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Research Article

Academic Entrepreneurship a Strategic Framework for Indian Sponsored Technical Institutions for Patent Commercialization

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ABSTRACT

Over the past decade, the academic sector in the Indian subcontinent has garnered significant global attention due to a rise in patent filings, largely driven by various initiatives from the Government of India (GoI). These initiatives include subsidizing patent filing fees for academic institutions, accelerating the processing of pending patent applications through increased hiring of patent examiners, and incorporating patent filing counts into university rankings, among others. However, Indian centrally sponsored technical institutions (CSTIs) lag considerably in academic entrepreneurship for patent commercialization compared to global leaders or developed countries. This study aims to identify the challenges and propose a well-defined patent commercialization model for CSTIs based on last 20 years patent portfolio. The study presents three key findings: 1. An analysis of challenges and issues in CSTIs' patent portfolios over the past 20 years, 2. A proposed patent commercialization modular framework, and 3. A step-by-step implementation plan for the proposed model using a technology cluster from CSTIs.

Keywords: Academia Technology Transfer; Academic Entrepreneurship; Technology Key Performing Indicators; Patent Commercialization Model.

1. Introduction

India's position in the 2022 Global Innovation Index (GII), where it ranks 40th among 132 global economies, is a significant indicator of its innovation potential. This index also ranks India 42nd in innovation inputs and 39th for innovation outputs on a global scale (**WIPO, 2022**). The United Nations Industrial Development Organization (UNIDO) is dedicated to advancing inclusive and sustainable industrial development (ISID), focusing on assisting industries in developing countries and economies in transition. In India, UNIDO has extensively collaborated with government agencies to formulate policies and establish institutional frameworks that promote entrepreneurship. Additionally, UNIDO has developed significant partnerships with various industrial and enterprise associations.

The shifting landscape of academic and industry publication trends reveals a concerning disparity in the alignment between academia and the industry's needs. While academia has historically focused on research and publications, the industry's primary concern lies in the application and commercialization of technology. This disconnect has led to a situation where academia is perceived as being "clueless" about the problems the industry is trying to solve, and the industry has become more secretive, limiting the flow of information and collaboration (**Koushik et al., 2020**).

One of the core challenges in this context is whether academia is investing in the right research to facilitate the seamless commercialization of technology (Peters et al., 2012). This issue is particularly relevant in the Indian context, where the Centrally Sponsored Technical Institutes (CSTIs), play a crucial role in driving research and innovation (**Peters et al., 2012**).

A closer alignment and collaboration between academia and industry is imperative to address this challenge (**Luan et al., 2020**). Industry offers a thorough understanding of market challenges and the ability to commercialize innovations, while academia supplies technical expertise and fresh perspectives on problem-solving. By fostering strong personal relationships and clear communication of objectives, these collaborations can create a mutually

beneficial ecosystem where both parties can leverage their strengths and work towards the common goal of driving innovation and economic growth (**Rees et al., 2020**).

Another significant study by (**Steven et al.,2013**) reveals that industry was responsible for 85% of publications, with academia contributing only 7%. However, by the end of 2006, industry publications had declined to 7%, while those from academia had increased to 93%. This significant shift indicated that the industry was becoming more secretive while academia was becoming increasingly unaware of the problems the industry was addressing. This lack of awareness suggests that academia did not fully understand the sector-specific problems that industry aimed to address. As a result, a major challenge for academia was determining whether it was directing its research efforts appropriately to support technology commercialization. For Indian Centrally Sponsored Technical Institutions (CSTIs), this issue is central to all other challenges and can be demonstrated by examining the patent portfolio over the past 20 years. Hence, this study aims to streamline the patent commercialization process of CSTIs and enhance the effectiveness of technology transfer. Below is a detailed outline of the proposed work:

- **Challenges and Issues in CSTIs' Patent Portfolios Over the Past 20 Years**: Examining the CSTIs' patent portfolios from the last two decades reveals several challenges and issues.
- **Proposed Patent Commercialization Model with Modular Framework**: A detailed patent commercialization model with a modular framework is designed to address and rectify the identified gaps. This model, which will be further detailed in the following sections, aims to streamline the patent commercialization process in CSTIs, making it more efficient and effective.
- **Step-by-Step Implementation of the Proposed Model Using a Technology Cluster from CSTIs**: The proposed model will be implemented using a structured, step-by-step approach within a technology cluster of CSTIs.

2. Literature Review

Patent monetization—the process of extracting financial value from patents—is a cornerstone of academic entrepreneurship. Universities globally are increasingly leveraging intellectual property (IP) as a key resource for fostering innovation, creating spin-offs, and driving regional economic development. The literature review explores the contributions of prominent scholars to the academic entrepreneurship literature, focusing on their work on patent monetization.

1. Donald Siegel: Leadership in University-Industry Partnerships

Institution: Arizona State University

Donald Siegel (**Siegel et al., 2003**) is a leading figure in the study of academic entrepreneurship and university-industry linkages. His research often highlights the mechanisms universities use to commercialize patents and the role of technology transfer offices (TTOs) in facilitating these processes. Siegel has examined the incentives for faculty participation in commercialization and the organizational efficiency of TTOs.

One of his seminal contributions lies in identifying barriers to effective patent monetization, such as bureaucratic inefficiencies and misaligned incentives between academics and university administrators. Siegel advocates for reforms that streamline university patenting processes, including public-private partnerships and regional innovation ecosystems.

2. Maribel Guerrero: Academic Entrepreneurship and Regional Development

Institution: Arizona State University

Maribel Guerrero's (**Guerrero et al., 2012**) research focuses on the interplay between universities and regional economic systems. She has extensively studied how universities use their patents to foster entrepreneurship and innovation. Guerrero argues that effective patent monetization not only depends on internal university policies but also on external regional dynamics such as government support, funding availability, and the presence of industrial clusters.

Her work underscores the importance of "entrepreneurial ecosystems" where universities collaborate with industry and government to maximize the economic impact of patents. Guerrero's studies often highlight the social and cultural factors that influence patent commercialization in different regions.

3. David Johnson: Spin-offs and Commercialization Pathways

Institution: Durham University

David Johnson's (**Johnson et al., 1999**) work centers on university spin-offs, a vital avenue for patent monetization. His research explores the lifecycle of spin-off companies, from their inception in academic labs to scaling in competitive markets. Johnson has identified the critical role of entrepreneurial training for academics and the impact of university policies on spin-off success.

He emphasizes that monetizing patents often involves long-term support structures, such as incubators and mentorship programs. His studies provide insights into how universities can design policies to support sustainable business models for spin-offs, ensuring long-term value extraction from patents.

4. Adam J. Bock: Business Models in Academic Entrepreneurship

Institution: University of Madison-Wisconsin

Adam J. Bock (**Block et al., 2012**) work has significantly contributed to the understanding of business models in academic entrepreneurship. His research addresses how universities design and implement commercialization strategies for their patents. Bock emphasizes that effective patent monetization requires a deep understanding of market needs and the adaptability of technologies to meet those needs.

He has also explored the role of interdisciplinary collaboration in academic patenting, arguing that diverse teams increase the likelihood of successful commercialization. Bock's framework for evaluating commercialization potential has become a valuable tool for university TTOs.

5. Markus Perkmann: The Dual Role of Academics

Institution: Imperial College London

Markus Perkmann's (**Perkmann et al., 2007**) work work investigates the dual roles of academics as researchers and entrepreneurs. He examines how academics navigate these roles and the institutional frameworks that support patent commercialization. Perkmann has highlighted the tension between traditional academic values and the commercial imperatives of patent monetization.

His research often focuses on collaborative research agreements and their role in licensing university patents. Perkmann advocates for creating supportive environments that allow academics to balance research excellence with entrepreneurial endeavours.

6. Phil Phan: Governance in Academic Entrepreneurship

Institution: Johns Hopkins University

Phil Phan (**Phan et al., 2005**) is a prominent scholar in the governance of academic entrepreneurship. His work examines how universities manage their intellectual property portfolios and the structures they use to monetize patents. Phan argues that governance models significantly influence the success of patent monetization efforts.

He has also studied the role of institutional culture in shaping entrepreneurial outcomes, finding that universities with supportive governance frameworks for commercialization tend to outperform their peers. His research provides a roadmap for universities looking to enhance their patent monetization strategies.

7. Rosa Grimaldi: Technology Transfer Processes

Institution: University of Bologna

Rosa Grimaldi (**Grimaldi et al., 2011**) is a key figure in the study of technology transfer. Her research focuses on the processes and mechanisms through which universities commercialize their patents. Grimaldi has contributed significantly to understanding the role of intermediaries, such as TTOs and incubators, in facilitating patent monetization.

Her work also emphasizes the importance of entrepreneurial education and training in fostering a culture of innovation among academics. Grimaldi's studies highlight best practices for streamlining technology transfer processes and maximizing the economic impact of university patents.

8. Peter Gianiodis: Strategic Management of Innovation

Institution: Duquesne University

Peter Gianiodis's (**Gianiodis et al., 2014**) research explores the strategic management of innovation in universities. He examines how universities align their patent portfolios with broader strategic goals, such as regional economic development and societal impact. Gianiodis highlights the importance of strategic alliances and partnerships in monetizing university patents.

His work provides insights into the decision-making processes behind licensing agreements, spin-off creation, and collaborative R&D initiatives. Gianiodis emphasizes that successful patent monetization requires not just technical innovation but also strategic foresight.

Key Takeaways from Literature Review

1. **Institutional Support**: Across these scholars' works, a recurring theme is the importance of institutional support structures, such as well-functioning TTOs, entrepreneurial training programs, and incubators, in enabling patent monetization.
2. **Collaborative Ecosystems**: Successful commercialization often depends on collaborative ecosystems involving industry, academia, and government. Guerrero and Perkmann, in particular, stress the need for universities to integrate into regional innovation systems.
3. **Entrepreneurial Academics**: The dual role of academics as researchers and entrepreneurs is a focal point of Perkmann and Phan's research. Balancing these roles requires supportive institutional policies and cultural shifts within academia.
4. **Strategic Alignment**: Gianiodis and Johnson highlight the importance of aligning patent strategies with broader university and societal goals.
5. **Barriers and Challenges**: Siegel and Grimaldi identify bureaucratic inefficiencies, cultural resistance, and misaligned incentives as major obstacles to effective patent monetization.

The contributions of these scholars have significantly shaped our understanding of patent monetization in universities. Their work underscores that successful commercialization requires a blend of institutional support, strategic vision, and entrepreneurial culture. By implementing the insights from this body of literature, universities can unlock the full potential of their intellectual property, driving innovation and economic growth.

2.1 India's Global Rank in IP Commercialization

A Forbes report (**Jay, 2014**) indicates that only around 5% of the 2.1 million active US patents have made it to the market. Nearly 90% of these patents are not commercialized and fail to secure angel investors or licensees, including over 50,000 high-quality patents from universities. Similarly, fewer than 5% of patents are successfully brought to the market in India. Hence, in 2014, the Indian government launched the "Make in India" initiative, which included a five-point agenda to advance intellectual property rights (IPR) to enhance innovation.

The U.S. Chamber International IP Index ranks countries based on the reliability of their IP systems for investment and commercialization. The latest edition (**GIPC, 2024**) assesses 55 global economic countries using 50 distinct indicators across nine categories. This paper examines countries in the "Commercialization of IP Assets" category, where India's overall score is 38.64, which substantially lag the scores of other developed and developing countries. **Figure 2**. depicts the overall economic score for 50 economic countries.

2.2 Challenges with the patent Commercialization Model in the Indian context

Patent monetization, the process of extracting economic value from patented technologies, has been a topic of significant interest within the academic community, particularly in the context of Indian universities. The increasing emphasis on commercializing university research has led to a growing focus on effectively managing and leveraging intellectual property assets to generate returns for both the researchers and the institution.

One of the key aspects of patent monetization is the role of technology transfer offices within universities. These offices are responsible for identifying, protecting, and commercializing university-generated intellectual property, often through licensing agreements or the establishment of spin-off companies. However, the performance of these

offices has been a subject of debate, with some studies highlighting the challenges and bottlenecks that hinder the successful commercialization of university inventions (**Swamidass et al., 2008**).

Recommendations from these studies suggest that a deeper understanding of the factors contributing to the success of prolific licensing universities is necessary and that dedicated funding for commercialization purposes should be made available to universities. Alongside the internal efforts of technology transfer offices, the involvement of external stakeholders, such as lawyers, has also been identified as a crucial element in the commercialization process (**Hussain et al., 2010**).

The Oxford model, as discussed in the literature, provides a compelling example of a university's approach to balancing the pursuit of academic freedom and the objective of contributing to economic development. This model emphasizes the importance of a clear policy on intellectual property rights ownership and the strategic allocation of resources to support researchers in protecting and commercializing their inventions.

Overall, the literature suggests that the successful monetization of university patents requires a multifaceted approach, involving a combination of effective technology transfer management, dedicated funding, and the involvement of external professionals, all within the context of a well-defined institutional strategy (**Cook et al., 2008**).

The success of nations in the modern era is intricately linked to their ability to effectively translate research into commercial products and services (**Kumar et al., 2003**). As hubs of knowledge and innovation, universities play a crucial role in technology commercialization. However, Indian universities have faced many challenges in successfully commercializing their research outputs.

A crucial factor affecting the success of technology commercialization in Indian universities is the institutions' own internal characteristics and capabilities (**Kim et al., 2009**). Factors such as the university's technology transfer office, the entrepreneurial mindset of faculty and researchers, and the availability of resources and infrastructure can significantly impact the efficiency of the technology transfer process.

One key factor determining the success of technology commercialization is the characteristics of the individual university. Aspects such as the university's research focus, the nature of its intellectual property, and the presence of a dedicated technology transfer office can all influence the university's ability to commercialize its technologies effectively (**Siegel et al., 2007).**

Hence, based on the literature review, the primary challenges faced by CSTIs (Centers for Technological Innovation) in the commercialization of technologies can be summarized as follows:

- **Inefficient Allocation of R&D Resources**: A significant amount of funding is expended on research and development (R&D) with minimal return on investment (ROI). Despite substantial investment in R&D, universities often fail to achieve a significant share in high-impact innovations, leading to a disconnect between the financial resources allocated and the qualitative advancements realized.
- **Insufficient Industry Insights**: There is a lack of understanding regarding current industry challenges, exacerbated by the increasing secrecy within industries and the reduction in publications. This knowledge gap hinders CSTIs' ability to align their research efforts with industry needs and emerging problems.
- **Narrow Focus on Local Issues**: CSTIs tend to concentrate on solving small-scale societal problems rather than addressing broader, global issues aligned with the G20 theme of "One Earth, One Family." This limited scope restricts the potential impact and relevance of their innovations on a global scale.
- **Inadequate Investigation and Assessment**: There is a deficiency in investigating which technology areas are garnering global research interest, are underexplored, and possess real potential for innovation and commercialization. This lack of thorough assessment impairs the ability to make informed funding decisions and prioritize high-potential research areas.
- **Absence of a Strategic Framework**: There is no robust strategic model or framework available to assist in identifying high-potential research areas. The lack of such a framework result in missed opportunities for targeting research with a higher probability of generating significant ROI and achieving commercial success.

These challenges underscore the need for improved strategic planning and better alignment between research efforts and industry demands to enhance the commercialization prospects of technologies developed by CSTIs.

3. Research Methodology

The data collected for this study are as follows:

1. Indian CSTIs patent activities in last 20 years
2. Technology CAGR for technology cluster
3. Potential Player active in technology domain

The model is designed base on Quantitative Analysis & Qualitative Analysis. The variables taken are as follows:

1. Sample Size: 25 India's top technical universities such as Indian Institute of technology (IITs) & Indian Institute of Science (IISc)
2. Duration of Study: Last 20 years patent portfolio data (June 2005 - June 2024)
3. Sampling Type: Convenience Sampling
4. Data Collection: The data of the research is collected from various sources at global level from both paid and non-paid database which are as follows:

Database	Data type	Paid or Non-paid	Features
Questel Orbit	CSTI's patent data	Paid	1. Patent data-Bibliographic & technical 2. AI Classifier
Derwent Innovation	CSTI's patent data	Paid	Patent data-Bibliographic & technical
Thompson Reuters	Technology data	Paid	Potential players active in technology domain, technology market
Google	Technology data	Non-paid	Potential players active in technology domain, technology market

Table1: Data Collection Databases

4. Strategic Modular Framework Model for Indian CSTIs

Based on literature review and various challenges identified for Indian CSTIs, it has been evident that a strategic modular framework model is required to identify gem of patents for technology commercialization. The proposed technology commercialization model will enable to trim down patent at each stage so, that a hand full of patents can be considered effective commercialization. Each step of the proposed model **Figure 7**. has a detailed description with actional items explained with an suitable example or use case.

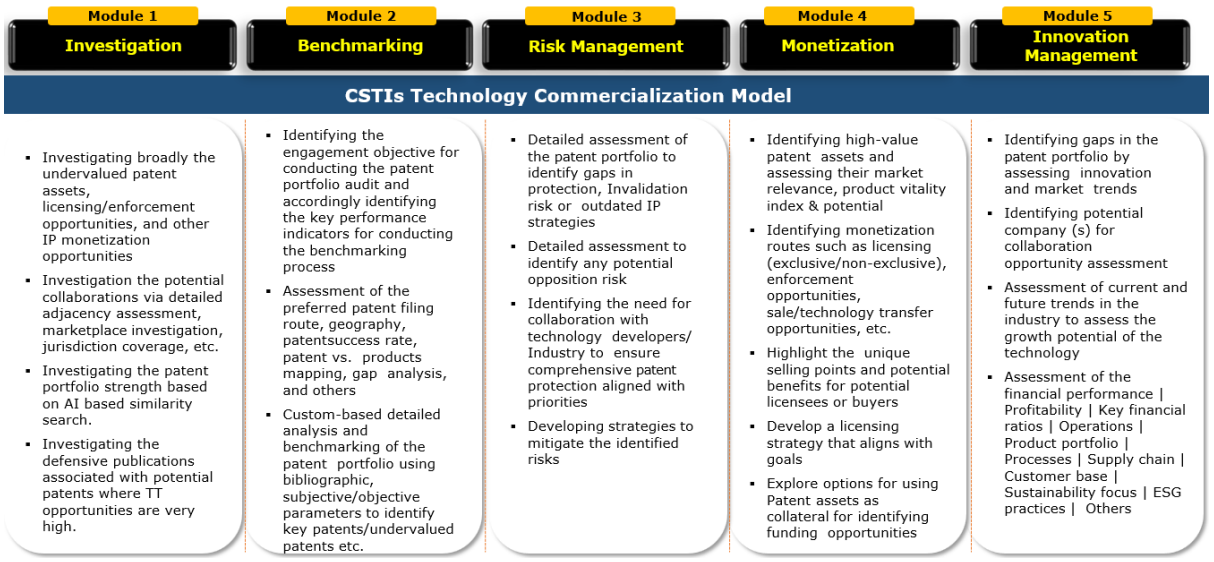

Figure 1: Strategic Modular Framework

Module 1: Investigation

The Investigation of technology is based on two different objectives. The first objective is based on an existing patent portfolio of CSTIs, and the second objective is how to create a potential new patent portfolio that can be commercialized. The investigation strategies are designed to fulfill both objectives.

For the first objective, CSTIs patent portfolio is classified based on an AI classifier (Questel Orbit AI Classifier), and the whole portfolio is clustered so that similar technology patents are segregated into different pools. The entire clustering of CSTIs portfolio from the last 20 years until 2024 is shown in **Figure 2.**

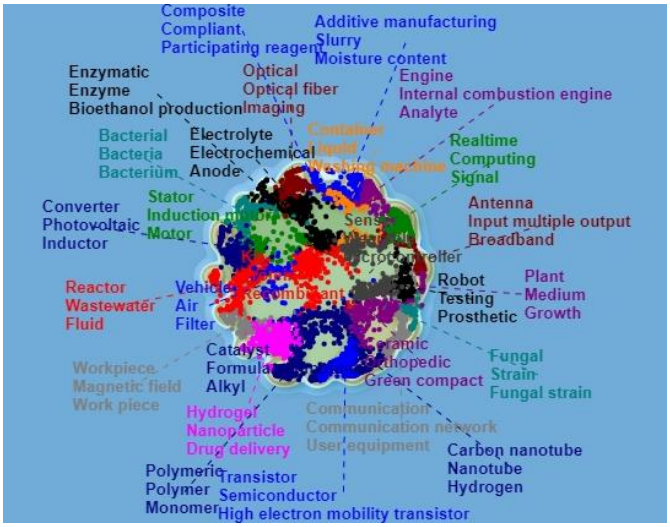

Figure 2: CSTIs Patent Portfolio Classification

The CSTIs IPR Cell selects a cluster of interest and conduct a technology landscape study of selected cluster to identify potential gem of patents which can be licensed out easily. Further based on second objective, a researcher will also execute a technology landscape based on technology of interest and cluster the patents in a similar fashion.

The below **Figure 3.** Depicts that the filling trends of IITs over the years are increasing however, based on similarity search the focus of technology is not as per the demand of the industry. It is very evident that Roche Diabetics Care and ISENS Inc are major two players where potential collaborations technology transfer can be a matter of discussion as these players are emerging as well as consistent patent filers. Further, after 2014, the gap has become deeper and hence, CSTIs need in depth domain demand as per the market needs so that investment on R&D leads to substantial RoI.

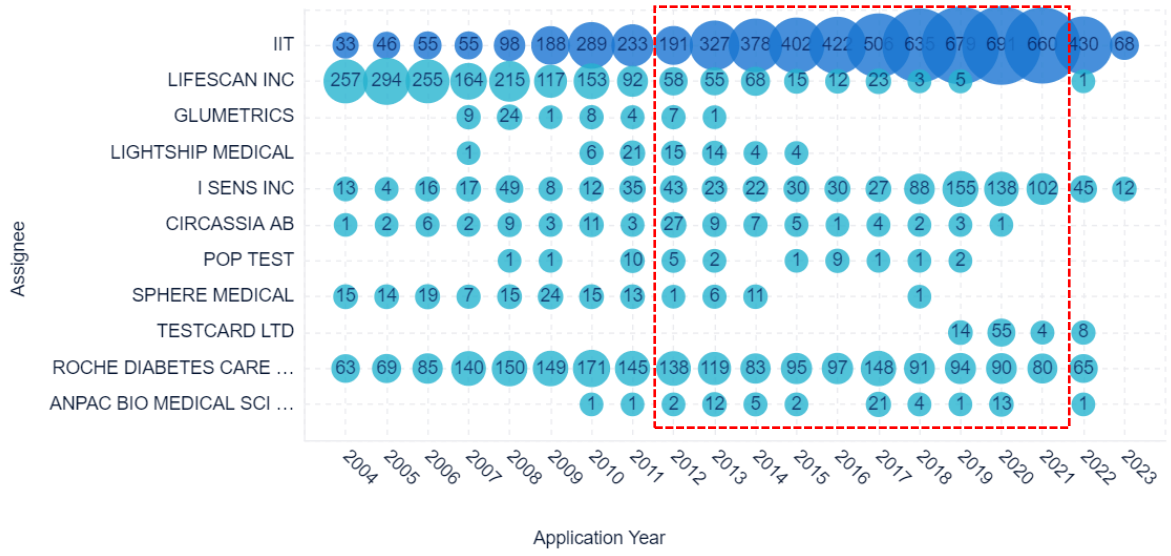

Figure 3: Similar Technologies Distribution Year wise

Module 2: Benchmarking

Patent portfolio benchmarking is based on successful outcome of investigation. The potential patent technology clusters are identified during investigation and relevant Key Performance Identifier (KPI) identified and appropriate weightage is embedded against each KPI as represented in **Figure 4**. Further, based on threshold score, such portfolio should be given major priorities for further actional plan as per the framework.

KPI >>	IP focus area Relevance	Independent claim (s) strength	Adjacent application area (s)	Opposition	Insurance rate | Citations (%)	Patent grant success rate (%)	CAGR of Technology	Standard essential category	Overall score
Weightage >	10%	8%	xx%	xx%	xx%	xx%	xx%	xx%	
IP clusters	Score	Score	Score	Score	Score	Score	Score	Score	xx
IP Cluster #1	xx	xx	xx	xx	xx	90	90	xx	xx
IP Cluster #2	xx	xx	xx	xx	xx	xx	xx	xx	
IP Cluster #3	xx	xx	xx	xx	xx	xx	xx	xx	
IP Cluster #4	xx	xx	xx	xx	xx	xx	xx	xx	
IP Cluster #5	xx	xx	xx	xx	xx	xx	xx	xx	
IP Cluster #6	xx	xx	xx	xx	xx	xx	xx	xx	

Figure 4: Clustering of CSTIs patent portfolio based on KPI

Module 3: Risk Management

The patent clusters which are identified as gems are accessed based on risk assessment parameters. The risk in bifurcated into external risk and Internal risk. The below strategic risk management module which consists of various parameters listed in below **Figure 5**. Below are the pointers based on which risk assessment is mandatory for any patent portfolio.

- Detailed assessment of the IP portfolio to identify gaps in protection, Invalidation risk or outdated IP strategies.
- Detailed assessment to identify any potential opposition risk
- Identifying the need for collaboration with technology developers/ Industry to ensure comprehensive IP protection aligned with priorities

- Developing strategies to mitigate the identified risks

Hence, if the final score falls below the required threshold value the patent cluster should be considered kept filtered out and outsourced for legal consultation.

KPIs	Points	Riskiness (A) High-Medium-Low										Weightage (B)	Weighted (A*B)
External Risks		1	2	3	4	5	6	7	8	9	10		
Regulatory risk/IP management standards	6											5.0%	0.3
Market potential of technology	4											5.0%	0.2
Technology shift risk	4											5.0%	0.2
Performance Risks													
Return on research capital	6											5.0%	0.3
Product vitality index/IP utilization rate (%)	6											5.0%	0.3
Patent success ratio													
Patent portfolio diversity													
Market exclusivity													
Global patent coverage													
Management Risks													
IP litigation	6											10.0%	0.6
IP infringement	6											10.0%	0.6
IP unused portfolio/patent non-usability	10											10.0%	1.0
Freedom-to-operate	6											10.0%	0.6
Active patent portfolio age	6											5.0%	0.3
Final Rating for company #A													6.0

Figure 5: Risk Management Module

Module 4: Monetization

Patent Monetization for low-risk patent cluster is further analyzed based on Qualitative analysis. The qualitative analysis broadly consists of three major parameters which are segregated in multiple KPI as per **Figure 6.**

Qualitative Analysis: Qualitative analysis is based on subjective analysis and the major parameters are detectability test, claim scope and business impact. Below is the methodology and detail ranking parameters.

- **Detectability:** Detectability is a score of infringement where a subject matter expert (SME) ranks the patent based on products identified by SME during the analysis. The detectability KPI's are Patent in use/unused, Infringement type, number of searched products/technologies.

- **Claim Strength:** Broader the claim scope higher is the chances of infringement and market coverage in terms of features. Claim strength KPI's are Scope of claim, adjacent application area possibility of invalidation.

- **Business Impact:** The business Impact is calculated based on many factors but one of the major factors for ranking patent in this parameter is compounded annual growth rate (CAGR) of a technology and sub technology. Business impact KPI is defined based on market potential of identified infringement cases.

KPI >>	Patent is in use/unused	Scope (broadness) of the independent claim (s)	Adjacent application area (s)	Possibility of invalidation	Number of searched products/ technologies	Market potential of identified infringement cases	Infringement type	Industry	Others	Overall score
Weightage >	10%	8%	xx%	xx%	xx%	xx%	xx%		xx%	xx%
IP clusters	Score	Score	Score	Score	Score	Score	Score		Score	xx
Patent #1	xx	xx	xx	xx	xx	90	90		xx	xx
Patent #2	xx	xx	xx	xx	xx	xx	xx		xx	xx
Patent #3	xx	xx	xx	xx	xx	xx	xx		xx	xx
Patent #4	xx	xx	xx	xx	xx	xx	xx		xx	xx
Patent #5	xx	xx	xx	xx	xx	xx	xx		xx	xx
Patent #6	xx	xx	xx	xx	xx	xx	xx		xx	xx

Figure 6: Patent Monetization KPI's

Module 5: Innovation Management

Innovation management accessed based on potential technology market trends and current & future collaboration opportunities. Further, identifying gaps in the IP portfolio cluster by assessing innovation and market trends Identifying potential companies for collaboration opportunity assessment. Assessment of current and future trends in the industry to assess the growth potential of the technology.

Figure 7. depicts the past potential collaborators of CSTIs where further market trends can be analyzed based on technology cluster.

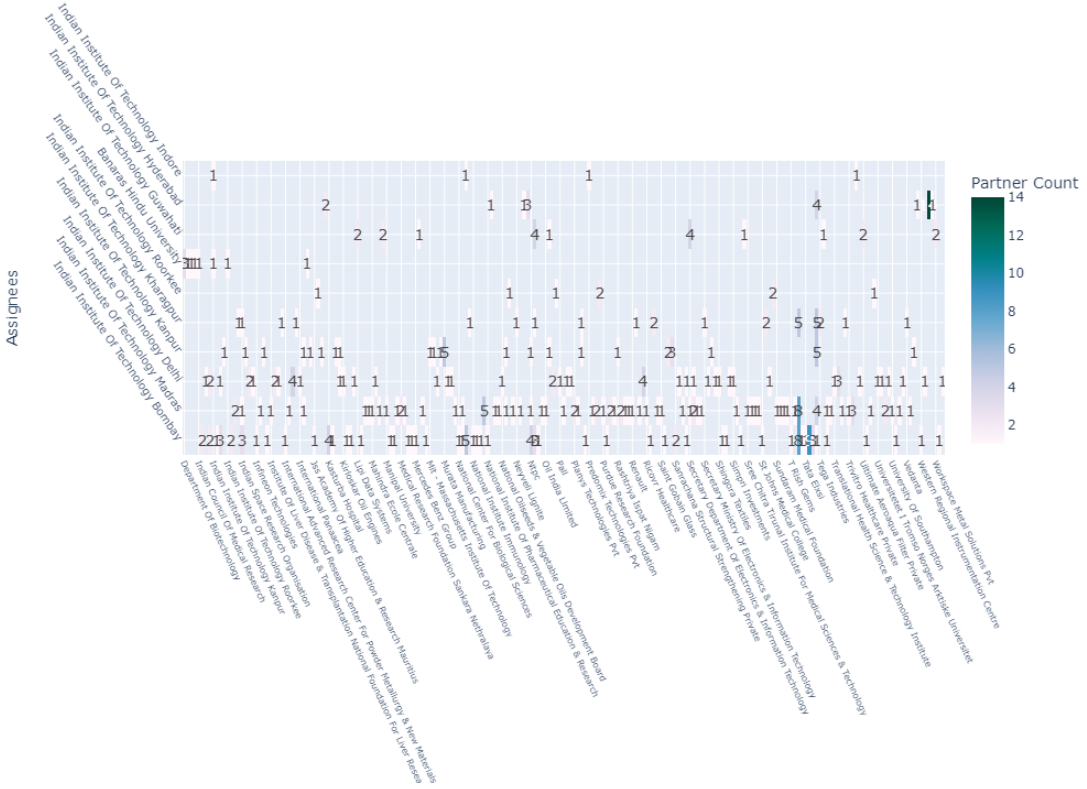

Figure 7: Potential Past Collaborators

Identify the future market/players based on IP Cluster based on below data points in **Figure 8**.

S No.	Company, Headquarter	Technology/ Component	Year	Investment Type	Initiative Details	Intent	Product Segment	Source
1	A	Semiconductor Production	2021	Private Investment	• **"A" announced it would be spending more than 400 million euros in 2022 alone to expand its semiconductor operations** in Dresden & Reutlingen (Germany) and in Penang (Malaysia). • Around 50 million euros of the decided amount is earmarked for the wafer fab in Reutlingen. • It also announced plans to invest 150 million euros in creating additional clean-room space within the existing facility at Reutlingen from 2021 to 2023.	• To combat the ongoing global chip shortage circumstances. • To meet the continuously growing demand for chips used in mobility and IoT applications.	Application-specific integrated circuits (ASICs), **Microelectromechanical Systems (MEMS sensors),** and Power Semiconductors	Link
2	B & Mercedes-Benz, Stuttgart, Germany	Automated Driverless Parking	2022	Collaboration	• **"A"** and Mercedes-Benz have received approval for a fully automated self-parking software that enables cars to self-drive into a pre-booked parking spot at a Stuttgart Airport parking lot. • It relies on the interplay between the intelligent infrastructure supplied by "A" installed in the parking garage and Mercedes-Benz automotive technology. • **The sensors designed by "A" in the parking garage monitor the driving corridor and its surroundings and deliver the information needed to guide the vehicle.**	• Car owners can book a parking spot ahead of time via an app and leave their vehicle in a drop-off area. • As soon as they walk out, the car will drive to its spot and can be called back again via the app.	Automated Valet Parking System	Link

Figure 8: Market/Players Identification Strategies based on Technology Cluster

Further, based on technology investment type a detailed identification of organic and inorganic growth strategies of IP cluster is identified in **Figure 9.**

Investment Type various Players for a IP cluster

Organic Growth Strategy				Inorganic Growth Strategy				Year	Initiative Details	Source
Product launch	Product development	Expansion	Investment	Acquisition	Partnership	Joint Venture	Collaboration			
-	-	-	-	-	Partnership with its subsidiary	-	-	2022	• **"A"** has developed a **surround sensing and collision warning system** for precisely maneuvering construction vehicles. • **It is taking the support of its subsidiary to deliver the off-highway robotics controller (ORC).** • **The modular sensor system comprises a range of ultrasonic**, radio detection & ranging (radar), and multicamera systems.	Link

Figure 9: Investment Identification Strategies based on Technology Cluster

5. Discussion & Conclusion:

The strategic patent commercialization model can be applied in developing countries like India, where the innovation index is rising due to steady increases in R&D investments. This model allows academic IPR offices to systematically identify valuable patents, referred to as "diamond patents," while also finding potential global collaborators. Additionally, the model helps save funds by identifying and abandoning obsolete patents, thus reducing maintenance costs. It also assesses whether the technology is globally relevant or addresses local needs. Consequently, this model can assist other developing nations in commercializing patents through a comprehensive strategic process based on below outcome.

1. The gaps in CSTIs' patent portfolio have been identified through various bibliographic analyses.
2. The patent portfolio has been examined across multiple parameters, with one challenge being the fragmentation of the portfolio into distinct technology clusters, which was accomplished using an AI-based tool.
3. A methodology has been developed to rank each technology cluster, utilizing KPIs to assess the strength of each cluster.
4. Quantitative analysis is employed to pinpoint "diamond" patents within the technology clusters.
5. To reduce risk, a patent validation approach is applied to relevant technology clusters to prevent invalidation during the monetization process for licensees.
6. A qualitative approach is used after the technology clusters pass the risk mitigation stage, enabling the creation of evidence of use charts for potential technology transfers.
7. Potential patents for effective technology transfer are identified based on market research, forward citations, and other indicators.

Limitation

The proposed model lacks sufficient insights on patent opposition and litigation due to the infrequent updates of commercially available databases. If such data were more accessible, it would provide more accurate insights, as patent litigation and opposition play a significant role in patent commercialization. Additionally, key performance indicators could be periodically introduced to improve the effectiveness of patent ranking.

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