

Investigation of the Patent Ecosystem in Bangladesh

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ABSTRACT

A robust patent ecosystem is essential for translating scientific research into technological innovation, practical implementation, and economic growth. Despite Bangladesh's rising scientific output, its patent filing and acceptance rates remain disproportionately low, highlighting a critical gap in the innovation landscape. This study examines the underlying causes of this disparity by analysing the patent ecosystem in Bangladesh using a mixed-methods approach. Analysing the data from the Bangladesh Patent Office (2017-2021), the study reveals that nearly 77% of patent applications were rejected, primarily due to non-compliance with drafting standards—a consequence of limited institutional expertise and public awareness. Further investigation identifies systemic barriers, including inadequate training programs, weak policy incentives, and a fragmented Intellectual Property (IP) infrastructure. Based on these findings, the targeted interventions are proposed: (1) capacity-building initiatives for researchers and legal professionals, (2) policy reforms to streamline IP governance, and (3) stronger linkages between universities, industries, and government agencies. The study contributes to innovation policy literature by empirically mapping challenges in a developing economy's patent system and offering actionable solutions. If implemented, these measures could enhance Bangladesh's innovation capacity, reduce import dependency, and align its IP framework with sustainable development goals.

Keywords: Patent Drafting, Patent Ecosystem, Patent Filing, Patent, Patinformatics.

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Received: 03-12-2025;

Revised: 16-01-2026;

Accepted: 23-03-2026.

INTRODUCTION

Bangladesh has developed into a lower middle-income country, achieving socio-economic progress over recent decades (Islam, 2022), with GDP growth averaging around 5% per year since the late 1990s (Amin, 2022; Jahan, 2022; IMF, 2023). According to the World Bank, the country has made remarkable progress in reducing poverty, with the poverty rate falling from over 43.5% in 1991 to around 14.3% in 2016 (World Bank, 2022). A primary catalyst for the economic growth of Bangladesh is the rapid expansion of the manufacturing sector, particularly in the areas of textiles and garments (Yunus, 2012). The nation has also demonstrated progress in areas such as telecommunications, banking, and infrastructure development. However, Bangladesh still faces several structural and institutional challenges within

its industrial sectors. These challenges include limited access to technology, inadequate infrastructure, a shortage of skilled labour, and a need for further development in research and development (R&D) capabilities and activities (Mahmud, 2014).

Patents are legal instruments that grant exclusive rights to inventors and are often considered central to enabling technological advancement and innovation-led growth. Yet, the role of patents in development is complex and contested. While patents can incentivise innovation by offering time-bound monopoly rights, they may also create barriers to knowledge diffusion, especially in developing economies where the absorptive capacity for high-end innovations remains low (Hall, 2012). However, increasing the number of patents in a territory indicates a gradual self-sufficiency in developing the consumable items of that nation, which leads to the sustainability of its prosperity. The concept of a "patent ecosystem" has emerged in the literature to describe the interplay of legal, institutional, educational, and economic factors that determine how effectively a learned society can generate, file, enforce, and benefit from patents. A robust patent ecosystem typically includes competent legal frameworks, trained patent professionals, access to patent



DOI: 10.5530/jscires.20261517

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information (patinformatics), awareness among inventors, supportive IP policies, and institutional coordination among universities, research institutions, industry, and regulatory bodies (Azad, 2018). For the sustainable development of the industrial sectors of any country, the patent ecosystem plays a crucial role (Wu, 2018). However, this concept remains under-explored in the context of low- and middle-income countries, including Bangladesh. In fact, patents are essential because they give inventors exclusive rights to their inventions and creations for a limited time. This exclusivity allows inventors to benefit financially from their innovations and encourages them to continue investing time and resources in developing new ideas and innovations. Therefore, patents serve as one of the key drivers for promoting new technologies and disseminating ideas.

The existing literature offers considerable insights into national and sectoral patent frameworks; however, it often falls short of providing a holistic understanding of ecosystem-level dynamics. Notably, there is a paucity of comprehensive articles addressing patent ecosystems in their entirety. Harrison's 2013 article on the Indian patent ecosystem highlights a regulatory development from the Indian Patent Office aimed at influencing the pharmaceutical sector (Harrison, 2013). Yet, the analysis does not extend to the broader patent ecosystem in India. In contrast, Schillaci *et al.*, conducted a detailed mapping of Singapore's patent ecosystem, analysing data from 173,597 patents filed between 1995 and 2020 (Schillaci, 2022). Their findings indicate a transition from a variety of knowledge domains to a pronounced specialisation in pharmaceuticals, high-tech, and emerging technologies such as blockchain. They introduced an innovative patent co-classification method to trace knowledge flows among actors within the ecosystem. However, their findings are context-dependent and may not translate to environments characterised by more laissez-faire policies (Choi *et al.*, 2021). Performed a bibliometric and scientometric analysis that delineates global patent trends over time, potentially offering insights across various regions and sectors. Despite this, their study lacks granular mapping of ecosystems and a robust analysis of regulatory influences. Iqbal and Sadaf (2023) concentrated on innovations in pharmaceutical production processes, providing insights into patenting within this domain, but did not delineate patent ecosystems or investigate institutional dynamics, thereby focusing narrowly on sector-specific concerns. Moser's review evaluates the financial repercussions of patent protection, elaborating on its policy ramifications (Moser, 2013). Sanyal and Arora (2022) addressed significant structural challenges within India's patent system through empirical analysis and policy recommendations, yet their study did not incorporate knowledge flow mapping akin to that observed in the Singapore context. Hall (2024) recently published findings from a survey that illuminate the impact of patents on innovation and economic growth in developing countries (Ahn, 2014). This work includes a succinct

history of international patent systems and contemporary global patent utilisation statistics. Furthermore, subsequent studies delving into the correlation between patent protection and the quality of inventions suggest that stronger patent protections are associated with higher-quality innovations (Moser, 2005; Moser, 2016). Mohammadi *et al.* (2024) explored technological advancements in engineering and computing patents. While they touch upon innovation networks, their focus is not explicitly on national patent systems or the regulatory implications. Graham *et al.* (2009) disclosed a survey report investigating the relationship among patents, innovation, and industrial firm performance. The technical report concluded that patents are a significant predictor of innovation and firm performance. Jana *et al.* (2014) analysed patenting trends in South Asian countries, comparing filing practices domestically and internationally, including submissions to multinational offices like the European Patent Office. There are a few articles discussing patent laws specific to Bangladesh (Azam, 2013; Azam, 2014; Mitsumori, 2018), mostly related to the pharmaceutical industries (Azad, 2018; Azam 2010). Therefore, a compilation of the literature review concerning current studies related to the patenting system worldwide is provided in Table 1.

Table 1 indicates that no investigation of the entire patent ecosystem has been conducted globally. To the best of the authors' knowledge, there is currently no comprehensive publication that systematically explores the patent ecosystem within a nation, including Bangladesh. The present article introduces a novel perspective that emphasises specific aspects of the patenting system. The primary objectives of this pioneering work are summarised as follows:

- Systematically evaluating all components of the patent ecosystem in Bangladesh.
- Investigating the current state of the patent ecosystem in Bangladesh.
- Exploring the barriers impeding patent filing and acceptance.

The work endeavours to raise awareness regarding patent specification preparation, patent application filing, patent-related data and information, termed patinformatics, and the obstacles to patent success. By placing patent activity within a broader ecosystem framework, this research aims to provide meaningful insights for researchers, policymakers, and industry stakeholders in developing nations who seek to strengthen national innovation systems. Additionally, a compilation of acronyms and key terms is provided in Table 2. The subsequent sections of the article are structured as follows: Section 2 explores the materials and methodology, detailing the patent ecosystem and its current status in Bangladesh, while Section 3 presents the results and discussions. Lastly, Section 4 concludes with recommendations that encapsulate the findings and implications of the study.

METHODOLOGY

To assess the patent ecosystem in Bangladesh, it is crucial to leverage insights from the extant literature that delineates the structural, legal, and institutional intricacies of patent systems. Research by Schillaci *et al.* (2022) has utilized co-classification and knowledge-flow analysis to map patent ecosystems, elucidating how national patent landscapes develop through sectoral specialization. However, such methodologies are scarce in South Asia, particularly in nations like Bangladesh, where patent systems are underdeveloped and empirical evaluations are limited. Critiques of the Indian patent framework, as articulated by Harrison (2013) and the EAC-PM report (Sanyal and Arora, 2022), raise concerns about regulatory inefficiencies and prompt an examination of the performance of neighboring countries. In Bangladesh, Azam and Richardson (2010) and Mitsumori (2018) have identified significant institutional divides between the Patent Office and other regulatory entities. Furthermore, researchers such as Moser (2013) and Hall contend that intellectual property (IP) regimes in developing countries must be adapted to local technological and economic realities, rather than merely adopting TRIPS-compliant frameworks (Hall, 2024). Analyses of patenting trends within SAARC (Jana, 2014) and the productivity of the pharmaceutical sector (Azad, 2018) further suggest that Bangladesh's innovation capacity remains underutilized, primarily due to ineffective IP infrastructure.

Building on this foundation, the present study employs a mixed-method approach that integrates patent informatics, bibliometric analysis, and institutional data collection. An online survey targeting R&D organizations, universities, and both national and international IP-related bodies was executed. Additionally, research institutions' supplementary

data were sourced from annual reports of the University Grants Commission (UGC) and organizational websites. Patent data were compiled from the World Intellectual Property Organization (WIPO, 2022), Scopus database (Scimago Lab, 2022), and the Bangladesh Patent Office (DPDT Bangladesh, 2022). To facilitate systematic analysis, a custom Excel-based tool was developed to calculate the patent-publication ratio and evaluate institutional contributions. Lastly, drawing on the WIPO Patent Drafting Manual (Milanez, 2017; WIPO, 2022), an ideal patent ecosystem model has been formulated to benchmark against the existing system in Bangladesh. This comprehensive approach not only quantifies performance metrics but also contextualizes them within broader policy and ecosystem frameworks, addressing the empirical deficiencies noted in prior studies (Azad, 2018; Hall, 2024; Jana, 2014; Sanyal and Arora, 2022; Schillaci, 2022).

Patent Ecosystem

Figure 1 delineates a conceptual model of an optimal patent ecosystem, showcasing the intricate interplay among principal stakeholders and processes that facilitate the continuum from research to commercialisation. The ecosystem initiates within R&D entities-comprising universities, corporate laboratories, and government research institutions-where researchers generate patentable inventions in controlled environments. These innovations follow a defined trajectory: (1) inventors collaborate with patent attorneys (lawyers) to construct robust patent specifications; (2) the intellectual property (IP) unit of the R&D organisation submits the patent application to the relevant patent office; and (3) patent examiners evaluate the application in accordance with applicable legal standards, providing feedback to the IP unit in the form of approvals, rejections, or requests for additional information.

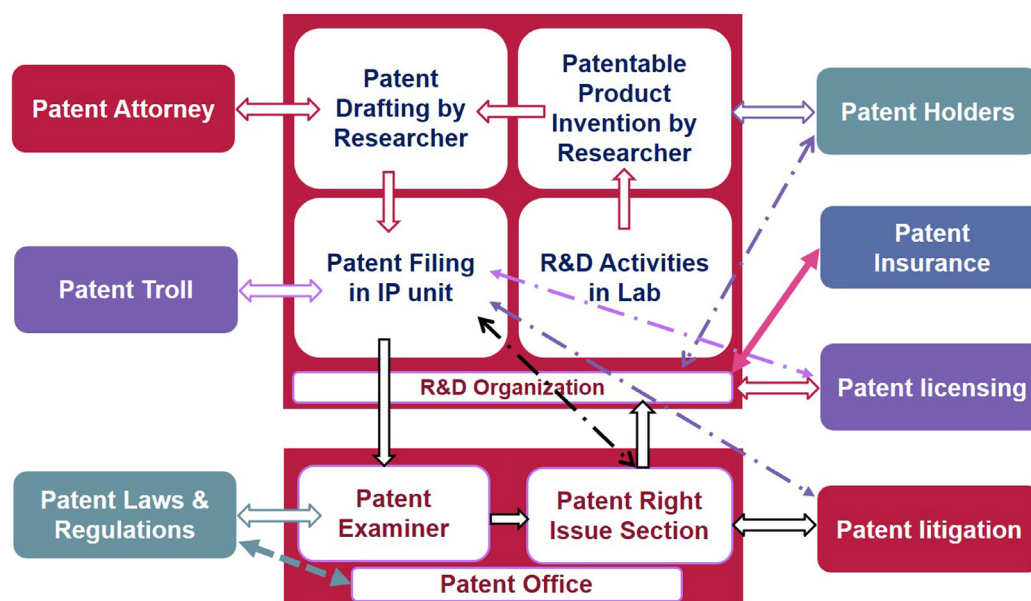


Figure 1: An ideal patent ecosystem and its components.

Table 1: Overview of modern literature studies on the patent ecosystem.

Author, Year	Focus	Findings	Limitations
Harrison, 2013	Indian pharma patent regulation	Identifies policy tension between patent strength and innovation.	Opinion-based; lacks empirical data.
Moser, 2013	Patents and innovation (history)	Shows how patent absence sometimes spurred innovation.	Historical focus; weak generalizability to modern systems.
Ahn <i>et al.</i> , 2014	IP and economic development	Contextual IP policy recommendations for developing countries.	Conceptual; limited applied data.
Hall, 2024	Patents in development	Aligns IP regimes with national innovation capacity.	General; lacks country-specific empirical examples.
Moser, 2005	Patent law and innovation (19 th century)	Historical evidence on patent law influence.	Context-dependent; less relevance today.
Moser, 2016	Patents in economic history	Traces how patents shape innovation type.	Historical and Western-centric.
Graham <i>et al.</i> , 2009	Startups and patent use	Large dataset; practical startup insights.	US-centric; doesn't apply to low/middle-income contexts.
Jana <i>et al.</i> , 2014	SAARC patent trends	Regional comparison using WIPO data.	Descriptive; lacks causal analysis.
Azam, 2013	TRIPS and LDC patent policy	Focus on LDC flexibility; warns of TRIPS-plus risks.	Policy-based; lacks innovation performance data.
Azam, 2014	Patent law reforms in India, Brazil, SA	Comparative legal lessons for Bangladesh.	Legal narrative; lacks empirical validation.
Mitsumori 2018	Bangladesh Patent Act 2022	Sees reform aligning with TRIPS with safeguards.	Lacks implementation data; future-oriented.
Azam and Richardson, 2010	Bangladesh pharma regulation	Identifies inter-agency regulatory gaps.	Administrative focus; limited on innovation outcomes.
Azad <i>et al.</i> , 2018	Process patents in Bangladesh pharma	Empirical productivity analysis; shows moderate patent impact.	Limited to firm-level data; not policy evaluative.
Schillaci <i>et al.</i> , 2022	Patent ecosystem mapping	Visualizes codified knowledge flows; sector trends.	Single-country focus; top-down, government-led context.
Choi <i>et al.</i> , 2021	Global patent trends	Macro bibliometric insight.	Lacks ecosystem/regulatory granularity.
Iqbal and Sadaf, 2023	Pharmaceutical innovation	Domain-specific technical insight.	Not ecosystem-focused.
Mohammadi <i>et al.</i> , 2024	Engineering/tech patents	Technical cases.	Legal/ecosystem aspects not addressed.
Sanyal and Arora, 2022	Indian patent system	Strong policy analysis; data on manpower/backlog.	Does not map knowledge flows or sector-specific dynamics.

Once patents are granted, the ecosystem upholds protection through various enforcement mechanisms (e.g., litigation against infringement) and the establishment of secondary markets (e.g., licensing agreements, insurance products). However, the presence of patent trolls introduces a disruptive externality that complicates the landscape. By securing the rights of inventors and encouraging innovation, this ecosystem not only propels economic development but also facilitates the conversion of theoretical concepts into commercially viable products that meet societal needs. The figure synthesises both theoretical and empirical frameworks from existing literature on intellectual

property systems (e.g., WIPO reports, cornerstone patent studies) and is uniquely developed for this study, as noted in the accompanying caption.

Evaluating the Current Status of Patent Ecosystem in Bangladesh

In this section, an exploration has been conducted to assess the current patent ecosystem in Bangladesh. This current study was carried out from 2020 to 2022 at the Bangladesh Council of Scientific and Industrial Research (BCSIR) and utilizes publication data indexed in Scopus, which has been openly

Table 2: Acronym and frequently used terms.

Nomenclature	
BAEC	Bangladesh Atomic Energy Commission
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BAT	British American Tobacco
BCSIR	Bangladesh Council of Scientific and Industrial Research
DPDT	Department of Patents, Designs, and Trademarks
ICDDR, B	International Centre for Diarrhoeal Disease Research, Bangladesh
IP	Intellectual Property
LDC	Least Developed Country
R&D	Research and Development
UGC	University Grant Commission
WIPO	World Intellectual Property Organization

Table 3: The components of the patent ecosystem, their functions and present status.

Components	Functions of the components	Present status of the components in Bangladesh
R&D organisations	To conduct research and development activities, and develop patentable products.	There are approximately 234 professional R&D organisations currently functioning in Bangladesh, but their product development activities, patent filing, and accepting number are significantly lower.
Patent offices	To examine, grant, and related official issues for patent rights.	Ministry of Industries of Bangladesh operates a Patent Office named Department of Patents, Designs, and Trademarks (DPDT), which is affiliated with WIPO.
Patent laws and regulations	These are the rules and guidelines that govern the patent system and determine what can be patented, how patents are granted, and how they can be enforced.	Patent office and courts of Bangladesh follow all the patent rules (Bangladesh Patent Act, 2022), but there is a lack of awareness to implement the laws.
Patent holders	These are the individuals or organisations that own a patent. They have the right to exclude others from making, selling, or importing the patented invention.	The number of inventors or organisations that own a patent is significantly less in Bangladesh.
Patent attorneys	These are lawyers who specialize in the field of patents and can assist with the patent application process, including drafting and prosecuting patent applications.	According to the Bar Council, there is no registered patent attorney (advocate) or specialised law firm dedicated to dealings of patent filing in Bangladesh.
Patent trolls	These are individuals or organisations that hold patents and attempt to extract licensing fees or settlements from other companies by threatening to sue for patent infringement.	The inventor(s) or organisation that owns a patent is unaware of patent a troll.
Patent licensing	This is the process by which patent holders allow others to use their patented inventions in exchange for a fee.	Being a Least Developed Country (LDC), Bangladesh enjoys a free patent license. The patent licensing phenomena in the country are rare.
Patent litigation	This is the process of resolving disputes over patents through the legal system, including lawsuits and other legal proceedings.	There is a patent litigation process in Bangladesh's courts, but the practice is rare.
Patent insurance	This is a type of insurance that helps companies to protect against the financial risks associated with patent litigation.	There is no such type of insurance in Bangladesh's courts, and the practice is also rare.

accessible since 1996 through the Scimago Lab platform. The research exploits this comprehensive dataset, covering the period from 1996 to the end of the study timeline in 2022, to critically assess the patent landscape in Bangladesh. This assessment is bolstered by a comparative analysis of patent statistics sourced from both Scopus and the Department of Patents, Designs and Trademarks (DPDT) website. Notably, BCSIR is currently the only entity in Bangladesh that publishes an annual list of total scientific publications on its website (BCSIR, 2021), which has been integrated into this analysis.

In Bangladesh, the research landscape encompasses a diverse array of stakeholders, including research scientists affiliated with various organisations, M.Phil. and Ph.D. students, and faculty members from universities. However, a comprehensive assessment of the number of research institutions and active professional researchers within Bangladeshi organisations remains absent. In response to this gap, the current investigation implements a systematic survey, utilising official institutional websites and annual reports to gather data. The findings indicate that approximately 5,650 research scientists are employed across nearly 70 state-owned, private, and multinational research entities. Overall, about 36,353 research scientists and faculty members engage in the activities of 234 research organisations and Universities throughout the Country (UGC Bangladesh, 2020). Key public research organisations in Bangladesh include BCSIR, the Bangladesh Atomic Energy Commission (BAEC), the Bangladesh Agricultural Research Institute (BARI), and the

Bangladesh Agricultural Research Council (BARC). Moreover, a range of private and multinational research organisations, such as Walton BD Ltd., BEXIMCO Pharmaceuticals Ltd, Square Pharmaceuticals Ltd, ACI Pharmaceuticals Ltd., ICDDR, B, and British American Tobacco Bangladesh Ltd, play significant roles in the research ecosystem. A detailed overview of the patent ecosystem and its current status is provided in Table 3. This table has been generated using the results derived from the present study.

RESULTS AND DISCUSSION

This study systematically investigates all components of the patent ecosystem. Relevant information and numerical data pertaining to these components have been gathered from a variety of national and international sources. The analysis employs three distinct timeframes: 1996-2022, 2012-2021, and 2010-2023, incorporating publication data from the Bangladesh Council of Scientific and Industrial Research (BCSIR). The rationale for utilizing these specific periods to assess data availability from open sources, as outlined in the methodology section, is integral to the context of this investigation. The data regarding resident patents granted from 1996 to 2022 is sourced from the Patent Statistics of Bangladesh (DPDT Bangladesh, 2023), and is illustrated in Figure 2. It is evident that the Bangladesh patent office granted 18 patent applications in 1996 and 29 applications in 2021, with fluctuations ranging from 4 to 29 during this period. To gain insight into the real innovation landscape,

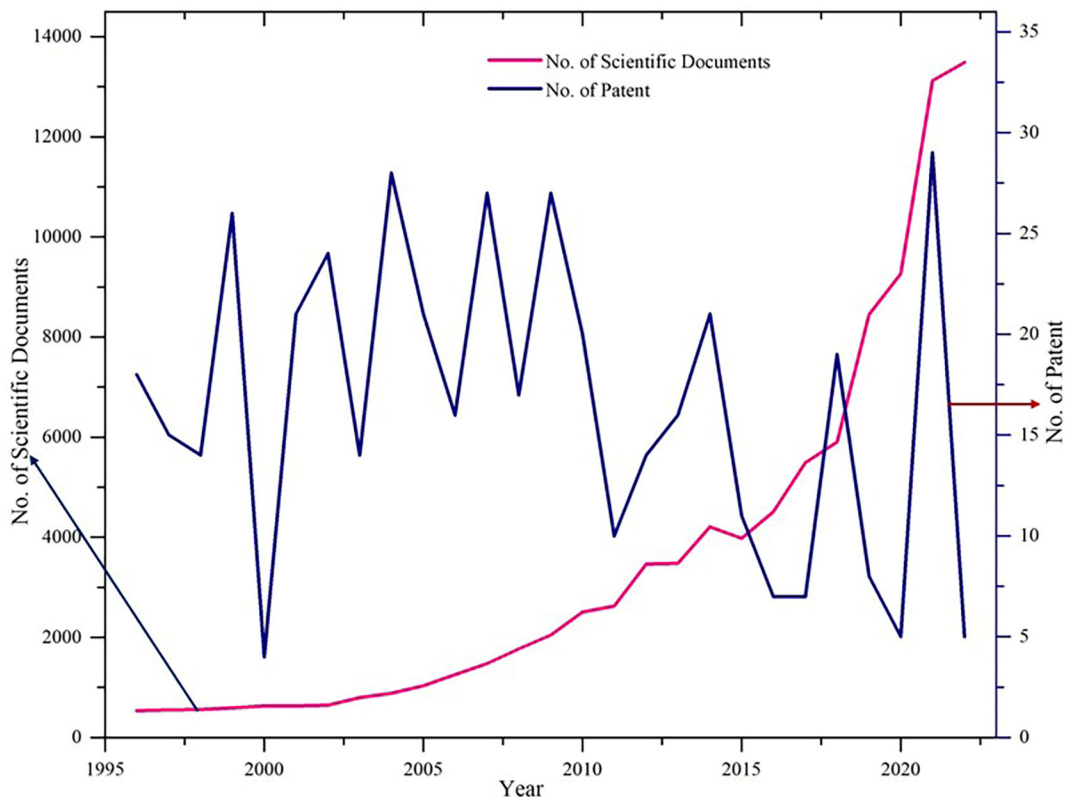


Figure 2: Scientific publication Vs. granted patent scenario of Bangladesh.

Table 4: Comparison of the patent and publication ratio of the USA, Japan, China, India, South Korea, and Bangladesh.

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
USA	Patent	229410	244183	254697	257091	277141	285846	289079	308611	306524	298575
	Publication	666841	682884	675689	693179	695642	709480	718762	707258	700795	726552
	Patent: Publication	1: 2.91	1:2.80	1:2.65	1:2.70	1:2.51	1:2.48	1:2.49	1:2.29	1:2.29	1:2.43
Japan	Patent	363584	340230	297040	271165	289250	286014	284068	283923	278935	278117
	Publication	135307	137884	132818	130268	133024	134865	137913	137582	137913	144778
	Patent: Publication	1:0.37	1:0.41	1:0.45	1:0.48	1:0.46	1:0.47	1:0.49	1:0.48	1:0.49	1:0.52
South Korea	Patent	112115	123841	127404	109112	120553	130978	131912	141543	151187	158495
	Publication	72164	75643	79324	82714	83958	84839	87554	91748	95511	101692
	Patent: Publication	1:0.64	1:0.61	1:0.62	1:0.76	1:0.70	1:0.65	1:0.66	1:0.65	1:0.63	1:0.64
China	Patent	152106	154472	176351	279509	322523	352576	377306	399862	485159	639309
	Publication	416372	456875	489224	465328	501174	542098	609496	699385	771730	860012
	Patent: Publication	1:2.74	1:2.96	1:2.77	1:1.66	1:1.55	1:1.54	1:1.62	1:1.75	1:1.59	1:1.35
India	Patent	3599	4353	5014	5822	6699	7523	8350	10803	13069	14613
	Publication	110205	118292	133608	145567	156756	158494	183075	201857	212665	237429
	Patent: Publication	1:30.62	1:27.17	1:26.65	1:25.00	1:23.40	1:21.07	1:21.93	1:18.69	1:16.27	1:16.25
Bangladesh	Patent	14	16	21	11	7	7	19	8	5	29
	Publication	3466	3477	4209	3976	4513	5489	5903	8494	9263	13119
	Patent: Publication	1:248	1:217	1:200	1:361	1:645	1:784	1:310	1:1061	1:1853	1:452

Scopus-indexed publication data for the same timeframe was examined. It was observed that the number of publications experienced an exponential increase, reaching 13,396 from 539 between 1996 and 2022 (Scimago, 2022). Figure 2 illustrates that research activities in Bangladesh are significantly increasing, as demonstrated by the upward trend in publication numbers. However, it is noteworthy that the patent acceptance rate has not improved and remains exceptionally low in comparison to the publication data. Consequently, it is imperative to investigate the underlying factors contributing to this low patent success rate, as outlined in the subsequent sub-sections.

To comprehend the chronological behaviour of the local patent submission and acceptance rate, the study pursued an examination of the patent statistics in Bangladesh from 2010 to 2023. It has been elucidated from Figure 3 that the patent acceptance rate fluctuates in a random fashion. The highest and lowest patent acceptance rates were 47.7% in 2014 and 6.1% in 2023, respectively, with a yearly average acceptance rate of 23.2%. On an annual basis, an average of 57.1 local patent applications were filed, with 12.7 being accepted.

The Bangladesh Patent Office exhibited a notably higher acceptance rate for foreign patent applications compared to

domestic ones from 2010 to 2023. In this case, as shown in Figure 4, the acceptance rates ranged from a high of 55.8% in 2021 to a low of 19.7% in 2023. On average, the foreign patent acceptance rate was 41.1% per year, which is 1.77 times higher than the local acceptance rate. Additionally, the annual averages for foreign patent application filings and acceptances were 296.5 and 122.3, respectively, indicating relatively favourable outcomes.

An examination of patent and publication statistics from both developed and developing nations can provide valuable insights into the effective functioning of the patent ecosystem. So, as a case study, the patent and publication scenarios have been demonstrated for high-income and technologically advanced countries such as the USA, Japan, and South Korea, as well as for China, which is progressing toward a high-income and technologically robust position, and India, a lower-middle income country like Bangladesh, experiencing an increase in the number of patents and publications. Figure 5 illustrates the patent scenario of these countries spanning from 2012 to 2021. The data demonstrate that the number of patents in the USA, Japan, and South Korea is notably high and relatively stable, indicative of their advanced research and development culture, strong infrastructure, and established patent ecosystem. China

has consistently accelerated its number of patents from 152,106 to 639,309 within a decade, aligning with the patent ecosystem of developed countries. China's significant resource allocation, favourable policy formulation, and incentives in R&D and the patent ecosystem contributed to its remarkable achievement. Being a developing and lower-middle-income country, India is also experiencing growth in its number of patents, albeit still trailing behind high-income countries and China. Again, Figure 6 shows the Scopus-indexed publication trends within the five aforementioned countries. This analysis presents a parallel pattern to that observed in patent statistics. The number of publications in the USA, Japan, and South Korea has been consistently increasing, though China and India have demonstrated rapid growth in their publication output. For instance, during the period from 2012 to 2021, China's publication count surged from 416,372 to 860,012, while India's increased from 110,205 to 237,429.

The number of publications serves as an indicator of the quality of research activities, while patent acceptance signifies the effectiveness of product/process development. Accordingly, the patent-to-publication ratio of a country reflects the extent to which patentable products are derived from research activities dedicated to product development. Therefore, the ratio could be a significant indicator of a robust patent ecosystem. Table 4 presents the patent-to-publication ratios for the USA, Japan, China, India, South Korea, and Bangladesh from 2012 to 2021. The data indicate that the ratios are similar for developed countries. Notably, countries such as Japan and the USA, with extensive R&D histories, are characterised by patent-to-publication ratios of 1:0.52 and 1:2.43, respectively, in 2021. This suggests that developed countries maintain strong patent ecosystems, and a significant portion of research activities culminates in patentable products. South Korea and China have now been

rated as high-income countries by the World Bank, and Table 4 highlights the similarity of their patent-to-publication ratios. On the other hand, the ratio is much larger for India and Bangladesh, standing at 1:16 and 1:452, respectively. The extremely high ratio of Bangladesh indicates a significant gap in converting research activities into patentable products.

To investigate the notable disparity between the number of patents and publications, we undertook a case study utilizing the publication list (Year-2021) of the Bangladesh Council of Scientific and Industrial Research (BCSIR) (BCSIR, 2023). BCSIR is a multidimensional research organization in Bangladesh that collaborates with various research institutions and universities. Consequently, its publications provide a comprehensive overview of the country's publishing landscape, making it a suitable case study. Table 5 delineates the publication categories by BCSIR. It is evident that researchers of the organization predominantly published analytical and review articles, constituting 78.23% of the total. A mere 21.77% of the articles pertained to method/process and product development, thereby meeting the criteria for patent acceptance, i.e., novelty, non-obvious inventive steps, and commercial applications. This marked emphasis on analytical research arguably underscores the limited number of patent applications within Bangladesh.

Concurrently, to scrutinise the precision of the patent filing process, a total of 30 verification reports for resident patent applications were procured from DPDT, Bangladesh, for the fiscal year 2020-21, as presented in Table 6. The data reveal that 73.33% of the total applications were inadequately drafted, 26.67% were incomplete due to the absence of supporting documents/materials, 36.67% inaccurately specified their claims, and 80% failed to substantiate novelty, a pivotal criterion for patent acceptance. These collective factors impede the advancement

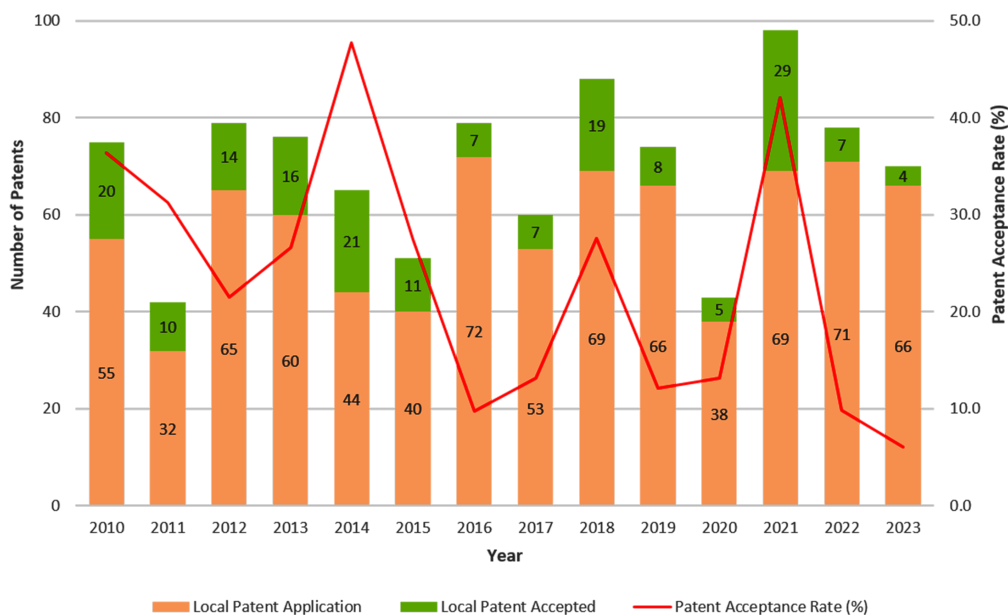
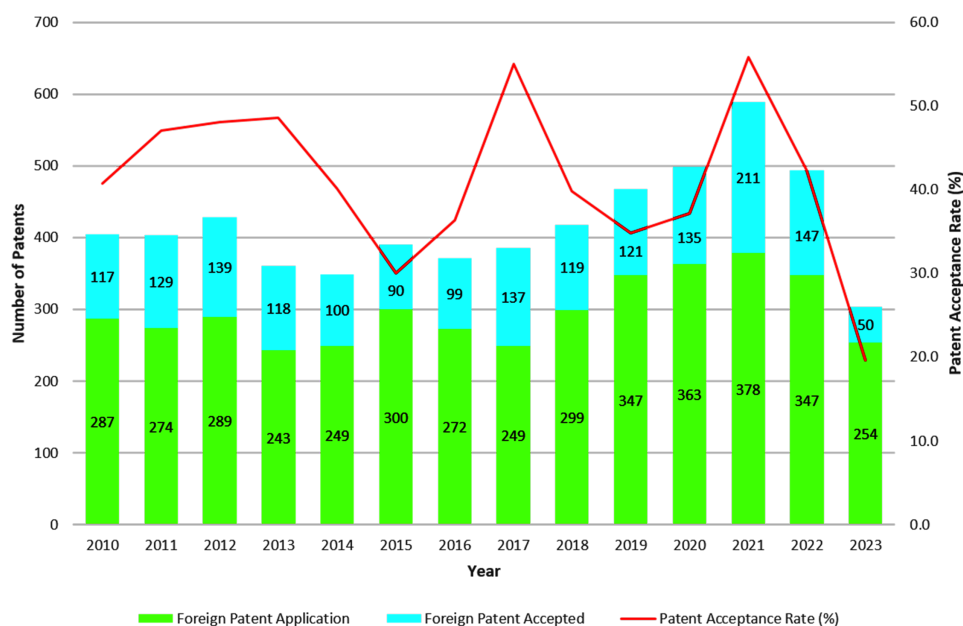


Figure 3: Bangladesh's resident patent application filing and acceptance scenario during the 2010-2023 period.

Table 5: Publication types of BCSIR.

Sl. No.	Nature of the research papers	Number of the papers	Percentage (%)
1	Analytical type articles	156	69.34
2	Review articles	20	8.89
3	Articles related to the process development	32	14.21
4	Articles related to product development	17	7.56
Total		225	100

**Figure 4:** The patent submission and acceptance scenario in the Bangladesh patent office by foreign inventors during 2010-2023.

of patent applications in contrast to the perceptible progress in publications.

In order to determine the reasons behind the low rate of patent success in Bangladesh, an assessment of all components of the patent ecosystem is imperative. Research activities commenced in the Ganges Delta in the early twentieth century. For much of that century, Bangladesh grappled with poverty. However, the early twenty-first century saw a gradual emergence from poverty, transforming the nation into a robust economy. The introduction of the National Science and Technology Policy 2011 (MoST Bangladesh, 2011) marked the commencement of systematic research and development in Bangladesh. Under this policy, the Government of Bangladesh (GoB) established and revitalised various research organisations and infrastructures, recruited a substantial number of researchers, provided both local and international training, and offered research grants through different schemes. These initiatives prompted scientists, faculty members, and R&D organisations to engage more extensively in research activities, leading to a discernible increase in scientific publications, as shown in Figure 2.

One of the major drawbacks of low patent success is the lack of proper patent specification guidelines provided by the patent office (DPDT Bangladesh, 2024). However, the patenting process is cumulatively influenced by various technical and logistical factors. Notable limitations in the patenting system in Bangladesh include:- (i) lack of resources and expertise within research organizations for successful product development and precise patent specification preparation, (ii) absence of IP protection units within research institutions, (iii) inadequate resources and expertise within the patent office, (iv) absence of a patent attorney and associated law firm in the country, and (v) lack of awareness among researchers and the public about the importance of patents and IP protection. Bangladesh, as an LDC-listed country, enjoys accessible patent rights facilities. However, after graduating to middle-income status in 2026 (Hobbs, 2023), it will forfeit the existing free patent right opportunity. Consequently, there is an urgent need to augment the quality of patentable product development and increase the number of patents. The National IP Office of Bangladesh, DPDT, is responsible for examining patent applications, granting patents, and protecting intellectual property rights within the country. The recent formulation of

Table 6: Defects of the Bangladeshi local patent applications.

SI. No.	Nature of the defects of patent filing	Number of patent applications	Percentage (%)
1	Improper patent specification preparation	22	73.33
2	Lack of specification filing material	8	26.67
3	Inaccurate claims	11	36.67
4	Lack of novelty	24	80
5	Lack of permission	6	20
6	Repetition with the literature	6	20
7	Inaccurate filing procedure	2	6.67

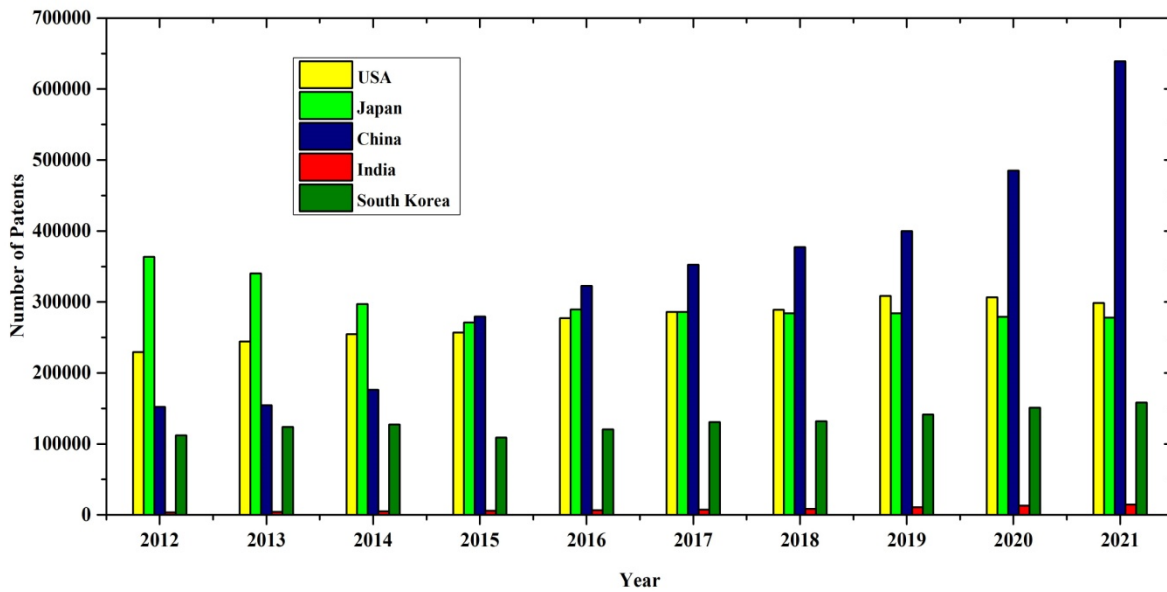


Figure 5: Patent statistics of the USA, Japan, China, India, and South Korea.

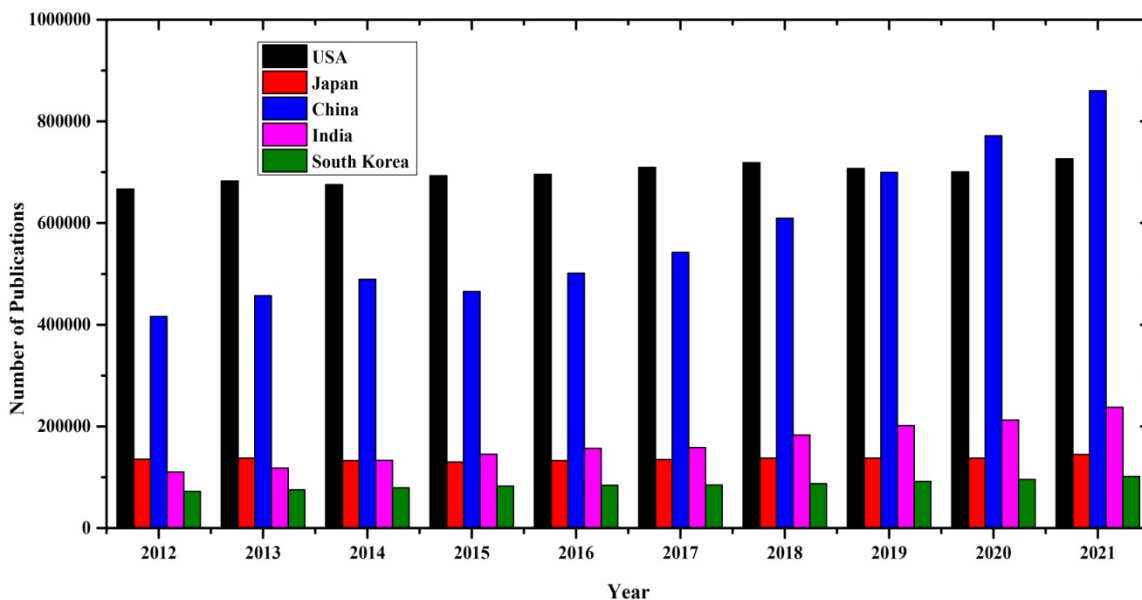


Figure 6: Publication statistics of the USA, Japan, China, India, and South Korea.

the Bangladesh Patent Act 2022 (Bdlaws, 2022) has positively influenced the patenting system. According to data from WIPO and DPDT, the number of patent applications filed in Bangladesh has increased in recent years. For example, 69 patent applications were filed in 2021, marking a 45% increase from the previous year.

A robust and effective patent ecosystem is indispensable for a nation's development. By addressing the challenges associated with the patent system and fostering an environment conducive to innovation, Bangladesh can fully harness the potential of its patent ecosystem, thereby supporting the long-term sustainable development of its economy.

CONCLUSION

The study looked at the patent ecosystem of Bangladesh, encompassing its present status, constraints, trends, challenges, and potential implications in light of developed nations. The major findings are summarised as follows:

Publications and patents serve as indicators of a nation's innovation capacity, technological advancement, and economic strength. Developed countries, including the USA, Japan, South Korea, and the higher middle-income nation of China, are global leaders, whereas developing countries like India and Bangladesh lag significantly behind. In comparison to India, Bangladesh, which possesses a comparable per capita GDP, falls significantly behind India by a factor of 28 in its publication-to-patent ratio.

While China and the USA have similar patent-to-publication ratios, Japan and South Korea have nearly twice as many patents per publication compared to those of the USA and China.

Bangladesh has a very low publication-to-patent ratio. The study revealed that a lack of adherence to the required drafting criteria led to the denial of almost three-quarters of patent applications. This decrease is mostly attributable to a lack of public and institutional knowledge, poor policymaking, inefficient patent filing procedures, and insufficient policy incentives.

The following targeted interventions are proposed to improve the publication-to-patent ratio of the patent ecosystem for emerging and developing nations, including Bangladesh: (1) capacity-building initiatives for researchers and legal professionals, (2) policy reforms to streamline IP governance, and (3) stronger linkages between universities, industries, and government agencies. Such a patent ecosystem is expected to enhance a nation's innovation and industrial capacity, reduce import dependency, and align its IP framework with sustainable development goals.

ACKNOWLEDGEMENT

The authors would like to acknowledge Mr Md. Tasnim Rana, Engineer, BCSIR, for technical support, and Dr. A. K. Mahmudul Hasan, Post-Doctoral Fellow, BCSIR, for the proofreading of the manuscript.

ABBREVIATIONS

BAEC: Bangladesh Atomic Energy Commission; **BARC:** Bangladesh Agricultural Research Council; **BARI:** Bangladesh Agricultural Research Institute; **BAT:** British American Tobacco; **BCSIR:** Bangladesh Council of Scientific and Industrial Research; **DPDT:** Department of Patents, Designs, and Trademarks; **ICDDR, B:** International Centre for Diarrhoeal Disease Research, Bangladesh; **IP:** Intellectual Property; **LDC:** Least Developed Country; **R&D:** Research and Development; **UGC:** University Grants Commission; **WIPO:** World Intellectual Property Organization; **GDP:** Gross Domestic Product; **TRIPS:** Trade-Related Aspects of Intellectual Property Rights; **SAARC:** South Asian Association for Regional Cooperation.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

DATA AVAILABILITY

All data generated or analysed in this study are available from the authors on request.

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Cite this article: Kowsar A, Debnath SC, Khatun MH, Ahmed S, Asrafuzzaman ABM, Islam AMT, *et al.* Investigation of the Patent Ecosystem in Bangladesh. *J Scientometric Res.* 2026;15(1):239-50.