

Intellectual Property Rights Management Framework for Regulatory Sandbox

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Abstract

Regulatory sandbox initiatives have emerged globally as important instruments for facilitating innovation, experimentation, regulatory learning, and commercialisation of emerging technologies. While existing literature has extensively examined sandbox governance, regulatory flexibility, and innovation outcomes, limited attention has been devoted to intellectual property rights (IPR) management within sandbox environments. Regulatory sandboxes frequently involve collaborative innovation among regulators, universities, research institutions, start-ups, industry partners, investors, and technology developers, creating complex challenges relating to ownership, inventorship, licensing, confidentiality, data rights, trade secrets, and the commercialisation of intellectual assets. The absence of structured IPR management mechanisms may create legal uncertainty, discourage investment, impede technology transfer, and undermine commercialisation outcomes. Using doctrinal legal research and comparative policy analysis, this study examines intellectual property challenges associated with the regulatory sandbox and proposes an Intellectual Property Rights Management Framework (IPRMF) comprising legal, administrative, technological, and commercialisation management dimensions. The proposed framework contributes to strengthening innovation ecosystems by providing a systematic approach to managing intellectual property throughout the sandbox lifecycle while balancing innovation facilitation, regulatory objectives, and commercialisation outcomes.

Keywords: Intellectual Property, Regulatory Sandbox, Innovation Governance, Technology Transfer, Commercialisation

Introduction

Regulatory sandbox initiatives have emerged as important innovation policy instruments for facilitating the development, testing, validation and commercialisation of emerging technologies in regulated sectors. Originally introduced by the United Kingdom Financial Conduct Authority in 2015 to support financial technology (FinTech) innovation, the sandbox model has since expanded globally across sectors including financial services, artificial intelligence (AI), telecommunications, healthcare, energy, agriculture, transportation and the

digital economy (Allen, 2025; Markellos et al., 2024). This expansion reflects growing recognition that traditional regulatory frameworks often struggle to respond effectively to rapid technological change, thereby requiring more adaptive and experimental regulatory approaches (Jeník & Duff, 2020; Stavi & Jovine, 2025).

Regulatory sandboxes provide controlled environments in which innovators can test new products, services and business models under regulatory supervision while benefiting from temporary regulatory flexibility (Allen, 2019; Jeník & Duff, 2020). They enable regulators to better understand emerging technologies and associated risks, while allowing innovators to demonstrate the viability of innovations before full-scale market deployment (Ford & Ashkenazy, 2024; Novelli et al., 2026). Consequently, sandboxes have become important mechanisms for reducing regulatory uncertainty, accelerating innovation, attracting investment and supporting commercialisation (Goo & Heo, 2020; Truby, 2020). Contemporary sandbox initiatives have also evolved into broader innovation ecosystems involving regulators, universities, research institutions, start-ups, technology developers, industry partners and investors (Allen, 2025; Ford & Ashkenazy, 2024; Markellos et al., 2024). As regulatory sandboxes increasingly facilitate the transition of innovations from research to market, they generate significant volumes of intellectual assets, including inventions, software, algorithms, datasets, AI models, technical know-how, trade secrets, prototypes and designs (Peters, 2025; Modilim et al., 2024). The growing use of artificial intelligence, digital technologies and data-driven innovation has further increased the strategic importance of intellectual property rights (IPR) within sandbox environments (Puri, 2025; Mahala & Chauhan, 2025; Leka, 2021).

The management of intellectual assets is becoming an increasingly important component of innovation governance because intellectual property rights influence technology transfer, investment decisions, market entry and commercialisation outcomes (Peters, 2025; Leka, 2021; Modilim et al., 2024). Within regulatory sandbox ecosystems, intellectual assets may be created, refined, disclosed, tested or validated throughout the innovation lifecycle. As sandbox initiatives continue to expand across sectors and jurisdictions, the governance of intellectual assets is becoming increasingly relevant to the effectiveness and sustainability of sandbox programmes.

Despite the rapid growth of regulatory sandbox initiatives, existing scholarship has focused predominantly on regulatory governance, regulatory experimentation, innovation facilitation and commercialisation outcomes (Ford & Ashkenazy, 2024; Truby et al., 2022; Novelli et al., 2026). Comparatively less attention has been devoted to intellectual property rights management as a distinct governance dimension within sandbox ecosystems (Peters, 2025; Modilim et al., 2024; Gromova, Koneva and Titova, 2022).

This article examines how existing regulatory sandbox policies, guidelines and procedures address intellectual property rights management and develops an Intellectual Property Rights Management Framework (IPRMF) for Regulatory Sandbox Initiatives. The proposed framework seeks to support innovation, technology transfer and commercialisation while protecting intellectual assets generated, disclosed and validated within sandbox ecosystems.

Problem Statement

As sandbox initiatives increasingly function as collaborative innovation and commercialisation platforms, the absence of structured intellectual property rights (IPR) management mechanisms has emerged as a significant governance challenge. A primary challenge concerns the ownership of intellectual assets generated within sandbox environments. Sandbox participation frequently involves regulators, universities, research institutions, start-ups, technology developers, investors and industry partners working together to develop new technologies, software, algorithms, datasets and business solutions (Ford & Ashkenazy, 2024). Such collaborative activities often create uncertainty regarding ownership allocation, particularly where contributions are jointly made or arise from public-private partnerships. Without clear ownership arrangements, disputes may arise concerning commercial exploitation, licensing and future development of sandbox-generated innovations (Peters, 2025; Modilim et al., 2024).

A second challenge relates to inventorship and authorship in emerging technology environments. The increasing use of artificial intelligence, machine learning systems and automated software development tools has blurred traditional legal concepts of inventorship and authorship (Puri, 2025; Mahala & Chauhan, 2025). Questions arise regarding ownership of AI-generated outputs, machine-assisted inventions and algorithmically created content. Existing intellectual property frameworks remain largely based on human inventorship, creating uncertainty regarding the protection and ownership of innovations developed through AI-enabled sandbox experimentation (Nabil, 2024; Mahala & Chauhan, 2025).

Confidentiality and trade secret protection represent another significant challenge. Sandbox participation often requires disclosure of proprietary technologies, technical know-how, source code, algorithms, business models and commercially sensitive information to regulators and other participants (Valeriano Catano, 2025; Gromova & Ferreira, 2025). While such disclosures are necessary for testing and regulatory assessment, they may expose innovators to risks of information leakage, misappropriation or loss of trade secret protection, particularly where reporting and information-sharing obligations are not matched by adequate confidentiality safeguards (Gromova & Ferreira, 2025; Valeriano Catano, 2025).

The growing importance of data as a strategic innovation asset further complicates intellectual property management within sandbox ecosystems. Sandbox activities frequently generate valuable operational, transactional, technical and experimental datasets (Hews & Dunphy, 2026; Waseem et al., 2026). However, ownership, access rights, usage rights and commercial exploitation rights relating to sandbox-generated data are often unclear. The absence of effective data governance mechanisms may create uncertainty regarding the future use and monetisation of these data assets (Puri, 2025).

Licensing arrangements also present significant challenges. Sandbox participants commonly enter programmes with existing intellectual property assets (background IP) while simultaneously generating new intellectual property (foreground IP) and technological improvements during testing activities (Modilim et al., 2024). Without clear arrangements governing background intellectual property, foreground intellectual property and improvement rights, licensing disputes may arise and impede future technology deployment and commercialisation.

These challenges ultimately affect the commercialisation potential of sandbox-generated innovations. Effective commercialisation requires legal certainty regarding ownership, protection, valuation, licensing and exploitation rights. Investors, technology transfer offices and industry partners typically require clear intellectual property positions before committing resources or entering commercial arrangements (Goo & Heo, 2020; Peters, 2025). Uncertainty regarding intellectual property rights may therefore reduce investment attractiveness, hinder technology transfer and delay market deployment of innovations. Moreover, the absence of systematic intellectual property management mechanisms may prevent innovators from fully capturing the economic value generated through sandbox participation (Modilim et al., 2024; Leka, 2021).

Despite the growing significance of these issues, existing regulatory sandbox literature continues to focus primarily on regulatory design, governance structures, innovation facilitation and regulatory learning, with limited consideration of intellectual property rights management as a distinct governance dimension (Allen, 2025; Allen, 2019; Ford & Ashkenazy, 2024). Current sandbox frameworks generally lack comprehensive mechanisms governing ownership, inventorship, confidentiality, data rights, licensing arrangements and commercialisation pathways. Consequently, a significant gap exists in both scholarship and practice regarding the systematic management of intellectual property rights within regulatory sandbox ecosystems.

This gap highlights the need for a dedicated IPRMF capable of addressing the legal, technological, administrative and commercialisation challenges associated with regulatory sandbox initiatives. Such a framework would enhance legal certainty, strengthen stakeholder confidence, facilitate technology transfer, support investment readiness, reduce intellectual property disputes and improve the commercialisation outcomes of innovations developed within sandbox environments.

Literature Review

Regulatory Sandbox Initiatives and Innovation

Regulatory sandboxes have emerged as important policy instruments for promoting innovation in regulated sectors. Initially developed within the financial technology (FinTech) sector, regulatory sandboxes provide controlled environments in which innovators may test new products, services and business models under regulatory supervision while benefiting from temporary regulatory flexibility (Allen, 2019; Markellos et al., 2024; Stavi & Jovine, 2025). Since their introduction by the United Kingdom Financial Conduct Authority in 2015, sandbox initiatives have expanded globally and are now used in sectors including healthcare, artificial intelligence (AI), telecommunications, energy and the digital economy (Allen, 2019; Sharma, 2025).

The literature generally views regulatory sandboxes as responses to the regulatory “pacing problem”, whereby legal frameworks struggle to keep pace with technological innovation (Jeník & Duff, 2020). By reducing regulatory uncertainty and enabling controlled experimentation, sandboxes facilitate innovation, investment and market entry (Goo & Heo, 2020). More recent studies suggest that sandboxes have evolved beyond their original regulatory function into broader innovation ecosystems involving regulators, industry, universities, investors and consumers (Allen, 2025; Markellos et al., 2024). Contemporary

sandbox models are increasingly viewed as strategic policy tools that support innovation, competitiveness and economic development (Stavi & Jovine, 2025).

A parallel body of literature examines sandbox governance from the perspective of regulatory innovation and adaptive governance. Scholars argue that sandbox frameworks enable regulators to experiment with new governance approaches while balancing innovation promotion and public protection (Sharma, 2025). Key governance themes include regulatory flexibility, stakeholder engagement, transparency, accountability, risk management and dispute resolution (Allen, 2025). However, despite these advances, sandbox governance literature remains largely focused on regulatory learning and compliance. Intellectual property governance receives comparatively limited attention, despite the growing importance of intellectual assets within sandbox ecosystems (Ford & Ashkenazy, 2024).

Sandbox Governance and Regulatory Innovation

Intellectual property rights are widely recognised as essential components of innovation ecosystems because they encourage innovation, facilitate technology transfer, attract investment and support commercialisation activities (Truby, Dahdal & Ibrahim, 2022; Truby et al., 2022). Contemporary innovation environments, however, increasingly involve collaboration among multiple stakeholders, creating challenges for traditional intellectual property frameworks that were designed around clearly identifiable inventors and ownership structures (Gromova & Ferreira, 2025).

Studies on digital innovation and Industry 4.0 similarly emphasise that uncertainty regarding ownership, protection and exploitation rights may discourage investment and hinder technological development (Novelli et al., 2026). Within FinTech ecosystems, intellectual property governance has become an increasingly important component of innovation management, particularly in relation to proprietary software, algorithms, digital assets and technology-based business models (Peters, 2025). As a result, intellectual property management is increasingly viewed not merely as a legal function but as a strategic mechanism supporting innovation and commercialisation.

Despite these developments, the intellectual property literature rarely addresses regulatory sandbox environments specifically. Consequently, limited guidance exists regarding how ownership, protection, licensing and commercialisation rights should be managed within collaborative sandbox ecosystems.

Intellectual Property Rights in Innovation Ecosystems

Rapid advances in digital technologies have transformed the management and governance of intellectual property. Technologies such as blockchain, artificial intelligence, smart contracts and data analytics create new opportunities for protecting, monitoring and commercialising intellectual assets while simultaneously generating new legal and governance challenges.

Blockchain and smart contract technologies have been proposed as tools for improving intellectual property ownership records, licensing arrangements and technology transfer activities (Peters, 2025). At the same time, the increasing use of artificial intelligence has challenged traditional concepts of inventorship, authorship and ownership (Gromova, Koneva

and Titova, 2022). Questions arise concerning the legal status of AI-generated inventions, machine-assisted innovations and algorithmically generated outputs.

Existing intellectual property frameworks remain largely premised on human creativity and inventorship, creating uncertainty regarding the ownership and protection of AI-generated innovations (Modilim et al., 2024). Consequently, scholars increasingly argue that intellectual property governance frameworks must evolve to accommodate emerging forms of digital and AI-enabled innovation (Leka, 2021).

Although these studies contribute valuable insights into digital intellectual property governance, they rarely examine how such issues should be managed within regulatory sandbox environments where experimentation, collaboration and regulatory oversight occur simultaneously.

Digital Technologies and Intellectual Property Management

An emerging body of scholarship suggests that regulatory sandboxes create distinctive intellectual property management challenges. One of the most significant concerns relates to the tension between regulatory transparency and intellectual property protection. Sandbox participation often requires innovators to disclose proprietary technologies, business models, algorithms, source code, and commercially sensitive information to regulators and other stakeholders (Puri, 2025). Such disclosure obligations may create risks relating to confidentiality, trade secrets and competitive advantage.

Ownership and licensing issues also become more complex within sandbox environments. Collaborative testing frequently involves multiple contributors who may jointly create new technologies, software applications, datasets and technological improvements (Mahala & Chauhan, 2025). Questions therefore arise regarding ownership of background intellectual property, foreground intellectual property and subsequent improvements. Existing literature provides limited guidance on how these rights should be allocated and managed within sandbox ecosystems (Valeriano Catano, 2025).

The increasing use of artificial intelligence further complicates intellectual property governance. AI-generated innovations challenge traditional notions of inventorship and ownership, while data-driven innovation raises questions concerning ownership, access rights, commercial exploitation rights and governance of sandbox-generated data (Allen, 2025). These issues are particularly significant because data increasingly functions as a valuable commercial asset rather than merely a regulatory compliance resource (Mahala & Chauhan, 2025; Puri, 2025).

Commercialisation represents another underexplored area. Although regulatory sandboxes are intended to accelerate market deployment and innovation adoption, limited research has examined how intellectual property management influences technology transfer, licensing, investment readiness, valuation and commercialisation outcomes (Waseem et al., 2026). As investors and commercialisation partners typically require clear ownership and exploitation rights before committing resources, weaknesses in intellectual property governance may reduce the commercialisation potential of sandbox-generated innovations (Peters, 2025; Modilim et al., 2024).

Collectively, the literature identifies significant challenges relating to ownership, confidentiality, licensing, AI-generated innovation, data governance and commercialisation. While substantial scholarship exists on regulatory sandboxes, innovation governance, intellectual property rights and digital technologies, these bodies of literature have largely developed independently. Consequently, existing scholarship has not yet developed a comprehensive intellectual property rights management framework specifically designed for regulatory sandbox initiatives (Goo & Heo, 2020; Peters, 2025).

Methodology

Research Design

This study adopts a qualitative doctrinal and documentary analysis methodology to examine how existing regulatory sandbox policies, guidelines and procedures manage IPR. The study focuses on identifying whether sandbox frameworks contain adequate legal, administrative and procedural mechanisms governing intellectual property ownership, confidentiality, data rights, licensing, disclosure and commercialisation throughout the sandbox lifecycle.

The research combines three complementary approaches. First, doctrinal legal analysis is used to examine legal and regulatory provisions contained in sandbox documents. Second, content analysis is applied to identify and classify IPR-related provisions and governance mechanisms. Third, comparative policy analysis is employed to compare how different sandbox frameworks address similar intellectual property issues across jurisdictions and sectors.

Unit of Analysis and Sample Selection

The primary unit of analysis is the regulatory sandbox document, including policies, guidelines, application guides, procedural documents, legislation, regulatory toolkits and official sandbox materials. The study focuses on provisions that directly or indirectly affect intellectual property rights management.

A purposive sampling approach was adopted to select documents representing different sandbox models, sectors and jurisdictions. The sample comprises:

1. United Kingdom Financial Conduct Authority (FCA) Regulatory Sandbox Application Guide;
2. United Kingdom Financial Services and Markets Act 2023 (PISCES Sandbox Regulations 2025);
3. The Central Bank of Malaysia FinTech Regulatory Sandbox Framework;
4. Securities Commission Malaysia Regulatory Sandbox Guidelines;
5. Malaysia National Technology and Innovation Sandbox (NTIS);
6. Malaysia National Regulatory Sandbox (NRS);
7. The World Bank CGAP's How to Build a Regulatory Sandbox;
8. OECD Regulatory Sandbox Toolkit;
9. Pacific Regional Regulatory Sandbox Guidelines; and
10. Other relevant sandbox governance and procedural documents.

The UK frameworks offer insights from one of the most mature regulatory sandbox ecosystems, while the Malaysian frameworks provide examples of innovation and commercialisation-oriented sandboxes. International regulatory sandbox regulatory

instruments from the World Bank, OECD and Pacific Region are included because they provide recognised best practices for sandbox design and governance.

Data Collection and Data Analysis Approach

Data were collected through documentary review of the selected sandbox frameworks. Each document was examined to identify both express and implied treatment of intellectual property rights.

The analysis was guided by ten IPR management themes:

1. Ownership;
2. Inventorship and authorship;
3. Confidentiality and trade secrets;
4. Data rights and data governance;
5. Licensing and access rights;
6. Regulatory disclosure;
7. Commercialisation;
8. Dispute resolution;
9. Exit and post-sandbox rights; and
10. Disclosure and information governance.

These themes were selected because they represent the principal intellectual property issues arising in collaborative innovation and regulatory sandbox environments.

Stages of Analysis

The analysis was conducted through a systematic five-stage process to ensure consistency and comparability across the selected regulatory sandbox frameworks. The first stage involved document mapping, whereby each regulatory sandbox policy, guideline and procedural document was classified according to its jurisdiction, sector, sandbox model and legal status. This provided a structured overview of the regulatory landscape and facilitated cross-jurisdictional comparison.

The second stage comprised keyword identification, in which the documents were examined for provisions relating to intellectual property rights management. Keywords and concepts including intellectual property, ownership, inventorship, confidentiality, trade secrets, data governance, licensing, disclosure, technology transfer and commercialisation were identified to locate relevant provisions and governance mechanisms.

The third stage involved thematic coding, whereby the identified provisions were categorised according to the ten intellectual property rights (IPR) management themes developed for this study. This enabled a systematic assessment of how each sandbox framework addressed the various dimensions of intellectual property governance.

The fourth stage consisted of gap analysis, in which each framework was evaluated to determine whether the identified IPR management themes were addressed expressly, partially, implicitly or not at all. This stage facilitated the identification of governance strengths, deficiencies and areas requiring further development.

Finally, the fifth stage involved comparative synthesis, whereby the findings from the United Kingdom, Malaysian and international sandbox frameworks were compared to identify common approaches, regulatory differences and emerging best practices. The comparative analysis formed the basis for identifying existing governance gaps and informed the development of the proposed Intellectual Property Rights Management Framework (IPRMF) for Regulatory Sandbox Initiatives.

Sandbox Lifecycle Analysis

To assess the extent of IPR integration, the study analysed sandbox frameworks across six stages of the sandbox lifecycle:

1. Pre-Application;
2. Application and Evaluation;
3. Testing and Validation;
4. Monitoring and Reporting;
5. Exit and Transition; and
6. Commercialisation and Scaling.

This lifecycle approach enables assessment of whether intellectual property rights are managed consistently throughout the innovation journey rather than only at a single stage of sandbox participation.

Evaluation Criteria

The adequacy of IPR management within each framework was assessed using seven criteria:

1. Clarity;
2. Coverage;
3. Lifecycle Integration;
4. Stakeholder Protection;
5. Commercialisation Readiness;
6. Dispute Prevention; and
7. Regulatory Balance.

These criteria provide a structured basis for evaluating the effectiveness of sandbox frameworks in managing intellectual assets while balancing innovation, transparency and regulatory objectives.

Limitations

The study is limited to documentary analysis and does not assess implementation practices unless reflected in the analysed documents. It also does not evaluate the commercial performance of sandbox participants. Nevertheless, the selected documents provide a sufficient basis for identifying how intellectual property rights are currently addressed within regulatory sandbox governance frameworks.

Analysis of Regulatory Sandbox Policies, Guidelines and Procedures

Overview of the Analysed Sandbox Frameworks

The analysis of United Kingdom, Malaysian and international sandbox frameworks demonstrates that contemporary regulatory sandboxes are primarily designed to facilitate innovation, regulatory experimentation, risk management and commercial deployment. The UK FCA Regulatory Sandbox and PISCES Sandbox Regulations provide more extensive

governance mechanisms relating to disclosure, information management, reporting and regulatory oversight. Malaysian frameworks, including the Central Bank of Malaysia Regulatory Sandbox, Securities Commission Regulatory Sandbox, NTIS and NRS, focus on innovation testing, regulatory flexibility and commercial readiness.

Across all frameworks, regulatory governance is generally well developed. However, intellectual property rights management remains largely absent as a dedicated governance component.

Ownership and Licensing Governance

A notable finding is the growing importance of disclosure governance within modern sandbox frameworks. The FCA Regulatory Sandbox and PISCES Sandbox Regulations require extensive disclosures relating to innovation design, testing methodologies, business models, risk management, reporting and commercialisation plans. These frameworks also contain detailed provisions governing regulatory reporting, supervisory oversight and information management.

However, corresponding safeguards for proprietary technologies, trade secrets, algorithms and commercially sensitive information remain comparatively weak. While sandbox participants are required to disclose significant amounts of information, explicit mechanisms for protecting confidential intellectual assets are limited.

Consequently, the analysis reveals a governance imbalance between regulatory transparency and intellectual property protection.

Confidentiality, Disclosure and Information Governance

Confidentiality receives considerably greater attention than ownership, although its treatment remains uneven. The FCA Regulatory Sandbox Application Guide requires applicants to disclose detailed technical, commercial, operational and regulatory information concerning their innovations, testing methodologies, business models, customer segments and technological architecture. Applicants must also provide information relating to testing partners, operational dependencies and future commercialisation plans.

Similarly, the PISCES Sandbox Regulations establish extensive disclosure arrangements requiring companies and sandbox participants to provide information to regulators and investors. The regulations contain detailed provisions relating to disclosure governance, supervisory information requests, reporting obligations and liability for inaccurate disclosures. However, while the regulations create disclosure obligations, they provide limited explicit protection for trade secrets, proprietary know-how, algorithms or confidential commercial information disclosed during sandbox participation.

The OECD Toolkit remains one of the few documents that expressly recognises intellectual property rights, confidentiality and transparency as interconnected governance issues requiring formal management.

The overall finding is that sandbox frameworks impose substantial disclosure obligations but provide comparatively limited safeguards for confidential intellectual assets. Consequently, trade secret protection remains underdeveloped.

Data Governance

Data governance is more extensively addressed than ownership and licensing, particularly through reporting and monitoring requirements. Sandbox participants are commonly required to collect, monitor and report testing data throughout the sandbox lifecycle.

Nevertheless, existing frameworks generally regulate data from a compliance and supervisory perspective rather than as a commercial or intellectual asset. Few frameworks distinguish between operational data, AI training data, commercially valuable datasets or sandbox-generated innovation data. Questions concerning ownership, access rights, reuse rights and commercial exploitation remain largely unresolved.

Accordingly, data governance is only partially integrated into intellectual property management.

Commercialisation and Technology Transfer

Commercialisation is a central objective of most sandbox initiatives. FCA Sandbox, PISCE, NTIS and NRS all seek to facilitate innovation deployment, market entry and investment activities. Sandbox participants are commonly required to identify post-testing strategies, scaling plans and commercial objectives.

Despite this strong commercial orientation, intellectual property management is rarely integrated into commercialisation planning. Existing frameworks provide limited guidance on intellectual property valuation, licensing strategies, technology transfer, spin-off formation, revenue-sharing arrangements or intellectual asset monetisation. As a result, commercialisation is treated primarily as a regulatory and business objective rather than as an intellectual property management process.

Comparative Assessment

The comparative analysis demonstrates clear differences between regulatory governance and intellectual property governance.

Governance Area	Classification	Overall Assessment
Ownership	IP governance	Weak
Licensing	IP governance	Weak
Trade Secret Protection	IP governance	Weak
Data Rights	IP governance	Moderate
Confidentiality	IP governance	Moderate
Commercialisation Support	Regulatory governance	Strong
Regulatory Disclosure	Regulatory governance	Strong
Information Governance	Regulatory governance	Strong
Regulatory Oversight	Regulatory governance	Strong
IP Dispute Resolution	IP governance	Weak

International toolkits such as the OECD Regulatory Sandbox Toolkit provide broader recognition of intellectual property concerns than many operational sandbox frameworks. However, even these documents stop short of providing a comprehensive intellectual property governance model.

Key Governance Gaps

The analysis identifies six major gaps:

1. Absence of ownership frameworks for background and foreground intellectual property.
2. Lack of licensing and access-rights governance.
3. Incomplete protection of confidential information and trade secrets.
4. Limited recognition of data as an intellectual asset.
5. Weak integration between intellectual property management and commercialisation.
6. Insufficient balance between disclosure obligations and protection of proprietary information.

Collectively, these deficiencies create legal uncertainty regarding ownership, confidentiality, data rights, licensing and commercial exploitation of innovations developed within sandbox environments.

Overall Finding

The overall finding is that existing regulatory sandbox frameworks manage intellectual property rights only partially and indirectly. While the analysed frameworks provide sophisticated mechanisms for regulatory supervision, disclosure governance, information management, testing and commercial deployment, they do not provide a comprehensive framework governing ownership, licensing, confidentiality, data rights, technology transfer or post-sandbox exploitation of intellectual assets.

The findings therefore support the development of a dedicated Intellectual Property Rights Management Framework (IPRMF) capable of integrating intellectual property governance throughout the regulatory sandbox lifecycle.

Discussion

The analysis reveals a fundamental mismatch between the innovation and commercialisation objectives of regulatory sandbox initiatives and the governance of intellectual property rights generated during sandbox participation. Although contemporary sandbox frameworks provide sophisticated mechanisms for regulatory supervision, disclosure governance, information management and market oversight, intellectual property governance remains fragmented and underdeveloped. This finding suggests that intellectual property rights management has not evolved at the same pace as broader sandbox governance.

Regulatory Sandboxes as Innovation-Commercialisation Ecosystems

The findings confirm that regulatory sandboxes have evolved beyond their original function as regulatory testing environments. Frameworks such as the FCA Regulatory Sandbox, NTIS, NRS, the Central Bank of Malaysia Regulatory Sandbox and the Securities Commission Malaysia Regulatory Sandbox increasingly operate as innovation ecosystems involving regulators, universities, research institutions, start-ups, investors and industry partners. This observation is consistent with the literature, which characterises regulatory sandboxes as broader instruments for innovation, economic development and market transformation rather than merely regulatory experimentation tools (Allen, 2025; Markellos et al., 2024).

However, while sandbox governance has expanded to support innovation and commercialisation activities, intellectual property governance has not undergone a similar transformation. Most frameworks continue to emphasise regulatory compliance, disclosure

obligations and risk management while providing limited guidance on ownership, licensing, technology transfer and commercial exploitation of intellectual assets. Consequently, intellectual property governance remains one of the least developed dimensions of sandbox administration.

Ownership and Licensing as Foundational Governance Gaps

The most significant weakness identified across the analysed frameworks is the absence of clear ownership and licensing mechanisms. Existing sandbox frameworks rarely distinguish between background intellectual property, foreground intellectual property, jointly developed intellectual property or improvement rights. This creates uncertainty in collaborative environments where multiple stakeholders contribute technology, expertise, infrastructure and data.

Ownership uncertainty has significant commercial implications. Investors, licensing partners and technology transfer offices generally require clear ownership positions before committing resources or entering commercial arrangements. As Peters observes, contemporary innovation ecosystems increasingly challenge traditional assumptions regarding ownership and control of intellectual assets (Peters, 2025). Without clear ownership and licensing arrangements, the commercial value of innovations generated during sandbox participation may be difficult to realise.

The findings therefore suggest that ownership and licensing governance should be recognised as foundational components of sandbox governance rather than matters left solely to private contractual arrangements.

Disclosure Governance versus Intellectual Property Protection

One of the most important findings arising from the UK FCA Sandbox and PISCES Sandbox Regulations is the growing sophistication of disclosure governance and information governance. Modern sandbox frameworks increasingly require participants to disclose technical, operational, financial and commercial information throughout the sandbox lifecycle. These disclosure obligations support regulatory learning, market integrity and evidence-based policymaking.

However, the analysis also reveals a significant governance imbalance. While disclosure obligations are highly developed, corresponding safeguards for proprietary technologies, trade secrets, algorithms, software and commercially sensitive information remain comparatively weak. Sandbox participants may therefore be required to disclose valuable intellectual assets without adequate protection against misuse, unauthorised disclosure or loss of competitive advantage.

This finding reinforces Valeriano Catano's argument (2025) that regulators must balance transparency obligations with intellectual property protection). Future sandbox frameworks must therefore move beyond disclosure governance alone and incorporate stronger confidentiality, information governance and trade secret protection mechanisms.

Data and Artificial Intelligence as Emerging Intellectual Assets

The findings further demonstrate that existing sandbox frameworks generally treat data as a compliance, reporting or supervisory issue rather than as a strategic intellectual asset. While extensive data collection and reporting obligations are common, few frameworks address ownership, access rights, commercial exploitation rights or post-testing use of sandbox-generated data.

This issue becomes increasingly important as regulatory sandboxes are used to test artificial intelligence, machine learning and other data-driven technologies. AI systems frequently generate valuable datasets, models, software outputs and machine-assisted innovations. Yet current frameworks provide little guidance regarding ownership, inventorship, authorship or commercialisation of these outputs.

The concerns identified in this study are consistent with the observations of Mahala and Chauhan and Puri, who argue that traditional intellectual property frameworks are not adequately equipped to address machine-generated innovations and AI-enabled technologies (Mahala & Chauhan, 2025). As AI adoption increases across sandbox environments, intellectual property governance frameworks must evolve to accommodate new forms of digital and data-driven innovation.

Towards an Integrated Intellectual Property Rights Management Framework

Collectively, the findings indicate that existing sandbox frameworks are strong in regulatory governance, disclosure governance and information management but weak in intellectual property governance. Ownership and licensing issues remain unresolved, confidentiality protections are incomplete, data governance is insufficiently integrated with intellectual property management, and commercialisation pathways are rarely linked to intellectual property strategy.

These governance deficiencies support the development of a dedicated IPRMF for regulatory sandbox initiatives. Such a framework should integrate intellectual property identification, ownership management, disclosure governance, confidentiality protection, data governance, licensing, technology transfer, commercialisation planning and dispute resolution throughout the sandbox lifecycle.

By embedding intellectual property governance within sandbox operations, regulatory sandboxes can better support innovation, regulatory learning, investment attraction and commercialisation outcomes. Intellectual property rights management should therefore be recognised as a core governance pillar of future sandbox ecosystems rather than a peripheral legal consideration.

Proposed Intellectual Property Rights Management Framework for Regulatory Sandbox Initiatives*Overview*

The analysis demonstrates that existing regulatory sandbox frameworks provide strong regulatory oversight, disclosure governance, information management and commercialisation support but remain weak in intellectual property governance. Significant

gaps exist in relation to ownership, licensing, confidentiality, data governance, technology transfer and commercial exploitation of intellectual assets.

To address these deficiencies, this article proposes an IPRMF for Regulatory Sandbox. The framework is designed to provide a structured approach to identifying, protecting, managing and commercialising intellectual assets generated, disclosed or validated during sandbox participation.

Guiding Principles

The framework is guided by seven principles:

1. Legal Certainty – clear rights and obligations regarding ownership, protection, licensing and commercialisation.
2. Innovation Promotion – facilitating experimentation, collaboration and technological development.
3. Commercialisation Orientation – supporting technology transfer, investment readiness and market deployment.
4. Transparency and Accountability – ensuring regulatory oversight and governance integrity.
5. Protection of Proprietary Information – balancing disclosure obligations with confidentiality and trade secret protection.
6. Stakeholder Fairness – ensuring equitable treatment of innovators, regulators, universities, investors and industry partners.
7. Technological Neutrality – accommodating traditional and emerging forms of intellectual assets, including data and AI-generated innovations.

Framework Structure

The proposed framework comprises eight interrelated pillars operating across six stages of the sandbox lifecycle.

Eight Pillars

1. Intellectual Property Identification and Disclosure Management;
2. Intellectual Property Ownership Management;
3. Disclosure and Information Governance Management;
4. Intellectual Property Protection Management;
5. Data and Digital Asset Management;
6. Licensing and Access Rights Management;
7. Commercialisation and Technology Transfer Management; and
8. Intellectual Property Dispute Resolution Management.

Sandbox Lifecycle Stages

1. Pre-Application;
2. Application and Evaluation;
3. Testing and Validation;
4. Monitoring and Reporting;
5. Exit and Transition; and
6. Commercialisation and Scaling.

Pillar 1: Intellectual Property Identification and Disclosure Management

Participants should submit an Intellectual Property Disclosure Statement identifying:

1. background intellectual property;
2. third-party intellectual property;
3. open-source technologies;
4. proprietary data assets;
5. trade secrets and confidential information; and
6. anticipated foreground intellectual property.

This establishes the foundation for ownership, protection and commercialisation decisions throughout the sandbox lifecycle.

Pillar 2: Intellectual Property Ownership Management

To minimise ownership disputes, sandbox participants should enter into an Intellectual Property Ownership Agreement before testing commences. The agreement should address:

1. background intellectual property;
2. foreground intellectual property;
3. jointly developed intellectual property;
4. improvement rights;
5. derivative technologies; and
6. regulator or government contributions.

Pillar 3: Disclosure and Information Governance Management

Given the increasing importance of disclosure obligations within sandbox environments, a dedicated disclosure governance mechanism is required.

This pillar regulates:

1. application disclosures;
2. testing and monitoring reports;
3. confidentiality classifications;
4. regulator, investor and third-party access rights; and
5. information retention and disposal requirements.

Its primary objective is to balance regulatory transparency with protection of commercially valuable intellectual assets.

Pillar 4: Intellectual Property Protection Management

This pillar focuses on safeguarding intellectual assets throughout sandbox participation through:

1. confidentiality protocols;
2. trade secret protection;
3. source code and algorithm protection;
4. regulatory information protection procedures; and
5. appropriate intellectual property registration strategies, including patents, copyrights, trademarks and industrial designs.

Pillar 5: Data and Digital Asset Management

Recognising data as a strategic intellectual asset, this pillar addresses:

1. ownership of operational, transactional, experimental and AI-related data;
2. access and usage rights;

3. data commercialisation and monetisation rights; and
4. retention, storage and disposal requirements.

Pillar 6: Licensing and Access Rights Management

This pillar establishes clear rules governing:

1. background IP access;
2. foreground IP exploitation;
3. improvement rights;
4. regulator and third-party access rights; and
5. open innovation arrangements.

The objective is to ensure certainty regarding utilisation rights before commercialisation activities commence.

Pillar 7: Commercialisation and Technology Transfer Management

To strengthen commercial outcomes, this pillar incorporates:

1. intellectual property valuation;
2. technology transfer planning;
3. licensing strategy development;
4. investment readiness assessment; and
5. spin-off and start-up formation strategies.

The pillar links intellectual property governance directly to commercialisation objectives.

Pillar 8: Intellectual Property Dispute Resolution Management

This pillar provides mechanisms for resolving disputes relating to:

1. ownership;
2. licensing;
3. confidentiality;
4. data usage; and
5. commercialisation rights.

Proposed mechanisms include internal review procedures, mediation, arbitration and regulatory review processes.

Sandbox Lifecycle Integration

The framework integrates intellectual property governance throughout the sandbox lifecycle.

Sandbox Stage	Primary IPR Management Activities
Pre-Application	IP identification, ownership mapping and confidentiality planning
Application	IP disclosure, information governance and ownership declarations
Testing	IP protection, data governance and licensing management
Monitoring	Reporting controls and confidentiality safeguards
Exit	Ownership confirmation, licensing finalisation and data disposition
Commercialisation	Technology transfer, valuation, licensing and investment readiness

Expected Outcomes

Implementation of the IPRMF is expected to strengthen intellectual property governance throughout the regulatory sandbox lifecycle. By providing clear mechanisms for ownership, licensing, disclosure, protection, data governance and commercialisation, the framework enhances legal certainty and reduces ambiguity regarding the management and exploitation

of intellectual assets. It also strengthens the protection of confidential information, trade secrets and proprietary technologies while ensuring that regulatory transparency and information-sharing obligations are balanced with appropriate intellectual property safeguards.

In addition, the framework supports technology transfer and commercialisation by integrating intellectual property management into innovation validation, licensing strategies and market deployment. This is expected to improve investor confidence by providing greater certainty regarding ownership, commercial rights and investment readiness, while reducing the likelihood of disputes arising from ownership, licensing, confidentiality and data governance issues.

More broadly, the framework promotes stronger innovation and commercialisation outcomes by embedding intellectual property governance as an integral component of regulatory sandbox administration rather than treating it as a separate legal consideration. It therefore transforms intellectual property rights management into a strategic governance mechanism that supports innovation, regulatory learning, investment attraction and technology commercialisation across the entire sandbox ecosystem.

Figure 1 illustrates the proposed IPRMF and demonstrates how the eight governance pillars operate across the six-stage regulatory sandbox lifecycle to provide continuous and integrated management of intellectual property rights from pre-application through to commercialisation and market expansion.

SANDBOX LIFECYCLE STAGE	1 IP IDENTIFICATION & DISCLOSURE MANAGEMENT	2 IP OWNERSHIP MANAGEMENT	3 DISCLOSURE & INFORMATION GOVERNANCE MANAGEMENT	4 IP PROTECTION MANAGEMENT	5 DATA & DIGITAL ASSET MANAGEMENT	6 LICENSING & ACCESS RIGHTS MANAGEMENT	7 COMMERCIALISATION & TECHNOLOGY TRANSFER MANAGEMENT	8 IP DISPUTE RESOLUTION MANAGEMENT
1 PRE-APPLICATION STAGE	- Identify and map IP assets - IP disclosure checklist - Background IP declaration - Open-source review	- Clarify background IP ownership - Identify co-owners - Ownership intention statement	- Identify information to be disclosed - Classify information - Define confidentiality boundaries	- Plan IP protection strategy - Confidentiality requirements - Trade secret identification	- Identify data types - Data ownership mapping - Data sensitivity assessment	- Identify IP needs for testing - Check licensing requirements - Access rights planning	- Assess commercial potential - IP valuation (preliminary) - Market & technology landscape review	- Identify potential IP risks & conflicts - Agree dispute resolution method
2 APPLICATION & EVALUATION STAGE	- Review IP disclosures - Validate declarations - Identify gaps	- Evaluate ownership adequacy - Confirm joint development areas	- Assess disclosure adequacy - Information governance plan review	- Assess IP protection measures - Review confidentiality undertakings	- Evaluate data management plan - Review data security measures	- Review licensing arrangements - Confirm access rights	- Assess IP strategy - Evaluate commercial viability - Assess investment readiness	- Confirm dispute resolution clauses - Review governing law & jurisdiction
3 TESTING & VALIDATION STAGE	- Record new IP developments - Maintain IP inventory - Update disclosure	- Apply ownership agreement - Document contributions - Manage joint IP	- Implement information governance controls - Restrict information sharing - Monitor compliance	- Implement IP protection measures - Protect confidential information - Monitor for IP leakage	- Collect and store data safely - Enforce data security - Manage AI/ML data & models	- Manage background IP licences - Record improvement rights - Ensure third-party IP compliance	- Refine IP strategy - Identify potential licensees/partners - Track commercial opportunities	- Monitor IP-related issues - Early resolution of disagreements
4 MONITORING & REPORTING STAGE	- Report IP development progress - Update IP inventory - Track IP allocation	- Monitor compliance with ownership agreement - Review changes in contributions	- Monitor confidentiality compliance - Review information access logs	- Monitor IP protection activities - Reinforce confidential status	- Monitor data usage - Ensure data quality - Verify compliance with data rules	- Monitor licence compliance - Review access rights usage	- Assess market readiness - Update IP valuation - Engage investors/partners	- Handle IP complaints - Mediate where necessary
5 EXIT & TRANSITION STAGE	- Finalise IP inventory - Identify foreground IP - Prepare IP handover documents	- Confirm ownership of foreground IP - Settle joint IP arrangements - Document rights	- Secure and protect information - Confirm trade secret safeguards	- Determine data retention/deletion - Return or anonymise data as agreed	- Finalise data disposition - Define post-sandbox access rights	- Finalise licensing agreements - Prepare technology transfer plan - Identify commercial pathways	- Final IP valuation - Prepare technology transfer plan - Identify commercial partners	- Resolve outstanding IP disputes - Document settlement (if any)
6 COMMERCIALISATION & SCALING STAGE	- Maintain IP portfolio - File for IP protection (patents, trademarks, copyrights, etc.) - Monitor IP landscape	- Enforce ownership rights - Manage co-ownership governance	- Continue information governance - Manage post-exit confidentiality obligations	- Continue IP protection strategy - Enforce rights - Manage trade secret programs	- Commercialise data ethically - License or monetise data (where permitted)	- Execute commercial licences - Manage royalties - Expand access agreements	- Commercialise innovation - Technology transfer - Scale and expand to market	- Manage ongoing IP disputes - Use arbitration/litigation if needed

Figure 1 Intellectual Property Rights Management Framework for Regulatory Sandbox Initiatives.

Practical Implications

The proposed IPRMF has important implications for regulators, policymakers, innovation agencies, universities, start-ups, investors and industry participants involved in regulatory sandbox initiatives. The framework addresses a major governance gap identified in this study by integrating intellectual property rights management into the sandbox lifecycle.

For regulators and sandbox administrators, the framework provides a structured mechanism for incorporating intellectual property governance into sandbox policies, application processes, participation agreements, monitoring requirements and exit procedures. In particular, the framework introduces dedicated mechanisms for ownership management, disclosure governance, information governance, confidentiality protection and dispute resolution. This enables regulators to balance regulatory transparency and supervisory objectives with the protection of proprietary technologies and commercially sensitive information.

For governments and innovation agencies, the framework strengthens the relationship between regulatory sandbox initiatives and national innovation and commercialisation policies. By clarifying ownership, licensing and commercialisation rights, the framework supports technology transfer, entrepreneurship development, investment attraction and more effective utilisation of public investments in research and innovation.

For universities, research institutions and technology developers, the framework provides greater certainty regarding the management of background intellectual property, foreground intellectual property and jointly developed innovations. The framework also supports technology transfer offices and commercialisation units by establishing clearer processes for intellectual property disclosure, ownership allocation, licensing arrangements and commercialisation planning.

For start-ups, investors and industry partners, the framework reduces legal uncertainty relating to ownership, confidentiality, licensing and commercial exploitation rights. Clear intellectual property arrangements improve investment readiness, facilitate intellectual property due diligence and strengthen confidence in sandbox-generated innovations. The integration of intellectual property valuation, technology transfer planning and licensing strategies further enhances commercialisation opportunities.

A key contribution of the framework is its recognition of disclosure governance, data governance and artificial intelligence-related innovation as integral components of intellectual property governance. By addressing ownership, access rights and commercialisation of sandbox-generated data and digital assets, the framework responds to emerging challenges associated with data-driven and AI-enabled innovation.

Overall, the framework transforms intellectual property rights management from a peripheral legal issue into a strategic governance and commercialisation mechanism. By integrating intellectual property governance, disclosure governance, data governance and technology transfer within a single framework, regulatory sandboxes can better support innovation, investment attraction, technology commercialisation and long-term economic value creation.

Suggestion For Future Research

While this study proposes an IPRMF for Regulatory Sandbox Initiatives, further research is required to validate and refine the framework across different regulatory and technological contexts.

First, future studies should empirically assess the framework through interviews, surveys and case studies involving regulators, sandbox administrators, innovators, universities, investors and industry participants. Such research would provide practical evidence on the effectiveness of the framework in addressing ownership, confidentiality, disclosure, licensing, data governance and commercialisation issues.

Second, comparative research should examine intellectual property governance across different sandbox jurisdictions and models. Extending the analysis to jurisdictions such as Singapore, the European Union, the United States and China may identify additional best practices and contribute to the development of international principles for intellectual property management in sandbox environments.

Third, future studies should explore sector-specific challenges in areas such as fintech, artificial intelligence, healthcare, telecommunications, energy and agriculture. Different sectors involve distinct regulatory requirements, intellectual assets and commercialisation pathways that may require tailored governance approaches.

Fourth, further research is needed on disclosure governance, information governance and data governance. As sandbox frameworks increasingly rely on extensive reporting and information-sharing obligations, future studies should examine how regulatory transparency can be balanced with the protection of proprietary information, trade secrets and commercially valuable data. Particular attention should be given to issues relating to data ownership, access rights, cross-border data sharing and commercial exploitation of sandbox-generated data.

Fifth, additional research should investigate emerging issues involving artificial intelligence, machine-generated innovation, blockchain and smart contract technologies. These developments raise new questions regarding inventorship, ownership, licensing and digital asset management within sandbox ecosystems.

Finally, future studies should examine the relationship between intellectual property governance and commercialisation performance, including its impact on technology transfer, investment attraction, licensing activities, start-up formation and market deployment. Such research would strengthen understanding of how intellectual property governance contributes to successful innovation and commercialisation outcomes in regulatory sandbox environments.

Conclusion

Regulatory sandbox initiatives have become important mechanisms for supporting innovation, regulatory experimentation and commercialisation across a wide range of technological sectors. The comparative analysis of sandbox frameworks from Malaysia, the United Kingdom and selected international sandbox toolkits demonstrates that contemporary

sandbox governance has evolved considerably in areas such as regulatory oversight, disclosure governance, information management and commercialisation support. However, the study also reveals that IPR management remains one of the least developed dimensions of sandbox governance.

The findings indicate that key issues relating to intellectual property ownership, licensing, confidentiality, data rights, technology transfer and commercialisation are often addressed only indirectly or not at all. While modern sandbox frameworks increasingly require extensive disclosure and information-sharing obligations, corresponding safeguards for proprietary technologies, trade secrets and commercially valuable intellectual assets remain limited. These gaps may create legal uncertainty, discourage collaboration and investment, and reduce the commercialisation potential of innovations developed within sandbox environments.

To address these deficiencies, this article proposes an IPRMF for Regulatory Sandbox Initiatives. The framework comprises eight interrelated pillars integrated across the six-stage sandbox lifecycle, providing a structured approach to managing intellectual assets from initial participation through to commercialisation and market deployment. The framework incorporates ownership management, disclosure governance, intellectual property protection, data governance, licensing, technology transfer and dispute resolution as core governance components.

This study contributes to the regulatory sandbox literature by identifying intellectual property governance as a critical but underexplored aspect of sandbox design and operation. More importantly, it demonstrates that effective sandbox governance requires not only regulatory flexibility and innovation support, but also robust mechanisms for managing and commercialising intellectual assets. Integrating intellectual property rights management into sandbox governance can strengthen innovation ecosystems, enhance investor confidence, improve technology transfer outcomes and maximise the economic and societal value generated from sandbox-enabled innovation.

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