

IPR Commercialization in Higher Education Institutions: A Systematic Literature Review Using the ADO-TCM Framework

Mayur N. Kalasariya

Ph.D. Research Scholar

Gujarat Technological University (GTU), Gujarat, India

Email: mayurkalasariya555@gmail.com

Mobile: +91 89057 60256

Dr. Kaushal A. Bhatt

Associate Professor

Gujarat Technological University (GTU), Gujarat, India

Email: kaushal.bhatt@gtu.edu.in

Mobile: +91 98797 39171



Abstract:

Intellectual Property Rights (IPR) commercialization has emerged as a critical mechanism for transforming research outcomes into marketable innovations, fostering economic growth, enhancing university–industry collaboration, and promoting entrepreneurial ecosystems. Although higher education institutions (HEIs) worldwide have significantly increased their intellectual property generation, the successful commercialization of these innovations remains a persistent challenge. Despite the growing body of research, there is still a lack of a comprehensive and structured review that synthesizes the factors influencing IPR commercialization in HEIs. This study addresses this research gap by conducting a framework-based systematic literature review using the Antecedents–Decisions–Outcomes and Theory–Context–Method (ADO-TCM) framework from a global perspective. The review synthesizes two decades of literature (2004–2024) on IPR commercialization in HEIs. A total of 60 studies were systematically reviewed following the PRISMA guidelines and analyzed using the ADO-TCM framework. This review provides a comprehensive synthesis of the existing knowledge by identifying the key antecedents, decision mechanisms, and outcomes associated with IPR commercialization in HEIs. Furthermore, the study examines the theoretical foundations, research contexts, and methodological approaches employed in prior studies, offering a holistic understanding of the field. Finally, the review identifies emerging research trends, highlights existing knowledge gaps, and proposes future research directions to strengthen technology transfer, university–industry collaboration, and the commercialization of intellectual property in higher education institutions.

Introduction:

In the contemporary knowledge-based economy, higher education institutions (HEIs) have evolved beyond their traditional roles of teaching and research to become key contributors to innovation, economic growth, and societal development (Etzkowitz & Leydesdorff, 2000; Wright et al., 2004; Huang & Andrés, 2023). Historically, universities primarily functioned as centers for education and scientific knowledge creation. However, following World War II and particularly after the enactment of the Bayh–Dole Act (1980) in the United States, universities increasingly assumed an entrepreneurial role by actively transferring research outcomes to industry and society through technology commercialization (Bozeman, 2000; Siegel et al., 2003; O'Shea et al., 2005). Today, HEIs are recognized as central actors within national innovation systems, fostering technological advancement, entrepreneurship, and regional competitiveness (Etzkowitz & Leydesdorff, 2000; Ranga & Etzkowitz, 2013).

This transformation has given rise to the concept of the entrepreneurial university, where the creation, protection, and commercialization of intellectual property have become integral institutional missions alongside teaching and research (Rothermel et al., 2007; Guerrero et al., 2016). Universities are now expected not only to generate knowledge but also to convert research outputs into commercially viable technologies, products, and services that contribute to economic and social development (Wright et al., 2004; Perkmann et al., 2013). Consequently, technology transfer (TT), innovation management, and intellectual property rights (IPR) commercialization have become strategic priorities for universities worldwide (Siegel et al., 2004; WIPO, 2022).

Intellectual Property Rights (IPRs) provide the legal foundation for protecting innovation by granting inventors exclusive rights over their creations, thereby encouraging investment in research and technological development (WIPO, 2022; Sharif et al., 2018). Within higher education institutions, IPRs not only safeguard academic discoveries but also facilitate the transformation of research outcomes into economic and societal value (Roy & Choudhury, 2018). IPR commercialization refers to the process of converting intellectual assets—including patents, copyrights, industrial designs, software, and research outputs—into marketable products, technologies, or services through mechanisms such as licensing, technology transfer, collaborative research, consultancy, startup creation, and university spin-offs (Bozeman, 2000; O'Shea et al., 2005). Beyond revenue generation, successful commercialization strengthens university–industry collaboration, promotes innovation diffusion, creates employment opportunities, enhances institutional reputation, and contributes to national economic development (Wright et al., 2004; Perkmann et al., 2013; WIPO, 2022).

The commercialization of intellectual property has become a cornerstone of knowledge-driven economic development. Efficient commercialization systems encourage innovation, attract investment, strengthen industrial competitiveness, and enable nations to capitalize on their intellectual assets (Bozeman, 2000; WIPO, 2022). Consequently, many countries have introduced policies to strengthen university innovation ecosystems. The United States established a mature technology transfer ecosystem through the Bayh–Dole Act, while China transformed its universities into major contributors to the national innovation system through sustained investments in research capability and commercialization infrastructure (Wu, 2010). Similarly, European and South Korean universities have strengthened commercialization through dedicated Technology Transfer Offices (TTOs), innovation parks, incubators, and university–industry partnerships (da Silva et al., 2017; Ko et al., 2021).

Despite possessing the world's third-largest higher education system, India continues to face significant challenges in commercializing university-generated intellectual property (Kumar & Jain, 2003; Roy & Choudhury, 2018). Indian universities have traditionally focused on teaching and scholarly publications, with comparatively limited emphasis on translating research into commercial products and technologies (Chaudhary & Roy, 2018). Factors such as weak institutional IP policies, limited entrepreneurial culture, inadequate university–industry collaboration, insufficient commercialization funding, and underdeveloped Technology Transfer Offices continue to constrain commercialization activities (Abrol, 2020; Subramaniam et al., 2021). Although national initiatives such as the National IPR Policy, Startup India, Atal Innovation Mission, and university incubation programmes have strengthened the innovation ecosystem, commercialization outcomes remain relatively modest compared with leading innovation economies (Ravi & Janodia, 2021; WIPO, 2022).

Over the past two decades, research on university technology transfer and IPR commercialization has expanded considerably across disciplines including innovation management, entrepreneurship, strategic management, public policy, and intellectual property management (Siegel et al., 2004; Perkmann et al., 2013). Existing studies have examined Technology Transfer Office performance, university–industry collaboration, commercialization strategies, entrepreneurial universities, innovation ecosystems, and policy frameworks (Markman et al., 2005; Finardi & Breznitz, 2017; Shibayama et al., 2020). However, the literature remains fragmented, with limited integration of the antecedents influencing commercialization, the strategic decisions adopted by universities, and the outcomes of commercialization activities. Furthermore, previous reviews have generally concentrated on specific countries, technologies, or institutional contexts, leaving the field without a comprehensive synthesis grounded in a robust theoretical framework.

To address this research gap, this study conducts a systematic literature review of 60 peer-reviewed studies published between 2004 and 2024, following the PRISMA guidelines. The selected studies were analysed using the Antecedents–Decisions–Outcomes and Theory–Context–Method (ADO–TCM) framework. The review identifies the key antecedents influencing IPR commercialization, examines strategic commercialization decisions adopted by higher education institutions, analyses commercialization outcomes, and maps the dominant theories, research contexts, and methodological approaches employed in prior studies. Finally, the study identifies emerging research trends, highlights existing knowledge gaps, and proposes future research directions to strengthen technology transfer and intellectual property commercialization in higher education institutions.

Methodology

Systematic Review Design

This research utilized a systematic literature review (SLR) approach following the PRISMA guidelines (Mohr et al., 2009) and organized according to the ADO-TCM framework, which combines the ADO (Antecedents-Decisions-Consequences) model introduced by Paul and Benito (2018) with the TCM (Principles-References-Methods) model created by Paul et al. (2017). The methodology was crafted based on the stepwise instructions from Paul et al. (2021) to promote clarity, transparency, and reproducibility. To adhere to contemporary academic standards, recent uses of the ADO-TCM framework in SLRs were also taken into account (Lim et al., 2021; Paul and Bhukya, 2021).

Inclusion and Exclusion Criteria

The criteria for study eligibility were evaluated using specified inclusion and exclusion parameters to maintain uniformity and thoroughness. Only empirical research—whether quantitative, qualitative, or employing mixed methods—pertaining to the commercialization of intellectual property (IP) and technology transfer was included. Opinion articles, editorial pieces, and book sections were not considered. The review concentrated on literature published between 2000 and 2024, written in English, and accessible in full text.

Literature sources and search strategy

The sources were located through keyword searches across three primary databases: Web of Science, Scopus, and Google Scholar. The search terms employed included: (“IPR commercialization” or “technology transfer”) and (“university” or “higher education” or “HEIs”). As depicted in Figure 1, the initial search yielded 16,900 records. Following the elimination of duplicates and a review of titles and abstracts, 119 articles remained for further consideration. After a thorough review of the full texts, 60 studies satisfied the inclusion criteria and were chosen for the final analysis.

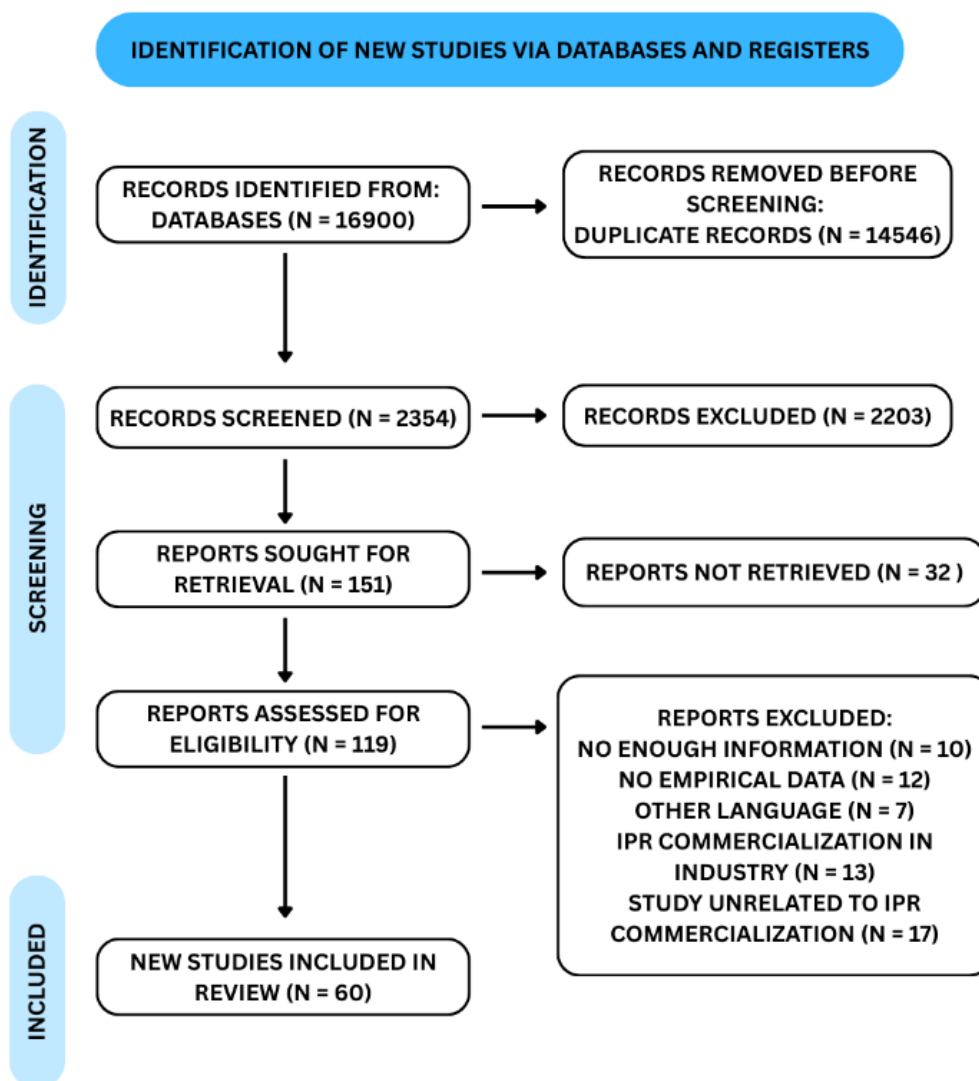
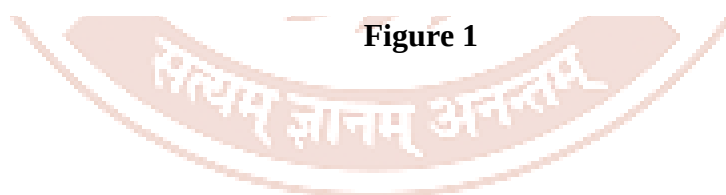


Figure 1



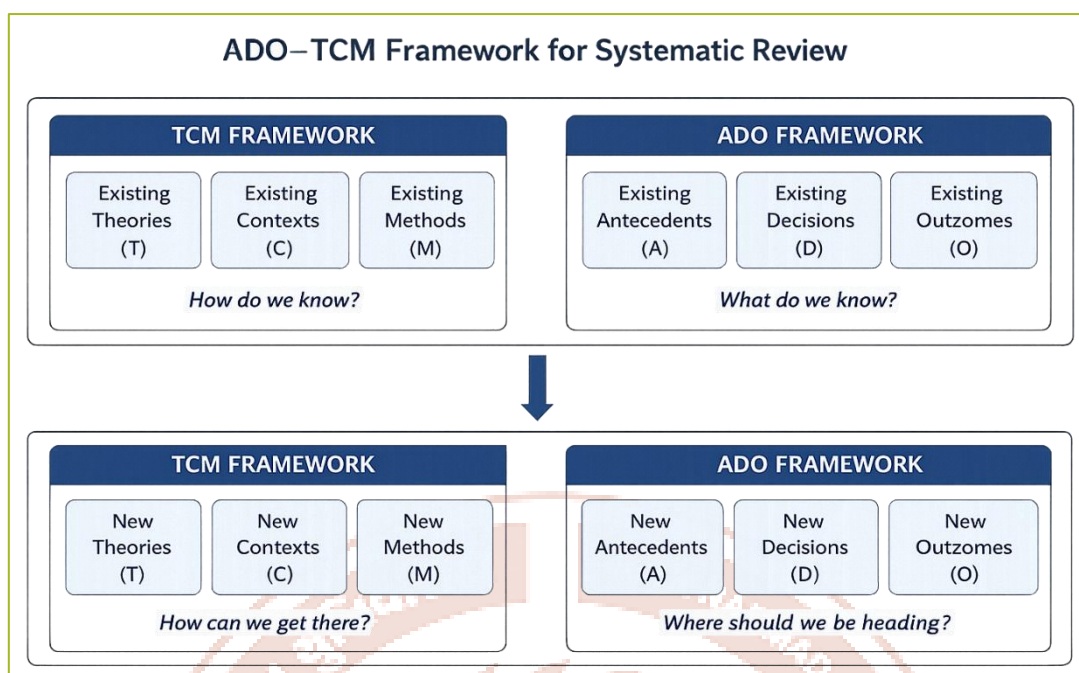


Figure 2

This section emphasizes a review of earlier studies utilizing the TCM-ADO framework established by Paul et al. (2017) and Paul and Benito (2018), illustrated in Figure 2. To organize and analyze the combined literature, this research employed the comprehensive TCM-ADO analytical framework. The TCM aspect—which encompasses theory, context, and methodology—was utilized to categorize the fundamental paradigms, institutional and regulatory contexts, and research approaches found in the chosen studies. Concurrently, the ADO aspect—which includes antecedents, decisions, and outcomes—facilitates a process-oriented examination of the elements affecting IPR commercialization within higher education institutions (HEIs).

Bibliometric Analysis:

Distribution of reviewed articles by year of publication

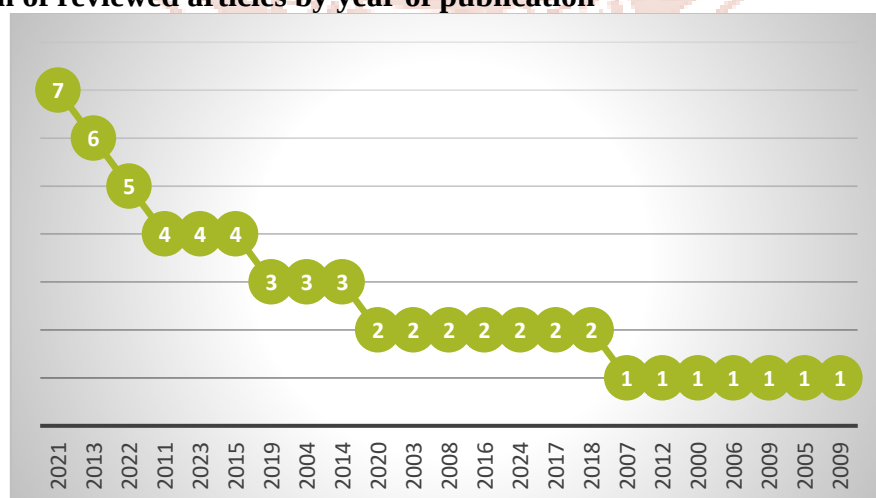


Figure: 3

Figure 3 indicates that most of the 60 articles examined were published from 2011 to 2023, with notable spikes in publications occurring in 2013, 2021, and 2022. This trend demonstrates the increasing and continued scholarly focus on technology transfer and the commercialization of intellectual property during the last ten years.

Top authors based on H-index in reviewed articles

Table 1 displays the top authors arranged by their H-index, indicating their output and citation impact. Mike Wright and David B. Audretsch stand out as the most significant researchers, with Donald Siegel and Abid Halim following closely behind. The notable number of authors with H-indexes exceeding 90 underscores the considerable academic impact in the fields of technology transfer and collaboration between universities and industries.

Sr no	Paper	Author	H index
1	Entrepreneurship and University Technology Transfer	Mike Wright,	173
2	Technology Transfer in a Global Economy	David B. Audretsch	171
3	Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices	Donald Siegel	117
4	Identification and evaluation of critical factors to technology transfer using AHP approach	Abid Haleem	108
5	Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices	David Waldman	93
6	Identification and evaluation of critical factors to technology transfer using AHP approach	Sunil Luthra	91
7	Identification and evaluation of critical factors to technology transfer using AHP approach	Sachin Kumar Mangla	90
8	University Technology Transfer in China: A Literature Review and Taxonomy	Martin Kenney	83
9	Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices	Albert N. Link	82
10	Entrepreneurial Universities and Technology Transfer: A Conceptual Framework for Understanding Knowledge-Based Economic Development	Maryann P. Feldman	75

Table:1

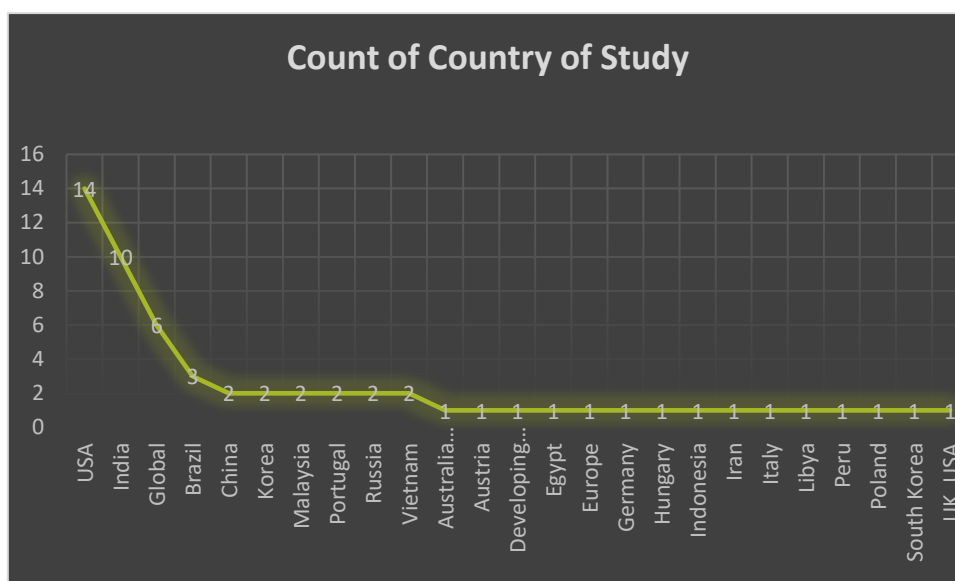


Figure: 4

Antecedents

The commercialization of intellectual property rights (IPR) within higher education institutions (HEIs) is influenced by a range of interconnected factors that collectively impact the efficiency of technology transfer. Policy frameworks serve as the institutional basis for commercialization; significant legislation like the Bayh-Dole Act (1980) has resulted in a notable rise in university patenting and licensing within the US, whereas comparable developments in emerging economies have been hindered by inadequate enforcement and limited connections with industry (Bozman, 2000; Siegel et al., 2003; Kumar and Jain, 2003; Finardi and Breznitz, 2017). Institutional preparedness, evident in well-defined IP ownership, benefit-sharing policies, and conflict of interest regulations, is vital for effective IPR commercialization and enhanced faculty involvement (Siegel et al., 2003; Chaudhary and Roy, 2018). In India, national IPR reforms have positively influenced licensing and academic entrepreneurship, despite ongoing implementation challenges (Roy and Choudhary, 2018). Research motivation, stemming from both intrinsic factors (social influence, recognition) and extrinsic incentives (financial gain, career progression), also affects commercialization results, with entrepreneurial university settings promoting increased faculty participation (Markman et al., 2005; Rothmel et al., 2007). The effectiveness and development of technology transfer offices (TTOs) – encompassing personnel, legal knowledge, independence, and funding – are crucial for promoting licensing and the establishment of spin-offs. Conversely, ineffective or overly bureaucratic TTOs hinder commercialization, especially in developing regions (Siegel et al., 2004; Kenny and Patton, 2009; Ko et al., 2021). A focus on market needs and collaboration with industries, bolstered by funding for proof of concept and prototyping,

enhances the market readiness of academic innovations; however, the absence of such resources poses a significant challenge in places like India (Perkman et al., 2013; Subramaniam et al., 2021; Abrol, 2020). Lastly, the maturity of the ecosystem, the attributes of the workforce, and the rise of new technologies all affect the commercialization of intellectual property rights (IPR). Robust innovation ecosystems nurture trust-based alliances between academia and industry, while disjointed systems impede the translation of knowledge (Etzkowitz and Leydesdorf, 2000; Ranga and Etzkowitz, 2013). Additionally, human elements like the ability to recognize opportunities and risk appetite, combined with cross-disciplinary knowledge, further influence faculty involvement, while the demands of Industry 4.0 technologies require flexible IP strategies and organizational capacities (Sharif et al., 2018; Heugel et al., 2023; Alkhazaleh et al., 2022).

Decisions

Decisions regarding the commercialization of intellectual property rights (IPR) involve strategic selections made by universities, technology transfer offices (TTOs), faculty inventors, and policymakers that influence the pathways and results of commercialization. Significant choices encompass intellectual property ownership, licensing frameworks, and royalty distribution models, which directly affect legal clarity and researcher encouragement. Bayh-Dole-type systems allocate IP ownership to universities, while Indian frameworks that provide 30–50% royalties to inventors have boosted faculty involvement (Bozeman, 2000; Siegel et al., 2003; Roy and Choudhury, 2018). Higher education institutions must also determine which inventions to commercialize by considering factors such as patentability, market viability, and technological readiness, with increasingly structured evaluation approaches used to minimize resource misallocation (Markman et al., 2005; Shibayama et al., 2020). The selection of a commercialization approach—be it licensing, joint ventures, or spin-off development—reveals a balance between risk, control, and impact, with licensing being favored for groundbreaking technologies and startups preferred for gradual innovations (Rothermel et al., 2007; Odresch and Lehmann, 2005). Decisions made about the design and independence of Technology Transfer Offices (TTOs), partnerships with industries and ecosystems, and the distribution of translational funding play a crucial role in enhancing the efficiency of commercialization, especially when navigating the challenging transition from discovery to market introduction (O’Shea et al., 2005; Abrol, 2020). Moreover, the selections made concerning faculty rewards, evaluation standards, and international intellectual property strategies have a significant impact on long-term commercialization practices and their compliance with both national and global regulatory standards (Wright et al., 2004; Siegel et al., 2003; WIPO, 2022).

Outcomes

The outcome measures of the ADO-TCM framework assess both the measurable and unmeasurable results of intellectual property rights (IPR) commercialization in universities and public research institutions. Research indicates that higher education institutions (HEIs) with well-defined IPR policies, incentive structures, and effective Technology Transfer Offices (TTOs) tend to achieve greater levels of discovery disclosure, patent applications, and licensing efforts (Siegel et al., 2003; Subramanian et al., 2021). Nevertheless, revenue from licensing remains highly inconsistent; only a small fraction of patents yield significant income, while most institutions see modest financial gains (Roy & Choudhury, 2018). Additionally, commercialization approaches play a role in the establishment of startups and spin-offs, thereby enhancing national and regional innovation ecosystems. However, long-term viability is reliant on access to funding after incubation and market support (Siegel et al., 2004; Ravi & Janodia, 2021). Robust partnerships with industry and formal technology transfer agreements enhance the significance of innovations and promote regional spillovers, as evident in established ecosystems in the US, EU, and South Korea (O'Shea et al., 2005; da Silva et al., 2017). In addition to economic indicators, successful intellectual property commercialization yields wider social and organizational benefits. These include impacting policy, spreading technologies focused on specific missions like healthcare and clean energy, enhancing international recognition, and fostering an entrepreneurial spirit within higher education institutions (Ebrol, 2020; Gupta and Ebrol, 2015; Wright et al., 2004).

Theory

The commercialization of intellectual property (IP) and technology transfer (TT) in higher education institutions (HEIs) is supported by a multidisciplinary body of theories that reflects the complexity of university innovation ecosystems. Since commercialization involves interactions among universities, industries, governments, researchers, and society, no single theory sufficiently explains the entire process. Instead, researchers adopt complementary perspectives from innovation management, strategic management, economics, and organizational theory to explain the antecedents, strategic decisions, and outcomes of IPR commercialization (Bozeman, 2000; Siegel et al., 2004). The ADO-TCM analysis indicates that these theoretical foundations provide a comprehensive understanding of commercialization across different institutional and national contexts. Among the most widely adopted theories is the Triple Helix Theory, which explains commercialization as the outcome of collaborative interactions among universities, industry, and government (Etzkowit & Leydesdorff, 2000). The Quadruple and Quintuple Helix models further extend this perspective

by incorporating civil society and environmental sustainability into the innovation ecosystem (Huang & Andrés, 2023). Similarly, the Resource-Based View (RBV) and Dynamic Capability Theory emphasize that institutional resources, faculty expertise, intellectual property portfolios, collaborative networks, and Technology Transfer Office (TTO) capabilities are critical strategic assets that enable universities to achieve sustainable commercialization and competitive advantage (Wright et al., 2004; Markman et al., 2005). Knowledge-oriented theories also play a significant role in explaining commercialization. Knowledge Spillover Theory, Knowledge Transfer Theory, and Innovation Diffusion Theory describe how scientific knowledge created within universities is transferred, adopted, and commercialized through collaboration with industry and other stakeholders (Siegel et al., 2004; Talley, 2019). In addition, Institutional Theory and Contingency Theory suggest that commercialization success depends on supportive regulatory environments, governance structures, institutional capabilities, and country-specific contexts rather than on technological excellence alone (Bozeman, 2000; Finardi & Breznitz, 2017). These perspectives explain why commercialization outcomes vary considerably across institutions and nations. Recent studies increasingly integrate the Entrepreneurial University, Open Innovation, and National Innovation Systems (NIS) perspectives to explain the evolving role of universities in innovation ecosystems. These theories emphasize entrepreneurship, external collaboration, knowledge exchange, and coordinated interactions among universities, industry, government, and other stakeholders to enhance commercialization performance (Chesbrough, 2003; Rothermel et al., 2007; Lundvall, 1992). Overall, the literature demonstrates that IPR commercialization is inherently multidisciplinary, with the Triple Helix Theory, Resource-Based View, Dynamic Capability Theory, and Entrepreneurial University Theory emerging as the dominant theoretical lenses. Together, these theories provide a robust conceptual foundation for understanding the antecedents, strategic decisions, and outcomes of IPR commercialization within the ADO–TCM framework.

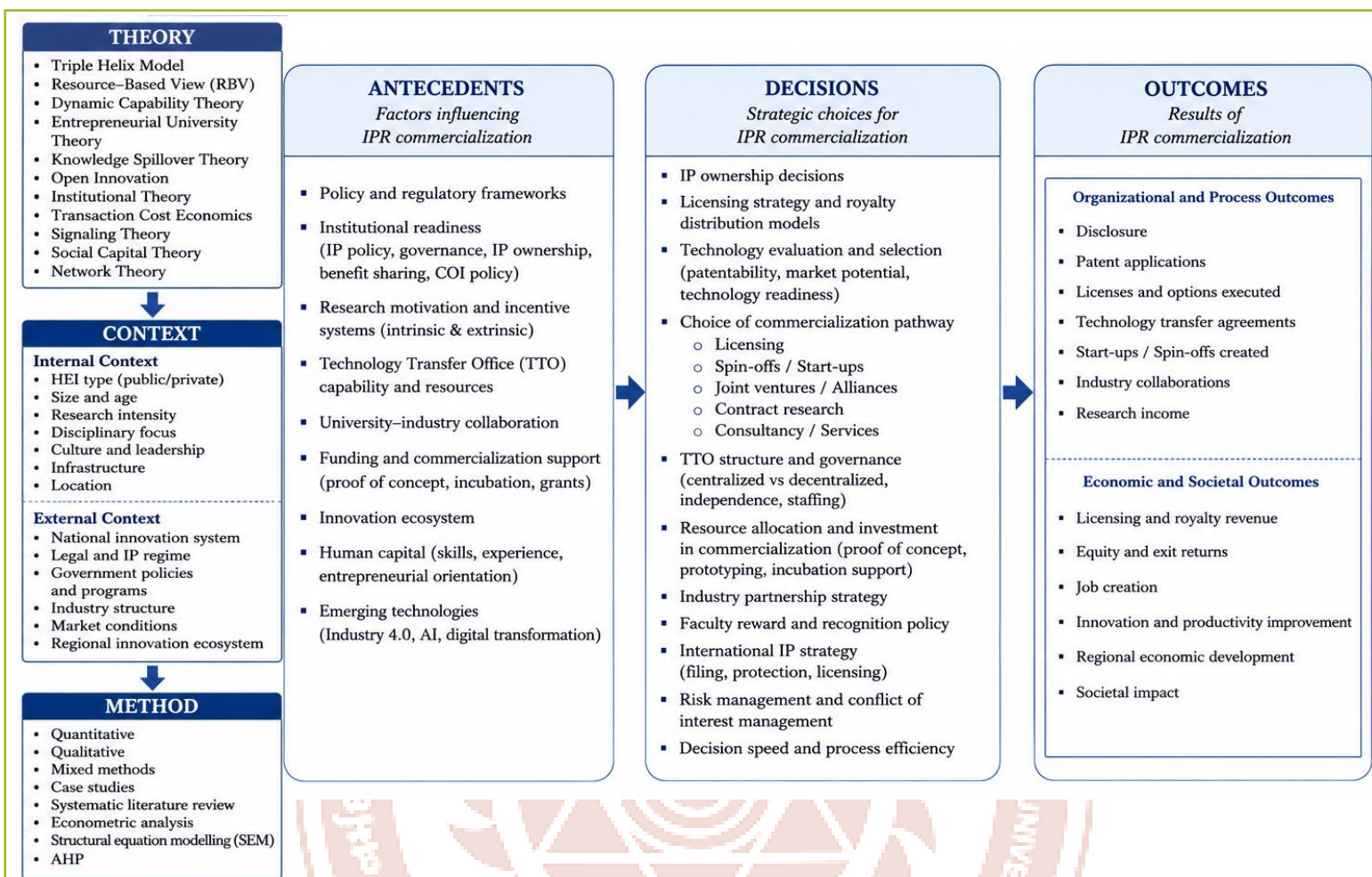


Figure: 5

Conclusion

Figure 5 summarizes the findings of this systematic literature review using the ADO–TCM framework, demonstrating that IPR commercialization in higher education institutions (HEIs) is a complex and context-dependent process. The review reveals that successful commercialization is driven by strong institutional policies, effective Technology Transfer Offices (TTOs), university–industry collaboration, commercialization funding, entrepreneurial capabilities, and supportive innovation ecosystems. Strategic decisions regarding IP ownership, licensing, commercialization pathways, and resource allocation play a crucial role in translating research outcomes into marketable innovations. The review further indicates that successful IPR commercialization generates outcomes beyond licensing revenue, including startup creation, technology transfer, enhanced university–industry collaboration, regional innovation, and societal impact. Overall, the findings suggest that effective commercialization requires an integrated innovation ecosystem where institutional capabilities, strategic decision-

making, and supportive policy environments work together. The study also provides a comprehensive foundation for future research and offers valuable insights for policymakers, university administrators, and Technology Transfer Offices to strengthen IPR commercialization in HEIs.

Study Results

This research carries important consequences for parties engaged in intellectual property (IP) commercialization within higher education institutions (HEIs). For policymakers and university leaders, the results underscore the necessity for a framework that is tailored to specific contexts, backed by robust institutional structures. This includes independent technology transfer offices (TTOs), well-defined policies for incentives and benefit sharing, as well as focused funding for early-stage projects to successfully connect research with commercialization.

Contributions to the Study, Innovation, and Future Research

This research is significant as it is the first to utilize the ADO-TCM framework for the commercialization of intellectual property in higher education institutions, offering a unified and context-aware perspective that goes beyond literature centered around the United States. It enhances theoretical understanding by integrating various innovation and institutional viewpoints, while also providing actionable insights for improving technology transfer, especially in developing economies. Future studies should aim to empirically validate these findings, include more industry-specific and individual factors, and examine how new technologies and policy shifts affect commercialization results.

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