



Research article

Intellectual property law protection for energy-efficient innovation in Saudi Arabia

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ABSTRACT

Laws and policies are important instruments to protect and promote innovation. Intellectual property laws like copyright, patent, and confidential commercial information law facilitate can increase business outputs, economic growth, and green production standards. The objective of the article is to analyze copyright, patent, and confidential commercial information laws in Saudi Arabia to see the availability of these laws in encouraging and protecting energy-efficient innovation while contributing to achieving sustainable development. Content analysis, doctrinal research method, and comparative legal analysis were used to achieve the research objective. The research findings demonstrate that the three selected legislation could be extended to protect energy-efficient innovation in Saudi Arabia though there is a need to amend some of the provisions of the existing laws. However, creating public awareness of the availability of laws and proper implementation of the laws are necessary to protect energy-efficient innovation. The article proposes recommendations to the policymakers about the need for further improvement of the law and its enforcement. The findings of this research could fill the gap in the literature on the assessment of intellectual property law to protect energy-efficient innovation in Saudi Arabia.

1. Introduction

Saudi Arabia, as a member of the United Nations Framework Convention on Climate Change (UNFCCC) since 2016, has pledged to improve greenhouse gas emissions mitigation measures. Accordingly, it introduced a circular on carbon economy to reduce emissions from oil and gas operations by 2060. Carbon emission is categorized into distinct groups under GHG (2017) protocols. The categories are direct emission, indirect emission, or other indirect emission. Direct emissions could be from production, fuel consumption, and use of vehicles. Indirect emission comes from the consumption of products using electricity, gas, and other energy resources. Other indirect emission comes from suppliers and consumers where a producer may not have direct control over the emission. Though it may not be under the control of manufacturers to control this type of emission, measures should be implemented on all types of emissions to achieve the Mandate of the Paris Agreement.

Many countries and industries introduce reform to achieve sustainable development. For instance, countries like China, Germany, and Spain introduced energy-efficient technology to control negative effects on the environment [1–3]. To make the introduction and adoption of energy-efficient innovation technologies easy and effective, the governments introduced localized carbon taxes, laws, and market policies [4]. Though the emission mitigation strategies might be costlier, it is necessary to balance economic and environmental

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well-being [5,6].

Studies suggest that energy consumption and economic growth which increased wealth, urban migration, and material consumption contribute to an increase in direct and indirect emissions Giljum et al. [7]. It is also shown that economic growth escalates energy consumption and environmental degradation [8]. The need to introduce laws and policies on material efficiency could reduce the environmental impact of economic growth. Economic growth calls for attraction of foreign investments which in turn positively influences countries' productivity, capital account relief, and economic growth. However, it negatively influences the environment [9–11]. It is shown that environmental degradation in developing countries is mainly caused by resource depletion, forest destruction, inequality of income, poverty, and increasing population [12,13]. A collective initiative is needed to protect and preserve the environment from further degradation [14,15]. As part of the collective initiative, the passing of laws and policies is considered one of the effective methods. The laws related to energy efficiency innovation not only provide protection but also control market distortion and manipulation. This will encourage the dissemination of knowledge without losing ownership of the innovation. The law could facilitate and protect green innovation, adoption, and sharing of innovation without affecting the financial benefit to innovators.

Environmental innovation could be defined as innovation that allows to creation of sustainable energy [16,17] while technological innovation could be defined as innovations that provide opportunities for energy-efficient products by applying innovative technologies Guo et al. [18,19]. The innovation may involve product innovation and process innovation. Product innovation can be related to new products or improving the existing products and services while process innovation could be related to the manufacturing process [20,21]. The law relating to process innovations could include innovation in processes or development [22]. Various types of intellectual property laws could be used to protect products or process innovation. For example, patents can be used to protect processes and products and ensure the innovators' right to protect their products or processes Seip et al. [22,23]. Similarly, copyright could protect expression, codes, and other designs while confidential commercial information law could protect ideas, information related to prototypes, design, and non-patented information. This law could be used to protect some trade secrets related to invention or innovation. According to Qiang et al. [24], laws could encourage innovation that works as part of remedial action for environmental protection.

Saudi Arabia became a member of the United Nations Framework Convention on Climate Change (UNFCCC) in 2016 and has pledged to improve greenhouse gas emissions mitigation measures. To achieve its commitment, Saudi Arabia diversified its economic activities, encourages innovations and provides stronger laws, and regulations. It also introduced Vision 2030 to achieve sustainable development (Vision 2030: , Heffron et al., 2018). Aligning Saudi Vision 2030 and other commitments. Saudi Arabia reduced energy subsidies, introduced measures to rely less on petroleum assets, and took the initiative to introduce better laws (Busch et al., 2018 [25–33]. Following the Berne Copyright and Paris Industrial Property Conventions, Saudi Arabia amended the intellectual property (IP) laws to ensure adherence to the international standard [34]. The copyright law could be explained as the law that protects literary, scientific, or artistic work that is original, expressed, and has creative capacities. The patent law allows the owner of an invention, product, or technology to benefit morally and financially for a limited period. Once a patent is registered, it recognizes the owner's right and prevents others from exploiting it during this period of protection [35]. A patent could be sought if it meets the requirement of novelty, newness, non-obvious, and industrial application Schmookler & Schmookler, [36–38]. Patentable products can be objects and tools, devices, equipment, and materials. Trade secrets or any information that is confidential in terms of commercial activities are protected for five years from the date of approval for protection under confidential commercial information law. This law is a very important legislation as foreign investors are concerned about the maximization of profit and competitive advantage in the market. After joining WTO, Saudi Arabia enacted the Regulation of Protecting Classified Commercial Information to protect trade secrets or confidential information. Thus, confidential commercial information law can be defined as the law that protects commercial confidential information.

The law relating to innovation is necessary to protect the innovators and inventors and they facilitate in achieving sustainable development. Based on the fourth going, this article analyzed the Saudi Arabian important three legislation in the protection of invention and innovation. Saudi copyright law was analyzed in this article to assess the availability of protection of expression, codes, and other designs for energy-efficient invention and innovation. The patent law was analyzed to see whether objects and tools, devices, equipment, materials, manufacturing processes, control methods, and measurement methods could be protected. The confidential commercial information law was assessed to investigate if protection for ideas, information related to prototypes, design, and non-patented information could be available. The objective of this research was to analyze the copyright, patent, and confidential commercial law to understand how they provide adequate protection for products and processes of energy efficiency. The main research question is: can the Saudi Arabian Copyright, Trademark, and Commercial Confidential Information protect energy-efficient innovation in Saudi Arabia? The research finding is significant as it could be used to identify the possible weakness of the law and suggest improvement in laws and policies if necessary. It also could fill the gaps in the literature as there is a dearth of literature on issues related to the level of protection that the Saudi Arabian intellectual property law confers on inventors and innovators.

The remainder of the article is organized in the following way: section 2 covers the methodology used in the article. Section 3 discusses existing literature on sustainability, Saudi Arabian Vision 2030, intellectual property rights, and innovation. The analysis of the findings is presented and discussed in section 4. Section 5 includes policy and legal measures to foster energy-efficient innovations by IP laws and the final part concludes the article with recommendations.

2. Methodology

This research used content analysis, doctrinal research, and comparative methods. Content analysis was used to analyze literature related to sustainability, energy efficiency, innovation, copyright, patent, and confidential commercial information so that appropriate

questions and themes could be derived. The literature for this research was collected from journals in Scopus, Web of Science, Lexis Nexis, and Google Scholar using terms or combinations of terms like “innovation”, “sustainability”, “copyright and innovation”, “patent and innovation”, “trade secret”, “confidential information”, “Intellectual property laws in Saudi Arabia”, and “Sustainability and laws in Saudi Arabia” and searched in all fields with no enforcement of date restrictions. The collected literature and laws were scanned, sorted, and reviewed if they were found to be relevant. The researchers found that 110 research materials were relevant.

The doctrinal research method was used to identify, extract, and analyze the laws, rules, policies, and case laws (Hutchinson and Duncan, 2012). This methodology helps to critically evaluate the law and the application of the laws to energy-efficient innovation in Saudi Arabia (Alomari and Heffron, 2021). Since cases are not published officially in Saudi Arabia unlike in common law countries, few available cases were investigated regarding innovation and copyright, patent, and commercial confidential information.

In addition, the comparative method of legal analysis was also used for relevant international conventions and laws that have similarities to Saudi Arabian laws. The main reason for this type of analysis was to understand the legislative trend internationally and in other jurisdictions so that appropriate recommendations could be made regarding the protection of energy-efficient innovation. In the context., TRIPS and the USA laws on copyright, patent, and trade secrets were considered so that current developments and initiatives could be utilized as a guide in protecting energy-efficient innovation. Based on content analysis, doctrinal research method, and comparative analysis, the research design shown in Fig. 1 was devised. The design predicts that copyright, patent, and information laws ensure protection for energy-efficient innovation.

3. Literature review

3.1. Arabian vision 2030 and sustainability

The Saudi Arabian Vision 2030 emphasizes achieving a lower-carbon economy or sustainable economy and necessitates the diversification of economic activities, attraction of foreign investment, encouragement of innovations, and stronger laws, and regulations (Vision 2030: . Law and policy play an important role in energy transition ([39] and achieving a sustainable economy [40]. Inefficient laws and policies could delay the transition to sustainable economic goals (Kivimaa et al., 2021 Johnstone et al., 2020). Aligning Saudi Vision 2030 goals to secure national industrial opportunity with low-carbon and energy-efficient systems while relying less on petroleum assets requires better laws and the creation of awareness of available green laws. (Busch et al., 2018 and Alomari and Heffron (2021). Low carbon or sustainable economy which is linked to achieving sustainable development as part of Saudi Vision 2030 has been promoted locally and internationally in various forums like the International Energy Forum (IEF) (IEF, 2020; Ministry of Energy of Saudi Arabia, 2020. As part of energy reform policies and energy efficient reforms, there was a decline of 3.9 % in CO2 emissions in 2018 ([41] and [42].

[43] discussed emission control and proposed technology measures to trade carbon while [44] provided pathways to fossil fuel-producing countries to control emissions while managing financial impact. Though emissions have increased by 1 % in 2019, the policies and measures implemented as part of Saudi Vision 2030 could reduce emissions to achieve sustainability. The Saudi Arabian approach to sustainability is tailored based on national circumstances and thus economic diversification, technical assistance, and capacity building are given important consideration [45]. In mitigating carbon emissions, for instance, Saudi Arabia introduced an energy-efficient program in 2012 to address energy-related issues. This program consisted of 35 different actions supported by 13 teams [44]. Under this program, more efficient air conditioning was introduced to reduce energy consumption[46]. Similarly, the government invested in replacing the old power plants with power-efficient plants and introduced conservation measures to control demand (DNA 2018). The government has increased the fuel price and introduced the Citizens Account Program to achieve energy efficiency (Al Dubyan and Gasim, 2021). Fuel-switching measures have also been introduced to increase natural gas networks in power generation by 2030 ([47].

Innovation plays a critical role in achieving sustainable development goals (SDGs) and controlling carbon emissions. SDG 9 recognizes technology as a crucial step in attaining sustainability and intellectual property law is an integral part as investors are willing to work with companies in countries where there is adequate protection of innovation [48]. Since science and technology are critical to achieving SDGs, the UN set up a Technology Facilitation Mechanism (TFM), educational institutions have set up technology transfer offices while governments are helping in intellectual property management. For example, the first United Nations Conference on Trade and Development (UNCTAD) meeting in 1964, in its resolution stated that developed countries should participate in the transfer of innovation, know-how, and technical documentation to developing countries to help them achieve sustainable development

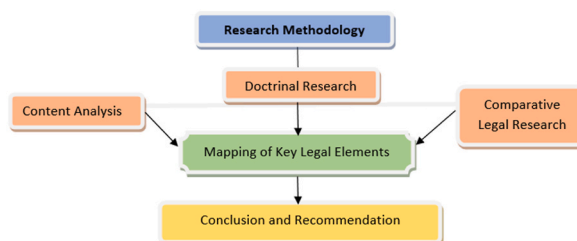


Fig. 1. Research methodology.

(UNCTAD, 2014). To facilitate technological transfer and development in developing countries, many bilateral and multilateral treaties and agreements were signed. For instance, the Anti-Counterfeiting Trade Agreement (ACTA) and the Trans-Pacific Partnership (TPP) included standards for the protection and enforcement of intellectual property rights [49]. Fintech and e-commerce innovation start-ups are on the rise in the Middle East and North Africa (MENA) region, along with the application of patent rights. There were 70 patent applications filed in 1989 and the number has increased to 3266 in 2016 (U.S. Chamber International IP Index, 2021). Computer programs that have proven to provide a solution or have a technical consideration and applied technical consideration are also entitled to patent protection [50].

Incentivizing innovations and economic well-being are vital under Saudi Vision 2030. As such, improving all areas that could accomplish this vision should be given enough consideration. In this aspect, the intellectual property laws were modified to suit local needs and achieve international standards. Saudi intellectual property administration is centralized under the Saudi Authority for Intellectual Property (SAIP) which organizes, empowers, and standardizes intellectual property protection and management. SAIP is missioned to provide a hub for the creation, protection, and commercialization of intellectual property rights [51]. For better protection of patents, the law was modified to allow the GCC member countries' patents to be recognized and protected without the need for further registration process.

3.2. Intellectual property rights and innovation

Various literature discusses issues related to intellectual property rights and highlights their crucial role in motivating innovation and achieving economic development. [52] studied the nexus between patented innovation and business success in Swiss companies and found that there is a good link between patented innovation and business success in small and medium enterprises. Innovation could include process innovations, innovation in processes, or development [22]. [53] surveyed the opinion of inventors on the harmonization of intellectual property in terms of software in Japan. The respondents agreed that there is a need for harmonization of the intellectual property system. [54] suggested a technology transfer measure to encourage start-up companies. Metallidou et al [55] conducted a survey among graduate students of Graduate Institutes in Greece on patent law awareness and entrepreneurial trends. The research found that the students lack patent-related knowledge, nonetheless, they have positive opinions about entrepreneurship in the technological industry. The laws could encourage innovation that works as part of remedial action for environmental protection Qiang et al. [24].

The economic impact of IP-intensive industry contributed greatly to the United States GDP. These industries include trademark, patent, utility patent, design, and copyright. They also contributed to employment tremendously [56]. Table 1 shows the contribution of IP-intensive industries to US GDP.

At the international level, intellectual property applications show an upward trend. The World Intellectual Property Organisation (WIPO) statistical database (2021) indicates that patent filing increased by 1.6 % in 2020 while trademark application grew by 13.7 % and industrial design filing increased by 2 %. There were 3.3 million global patent applications, 17.2 million trademark applications, and 1.4 million industrial design applications submitted. Table 2 below shows an overview of global applications received on patent, trademark, and industrial design. The number of patents, trademarks, and industrial designs filled in the subsequent year increased by 3.9 %, 5.5 %, and 9.2 % respectively.

In 2021, two-thirds of international intellectual property applications were received from various offices in Asia followed by North America, Europe, Latin America, and the Caribbean. Patent applications in Asia accounted for 67.6 % and it was a 13 % increase from 2011. Trademark applications from Asia accounted for 69.7 % followed by Europe, North America and Latin America, and the Caribbean. Similarly, the industrial design applications from Asia totaled 69.3 % followed by Europe, North America Latin America, and the Caribbean [57]. Fig. 2 shows the number of IP applications received from different continents.

In terms of world patent applications, China leads internationally. Chinese patent applications reached 46.6 % in 2021 compared to 24.4 % in 2011. Other countries that are left behind in patent applications include the United States, Japan, the Republic of Korea, and the European Countries. While China has taken over the United States in leading international patent applications, the United States, Germany, and the Russian Federation have experienced a decrease in international patent applications. Japan, the Republic of Korea, India, Germany, Canada, and Australia show an upward trend in patent applications [57]. Different countries have claimed leading positions in different types of technological patents. China, the United States, and the Republic of Korea are the leaders in computer technology patents. Japan leads in electrical machinery, apparatus, and energy followed by Germany. Germany leads in Transportation followed by Japan. China ranked second in measurement technologies, and it is third in electrical machinery, apparatus, and energy patent applications internationally [57,58]. Fig. 3 shows the number of patent applications received from a few selected countries' patent offices. The reports, statistics, and literature show that intellectual property motivates innovation, and innovation in turn helps to boost countries' economic and environmental well-being.

Table 1
Contribution of IP-intensive industries to US GDP.

IP-intensive Industries	Contribution
Trademark-intensive Industry	\$ 6.91 Trillion
Design Patent-intensive Industry	\$ 4.46 Trillion
Utility Patent-intensive Industry	\$ 4.43 Trillion
Copyright-intensive Industry	\$1.29 Trillion

Table 2
World global property application for 2020 and 2021.

	The year 2020	Year 2021
Patent	3,300,000	3,400,000
Trademark	17, 200,000	18,100,000
Industrial Design	1, 400,000	1, 500,000

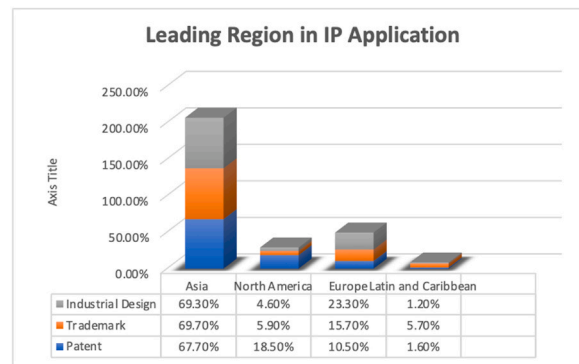


Fig. 2. Continents leading in patent, trademark, and industrial design.

Understanding the need for appropriate laws, Saudi Arabia amended the intellectual property (IP) laws to ensure adherence to the international standard and to meet the current demand [34]. Laws on copyright, patents, and trade secrets or confidential information corresponding implementation rules and regulations were also passed. Abdulla [59] stated that the IP laws, and implementing laws and regulations ensure a fair balance of entitlement between owners of the IP rights and the public interest the copyright law provides broader protection, however, Adeyemi [60] argued that the liability of ISPs as gatekeepers should follow the US Digital Millennium Copyright Act 1998. The ISPs should be only liable if they fail to cooperate or remove violating material. The copyright-based industry has thus far contributed economically to individuals, industries, and countries. According to WIPO the press, publication, software, and database industries contributed to the advancement of economic and social development in the MENA regions (UN, 2019) and adequate protection is necessary.

Schmookler & Schmookler [36] and Tripathi and Ghatak [38] discussed the condition of novelty, newness, non-obvious and industrial applications to meet patent protection. Patents could be granted for objects and tools, devices, equipment, and materials. Halewood [61] discussed various benefits of the law grants to patent holders. Accordingly, once the innovation is patented, all those who are involved in the innovation will have an equal share unless agreed otherwise. The patentees could also assign their right for commercialization. The assignment, however, does not deprive them of their moral right to innovation. He proposed digital intellectual property protection for software and IoTs-related innovations. Sheldon [62] discussed the need to show the requirement that the knowledge that the patented seeking should be publicly available, the process and product sought is not obvious to a skilled person and not identical to previous inventions or innovations. These ensure the originality of the patent that is being sought Sichelman [63]. Almarzoqi and Albakjaji [64] discussed the availability of patents for innovation and contented that there is a limitation in recognizing and granting patents. The patentability of the computer program was discussed by Almarzoqi and Albakjaji [64] and Gao [65]. Zaman [66] also supported the proposition that patents that have social value should not enjoy exclusive ownership for 20 years. Regarding

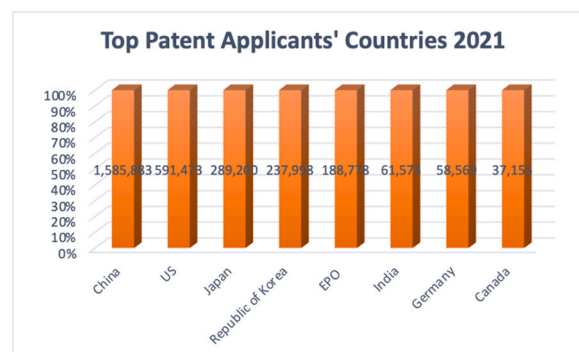


Fig. 3. Leading countries and number of international patent applications.

patent ownership in the academic environment, Sohan and Han (2019) investigated the view of students on ownership of funded research that resulted in patents.

Trade secrets may include know-how knowledge, designs, codes, customer, and supplier lists, and marketing plans. According to Dexter and Park [67], the USA was generous in recognizing trade secrets even if they were not continuously used in business. They suggested to protect a trade secret, it is necessary to take measures like non-disclosure or non-compete and implement security measures that control unauthorized access to trade. Wazzan [68] analyzed Saudi Arabian law and concluded that the types of misuses or abuses that are considered violations of trade secrets or confidential information are not available under the current legislation. However, looking at similar legislation in this context, a violation could include wrongful disclosure, acquisition, and use.

The literature review on sustainability and Saudi Arabian initiatives showed that Saudi Arabia has taken initiatives to embrace sustainability with the introduction of locally acceptable measures. The measures introduced were related to include economic diversification, technical assistance and capacity building emission control, and technology adoption to control carbon control [46], DNA 2018, Al Dubyan and Gasim, 2021, [69]. Some of the other literature has discussed issues related to a reduction in energy subsidiaries and the introduction of laws and enforcement of laws (Zakkour and Heidug (2019), Al Saud and Al Shalan (2020) [49]; [50]). No literature analyzed the application of copyright, patent, and commercial confidential laws in Saudi Arabia to energy-efficient technologies. The available literature on copyright, patent, and commercial confidential information simply elaborated on the law and discussed the importance of the laws to protect intellectual property. However, the literature failed to look at the combined effect of copyright, patent, and commercial confidential information law in protecting energy-efficient innovation. Thus, this research is an attempt to fill the gap in the literature by analyzing the three important legislation (copyright, patent, and commercial confidential information laws) to see the application of these laws in protecting energy efficient innovation and the levels of legal protection available for energy-efficient innovations under Saudi Arabian Law.

4. Analysis of energy-efficient innovation laws in Saudi Arabia

Green or eco-friendly innovations, such as alternative energy resources and climate change mitigation technologies are vital in controlling climate degradation and fostering a sustainable future [70]. The eco-innovation processes are said to be more complex and challenging than non-environmental innovation processes Jakobsen and Clausen [71]. These technologies could be processes, products, or technologies that reduce ecological risks or costs [72]. The OECD defined it as an "implementation of new, or significantly improved products (goods and services), processes, marketing methods, organizational structures, and institutional arrangements which – with or without intent – lead to environmental improvements compared to relevant alternatives" ([73], p. 40). Following this definition, energy-efficient innovation as part of green innovation could include research, development, adoption, and diffusion of technology. The Intergovernmental Panel on Climate Change (IPCC) states that green innovation or eco-friendly innovation is significant in various degrees to mitigate climate change. Some require extensive research and development while others require market incentives [74].

Green innovation can also be referred to as climate technologies. UNEP and UNFCCC [75] define climate technologies as technologies that reduce greenhouse gases and control adverse effects on climate. Technology is defined as "a piece of equipment, technique, practical knowledge or skills for performing a particular activity" [76]. It could be hardware-like equipment, software that will be used in production or use of hardware, or orgware that involves organizational framework in the production of diffusion of technology [77]. Energy efficiency innovation can be used to reduce emissions that cause climate change and provide energy security. Countries like China have increased government subsidies as high as 40 % and intellectual property protection to promote technological innovation in the renewable energy sector [78]. It was shown that investment in energy-efficient innovation is not sustainable without appropriate protection for invention or innovation. As such many countries looked at their legal systems to support and facilitate the rapid growth energy energy-efficient innovation or eco-innovation [79]. Saudi Arabia is one of those countries that took the initiative to strengthen the IP regime.

Intellectual property laws act as an enabler in protecting hardware or software that promotes the innovation of green or eco-friendly innovation systems like any other technology innovation. Currently, there is a greater awareness of the need for sustainable and eco-friendly practices, this brings intellectual property rights in foreplay. Among the intellectual property, the most relevant IP related to technology like energy-efficient innovation are patents, copyrights, and confidential information or trade secrets. The patent could be applied to hardware or software as long it meets the patent requirements. Computer programs can be software (Green Operation Software) or solutions (Green Software) that support green technology and can be protected by copyright. Software that can operate climate change mitigating vehicles or flexible fuel components in cars, wind turbine generators, and smart grid control software can be copyrighted. Electronic circuit diagrams can also be protected under copyright as part of literary works. Integrated circuit (IC) designs and circuit diagrams that are used in clean technology can also be protected by copyright law [74]. Some of the technologies may not monopolize the market as it is possible to come up with alternative technologies. Protections for confidential information give longer protection for innovators and require no registration. No one will know the existence of the technology or how the technology works. The disadvantage will be that the innovators may not be able to get to the market until disclose some information. For instance, China's shale gas is a cleaner alternative to coal. It only started tapping the resources recently in collaboration with foreign investors once it disclosed relevant trade information [80]. Generally, intellectual property law guarantees the exclusive right to exploit, prevents others from exploiting, grants the natural justice to monopolize and the moral right to be recognized internationally [74].

Intellectual property for green technology is said to be different from pharmaceutical innovation as it may not prevent a class of green technology from being adopted though it may hinder the widespread adoption for better quality. This eventually could affect

conversion to less energy-efficient technology. The importance of eco-friendly innovation can be seen in the initiatives taken by the World Intellectual Property Organization (WIPO) when launched the WIPO GREEN platform to accelerate the adaptation, adoption, and deployment of green technologies [81]. The IP law facilitates the dissemination of green technology which encourages development in this area. This also could control "second-mover advantage" or "free-riding" [82]. To encourage innovation in this area, countries like China and the UK launched "fast-track" schemes to register green patents Vimalnath, 2022. In this regard, the International Patent Classification Committee developed a non-exhaustive "IPC Green Inventory" called "Environmentally Sound Technologies." [74]. The energy-efficient technology could provide new solutions or enhance clean technology by lowering costs. It is said most of the promising technologies are still in their early stages of development as such appropriate protection is necessary. In particular, IPR plays a crucial role in research and development and market incentives for energy-efficient innovation.

4.1. Copyright law

Saudi Arabia is the first country that adopt Intellectual Property Law in the Gulf Region. As a member of WTO, party to Berne Copyright and Paris Industrial Property Conventions, Saudi Arabia amended the intellectual property (IP) laws to ensure adherence to the international standard [34]. Laws on copyright, patents, and trade secrets or confidential information were passed to address various issues of IP laws that are available internationally. In addition to IP laws, corresponding implementation rules and regulations were also passed. The IP laws, and implementing laws and regulations ensure recognition of rights and responsibilities and establish a fair balance of entitlement between owners of the IP rights and the public interest [59]. Saudi Arabian laws like any other country's laws on intellectual property need to be investigated to see if they could be extended to protect energy efficient innovations. This is important so that the innovators and companies can expect adequate protection and compensation for the time and money spent.

Saudi Arabia Copyright Law protects literary, scientific, or artistic works that are original, expressed, and have creative capacities. Article 2 of the Copyright Law has listed 12 types of protected original works that include written, oral, materials, drawings, sound audio maps, designs, computer programs, and other related works. Article 3 protects derivatives like translation, illustrations, databases, and other creative alterations. With the development of technology, copyright protection could be extended to cover digital downloads, graphs, and designs on video games, downloadable creative content, software, or computer source codes. The law is also extended to cover online and internet-based materials. Currently, it is illegal to counterfeit computer software, games, music, and video or involve smart cards and decoders/descramblers for the multitudinous satellite TV. The copyright law also could cover the technological protection measures and digital management of copyrighted works. In this aspect, the ISPs are generally considered gatekeepers and their liability follows the "safe harbor" approach of the US Digital Millennium Copyright Act 1998. The ISPs are expected to cooperate in deterring copyright violations. Failure to cooperate or remove violating material may face some liability on the part of ISPs Adeyemi, [60]. The copyright-based industry has thus far contributed economically to individuals, industry, and country. In 2015, WIPO provided a guideline to assess the economic contribution of copyright-based or creative industries to the GDP, employment creation, and trade. Accordingly, the press, publication, software, and database industries contributed to the advancement of economic and social development in the MENA regions (UN, 2019).

Applying Articles 2 and 3 of the Copyright Law to energy-efficient innovation; any writing, oral materials, drawings, maps, or computer programs that come within literal, artistic, and scientific work could be protected under this law. It appears the law could protect ongoing work on innovation, and prototypes even before the final innovation. The protection provided under the copyright law is comprehensive and many types of work are protected beyond the lifetime of the writer or producer. The law ensures moral and financial recognition of the writers by giving exclusive rights to recognition of their work. It also provides the right to reproduce, adapt, distribute, and communicate to the public. If any innovators or their company is in the planning, process, and production stages, they could claim protection under this law provided that the work falls within the scope of the protection. The protection granted, however, is not absolute as the law allows certain limitations and exceptions, and the allowable exceptions do not deprive or jeopardize the writers' or producers' rights (Berne Convention, Article 9(2)). Some of the exceptions are used by government or public entities without making financial gain, educational, or research use (Article 15). Similarly making backup copies or limited copies for public libraries or non-commercial documentation is not considered a reproduction of copyrighted work (Article 15 (3 & 9)). If the process of innovation is private and not publicly available, then the exceptions could not be used, and the unpublished work could be protected without exceptions.

However, the copyright law generally allows statutory or mandatory licensing where the copyrighted work could be used without the consent of the owners, but the owners are compensated for the use of their copyrighted work. This type of compulsory licensing is not unique to Saudi Arabia. Article 31 of the TRIPS agreement allows such type of licensing for public interest, where the copyrighted work is not available, overpriced, or undersupplied Xianrong and Xiao [83–85]. For mandatory licensing to be effective, it is necessary to show that the author refused to make the copyrighted work available, the copies are not available locally with comparable prices, or the original work or its translation is out of stock. Mandatory licensing is generally applied for public interest or educational purposes and not for purely commercial purposes. However, the mandatory license will not be granted for the first three publications of the copyrighted work so that the owners can benefit financially from the work that they have produced.

Hence, any energy-efficient invention or innovation would come under the exclusive protection of copyright for three years from the date of publication. After the initial three years of exclusivity, there is a likelihood of being subjected to mandatory licensing if these innovations are classified as public interest innovation and meet other conditions for mandatory licensing. Since Saudi Arabia is diversifying its economy and attracting foreign investors, there is little prospect of using mandatory licensing. In addition, if the innovation is still in progress and not published, the innovation will not face the issue of mandatory licensing (Implementations Regulations of Copyright Law, Article 30). In practice, many inventions tend to seek other intellectual property rights protection as

copyright in general does not protect ideas and only protects expressions. The non-protection of ideas under the copyright law could be considered a major weakness of copyright law in all the WTO member countries. However, if any innovators seek protection under copyright law, the law guarantees protection. Accordingly, any violation of copyright will lead to civil and criminal liabilities as prescribed in Articles 21 and 22 of the Saudi Arabian Copyright Law. The implementation Regulation in Article 24 also allows claiming of compensation for copyright infringement. The remedies and sanctions are in line with the TRIPS and follow the international standards in protecting copyrighted work (Muhannad Arif, 2014).

4.2. Patent law

Along with copyright law, the patent law allows the owner of an invention, product, or technology to benefit morally and financially for a limited period. Once a patent is registered, it recognizes the owner's right and prevents others from exploiting it during this period of protection [35]. A patent could be sought if it meets the requirement of novelty, newness, non-obvious, and industrial application Schmookler & Schmookler, [36–38]. Patentable products can be objects, and tools, devices, equipment, and materials. The processes that could be protected under patents are manufacturing processes, control methods, and measurement methods. Once the innovation is patented, all those who are involved in the innovation will have an equal share unless agreed otherwise. The patentees could also assign their right for commercialization. The assignment, however, does not deprive them of their moral right to innovation. Moreover, the innovator can prevent others from manipulating or using it without his consent for 20 years from the protection period Halewood [61].

The issue that has been debated about patentable products and processes is the patentability of algorithms. The law is clear that algorithms are not patentable but could be protected by copyright law. Since algorithms usually deal with code and mathematical calculations, they fall within copyright protection. In this context, Tripathi & Ghatak [38] agreed that code used in robotics could be covered by copyright law as the codes are based on formulas and procedures. However, most innovators would prefer to get patent protection than copyright protection as ideas and information could be fully protected by patent law. Kelly et al [86] asserted that the application of ideas and information that have commercial values may be protected by patent rights. Similarly, Spiege and Aoki [87] argued that the software should be protected under patent as it is a system that has been constructed from different applications and information. It should also be open for many different licenses to market the software as they present interoperability. USA laws are partial towards protecting innovation and inventions under patent law, and that led to the proliferation of algorithms-based patents registered in the USA. According to Schuster [88], about 3500 patents issued in the USA from 2008 to 2015 are related to machine learning technologies like Deep Learning, Big Data Analytics, and Neural Networks. In the context of the patentability of AI-related innovation, Hu [89] mentioned that the AI innovation will be patented if it displays technical features according to the new Chinese patent Examination Guidelines. Wang and Zhang [90] also analyzed the patentability for software and IoTs under the current Chinese law, which is similar to many WTO member countries, and recommended for patent protection. They also proposed digital intellectual property protection for software and IoTs-related innovations. In Saudi Arabia, like any other WTO member country, the patent requirements are identical. The innovation needs to be new, followed by inventive or innovative steps, and the product or process should have an industrial application. The requirement of newness requires that the process or product should not be part of the current state of the art. In other words, the knowledge is not publicly available, and the process and product sought are not obvious to a skilled person and not identical to previous inventions or innovations [62]. These ensure the originality of the patent that is being sought Sichelman [63]. Saudi Arabia is the leading country in patent application among the five Gulf Corporation (GCC) countries. Fig. 4 shows the number of patent applications made in different GCC countries for the years 2020 and 2021.

To get extensive exclusive protection and recognition of the patent right, it is necessary to register the patent where the patent owner would like to use the patent, for commercial or other purposes Alstadsæter et al. [91]. The Gulf Countries regional office allows for the registration of regional patents for the 6 GCC countries and there is also the possibility to apply for international patents through WTO-administered PCT. The statistics of patentees from GCC countries who have applied for international patents are provided in Fig. 5.

To secure a patent whether locally or internationally, it is necessary to meet the legal requirements. The Board of Grievances, Saudi Arabia, in case No. 11621/1/C, in the year 2017 refused to accept the patent granted to a computer program to handle the practice of

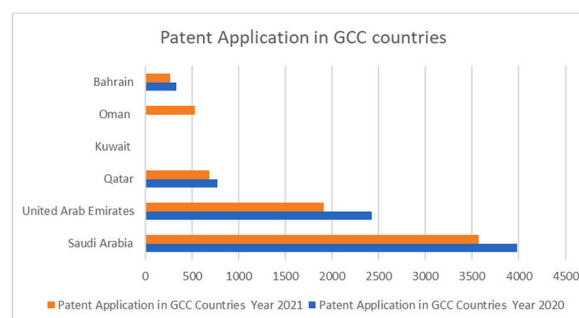


Fig. 4. Patent Application in GCC countries.

business and organize commercial accounts as the patent sought in this case was not related to manufacturing products or industrial application. The decision made it clear that there is a limitation in recognizing and granting patents Almarzoqi and Albakjaji [64]. Abstract ideas, learning methods, rules of games, therapeutic or surgical methods, and computer programs will not come under patentable products or processes. They perhaps fall under copyright protection [92]. To recognize a computer program as a patented product, it should be demonstrated that it is not abstract and has more process and application than an algorithm. Sophia robot is recognized under patent law in Saudi Arabia, as it was shown that Sophia has incorporated more than mere algorithms that include formulas and calculations made by computers Almarzoqi and Albakjaji [64,65]. The current law and practice in countries other than the USA are not certain if they would recognize computer-generated innovation without human interference as patentable products. As such Saudi Arabia authorized Saudi Authority for Intellectual Property (SAIP) to formulate appropriate laws to regulate IP about new technological inventions or innovation Abul-Enein, [93]. Such a policy became imperative with the recent establishment of a network of innovation laboratories where researchers and entrepreneurs may share ideas, develop, and test novel business models, and provide solutions to achieve Vision 2030 of Saudi Arabia [94].

Literature regarding infringement of patent rights looks through a different dimension and suggests that if the infringing invention could be developed independently of the patented invention and does not affect the incentives of the first inventor, it may be possible to hold them all equal rather than giving a monopoly to the first innovator so that more innovations could be encouraged [95]. If an innovation is a “cumulative innovation,” the infringing invention builds upon the patented invention, and the first inventor could opt to include it in the development phases by signing a contract or licensing agreement. Alternatively, the magnitude of improvement done to the original patent could be assessed before deciding on patent infringement or entitlement of a patent on its own (Green and Scotchmer, 1995; [96]). However, Scotchmer [97] argued that a cumulative patent should not be acceptable as this will deprive maximization of the benefit of the first patent. Kitch [98] stated that giving exclusive patent rights to the pioneering inventor ensures efficient and orderly development of technology. If the patent is about research tools that will help to develop other innovations, the patent owner could negotiate regarding downstream products. The parties involved could negotiate the amount of royalties for the use of research tools as well. The USA Supreme Court, in this aspect, said that a new patent application that is similar in function, operation, and output to the existing patent, should be treated as infringing. In this circumstance, it is irrelevant to examine the knowledge of the existence of the patent if it is designed around the existing patent [99]. Though the literature suggests that different approaches could be taken to avoid the monopoly of patentees, the current form of patent law in Saudi Arabia provides protection almost exclusively to the first inventor or innovator. Like the USA Supreme Court, the Saudi Courts and patent office may consider that the new products or services with similarity in function, operation, and output of the earlier patent as infringing.

Though a patent gives an exclusive right to monopoly for 20 years, there are exceptions to this. Article 30 of TRIPS on which many patent laws of WTO member countries are based allows limited exceptions provided the exceptions do not overly restrict the normal right of exploitation of the patentees Tesoriero, [100]. Similarly, Article 7 supports exceptions that balance social and economic welfare and aim for the benefit of society and the protection of the patentee. Article 8(1) permits amendments to local law on patent if they protect public health, and public interests and enhance their socioeconomic and technological development. One of the most important exceptions is the issuance of mandatory/compulsory licenses. Saudi Arabian patent law also allows for compulsory licensing in limited circumstances. Before seeking for compulsory licensing, a request for a voluntary license from the patentee should be made. If unsuccessful, then it could proceed for compulsory licensing. If the license is granted, the patentee will be paid compensation. However, in case of a local emergency, the requirement for seeking a voluntary license can be avoided.

SAIP's new implementing regulations on patents in general allow compulsory licensing against protected patents. Accordingly, the exclusive right to patent could be overridden for justifiable circumstances. Though the circumstances are not clarified, it can be generally assumed that compulsory licensing will only be issued for public interest, public health, and safety-related issues, and compulsory licensing shall not be allowed for commercial purposes as per Paragraph 6 of the Doha Declaration. In this aspect, Eisenberg [101] argued in favor of mandatory licensing of patents for research tools, and the patentees should not be given an option for an injunction of the sale of infringing products rather, they should be given a reasonable royalty. Zaman [66] also supported the proposition that patents that have social value should not enjoy exclusive ownership for 20 years. Regarding patent ownership in the academic environment, Sohan and Han (2019) investigated the view of students on ownership of funded research that resulted in patents. The research recommended having a clear ownership policy in this regard. The patent law in Saudi Arabia like in any other

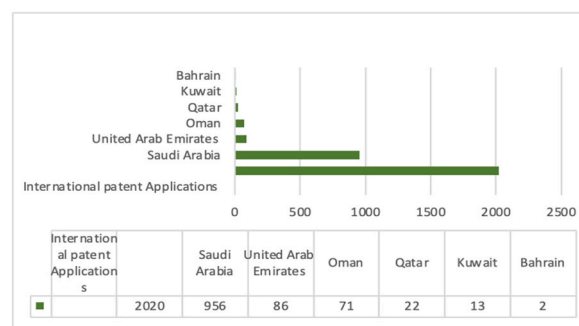


Fig. 5. International patent applications from GCC applicants.

country, provides exclusive protection while maintaining the right to override this exclusive right if national circumstance warrants such a measure.

4.3. Confidential commercial information

Besides patent law, the regulations for the protection of confidential commercial information, trade secrets, or any information that is confidential in terms of commercial activities are protected for five years from the date of approval for protection. The law of protection of confidential commercial information is a very important legislation as foreign investors are concerned about the maximization of profit and competitive advantage in the market. After joining WTO, Saudi Arabia enacted the Regulation of Protecting Classified Commercial Information to protect trade secrets or confidential information [102]. Though classified commercial information is not defined under the law, the conditions set in Article 1, show it could include a broader aspect of information that has commercial value. Article 1 mentions that confidential commercial information is protected if it contains any information of commercial value that is not known in totality, not known in its minute constituents, or not easily obtainable by the people in the same trade and the owners have taken reasonable measures to maintain confidentiality. The legislation seems to protect business owners from unfair competition and not the propriety ownership of the commercial information. As such, if the owners fail to take reasonable measures, they may not be able to get protection for their trade secrets. When comparing this law to the Uniform of Trade Secrets Act of the USA, trade secrets are protected in the USA if they contain information that has actual or potential economic value, and was kept secret from the public to achieve economic benefit. However, both conditions should be fulfilled to get the protection of the law (UTSA, S. 1.4). Trade secrets may include know-how knowledge, designs, codes, customer, and supplier lists, and marketing plans. The courts in the USA, have granted protection for trade secrets even though some parts of the secret are available to the public, or the trade secret was not continuously used in business [67]. It is not clear if the courts will take the same path in Saudi Arabia since this issue has not been tested in court yet.

In satisfying the requirement of taking reasonable measures under the given circumstances, the employers could take measures through employment agreements where non-disclosure and non-compete provisions to avoid misuse of trade secrets or trade-related confidential information by the employees. The owners of trade confidential information also could implement security measures that control unauthorized access to trade secrets [67]. Though what is reasonable measure according to the circumstance is not defined under Article 1 of Saudi Law, the US courts explain what could be considered as "reasonable efforts" and this explanation may be relevant to understanding the Saudi Arabian law. Accordingly, if the owner of the trade secrets took the initiative by including confidentiality and non-disclosure terms in the employment agreement, locking doors, and limiting access, this could be treated as reasonable efforts or measures. The Saudi Arabian law does not also mention the types of misuses or abuses that are considered violations of trade secrets or confidential information. However, looking at similar legislation in this context, violations could include wrongful disclosure, acquisition, and use Wazzan, [68]. The courts in the USA found when an employee obtained confidential information and used it to the detriment of the employer's interest, the employee misappropriated the confidential information (*RKI, Inc.*

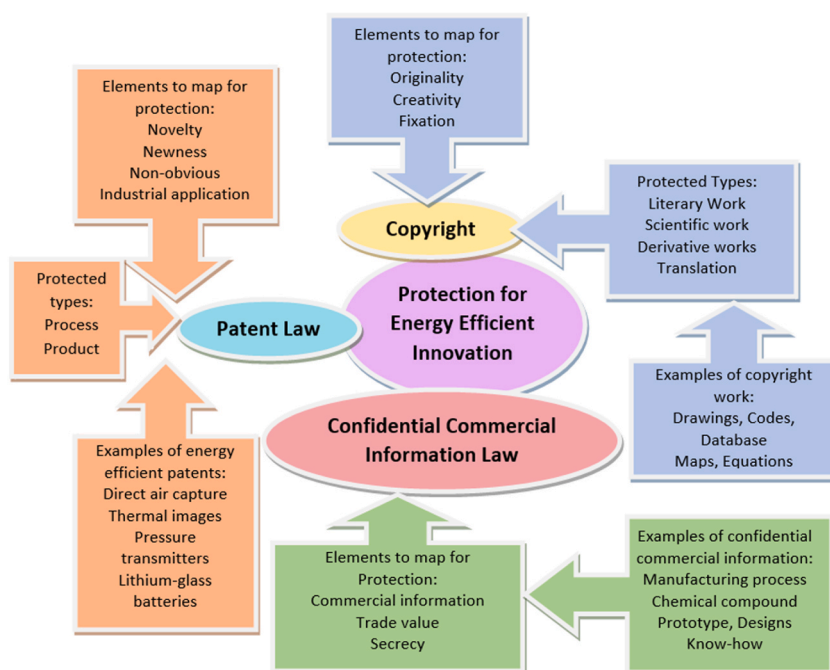


Fig. 6. Mapping of key elements under copyright, patent, and confidential commercial information laws.

v. Grimes (177 F. Supp. 2d 859 (N.D. Ill. 2001) and *Fastenal Co. v. Crawford* 609 F. Supp. 2d 650 (E.D. Ky. 2009)).

Once it is revealed that the trade secret or confidential information was misused, the owner could apply for compensation. The violation does not allow for any other orders like temporary or permanent injunction. Usually, the injunction is granted as monetary compensation and helps to stop the competitor from economically manipulating the trade secret or confidential information. The employment contract comes in handy to stop misuse of the trade secrets or confidential information by employees. However, this does not stop a third party from violating the trade secret or confidential information. Law in its current form could protect information, design blueprints, and materials related to innovation as long as it could be shown that the information had trade value, and it has been kept as confidential information. The confidential commercial information law could be used along with other laws to protect the initial invention and related information of a corporation that is involved in energy-efficient innovation. Keeping the confidential information secret will be the better option even if one fails to secure protection under this law, as those secrets could be protected under copyright law if they meet the requirements. The European Intellectual Property Office (EUIPO) report (2017) showed law related to trade secrets, equivalent to the confidential commercial information law in Saudi Arabia, was used better than patent protection as patent protection requires disclosure of confidential information for qualifying for patent grant, patent application processes is lengthy and costly. Trade secret was used at a value of 52.3 % and the patent was used by 31.7 % of the innovating firms to protect their innovations between 2010 and 2012. This shows the trend that confidential commercial information law is helping innovators protect their innovation until they are ready to apply for patent protection. Larger companies utilized the trade secret-related laws for their benefit followed by small and medium enterprises.

The copyright, patent, and confidential commercial laws protect differing scales for innovation. The energy-efficient innovators will not be deprived of the right to protection under Saudi law unless there is a need to restrict their rights, save by the law. The key elements related to copyright, patent, and confidential commercial information laws have been mapped in Fig. 6. Saudi Arabia, besides providing laws, is implementing the law through various administrative measures. SAIP has signed a membership agreement with the Patent Protection Highway (PPH), Korean Intellectual Property Office, and USPTO in 2019 and 2020 respectively. Another PPH agreement was signed by the Japan Patent Office. In 2020, SAIP obtained the approval of the Council of Ministers to follow a standardized memorandum of the international corporation so that it could ensure wider protection of invention and innovation. SAIP has also worked in acting against IPR violators. For example, in 2019 more than 160 cases of copyright violation cases have been enforced, and in June 2020, SAIP disabled 231 websites with infringing content [102].

5. Policy and legal measures to foster energy efficient innovations by IP laws

The government policy and legal measures to foster energy-efficient innovation should look at the current laws to strengthen the protection of intellectual property rights so that investment in eco-innovation could be encouraged. It also can help to establish an eco-friendly energy market. Lack of IP protection demotivates and demoralizes the innovators as there will be a lack of economic return on investment. The IP legislation should match the country's technological capacity and economic base which should avoid excessive legislation. Organizing IP publicity and training will attract more innovators [78].

There should be policy guidelines dictating an IP model and IP Strategy. IP model explains the way IP ownership could be controlled, accessed, and used for a specific purpose within a specific setting. IP strategy explains the decision-making process to maximize IP value as per the organizational objective [103]. According to Holgersson et al. [104], organizations are making IP a strategic tool for managing all green innovation including energy-efficient technologies and collaborative innovation processes. The strategic decisions on IP could be closed, semi-opened, or fully opened IP models. When inventors and innovators keep their invention or innovation protected or secret, it is called "closed", when they share it with select partners or collaborators via exclusive or non-exclusive contracts or licensing, it is called "semi-opened". The sharing of energy-efficient inventions or innovations with everyone is called "fully opened" [103].

During innovations, the innovators face imitation by followers and it may be difficult to prove imitation, as such it potentially reduces the competitive advantage to the innovators or inventors. To cope with this, many innovators use a closed strategy. However, Stefan and Paul [105], using examples from pollution control technology, suggested that resourceful firms could license their innovations to benefit from their research capacity. Collaborations with green innovators will provide needed capabilities and resources at lower cost Calza et al. [106]. Some innovators share their innovation free of cost and without any usage or commercial restrictions. For instance, the open-source software movement helps to disseminate ideas and processes for free Benkler, [107]. Similarly, Royalty-free licensing, patent pledges [108,109], and defensive publishing promote IP in the public domain [110]. However, many new ventures would need the support of the law as they have wealth constraints and need strong IP protection to recoup their investments through investors. The IP protection is also shown to protect resource-strong companies Libaers et al. [111].

Different organizations can adopt different IP models in different phases of energy-efficient innovation processes. In the research phase organizations can adopt closed IP models to attract investors in the innovation phases or commercialization phase and to get first-mover benefits. The closed model is also used for economic success and competitive advantage. Organizations might use semi-open IP models like exclusive licensing during the development phase if they lack the expertise in commercialization [103].

During the diffusion phase, innovators can utilize a semi-open IP strategy to expand the market for green innovation locally and internationally. This is mainly done through non-exclusive licensing. This model also facilitated them to generate revenue. They could establish partnerships with other established firms to be the leader in this domain [103]. The government should also introduce fast-track patent examination as introduced by the UK sustainability-focused innovations. Patent policy should detail the subject matter of patents, the breadth of items that could be patented, and types of novelty that can be patented this will increase the utilization of knowledge, and innovation. The policy should also allow alternatives to patent systems e.g. open-source systems and publicly

financed innovation for some important energy-efficient innovations [112]. In certain circumstances, compulsory licenses should be open to mitigate any deficiencies in the current system like in Canada and the USA. The compulsory license can be used for health, antitrust cases, and defense procurement purposes [113,114]. There should be appropriate IP management of ownership and licensing to avoid disputes as it happened on climate-ready crops Rimmer [115,116] or control misappropriation of trade secrets as was shown in Solar World and the American Superconductor Corporation [81,117].

6. Conclusion and recommendation

The copyright, patent, and confidential commercial information laws provide different protection to different levels of development of energy-efficient innovation. Copyright provides somehow exclusive protection from the date of publication. However, the current law may create an exception if the invention or innovation comes within the public interest. After three years of publication, there is a possibility to use the invention for public interest without the consent of the inventor or innovator. Nonetheless, the ongoing innovation that is not published may not face the challenge of mandatory licensing issues. Under the copyright law the computer program algorithm that does not have any functional application, but codes for information may seek initial protection. Since copyright is an automatic right once the literal artistic, scientific, derivative related works are published without the need for registration, it is one of the easiest and cheapest to claim protection. This law provides civil and criminal sanctions against the violators.

Patent law protects innovation that meets the conditions of the patent law. The law requires the invention to be new and novel as such, it cannot be the improvement of an existing product or process. The innovation sought for protection should not be obvious and it should have industrial application. If all the conditions are fulfilled, any innovation including energy efficient innovation is eligible for patent right. Unlike copyright, for the protection of innovation under patent law, the innovator should apply for patent protection. However, patent protection for software and computer programs may not be available unless it is shown that the computer program has a solution, or applied technical consideration, and industry application. Once a patent is registered, the Saudi Arabian law provides protection almost exclusively to the first inventor or innovator. If the patentee seeks wider protection, he could register the patent at the regional patent office or international patent application through WIPO-administered PCT where the patentee could apply to multiple countries without the need for separate patent applications for each jurisdiction. However, a patentee may face the challenge of compulsory licensing like copyrighted products. Under compulsory licensing, the patentee's right could be compromised for the use of public interest with the payment of a reasonable fee.

Confidential commercial information protects information commercial in nature. That information could be related to process, prototype or product development, budgeting, or marketing strategies related to energy-efficient innovation. The protection could be available as long as it could be shown that information has trade value, and has been kept as confidential information. Any violation will entitle the owner to claim compensation. However, the proprietor of commercial confidential information cannot demand the halt of the use of the confidential information temporarily or permanently. Further, the current law is very broad and may create doubt in the scope of the subject matter that comes under the protection of this law. There is also ambiguity on what could be considered a violation since the law does not define abuses. Regardless, the combination of copyright, patent, and confidential commercial information laws protects energy-efficient innovation like any other WTO member countries' legislation. The government, perhaps, should take the initiative to promote the availability of laws to protect the innovations and enforce the law against violators locally and internationally. SAIP has taken many initiatives in this direction by signing many bilateral and multilateral agreements. However, SAIP may issue guidelines to clear some of the ambiguities in the legislation and support the low-carbon innovators by providing training, financing, and education on applicable laws to protect their innovation.

To encourage SMEs in invention and innovation, various IP advisory clinics and guidelines on patent registration, management, and commercialization have been set up, though there is no fee reduction or expedited services available under the law targeting SMEs. However, institutions like the King Abdullah University of Science and Technology and King Abdulaziz City for Science and Technology (KACST) provide support and financial incentives for inventors, innovators, and SMEs (U.S. Chamber International IP Index, 2021). Additionally, SAIP has recently taken the initiative to join several international treaties like the Hague Agreement Concerning the International Registration of Industrial Designs and the Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks. Saudi Arabia also became a contracting party to the Locarno Agreement. All these memberships help to strengthen the IP protection regime in Saudi Arabia.

Nonetheless, to push for more energy-efficient innovations, there is a need to create awareness, financial support to R&D, and commercialization of innovation so that industries can achieve a critical size. Alomari and Heffron (2021) suggested creating awareness campaigns among the residents about laws and initiatives in Saudi Arabia to achieve sustainability effectively. Shim and Deguchi [118] studied the Intellectual property support system for university students in Japan and Korea to involve students in gaining intellectual property support for inventions as part of creating awareness about the intellectual property system. In educating and creating awareness about intellectual property law and related matters, Wilk (2015) insisted that the computer graduate needs technical as well as legal, ethical, and commercial knowledge and therefore, there is a need to introduce a law course to computer students. Lin and Lian [119] studied awareness of various intellectual property rights and found that China's cultural and creative industries have very low awareness of intellectual property rights. Jajpura et al [120] looked at Indian laws on intellectual property and pointed out that the law provides various rights to innovators, however, there is a lack of awareness. This will eventually cost innovators and the country economically and socially.

Additionally, trade liberalization – making the internal market attractive and competitive and reducing the cost of IP-enabled technology would attract more interest in innovation that in turn will help to achieve SDGs. The Global Innovation Index (GII) report of 2020 ranked Saudi Arabia as 66th worldwide in innovation performance and is considered lower than expected. The report

looks at the institution, human capital, and research, market sophistication, infrastructure, business sophistication, creativity, knowledge, and technology output in ranking the countries [121]. The GII found that the limited absorptive capacity of foreign technologies is one of the major deficiencies that affect innovation in Saudi Arabia. Understanding this, the policymakers introduced policies called the indigenization of knowledge and technologies and are trying to implement IP-related policies through SAIP Alsodais, [122]. In the adoption and deployment of foreign technology, private sector involvement is very important. Unfortunately, the 2018 GASTAT institutional innovation survey showed that the private sector only spent about 2 % on R&D. The involvement of industries is very high in developed countries and helps manufacturing processes to create prototypes and high-scale IP innovation. Whereas the MENA region suffers from a lack of private sector involvement as they do not have legal and other infrastructures to support innovation or transfer of innovation. Many of have agreed to use foreign technology without negotiating the opportunity to incorporate local technologies AlZaid, [123].

Further, the government should perhaps provide incentives to private sectors to invest more in developing innovation and technology. The government may provide guidance and assistance in negotiating technology transfers with the opportunity to incorporate local technologies. Saudi Arabia should create high-tech development zones like previously done in China and make funding and collaboration easy so that innovation could be possible. The Chinese high-tech development zones came up with 52 innovations within a few years of set up. To improve a country's absorptive capacity for foreign technology, special economic zones (SEZs) could be set up as hubs for learning. With flexible policies, tax incentives, and a skilled workforce, these hubs could attract foreign investment and facilitate the transfer of technology AlZaid, [123]. Additionally, to maximize IP-related R&D, there is a need to set up accelerators and incubators that could encourage participation in the innovation and development, preservation, and commercialization of innovations.

Data availability statement

No data is available.

CRediT authorship contribution statement

Jawahitha Sarabdeen: Writing – original draft, Formal analysis, Data curation, Conceptualization. **Mohamed Mazahir Mohamed Ishak:** Writing – review & editing, Validation, Investigation, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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