Volume 79, December 2024, 102306

World Patent Information

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World Patent Information 79 (2024) 102306

Contents lists available at ScienceDirect

World Patent Information

journal homepage: www.elsevier.com/locate/worpatin

Strategic portfolio management of university-owned patents for commercializing inventions☆

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ARTICLE INFO

Keywords:
University patents
Sustainable patent portfolio management
Evaluation
Invention
Commercialization

ABSTRACT

In the contemporary knowledge-driven economy, universities are pivotal in generating intellectual property through research. Efficiently managing and commercializing the resulting patents are critical for fostering innovation and economic growth. This article presents a comprehensive framework for the strategic portfolio management of university-owned patents, focusing on effective patent selection and periodic evaluation through a structured scoring system. Drawing inspiration from international experiences such as the Bayh-Dole Act, the framework incorporates scoring scales that evaluate novelty, inventive step, commercialization potential, and inventor team status. The process guides universities in selecting patents for their portfolio and periodically reevaluating their relevance. This systematic approach aims to optimize patent commercialization efforts, enhance innovation transfer, and align universities' patent portfolios with their strategic goals. However, the framework is not without limitations, including subjectivity in scoring and evolving market dynamics. Future research directions could address these limitations and further refine the framework to maximize the impact of university-owned patents in driving innovation and economic progress.

1. Introduction

Numerous inventions made by academics are granted patents where academics' universities are registered as applicants. The number of such patents vary by country. The US usually tops such a list. For example, Massachusetts Institute of Technology's (MIT) active patents are more than 3500 are of 2021 [1]. In comparison, the total patent portfolio originating from Turkish universities until May 2023 contains a little over 6100 published patents.[1] (see Tables 1–14

A closer examination of these 6100 patents is noteworthy. First, over 97 % of the patent portfolio owned by Turkish universities consists of applications filed in 2012 and beyond. Moreover, approximately 80 % of this patent portfolio comprises applications filed in 2017 and later. As can be seen, 2012 and 2017 were two turning points. In 2012, TUBITAK (Scientific and Technological Research Council of Türkiye) implemented a policy related to technology transfer offices (TTOs) and launched the 1513 Technology Transfer Offices Support Program. This program aimed to support TTOs and facilitate the commercialization of knowledge and technologies generated within universities and technology development regions. This was done to ultimately create economic, social, and cultural value [3]. As a result of TÜBITAK's TTO support program, many universities established TTOs on their respective campuses, regardless of whether they received direct program support [4]. Another pivotal moment occurred in 2017 with the enactment of Law No. 6769 on Industrial Property in Turkey, which granted universities the right to claim ownership of inventions originating within their premises.

Fig. 1 presents the distribution of patent applications owned by universities in Turkey throughout the years. It is evident from the chart that there was a notable increase in university-owned patent applications in Turkey after 2012, coinciding with the establishment of TTOs. However, it was in 2017, with the enactment of Law No. 6769 on

☆ The IP Evaluation Board assesses the inventions based on the scoring scales mentioned above. The IP Evaluation Board is composed of both academicians and sector representatives. The IP Evaluation Board typically consists of a minimum of 3 members and can extend up to 7 members, all possessing expertise in the technical field relevant to the invention disclosure. Each of these Board members individually assigns scores out of 10 for scoring scales, which encompass novelty, inventive step, commercialization potential, and the capabilities of the inventor team.

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[1] The data on the number of university-owned patents in Turkey was obtained by searching the TÜRKPATENT Patent Search Web Page using the keyword '*üniversitesi*' (which means … university) in the Applicant line.

https://doi.org/10.1016/j.wpi.2024.102306
Received 1 September 2023; Received in revised form 30 August 2024; Accepted 5 September 2024
Available online 19 September 2024

Table 1
Global trends in university patent ownership legislation [2].

Policy and legal changes	Country	Change Date	Trend
Abolishment of the professor's privilege, to increase scientists' incentives to disclose inventions to university managers	Denmark	2000	Universities assign a share of the patent licensing revenue to the inventor and pay all the costs associated with the patent application
	Germany	2002	
	Austria	2002	
	Norway	2003	
	Finland	2007	
Stronger enforcement of institutional ownership system already in place	United Kingdom	1997	Harmonisation, measures to encourage intellectual property awareness, commercialization, and creation of technology transfer offices
	Spain	1986	
	France	1999	
	Switzerland	1991	
	Belgium	1997	
	Portugal	1998	

Table 2
Novelty scoring scale.

NOVELTY	
Score	Score Definition
1–2	In the prior art, there exist one or more solutions that are exactly similar to the invention.
3–4	There are substantially similar solution(s) in the prior art.
5–6	In the prior art, there are similar solutions/solutions in terms of basic features of the invention, but the invention includes features that can be considered new.
7–8	The invention includes new solutions/features in many aspects according to the prior art.
9–10	The invention includes solutions/features that are revolutionary in their differences from the prior art.

Table 3
Inventive step/Non-obviousness Scoring Scale.

INVENTIVE STEP/NON-OBVIOUSNESS	
Score	Score Definition
1–2	The solution proposed in the invention disclosure can be achieved obviously by using known technologies or by combining known technologies without any creativity.
3–4	The solution proposed in the invention disclosure can obviously be achieved with modifications to known technologies, that do not provide a significant benefit.
5–6	The solution proposed in the invention disclosure includes features that provide little benefit over known technologies and are not obvious.
7–8	The solution proposed in the invention disclosure provides surprising benefits over known technologies and requires significant creativity.
9–10	The invention contains solutions that require creativity to problems that cannot be solved for a long time at the state-of-the-art or beyond cutting-edge technologies.

Industrial Property, that this upward trend gained significant momentum.

Similar to the Bayh-Dole Act (also known as the University and Small Business Patent Procedures Act of 1980) in the US, Turkish Law No. 6769 grants universities the right to claim ownership of inventions created using their resources. The Bayh-Dole Act established a default rule that allowed non-profit organizations (including universities) and small businesses to own, patents on inventions resulting from research sponsored by the federal government. However, the primary goal, as reflected in the policy and objective part of the Act, was not to benefit universities but to promote the commercial development and utilization of federally funded inventions [5,6].

Table 4
Commercialization potential scoring scale.

COMMERCIALIZATION POTENTIAL	
Score	Score Definition
1–2	The invention disclosure contains solution(s) that cannot be turned into a commercial product.
3–4	The invention disclosure includes solutions that are lengthy and costly to turn into a commercial product/method, and that do not meet the industry's needs even if they turn into a commercial product/method.
5–6	The invention disclosure includes solutions that are lengthy and costly to turn into a commercial product/method, but which may attract the attention of the industry when they become a commercial product/method.
7–8	The invention disclosure includes solutions that require a relatively short and low-cost process to turn into a commercial product/method and may attract industry attention when they become a commercial product/method.
9–10	The invention disclosure includes solutions with high technology readiness level (TRL 8 - TRL 9) that will meet the important needs of industry when they become a commercial product/method.

Table 5
Inventor team scoring scale.

INVENTOR TEAM	
Score	Score Definition
1–2	The inventor team consists of students who will graduate soon and will work in professions other than invention field.
3–4	The inventor team consists of academics and students working together for the first time.
5–6	The inventor team consists of academics and students who have been doing some researches in the field of invention for a while but are working together for the first time.
7–8	The inventor team consists of academics and students who have been doing some researches in the field of invention for a long time and are working together for a maximum of 2 years.
9–10	The inventor team consists of academics and students who have been researching in the field of invention for a long time and have been working together for at least 2 years.

The widespread adoption of policies akin to the Bayh-Dole Act has ignited a global shift, enabling universities to own, manage, and commercialize patents (inventions) derived from government or university-funded research. This model has prompted countries worldwide to reevaluate their intellectual property management approaches within academic institutions, signalling a universal shift towards enhancing academic research commercialization [7].

In Europe, the movement towards more homogeneous IP regimes in the early 2000s reflects this global trend. The abolishment of the professor's privilege in several countries, permitting universities to own and manage patents, signifies a major shift towards institutional ownership. This change mirrors the Bayh-Dole Act's intent to foster innovation and technology transfer through strategic IP management. Countries such as Denmark, Germany, Austria, Norway, and Finland have enacted reforms to support the strategic management of university patents, acknowledging the significant value of academic research and the crucial need for its commercial exploitation [2].

This trend extends beyond Europe, with nations like Japan adopting similar frameworks to boost the commercial output of university-based research, further demonstrating the impact of university-industry technology transfer and strategic IP management. The implementation of such policies across various regions highlights the growing recognition of academic research's value and the necessity of its commercial exploitation to drive innovation and economic growth [7].

In recent decades, a significant shift has been observed globally in the legal framework governing intellectual property (IP) generated within universities, with a particular focus on patent ownership. This evolution is encapsulated in below table summarizing key policy changes across several countries, including Denmark, Germany, Austria, Norway, Finland, the United Kingdom, Spain, France, Switzerland,

Belgium, and Portugal. These changes range from the abolishment of the professor's privilege, enhancing scientists' incentives to disclose inventions to university management, to the strengthening of institutional ownership systems and harmonization measures aimed at bolstering IP awareness, commercialization, and the establishment of Technology Transfer Offices (TTOs).

This table highlights not only the widespread adoption of university-owned patent rules but also underscores the diverse approaches taken by different countries to foster innovation and technology transfer. Together with Turkey, the United States, and Japan, these countries represent a global trend towards enhancing the management and commercialization of university patents. Such policies have crucial implications for the financial sustainability of patent portfolios, emphasizing the need for strategic approaches to cover patent application costs, licensing, and commercialization efforts. The establishment and operation of TTOs in these contexts serve as a cornerstone for bridging the gap between academic invention and market application, ensuring that universities can effectively contribute to technological advancements and economic growth.

These legislative adaptations across a spectrum of countries have significantly contributed to the enlargement of university patent portfolios. With the increase in patents under university ownership, the challenge of managing these extensive portfolios effectively has become more pronounced. This burgeoning need underscores the importance of implementing a robust and user-friendly yet effective scoring system for patent portfolios. Such a system enables universities to evaluate and prioritize their patents based on commercial potential, technological impact, and alignment with strategic objectives. By adopting a structured approach to scoring, universities can navigate the complexities of their expanded portfolios, ensuring that resources are allocated efficiently and that their patent management strategies are optimized for fostering innovation and driving economic development.

In addition to the well-documented examples of the United States, Turkey, and Japan, China emerges as a pivotal case in the global trend towards university-owned patents, showcasing significant legislative efforts aimed at enhancing the commercialization of academic research. The implementation of reforms such as the Three Rights Reform (TRR) and the Mixed Ownership Reform (MOR) at institutions like Southwest Jiaotong University marks China's commitment to fostering an environment where universities can more effectively manage and exploit their patent portfolios. These reforms have introduced novel models of patent ownership allocation, distinctly impacting the landscape of patent commercialization within universities. Specifically, the contrasting outcomes of TRR and MOR in terms of patent licensing and transfers underscore the intricate interplay between policy frameworks and commercialization strategies. This scenario in China reinforces the necessity for strategic patent portfolio management within universities globally, highlighting the varied approaches nations are adopting to navigate the complexities of intellectual property in academia. As we observe China's endeavours to optimize patent commercialization through nuanced legal and institutional reforms, it becomes evident that the strategic management of university-owned patents is a universal challenge, demanding adaptive and forward-thinking strategies to ensure the alignment of academic innovations with market demands [8].

In these laws, licensing, patenting, and commercialization of academic inventions are encouraged and legally supported. In addition, these laws are very important in terms of the commercialization of inventions and emphasizing the importance of this in the development of countries [9]. Echoing the foundational principles that led to the establishment of Technology Transfer Offices (TTOs) and key legislative frameworks such as the Bayh-Dole Act, a wide range of countries around the globe have adopted policies designed to unlock the commercial potential of research conducted in universities.

The approaches and recommendations presented are applicable to a broad range of countries encountering similar challenges in managing university-owned patents. This study contributes to the collective effort to bolster the global innovation ecosystem through strategic patent portfolio management, emphasizing the universal relevance of its insights and recommendations for a diverse array of stakeholders, including universities, policymakers, and innovation managers globally.

Legislation granting universities the right to own inventions reflects a broader trend towards enhancing the commercial potential of academic research. The essence of 'Commercialization' encompasses not only generating sufficient revenue to cover patent portfolio costs but also maintaining the portfolio's quality. This quality is vital for fostering technological advancements and contributing to economic growth, making a strategic approach to managing patent portfolios essential to ensure their long-term vitality and relevance.

The overarching goal of commercialization requires a strategic approach beyond merely generating licensing revenues. Our scoring method, conceived with the realities of TTO operations and crowded patent portfolios in mind, provides a straightforward yet effective framework for evaluating patent quality and commercial potential. This method enables the efficient allocation of TTO resources, giving priority to patents with the most significant potential for impact. By emphasizing quality and strategic fit, our approach highlights the critical role of patent portfolio management in advancing technological innovation and contributing to economic development. Stressing practicality, the scoring method aligns with the operational needs of TTOs, ensuring that university inventions are not only protected but also optimally positioned for commercial success and societal benefit.

To explore the strategic management of university-based inventions, this study addresses the following key questions.

- How can a scoring system enhance the decision-making process for managing university-owned patent portfolios? This question investigates how structured scoring methodologies can be used to systematically evaluate and prioritize patents, ensuring that those with the highest potential for commercial success and strategic alignment are selected for further development.
- What are the benefits and limitations of a structured approach to patent portfolio management in universities? This inquiry examines the strengths and weaknesses of implementing a systematic management framework, focusing on the clarity it brings to patent

Table 6
Novelty (scoring Average).

	NOVELTY (Scoring Average)									
1. Step	1	2	3	4	5	6	7	8	9	10
	Release to inventor(s)									

selection and management, as well as the challenges related to subjective assessments and changing conditions.
- What are the possible pathways for university-based inventions after evaluation, and how are they determined? This question explores the various potential outcomes for inventions post-evaluation based on their assessed potential and strategic fit.
- How does the composition and strength of the inventor team impact the commercialization potential and strategic management of university-owned patents? This question considers the critical role of the inventor team's expertise and commitment in enhancing the commercialization prospects of patents, highlighting the importance of sustained involvement throughout the commercialization process.

By addressing these questions, this study aims to provide a comprehensive approach to how universities can strategically manage their patent portfolios to optimize both academic impact and commercial opportunities.

To develop a comprehensive framework for the strategic portfolio management of university-owned patents, this study adopted an approach on practical observational experience.

The research began with a literature review to explore existing frameworks, models, and practices related to patent management in universities, such as the Bayh-Dole Act and similar international policies. This review helped clarify key criteria for patent evaluation, including novelty, inventive step, commercialization potential, and the expertise of the inventor team. These criteria were selected based on their frequent citation in the literature as critical factors for successful patent commercialization.

In addition to the literature review, the framework was informed by observational experience from applying a scoring system within a university Technology Transfer Office (TTO) over a three-year period. During this time, the scoring system was used to guide patent management decisions, contributing to several licensing agreements. Although these outcomes are not formally documented in academic literature, they provided valuable preliminary insights into the framework's practical applicability and effectiveness. However, it is important to note that further empirical validation is required to rigorously test the framework's effectiveness across different settings.

By integrating insights from both the literature and observational practice, this study developed a structured framework for managing university patent portfolios. The framework is designed to ensure that patent selection and management processes are aligned with strategic goals and optimized for both academic and commercial success.

2. Strategic integration of patent management maturity models with the scoring system

Our developed scoring system, aimed at enhancing the strategic management of university-owned patents, naturally complements key concepts derived from established patent management maturity models. While these models—such as the Edison Pyramid, Strategic Patent Management Maturity, AIDA approach, Intellectual Asset Governance, and the 7D Patent Management Maturity—provide a broad framework for assessing organizational maturity in patent management, our scoring system offers a focused tool for evaluating patents within the university's portfolio.

The Edison Pyramid model, which delineates maturity levels from "defend position" to "shape the future", illustrates a strategic progression that our scoring system seeks to facilitate at the patent level. By evaluating patents on novelty, inventive step, and commercialization potential, the scoring system helps universities to identify which patents have the potential to move them towards higher maturity levels, such as "synthesize opportunities" and "shape the future" [10].

Similarly, the Strategic Patent Management Maturity model's distinction between inherent and attributed patent functions echoes in our scoring system's dual focus on the intrinsic value of patents and their strategic fit within the university's broader goals. This alignment ensures that patents are not only evaluated for their immediate legal and protective value but also for their role in the university's long-term strategic patent management [5,10].

The flexibility of our scoring system is in harmony with the modular nature of the maturity models. Universities can adapt the scoring criteria to match their current maturity level, choosing aspects from different models that resonate with their specific context and objectives. This adaptability is crucial for providing actionable insights that are aligned with the university's stage of patent management maturity.

However, it's important to note that while our scoring system aligns with the strategic directions suggested by these maturity models, it is primarily a tool for the evaluation of individual patents rather than an assessment of the institution's overall patent management maturity. The system serves as a practical method for universities to prioritize patents for development, licensing, or commercialization, contributing to the strategic management of their portfolio in alignment with their maturity goals.

By integrating insights from patent management maturity models, our scoring system empowers universities to make informed decisions about their patents, supporting the strategic enhancement of their patent portfolios. This considered approach aids universities in navigating the complexities of patent management and commercialization, aligning with best practices suggested by the models without claiming to replace a comprehensive institutional maturity assessment.

The strategic management of patent portfolios, as previously discussed, underscores the importance of not only protecting but also maximizing the value of university inventions. This complex endeavour naturally segues into three critical areas of focus.

1 Invention Evaluation and Portfolio Acceptance Criteria: Efficient evaluation and selection criteria for inventions are essential for

Table 7
Novelty and inventive step/non-obviousness (scoring Average).

2. Step	NOVELTY (Scoring Average)									
					5	6	7	8	9	10
	INVENTIVE STEP/NON-OBVIOUSNESS (Scoring Average)									
	1	2	3	4	5	6	7	8	9	10
	• Industry cooperation projects • Utility model • Academic publications				Patent					

building a successful patent portfolio. Universities need to establish clear guidelines for assessing the potential value, uniqueness, and marketability of inventions before accepting them into their patent portfolio.

2 Periodic Portfolio Control and Elimination Criteria: Regular assessment and control of the patent portfolio are necessary to ensure that it remains relevant, valuable, and cost-effective. Universities should periodically review their patent portfolio and abandon patents or return them to the inventors, which no longer align with their strategic objectives or have limited commercial potential.

3 Commercialization (Technology Transfer) Activities: To bridge the gap between university research and commercial success, effective technology transfer and commercialization activities are crucial. Universities should explore various avenues for licensing their patents to organizations that can bring the inventions to market. Additionally, establish partnerships with industry players, research organizations, and start-ups can facilitate the commercialization process.

By addressing these three main topics and implementing a robust patent portfolio management system, universities can optimize their chances of successfully transferring technology and enhancing the overall commercialization of their inventions. This article will delve into the examination of the first and second themes, as its scope centres around presenting a measurement and evaluation approach for patent portfolios. For a comprehensive understanding of commercialization actions, a separate article can be dedicated to the topic. The initial qualitative analysis, aimed at isolating the most crucial patents within a portfolio, significantly streamlines the valuation process. This evaluative framework promises to enhance the assessment process for new patent applications within research and innovation organizations, suggesting a path toward more sophisticated evaluation tools [11].

Also, patent rankings and scoreboards are commonly used to compare the patent portfolios of companies across various industries, with publications like The Wall Street Journal regularly featuring these benchmarks. These evaluations are closely followed by executives, investors, and the wider public, serving as indicators of a company's innovation and competitive edge. For example, corporations such as DuPont and Halliburton leverage these rankings to showcase their innovative prowess and leadership in the market to stakeholders [12].

Table 9
Development level of invention scoring scale.

DEVELOPMENT LEVEL OF INVENTION	
Score	Score Definition
1–2	No development work has been conducted on the invention following the national application.
3–4	Development work on the invention after the national application are deemed insufficient.
5–6	Development work on the invention after the national application is at an average level.
7–8	Development work on the invention after the national application are considered sufficient.
9–10	Development work on the invention after the national application have exceeded expectations, showcasing a high potential for the product.

Table 10
Commercialization potential scoring scale.

COMMERCIALIZATION POTENTIAL	
Score	Score Definition
1–2	The patent application contains solution(s) that cannot be turned into a commercial product.
3–4	The patent application includes solutions that are lengthy and costly to turn into a commercial product/method, and that do not meet the industry's needs even if they turn into a commercial product/method.
5–6	The patent application includes solutions that are lengthy and costly to turn into a commercial product/method, but which may attract the attention of the industry when they become a commercial product/method.
7–8	The patent application includes solutions that require a relatively short and low-cost process to turn into a commercial product/method and may attract industry attention when they become a commercial product/method
9–10	The patent application includes solutions with high technology readiness level (TRL 8 - TRL 9) that will meet the important needs of industry when they become a commercial product/method.

3. Invention Evaluation and Portfolio Acceptance Criteria

According to Turkish Law No. 6769, inventors are required to make an invention disclosure to their institutes. Turkish Law No. 6769 Article 121 (2) states: When an invention is made in consequences of scientific studies and researches conducted in higher education institutions; the inventor shall be obliged to notify their invention in written to the higher education institution without a delay [13]. Across different

Table 8
Overall score (scoring Average).

3. Step	NOVELTY (Scoring Average)									
					5	6	7	8	9	10
	INVENTIVE STEP/NON-OBVIOUSNESS (Scoring Average)									
	1	2	3	4	5	6	7	8	9	10
	• Industry cooperation projects • Utility model • Academic publications				Patent					
	OVERALL SCORE									
	1	2	3	4	5	6	7	8	9	10
	Release to inventor(s)			• Industry cooperation projects • Utility model • Academic publications			Patent application with university ownership (University Patent Portfolio)			

Table 11
Market size scoring scale.

MARKET SIZE	
Score	Score Definition
1–2	The invention is unlikely to have demand in the international market.
3–4	The invention might find demand within a limited international market, particularly in regions with below-average economic development (low and medium-low).
5–6	The invention could potentially find demand within a limited international market, particularly in regions with above-average economic development (medium, medium-high, and high).
7–8	The invention has the potential to meet demand across a broad international market geography.
9–10	The invention possesses a global market size.

Table 12
Status of the inventor team scoring scale.

STATUS OF THE INVENTOR TEAM	
Score	Score Definition
1–2	The inventor team is no longer actively engaged in collaboration and has moved on from the invention's development.
3–4	The inventor team's involvement has diminished, with occasional contributions to the invention's progress.
5–6	The inventor team maintains moderate engagement, occasionally contributing to the invention's subject matter.
7–8	The inventor team consistently participates in collaborative efforts and remains dedicated to advancing the invention.
9–10	The inventor team demonstrates an exceptional level of ongoing collaboration, actively driving the invention's development and commercialization activities forward.

countries, similar legal frameworks mandate inventors associated with academic institutions to formally disclose their inventions, aiming to protect intellectual property rights while fostering an environment conducive to innovation and commercialization.

If the university decides to claim ownership of the patent, the invention will become an asset in the university's patent portfolio. Article 121 (3) states: In case the higher education institution claims rights on the invention, they shall be obliged to make a patent application [13].

Commercializing the patent offers several benefits. It transforms the invention into a tangible product, creating financial opportunities. Inventors can earn a share of the financial gains through licensing or royalties. Additionally, commercialization allows them to form valuable partnerships with industry experts, leveraging their resources and expertise for further development. Article 121 (8) states: Sharing form of the revenue earned from the invention between the higher education institution and the inventor shall be determined by means of at least one third of the revenue to be paid to the inventor [13]. The example from Turkish law serves as a specific illustration of how universities can manage patent ownership and commercialization when such regulations are in place. While the legal framework may vary from one country to another, the underlying principles of protecting intellectual property, incentivizing inventors through revenue sharing, and encouraging the commercialization of university-owned patents are broadly applicable.

A patent is indeed an asset with value and potential. It represents an investment for the university, but it also involves expenses. The university must allocate funds to support the application, maintenance, and protection of the patent. Commercialization plays a vital role in capitalizing on the patent's value, generating revenue that offsets these expenses and enables sustainable management of the patent portfolio. However, the most crucial step in sustainable management comes during the creation of the patent portfolio. In other words, it is of great importance to carefully select the inventions that best align with the university's strategy for inclusion in the patent portfolio. To achieve this, a possible scoring and criterion method for the selection of inventions to be included in the patent portfolio is presented below.

There are three main criteria for choosing inventions for the patent portfolio: patentability, commercialization, and team.

Patentability serves as the primary criterion for selecting inventions to include in the patent portfolio. It relies on key conditions such as.

- Sufficiency of Disclosure: The invention must be described in the application with sufficient clarity and completeness to enable a person with ordinary skill in the relevant technical field to implement it [14].
- Novelty: The invention must demonstrate new characteristics that were not previously known or part of the existing body of knowledge before the filing date (or priority date) [14].
- Inventive Step/Non-obviousness: The invention must involve a significant step that, considering the prior art, would not be evident to a person with ordinary skill in the relevant technical field [14].
- Industrial Application/Utility: The invention must be capable of practical use for industrial or business purposes beyond being merely a theoretical concept, or it should achieve a beneficial result [14].

The sufficiency of disclosure is determined through the examination of the invention disclosure. The invention disclosure should include essential technical details about the invention, information about the roadmap of the invention, and the group of inventors. Typically, Technology Transfer Offices (TTOs) provide invention disclosure forms to inventors, which facilitate the process of disclosing their inventions. The inclusion of detailed invention disclosures is crucial for accurate scoring within our system. This is because the scoring hinges not only on the invention's technical aspects but also on its developmental roadmap and the collaborative dynamics of the inventor group. Such comprehensive disclosures enable the TTOs to evaluate the invention's potential accurately, ensuring that scoring reflects both the innovation's current value and its future commercialization prospects. This meticulous approach underpins the reliability of the scoring system, facilitating strategic decisions regarding patent management and technology transfer activities. An invention disclosure form includes the following main sections.

- Title of Invention
- Problem Definition
  - o Key pain points

Table 13
Overall score for the first control phase (scoring Average).

	OVERALL SCORE									
The first control phase	1	2	3	4	5	6	7	8	9	10
	Release to inventor(s)			Limited international patent applications with university ownership				All reasonable international patent applications with university ownership		

- o Context of the problem (Need for a solution)
- o Complexity of the problem
- Background (Prior art)
- Detailed Description of Invention
  - o Motivation behind the invention
  - o General utility of the invention
  - o Technical applications of the invention
  - o Advantages and disadvantages
  - o Best ways of using the invention (Variations)
  - o Drawings, schematics, flow diagrams, etc.
- Invention Development Stage
  - o Idea/concept
  - o Early stage
  - o Proof of concept
  - o Prototype
  - o Industrial interest/use
- Possible Commercial Applications of Invention
- Inventor Information
  - o Personal information of each inventor
  - o Employer during the invention development
  - o Estimated intellectual contribution (% allocation per inventor)
  - o Any previous publications related to the invention
- Invention Development Process
  - o Infrastructure utilized in the process
  - o Funding sources supporting the process
  - o University-Industry cooperation during the process
  - o Companies involved in the cooperation
- Future Developments
  - o Projected milestones and advancements
  - o Anticipated evolution of the invention
  - o Potential improvements planned
- Inventors' Dedication
  - o Are the inventors part of a research group collaborating on the invention?
  - o If yes, has the research group been working together for more than 2 years?
  - o Track record of the inventors (previous inventions or notable contributions)
  - o Commitment beyond graduation (intentions of the members who will graduate, if any)

By utilizing these comprehensive invention disclosure forms, Technology Transfer Offices (TTOs) can gather all the necessary information to evaluate the potential of an invention, its patentability, and the prospects for commercialization. This process facilitates effective decision-making and helps universities and research institutions efficiently manage their patent portfolios. In the method, sufficiency of disclosure and industrial application/utility conditions are read and evaluated from the invention disclosure form.

This thorough evaluation process, underscored by the invention disclosure form, sets the stage for the subsequent visualization of our system through a flow chart. This chart will further elucidate the step-by-step assessment procedure, enhancing understanding of how TTOs operationalize these criteria to navigate patent management and commercialization strategies effectively.

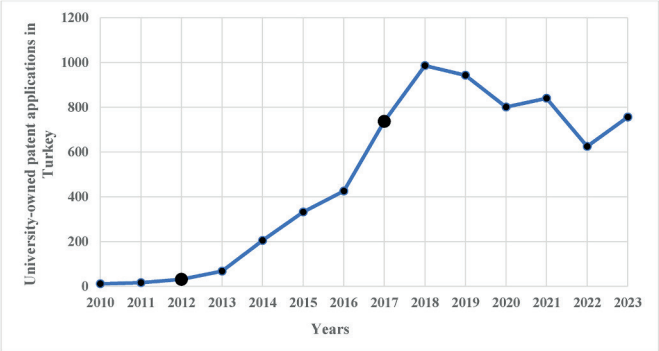

Fig. 1. Distribution of patent applications owned by universities in Turkey (2010–2022).

Fig. 2 illustrates the evaluation process flow used by TTOs and the IP Evaluation Board to assess potential inventions for inclusion in the university's patent portfolio. This flow chart outlines the key stages and decision points that guide the determination of the most viable inventions for patenting and commercialization.

The process begins with the TTO reviewing the invention disclosure form to ensure all necessary information is provided. This is the first touchpoint where the invention is either accepted for evaluation (scoring) or sent back for additional information.

If the disclosure meets the basic criteria, it moves to the scoring phase, where the invention is evaluated based on four key criteria: novelty, inventive step, commercialization potential, and the strength of

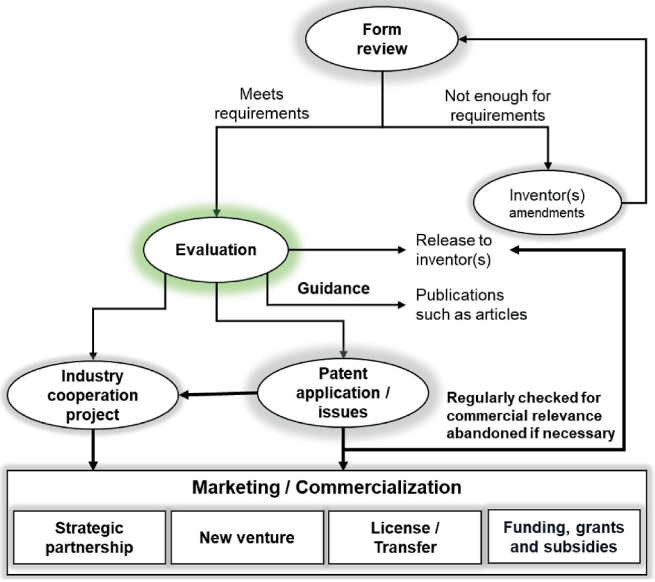

Fig. 2. Navigation of patent management and commercialization strategies.

Table 14
Overall score for the subsequent control phase (scoring Average).

The subsequent control phase	OVERALL SCORE									
	1	2	3	4	5	6	7	8	9	10
	Removed from the portfolio			Monitoring until the subsequent control period			Continuation within the Portfolio			

the inventor team.

At decision node in the flow, the invention's score is assessed against predefined thresholds. For example, if an invention's novelty score falls below a certain threshold, the invention may be released back to the inventors rather than pursued further. If the novelty and inventive step scores are adequate, the evaluation continues to assess commercialization potential and team strength. These decision nodes ensure that only the most promising inventions, which align with the university's strategic objectives and have strong commercial potential, proceed to the next stages.

The flow chart shows how these process steps interlink and influence the final decision to either include the invention in the patent portfolio, suggest it for industry collaboration, or recommend it for academic publication.

This systematic approach ensures that TTOs have access to essential details about the invention, including its technical aspects, market potential, and developmental stage. Additionally, the form allows for a thorough assessment of the invention's novelty, inventive step, and potential industrial and commercial applications. In the method, individual scoring scales for novelty, inventive step, commercialization potential, and the inventor team are utilized. First of all, the scoring scale related to novelty is presented below:

The novelty scoring scale allows for the quantification of the level of originality and uniqueness of each invention. Inventions that score higher on the novelty scale are considered more distinct, indicating that they have the potential to bring significant advancements to their respective fields.

In the development of our patent scoring system, we've introduced a nuanced scale ranging from 1 to 10, deliberately assigning two possible scores within each category to accommodate the intricacies inherent in patent evaluation. This dual-scoring approach is designed to empower the selection board with greater flexibility, facilitating a more precise and tailored assessment of each patent's unique attributes. To operationalize this approach, we have established comprehensive guidelines that delineate specific conditions under which each score within a category may be applied. These conditions are based on a variety of factors, including but not limited to, the patent's innovative strength, potential for commercialization, technological significance, and alignment with strategic goals. Through this method, evaluators are equipped to make informed decisions, ensuring that the scoring reflects a deeper understanding of the patent's value to the organization's objectives.

Secondly, the scoring scale related to inventive step/non-obviousness is presented below:

The inventive step scoring scale allows for the assessment of how much the invention goes beyond what is already known in the relevant technical field. Inventions that score higher on the inventive step scale demonstrate greater ingenuity and originality, indicating that they involve significant progress beyond existing knowledge and common practices.

As the third, the scoring scale related to commercialization potential is presented below:

The commercialization potential scoring scale allows for the evaluation of an invention's likelihood of success in the market and its ability to generate revenue through licensing, sales, or other commercialization strategies. Inventions that score higher on the commercialization potential scale are considered more promising for technology transfer and partnership opportunities. High-scoring inventions are more likely to attract interest from industry players, investors, and potential buyers, leading to successful technology transfer and commercialization.

The inventor team plays a pivotal role in the commercialization process as it is the most important element. Industry partners cannot simply take the invention and apply it as a plug-and-play solution. They require the ongoing involvement of the inventor team to continue developing and refining the invention for practical implementation. The scoring scale related to the inventor team is presented below:

In the context of commercializing university-owned patents, the role of the inventor team becomes even more critical. Industry partners value the ongoing involvement of the inventor team as it ensures a deeper understanding of the invention's technical aspects and potential applications. This ongoing collaboration allows for continuous improvement and adaptation of the invention to meet industry requirements and market demands. The inventor team's expertise and commitment can also build trust and confidence among potential partners, investors, and buyers, leading to fruitful technology transfer and successful commercialization.

In conclusion, a strong and dedicated inventor team is an invaluable asset in the commercialization journey of an invention. By prioritizing inventions with high-scoring inventor teams, universities and technology transfer offices (TTOs) can significantly elevate their technology transfer efforts, foster successful collaborations with industry players, and maximize the overall impact of their patent portfolio. The high score of the inventor team indicates their exceptional expertise, experience, and commitment, which are vital for effectively translating the invention into practical implementation.

During the scoring process, Board members may consider a range of supportive reports associated with the invention disclosure. These reports can comprise the invention disclosure form itself, supplementary statements, a patent pre-search report, a comprehensive technical field landscape report, market research insights, and the opinions expressed by the inventors. The thoroughness and precision with which these reports are compiled and presented by the TTO play a pivotal role in ensuring the accuracy of the Board's decision-making process.

Moreover, the quality of these reports carries implications for the future. If the invention eventually becomes part of the university's patent portfolio, the TTO's adeptness in orchestrating the commercialization efforts surrounding the invention will be significantly elevated. This elevated command will facilitate the seamless preparation of commercialization documents, streamlining the processes that lead to the realization of the invention's potential in the market.

After scoring, the inventions are directed towards suitable paths. These paths include university patent portfolio inclusion, release to inventor(s), academic publications, or industry cooperation projects. The path to be chosen is determined by the overall average score. The scores and their corresponding paths are presented below:

The first step in the evaluation process is the novelty scoring. For example, if the average novelty score is below 4, it indicates that the invention disclosure does not include new knowledge. In such cases, the IP Evaluation Board may decide to release the invention directly to the inventor(s). On the other hand, if the average novelty score is 5 or higher, the evaluation process continues with the scoring of other criteria.

The second step in the evaluation process is the inventive step scoring. For invention disclosures with a novelty score of 5 or higher, the evaluation considers the inventive step scores. For instance, if the average inventive step score is below 4, it suggests that the invention disclosure includes obvious knowledge. In such cases, the IP Evaluation Board may decide to direct the invention towards industry cooperation projects, utility model (in some countries), or academic publications. On the other hand, if the average inventive step score is 5 or higher, the evaluation process proceeds with the scoring of other criteria.

If both the average novelty score and the average inventive step score are 5 or higher, the invention disclosure may be considered for patent protection. However, it does not necessarily mean that the invention will be automatically accepted into the university's patent portfolio. The IP Evaluation Board examines other criteria (commercialization potential and the inventor team) before making a final decision. These criteria play a crucial role in determining whether the invention is suitable for inclusion in the university's patent portfolio and its potential for successful commercialization.

The third step in the evaluation process involves an overall scoring that takes into account the factors of novelty, inventive step, commercialization potential, and the inventor team. This overall score is

obtained by calculating the arithmetic mean of all four scoring scales. The evaluation of overall score represents the culmination of a comprehensive assessment conducted by the IP Evaluation Board, aimed at determining the most appropriate path for each invention disclosure.

By amalgamating all the individual scores, a comprehensive and holistic understanding of the invention's potential is attained. In instances where the average scores fall within the range of 1–3, the IP Evaluation Board may opt to release the invention back to its inventor (s). This decision acknowledges that the disclosed invention might not present substantial advancements beyond existing knowledge and may lack significant commercial potential.

In cases where the average scores align within the range of 4–6 across for all scoring scales, the evaluation process enters a pivotal phase. Here, the IP Evaluation Board might opt to guide the invention toward avenues such as industry cooperation projects, utility model protection (in applicable countries), or dissemination through academic publications. Such an outcome suggests that while the invention displays promise in terms of originality and inventive depth, it might not possess strong commercial potential.

While meeting certain criteria may open the door to potential patent protection, the final decision regarding the inclusion of the invention in the university's patent portfolio is not solely contingent on novelty and inventive step scores. The IP Evaluation Board recognizes the importance of other crucial factors, such as commercialization potential and the capabilities of the inventor team, in shaping the eventual trajectory of the invention.

In instances where the overall score reaches 7 or higher, the IP Evaluation Board may recommend pursuing a patent application with university ownership, leading to involvement in the University Patent Portfolio.

As a result, the overall score functions as a guiding metric that informs the assignment of invention disclosures to distinct pathways. These paths encompass a variety of options, ranging from collaborative endeavours with industries for practical applications, seeking utility model protection where relevant, disseminating insights through academic publications, to the ultimate pursuit of patent protection under the university's ownership. The overarching objective of this thorough evaluation process is to ensure that each invention discovers its optimal route, thereby maximizing its impact, nurturing innovation, and contributing to the broader intellectual property landscape of the university.

Fig. 3 illustrates the process flow for the evaluation and decision-making regarding university-based inventions. This flow chart shows how the IP Evaluation Board assesses each invention's potential and determines the most appropriate path for each invention.

The process begins with three key inputs: the Invention Disclosure Form, the Patent Pre-search Report, and the Market Analysis Report. These documents provide the essential information required for a comprehensive assessment by the IP Evaluation Board. The Invention Disclosure Form outlines the invention's technical details and potential applications, the Patent Pre-search Report provides an initial assessment of the invention's novelty and patentability, and the Market Analysis Report offers insights into the market size and commercialization opportunities.

The IP Evaluation Board reviews these inputs and proceeds to the Evaluation phase, where the invention is assessed based on criteria such as patentability, commercialization potential, and the strength of the inventor team. This evaluation is a critical step in the process, determining the future course of action for the invention.

Depending on the results of the evaluation, the process flow diverges into four potential paths.

- Academic Publications: If the invention does not meet the criteria for patentability or commercialization potential but has a strong team, it may be redirected towards academic publication. This path allows the invention to contribute to the academic community, even if it has limited commercial potential.
- Industry Cooperation Project: If the invention shows potential for development but is not ready for patenting and the team is strong, it may be suggested for industry cooperation projects. This path

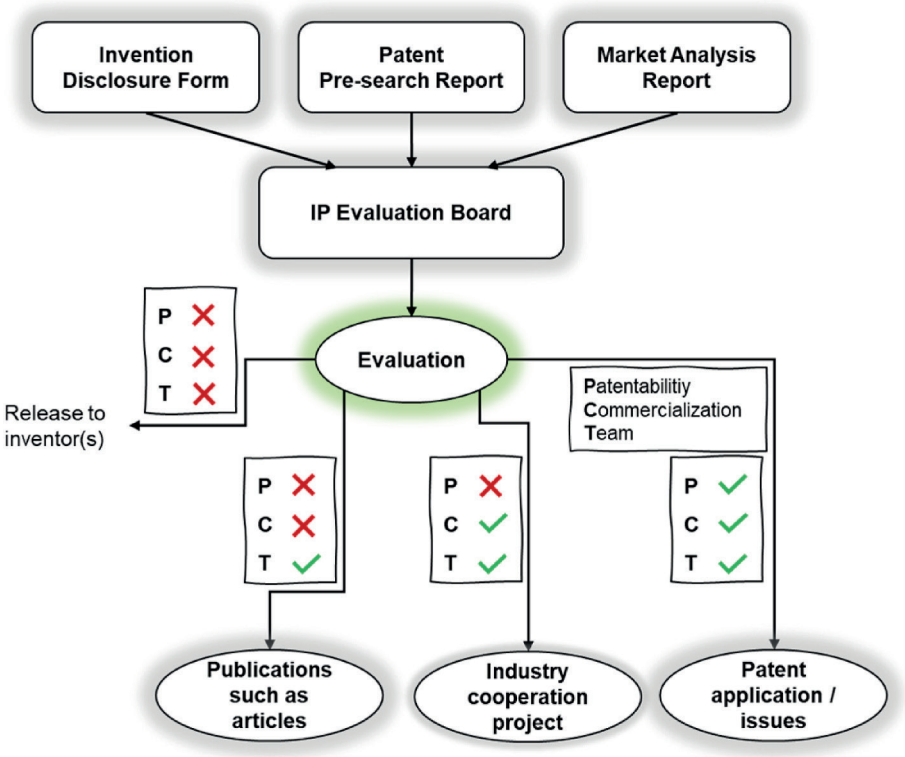

Fig. 3. An example of scoring flow.

involves collaborating with industry partners to further develop the invention and explore its potential applications. This route is chosen when the invention has both good commercialization potential and a strong inventor team.

- Patent Application: For inventions that score highly across all evaluation criteria—patentability, commercialization potential, and inventor team strength—the board may recommend proceeding with a patent application. This route indicates that the invention has significant commercial potential and aligns well with the university's strategic objectives.
- Release to Inventors: If the invention fails to meet the necessary thresholds across all criteria—patentability, commercialization potential, and team strength—it is released back to the inventors. This option allows the inventors to pursue their own path for development or commercialization outside of the university's portfolio.

By following this structured process, universities can make informed decisions that align each invention with the most suitable path, balancing both academic and commercial potential.

4. Periodic Portfolio Control and Elimination Criteria

The tweet from the European Patent Office (EPO) on May 11, 2022, delivers a succinct yet powerful message: "Patents should be checked for commercial relevance on a regular basis and abandoned if necessary [15]. This statement underscores a fundamental principle in patent portfolio management – one that resonates with the dynamic nature of commercialization and business landscapes.

When considering the commercialization of a patent portfolio, the ultimate objective is to ensure profitability at any given point in the future. To achieve this goal, licensing agreements stand as a notable avenue for generating income. Nonetheless, another approach of equal significance comes into play: the periodic control (assessment) of the portfolio and elimination of patents with limited commercial potential. These crucial procedures for periodic control and elimination are expounded upon in following sections.

In this portfolio control process, both the TTO and the IP Evaluation Board once again assume crucial roles. Within the portfolio, for patent applications, the inventor team is required to provide an invention progress report to the TTO within 12 months (preferably within 10 months) from the filing of the first patent application. This reporting cycle then repeats every three or five years. The rationale behind submitting the first invention progress report within the initial 12 months is to facilitate timely decisions regarding potential international patent applications. This is particularly important as, following the initial decision to include the invention in the portfolio, patent applications are often pursued at the national level. The subsequent phase involves determining whether to maintain international patent applications in the portfolio or release them back to the inventors.

The invention progress report comprises two crucial components: the current stage of development of the invention (development level of invention) and the status of the inventor team. Inventors provide comprehensive written details concerning both of these aspects. Once the TTO receives the invention progress report, the IP Evaluation Board makes decisions about the international phases or/and whether the invention should be retained in the portfolio. These decisions are determined based on the following scoring scales.

In the method, individual scoring scales for development level of invention, commercialization potential, market size, and the status of the inventor team are employed. To begin, the scoring scale associated with the development level of invention is presented below:

The development level of the invention factor assesses the degree to which the invention has progressed subsequent to the national application. The IP Evaluation Board assigns a score for the development level of the invention, taking into consideration the specific year of evaluation. This dynamic approach acknowledges the evolving nature of innovations over time.

Moving on, the scoring scale for commercialization potential is presented below:

This represents the secondary evaluation of the invention's commercialization potential. The initial assessment took place when the invention was reviewed for inclusion in the portfolio. Consequently, this secondary evaluation aims to determine whether the invention, which was previously deemed suitable for portfolio inclusion, maintains its prospects for future commercialization.

Moving forward, the third scoring scale, which pertains to market size, is presented below:

The market size scoring scale offers a nuanced understanding of the potential global reach of the invention, albeit not in terms of monetary size. A score of 1 or 2 suggests that the invention may encounter challenges in gaining substantial traction in the global market, highlighting the need for further exploration to identify potential demand pockets. Scores of 3 and 4 indicate that the invention could find a foothold within specific segments of the international market, particularly in regions with comparatively lower economic development. Tailored strategies targeting these specific opportunities hold the potential to enhance success. Meanwhile, scores of 5 and 6 signify that the invention's market prospects extend to regions characterized by an above-average level of economic development. Adapting the invention's approach to align with the distinct economic conditions of these regions can elevate its likelihood of success. Attaining scores of 7 and 8 signals that the invention is poised to meet demand across a diverse array of international markets. Its broad applicability and universal appeal set the stage for widespread adoption. Lastly, scores of 9 and 10 indicate that the invention boasts a global market size, underlining its potential to excel in numerous international markets, irrespective of varying economic conditions. While the approach may not directly mirror precise market size, it strategically measures suitability for markets with elevated monetary potential and advanced technology utilization. This comprehensive scoring scale offers insights into the invention's potential market reach, thereby facilitating informed decision-making in the realm of patent portfolio management.

As the last, the scoring scale for the status of the inventor team is presented below:

The scoring scale for the status of the inventor team sheds light on their level of involvement and dedication to the ongoing development of the invention. Notably, when the inventor team remains intact and remains focused on the invention's subject, it significantly elevates the potential for commercialization. This aspect holds paramount importance for client organizations seeking to acquire patents. In the realm of commercialization, clients seek trust and enduring commitment from sellers, akin to an ongoing service. Herein lies the crucial role of the inventor team, TTO, and the university in cultivating client confidence—an indispensable and foundational component of successful commercialization. The status of the inventor team becomes a pivotal metric that shapes the future trajectory of patents within the portfolio, encapsulating the promise and potential they hold.

After the scoring process, the IP Evaluation Board provides recommendation decisions for the future of patents. In the first control phase (conducted within the first 12 months), these decisions encompass three primary options:

Including all possible international patent applications in the portfolio: This choice involves incorporating all reasonable international patent applications into the patent portfolio, signalling a strong potential for global market demand and subsequent commercial success.

Including limited international patent applications in the portfolio: In this scenario, a selection is made to include only specific international patent applications in the portfolio. This approach recognizes potential market niches and focuses resources on applications with the greatest commercialization prospects.

Releasing international patent applications to the inventors: Based on the evaluation's findings, international patent applications may be

relinquished to the inventors. This alternative is favoured when a patent demonstrates limited commercial potential or no longer aligns with the university's strategic objectives.

Determining the scope of international patent applications and selecting the appropriate application methods (such as PCT, EP, National phases, etc.) should be underpinned by comprehensive research that encompasses market analysis, import-export dynamics, and the geographic locations of potential producers. The ultimate selection among these paths is guided by the overall average score achieved in the evaluation process. The scores and their corresponding pathways for the first control phase (conducted within the first 12 months) are presented below:

The culmination of the evaluation process resides in determining the overall score, an arithmetic mean derived from four distinct scoring scales: development level of invention, commercialization potential, market size, and the status of the inventor team.

Embedded within this framework, the calculated overall score steers the selection of the optimal trajectory for each patent, ensuring a tailored journey ahead. The spectrum of potential scores unfolds in the following manner:

Scores 1 to 3: These scores prompt the decision to release the international applications to the inventor(s). Acknowledging that the invention may lack the requisites for further advancement in the commercialization journey, this path acknowledges the constraints in the invention's potential.

Scores 4 to 7: Within this range, the decision leans towards incorporating limited international patent applications under the university's ownership. This approach strikes a balance, securing the invention's place in the patent portfolio, with a targeted focus on markets aligned with its strengths.

Scores 8 to 10: Representing the highest scores, this category signals the inclusion of all reasonable international patent applications within the university's patent portfolio. This resolute move affirms the invention's extraordinary potential, endorsing the pursuit of worldwide protection and commercialization.

Consequently, the overall score operates as a compass, adeptly navigating the diverse landscape of invention evaluation and portfolio management. It steers each invention towards its optimal path – whether that means release to inventors, strategic entry into specific international markets, or resolute adoption into a comprehensive international patent portfolio.

Subsequent controls occur at intervals of every three or five years. During these assessments, the determination revolves around whether to retain the patents within the portfolio or not. Similar to the first control phase, the IP Evaluation Board takes charge of making decisions based on the overall score. The ensuing scores and their corresponding pathways for this subsequent control phase are delineated as follows:

When the overall score falls within the range of 1–3, the patent is removed from the portfolio and offered to the inventors. If the inventors do not wish to take over the patent, the patent is abandoned. In cases where the overall score ranges from 4 to 6, the patent undergoes monitoring until the subsequent control period, yet no resources are allocated towards its commercialization endeavours. Instead, emphasis is placed on advancing its development. When the overall score registers between 7 and 10, the patent remains retained within the portfolio. Furthermore, substantial resources are channelled, and expenses are directed towards executing comprehensive commercialization strategies for the patent.

5. Limitations and future research directions

While the proposed approach for strategic portfolio management of university-owned patents provides a structured approach to optimize patent selection and periodic evaluation, it is important to acknowledge certain limitations.

Subjectivity in Scoring: The scoring process relies on the expertise and judgment of the IP Evaluation Board members. Variability in individual assessments could lead to inconsistent outcomes. Future research could explore methods to standardize and validate the scoring process, possibly incorporating machine learning techniques.

Dynamic Market Factors: The commercialization potential and market size assessments are based on current understanding, which may evolve over time due to market shifts, technological advancements, or regulatory changes. Ongoing monitoring and adaptation of evaluation criteria are necessary to ensure relevancy.

Lack of Formal Empirical Testing: Although the scoring system has been utilized in a university TTO over a three-year period, resulting in over ten licensing agreements, this application was conducted in a business context without formal academic documentation. While these outcomes suggest the practical utility of the framework, more rigorous empirical studies are needed to formally validate its effectiveness across different settings and provide a stronger academic foundation.

Long-Term Success Metrics: While the approach addresses short-term success through patent selection and periodic evaluation, long-term success metrics, such as the impact of commercialized technologies on industries and society, are not directly measured. Exploring comprehensive success indicators could enhance the evaluation process.

Cross-Disciplinary Challenges: The approach's applicability might vary across different fields and disciplines. Future research could investigate the adaptation of the framework to diverse academic domains and industries.

Framework Implementation Considerations: The initial implementation of the framework in a business setting at a university TTO provided valuable insights into resource allocation, training needs, and the integration with existing technology transfer processes. IP Evaluation Board members developed expertise and improved their scoring accuracy over time, indicating that practical, on-the-ground learning is essential for effective use of the framework. However, further exploration is needed to understand how these practical considerations might vary across different universities, including variations in resources, institutional structures, and the specific needs of diverse TTOs.

6. Future research directions

Predictive Analytics: Incorporating predictive analytics could enhance the accuracy of evaluating commercialization potential and market trends. Predictive models could assist in identifying patents with higher likelihoods of success.

Dynamic Scoring Models: Developing dynamic scoring models that consider the evolving nature of inventions and markets could provide more nuanced evaluations over time.

Global Comparative Analysis: Conducting cross-country comparisons of patent portfolio management strategies could unveil best practices and insights for enhancing technology transfer and commercialization on a global scale.

Economic Impact Analysis: Future research could delve into the economic impact of successful patent commercialization, considering factors like job creation, industry growth, and societal benefits.

7. Conclusion

In the rapidly evolving landscape of the knowledge-driven economy, the strategic management of university-owned patents stands as a pivotal factor in advancing innovation, fostering industry collaborations, and driving economic growth. This article has presented a comprehensive framework for patent portfolio management, offering universities and technology transfer offices a systematic approach for both initial patent selection and ongoing evaluation.

The proposed framework, inspired by global experiences like the Bayh-Dole Act, considers the nuanced interplay of factors that determine the fate of patents within university portfolios. By assessing the novelty, inventive step, commercialization potential, and the strength of the

inventor team, universities can make well-informed decisions that resonate with their innovation objectives and the ever-shifting currents of the market.

The study suggests the benefits of using a structured scoring system to support decision-making processes, helping universities identify and prioritize patents with the most potential for commercial success and strategic alignment with their objectives. While this structured approach offers clear guidelines and efficiency in patent selection and management, it also underscores the importance of addressing challenges such as the inherent subjectivity in scoring and the need to adapt to changing conditions.

The possible pathways for university-owned inventions can vary significantly based on their evaluated potential and strategic relevance. Inventions may proceed to patent applications, industry partnerships, academic publications, or be returned to inventors, ensuring that each invention is directed along the most appropriate route to maximize its impact. The study also emphasizes the vital role of the inventor team's skills and commitment in improving commercialization prospects, reinforcing the need for their active participation throughout the commercialization process.

Practically, universities and TTOs may consider adopting this framework to better align their patent management strategies with both academic and commercial objectives. Implementing the proposed scoring system could help these institutions make more informed decisions, prioritize patents with significant potential, and foster stronger collaborations with industry partners.

While this framework presents a robust strategy, it is essential to acknowledge its inherent limitations. The subjectivity embedded in the scoring process and the dynamic nature of market variables underscore the need for continuous refinement. However, these limitations pave the way for future research directions that could enhance the framework's efficacy. These include the integration of predictive analytics, development of dynamic scoring models, global comparative analyses, economic impact assessments, and interdisciplinary collaborations to harness insights from diverse fields.

Future research could explore case studies of universities that adopt this framework, providing empirical evidence to further refine and enhance its effectiveness. By doing so, this approach can become a valuable tool in the ongoing effort to maximize the impact of university-driven innovations in a rapidly changing world.

In essence, effective patent portfolio management empowers universities to transform their intellectual property into tangible drivers of progress. By aligning patent portfolios with strategic goals, making astute choices in patent selection, and continually evaluating their commercial potential, universities can position themselves as hubs of innovation and engines of economic transformation. As we forge ahead into an era characterized by rapid technological advancements, the application of this framework will play a pivotal role in propelling both academic institutions and industries toward a future brimming with possibilities.

CRediT authorship contribution statement

Volkan Okutan: Writing – review & editing, Writing – original draft, Validation, Supervision, Conceptualization. **Muhammed Zahid Kasapoğlu:** Writing – review & editing, Writing – original draft, Methodology.

Declaration of competing interest

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

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