and AI algorithms utilized here may be covered by trade secrets (T) and copyright (C).
- Copyright usually protects the software and user interface at the application layer, although trademarks (TM) or combination trademarks (CTM) may cover logos or brand names used in the interface (such as mobile apps).
- To ensure that the architecture, workflow, and integration are legally protected, the note at the bottom highlights that whole IoT systems can also be protected as a whole through patents.

This thorough approach demonstrates how different IP types may be stacked throughout an IoT ecosystem, from user-facing apps and cloud services to physical devices, to guarantee complete protection.

4. The Growing IoT Landscape in Botswana

When it comes to implementing IoT technologies in industries like smart city development, healthcare, and agriculture, Botswana has been making impressive progress. The nation's ability to lead in technical developments is demonstrated by initiatives like smart farming systems, water management solutions, and innovations in animal tracking (African Union 2020). To solve local issues, for example, students and businesses in Botswana have created Internet of Things based devices to track soil conditions, control cattle health, and maximize water use.

According to UNCTAD, even with these advancements, it's possible that many developers and business owners are unaware of how crucial IP protection is (UNCTAD 2021). It is possible to guarantee that Botswana's innovators keep ownership of their works by obtaining patents for distinctive sensors, copyrighting software code, or registering trademarks for creative goods. This would encourage domestic industry, draw in international investment, and position the country as a tech hub in Southern Africa.

4.1. IP Protection Strategy for IoT Projects:

IoT companies must implement a thorough IP strategy that may include a mix of patents, copyrights, trademarks, and trade secrets in order to effectively safeguard their intellectual property. When developing this plan, some important factors to take into account are:

- **Early IP Identification:** It's critical to identify possible IP assets early in the development process (AJ Park 2024). To provide effective protection, developers and engineers should be encouraged to document their ideas, designs, and code.
- **Global Protection:** IoT technologies and goods frequently have a global presence. As reported by WISKey (2020), businesses should think about obtaining intellectual property protection in several different countries, particularly if they want to sell their goods abroad.
- **IP Licensing and Partnerships:** Businesses may choose to work with other companies or license their intellectual property (WIPO 2024). It is important to carefully arrange licensing agreements in order to secure the company's intellectual property rights and facilitate strategic alliances.
- **Security and Confidentiality:** Protecting trade secrets is crucial because a lot of IoT solutions rely on proprietary data and algorithms. Companies must have policies in place to protect sensitive data, such as non-disclosure agreements with partners, contractors, and employees (FasterCapital n.d.).

4.2. IP and Global Trade:

IP rights are usually enforced on a country-by-country basis due to their territorial nature. Nonetheless, the process of protecting intellectual property across borders is made easier by international accords like the World Intellectual Property Organization and treaties like the Paris Convention and the Patent Cooperation Treaty. International rules for IP protection are established by the World Trade Organization through the Agreement on Trade-Related Aspects of Intellectual Property Rights (World Trade Organization 2012).

4.3. IP Regulatory Bodies in Botswana and Beyond

In Botswana, and many other developing countries, several organizations and international treaties play a crucial role in helping innovators protect their IP rights:

- **Companies and Intellectual Property Authority (CIPA):** Responsible for registering trademarks, patents, copyrights, and industrial designs. CIPA highlights that it also educates the public on IP issues and enforces local IP laws (CIPA n.d.).

- **World Intellectual Property Organization (WIPO):** An international body that provides global IP services, including the Patent Cooperation Treaty (PCT) for international patent protection and the Madrid System for international trademark registration. Botswana is a member, allowing local innovators to secure global protection (WIPO n.d.).
- **African Regional Intellectual Property Organization (ARIPO):** A regional body that facilitates IP registration and protection across multiple African countries, including Botswana. ARIPO, indicates that it streamlines the process of obtaining IP rights across member states through a single application (ARIPO n.d.).
- **Botswana Innovation Hub (BIH):** Supports local innovators and tech startups by providing resources, funding, and guidance on IP protection strategies (BIH n.d.).
- **The Southern African Development Community (SADC):** Works to harmonize IP policies across member states, creating a more unified and collaborative approach to protecting innovations regionally.

By leveraging these local, regional, and international bodies, developers in Botswana and other developing nations can build strong IP portfolios that safeguard their work, attract investment, and enable growth beyond their borders.

4.4. IP Enforcement:

Legal action, such as lawsuits, may be necessary to enforce intellectual property rights and prevent infringement. But enforcement can also be controlled by:

- Letters of cessation and desist
- licensing contracts that, with certain restrictions, permit others to utilize the intellectual property
- When it comes to resolving disputes outside of court, mediation and arbitration

5. Real-World Examples of IoT IP Protection

Several real-world IoT projects have effectively implemented IP protection strategies, serving as instructive examples for developers, especially in developing countries:

Case Study 1: Lynx's Anti-Cloning Security Measures

The crucial problem of hardware cloning, which endangered five years of intellectual property, was addressed by Lynx in partnership with a top consumer electronics manufacturer. Secure boot procedures, tamper-proofing methods, and encrypted file systems were all part of Lynx's multi-layered security strategy. These safeguards made sure that the business's confidential data and designs were shielded from illegal access and duplication (Lynx Software Technologies 2023).

Case Study 2: Scania's Connected Vehicle Services

To improve operational efficiency, Scania, a well-known manufacturer of commercial vehicles, created fleet management services enabled by the Internet of Things. Scania could forecast maintenance requirements, track performance, and streamline logistics by incorporating IoT technologies into their automobiles. According to Scania, to protect their innovations, Scania secured patents for their unique data analytics algorithms and communication protocols (Scania 2021).

Case Study 3: Hitachi Construction Machinery's ConSite

ConSite, an IoT based system that automatically checks the condition of construction equipment, was introduced by Hitachi Construction Machinery (HCM). ConSite gathers information from equipment to anticipate malfunctions and plan maintenance in advance. HCM protected their proprietary algorithms and data processing methods through a combination of patents and trade secrets (Hitachi Construction Machinery 2020).

Case Study 4: Facility Management IoT Solutions

Businesses have created IoT solutions in the area of smart facility management to maximize maintenance, security, and energy use. Securing the exclusive rights of distinctive software, system designs, and algorithms is necessary to safeguard these inventions. Ambitas (2020) highlights that in addition to protecting these technologies, a robust IP portfolio raises their market value and draws in investors.

6. Conclusion

This study has emphasized how critical it is to incorporate intellectual property protection into IoT project research and commercialization processes in Botswana and other developing nations. The lack of organized intellectual property frameworks hinders developers' capacity to safeguard their inventions, draw in investors, and transform prototypes into viable businesses, despite the fact that

local innovation in smart agriculture, health monitoring, energy systems, and environmental management has shown tremendous promise. In addition to providing protection, intellectual property acts as a link between enterprise and innovation.

Every layer of IoT systems, from sensors and embedded systems to cloud infrastructure, machine learning algorithms, and user interfaces, can be protected using various IP tools like patents, copyrights, trademarks, trade secrets, and utility models. This paper has demonstrated how real-world projects, ranging from Lynx's hardware security strategies to Scania's connected fleet services, have used IP to scale and protect their innovations. These cases provide practical lessons for Botswana's expanding IoT ecosystem.

Finally, it is important to consider intellectual property protection as a tool for innovation rather than just a formality. This paper lays a foundation for innovators to protect their inventions and turn them into viable business models. An institutional and cultural shift toward IP valuation is essential if Botswana is to reap the benefits of its expanding IoT research base. The government may open up new avenues for sustainable development, inclusive economic growth, and technical leadership by cultivating an innovation culture that is IP-conscious and conforming to international standards and enforcement mechanisms. In addition to enabling innovation, intellectual property protection will enable Botswana's innovators to own, grow, and export their ideas.

Declarations

Use of AI Technology

ChatGPT, an AI language model developed by OpenAI, was used in the development, writing, and editing of this paper. The AI was utilized to assist in drafting content, improving clarity, and providing suggestions for structure and language. However, all final content was reviewed and approved by the authors.

Conflicts of Interest

All authors declare that they have no conflicts of interest.

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