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REGULATORY SANDBOXES: GLOBAL EXPERIENCES AND LESSONS FOR HO CHI MINH CITY IN IMPLEMENTING THE NATIONAL ASSEMBLY'S RESOLUTION NO. 98/2023/QH15

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ABSTRACT

The rapid expansion of digital technologies has intensified regulatory challenges related to innovation, market stability, and consumer protection. Regulatory sandboxes, controlled environments for supervised experimentation, have emerged as key adaptive regulatory tools. This study conducts a PRISMA-based systematic review of 94 eligible studies drawn from academic databases and international institutional sources to examine global sandbox governance, operational models, performance indicators, and implementation challenges. Findings show that sandboxes function as policy learning laboratories, enabling regulators to test emerging technologies, reduce information asymmetries, and refine legal frameworks. Cross-country comparisons reveal substantial variation in governance design, inclusiveness, and market impact. Common challenges include resource constraints, inconsistent participation rates, limited data availability, and cross-border regulatory fragmentation. Effective practices identified across jurisdictions include digitally enabled supervision, standardized KPIs, hybrid sandbox–innovation hub models, and international coordination mechanisms. The study offers evidence-based recommendations to support Vietnam, particularly Ho Chi Minh City, in implementing experimental and adaptive regulatory mechanisms aligned with Resolution 98/2023/QH15.

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1. Introduction

Sandboxes are becoming increasingly important in managing innovation, especially with emerging technologies. Sandboxes provide a controlled environment for fintech, digital health, big data, and artificial intelligence companies to test new products and services under regulatory oversight (Aydin & Yardımcı, 2024; Cornelli et al., 2023; Allen et al., 2022; Alaassar et al., 2021; OECD, 2020; Zetzsche et al., 2020). Previously, sandboxes focused primarily on the financial sector. Now, sandboxes have expanded to other areas such as healthcare, digital identity, environment, and education (Cornelli et al., 2024; Ahern, 2021; Leckenby et al., 2021). The rapid development of sandbox models is based on theories of experimental and adaptive governance, emphasizing the role of experimentation, continuous learning, multilateral collaboration, and co creation of policy between the state and the private sector (McCarthy, 2023; Gil-Garcia et al., 2016; Chaffin et al., 2014; Sabel & Zeitlin, 2012). In fast paced innovation markets, traditional policies often lag, creating barriers and legal gaps. Sandbox models address these bottlenecks through controlled experimentation, accumulating legal governance knowledge, and promoting the diffusion of innovation (World Bank, 2024). As of 2024, more than 70 countries/territories have adopted sandbox models (World Bank, 2024; Tran Quoc Thinh, 2019). Notable models include FCA (UK) and MAS (Singapore) (Pham et al., 2025).

Sandboxes play a balancing role between "open ideas" and risk control. Unlike traditional legal frameworks, sandboxes flexibly limit the scope, time, subjects, and control of testing, responding to best practices and providing feedback on legal adjustments to ensure risk prevention (OECD, 2023; Cornelli et al., 2024; Leckenby et al., 2021; Brown & Piroska, 2022). Beyond their testing role, sandboxes also serve as "open forums" facilitating multilateral dialogue between government and businesses, helping to disseminate innovative knowledge more transparently (Lauren, 2022; Gil-Garcia et al., 2016). Sandboxes help shorten commercialization cycles, accelerate regulatory adaptation, increase market entry rates, enhance risk control, and protect the innovation ecosystem (World Bank, 2024; Cornelli et al., 2023; Beckstedde et al., 2023; Leckenby et al., 2021).

Many places also take advantage of PPPs, linking innovation labs/investment funds to increase value and spillover effects (Barany et al., 2024). However, sandboxes are not "omnipotent"; many difficulties still exist in standardizing indicators, shifting models across industries, and a lack of data or transparent processes (Allen et al., 2022; Leckenby et al., 2021; Cohn et al., 2024). Especially for developing countries, factors such as implementation costs, management capacity, and the risk of monopoly/benefiting only powerful groups pose significant problems (Brown & Piroska, 2022; World Bank, 2024; BIS, 2023). In Vietnam, sandboxes are becoming a "lever" to promote institutional innovation and remove obstacles to creativity, especially in digital transformation and the implementation of digital management. Sandboxes are seen as a bridge that helps shorten the testing time for new solutions under stricter and more transparent risk management (Cornelli et al., 2024; Lauren, 2022; Leckenby et al., 2021).

This research focuses on answering three main questions: Research Question 1: How does sandbox model management relate to overall management effectiveness? Research Question 2: Which operational components are effective and scalable across various sectors in Ho Chi Minh City? Research Question 3: What experiences are relevant for Ho Chi Minh City to implement sandboxes in practice over the next 18-24 months? The research methodology

is based on analyzing existing sandbox models through comparative analysis of operational methods, KPI standardization, and monitoring of policy learning loops. The combined analysis results provide a basis for proposing practical solutions regarding control, clear allocation of responsibilities across sectors, and standardization of the sandbox management roadmap (World Bank, 2024; Cornelli et al., 2023; BIS, 2023; Allen et al., 2022; Lauren, 2022).

2. Literature review and theoretical background

2.1. Management sandbox concept

Regulatory sandboxes can be considered a leading innovation model that allows businesses and startups to test products and services under the control, supervision, and support of regulatory bodies before launching to the market (Schilling de Carvalho, 2022; Allen et al., 2022; Alaassar et al., 2021; Zetzsche et al., 2017). The widespread adoption of sandboxes globally demonstrates that they are not only a tool for technological innovation but also a tool for protecting systems and consumers. In rapidly developing fields such as big data, artificial intelligence, healthcare, and energy, regulatory sandboxes play an even more crucial role (Aydın & Yardımcı, 2024; Beckstedde et al., 2023; Leckenby et al., 2021). Sandboxes are developed based on the theory of experimental and adaptive governance, emphasizing flexible policy design, iterative testing, and adjustments based on real world feedback (Chaffin et al., 2014; Sabel & Zeitlin, 2012). Some modern sandboxes also integrate more elements such as dispute resolution, security, privacy, and data access (Raudla et al., 2025; Gromova & Ferreira, 2025; Chen et al., 2024). Sandboxes currently are viewed as policy laboratories due to their capacity to produce empirical evidence for governance, augment legitimacy, and stimulate innovation (Qiu, 2025; Buscemi et al., 2025; Johnson, 2024). Zakharova-Goodman (2024) emphasizes that sandboxes create multidimensional connections between culture, science, and society, thereby dismantling conventional frameworks.

2.2. Global transfer, diffusion, and convergence

Several studies indicate that the United Kingdom is a pioneer in the sandbox model, allowing other countries to learn from its model and apply it to local operations (Cornelli et al., 2024; Allen et al., 2022; Fahy, 2022; Bennett & Raab, 2020; Zetzsche et al., 2020; Dolowitz & Marsh, 2012). This sandbox model allows for flexible adjustment of regulations at the local level, the establishment of expert advisory boards, multi level risk measurement, and integration of monitoring systems. Furthermore, sandboxes can be used for simultaneous testing across multiple fields such as financial technology, artificial intelligence, energy, social data, and personalized education. (Hellmann et al., 2024; Barany et al., 2024; Zheng & Wu, 2024; Ford & Ashkenazy, 2024; Lei et al., 2024; Alaassar et al., 2021). Recent studies indicate that when expanding beyond the financial sector, experimental models need to incorporate industry specific elements, consider relevant legal issues, and ensure transparency (Johnson, 2024; Chen, 2023; Truby et al., 2022; Lauren, 2022).

2.3. Expanding and innovative ecosystem

Originating from the financial technology (fintech) sector, sandboxes have now spread to digital health, energy, digital identity, education, open data, and social innovation (Qiu, 2025; OECD, 2023; Alaassar et al., 2021; Leckenby et al., 2021). Experimental models are interested and increasingly collaborate with many groups such as universities, technology incubators, investors, innovation centers, and startups to create experimental ecosystems and facilitate technology transfer effectively (Cornelli et al., 2024; Barany et al., 2024; Lei et al., 2024; Cohn et al., 2024; Gil-Garcia et al., 2016). Placed within an open ecosystem, sandboxes

help accelerate the commercialization of ideas, attract investment capital, and speed up the policy adjustment process (Hellmann et al., 2024; Beckstedde et al., 2023; Allen et al., 2022; Lauren, 2022).

2.4. Operating framework and performance evaluation

The sandbox process includes the following steps: approval, supervised testing, risk assessment, progress reporting, and precise "exit/market" mechanisms (Alaassar et al., 2021; Zetzsche et al., 2020; Thinh, 2019; Cornelli et al., 2024; World Bank, 2024). KPI metrics, such as adoption rate, approval time, number of tests, investment level, and product performance, are standardized to evaluate operational efficiency (Leckenby et al., 2021; OECD, 2023; Beckstedde et al., 2023). In areas such as healthcare (Leckenby et al., 2021) and education (Barany et al., 2024), cloud/data, data standards, transparency, and multisectoral coordination are decisive conditions. New research highlights the importance of testing institutional risks, knowledge security, and multi-stakeholder liability in technology sandboxes (Ford & Ashkenazy, 2024).

2.5. Knowledge gap, new topics

While sandbox research is diverse in breadth, it lacks a deep model: few studies evaluate long term outcomes, there is no standardized independent impact measurement, there is a lack of industry data on spillover effects, and the influence of policy mechanisms (Raudla et al., 2025; Zakharova-Goodman, 2024; OECD, 2023; Cohn et al., 2024). Hot topics today are security, privacy, data authentication, AI governance, the risk of "riskwashing", conflicts of interest, and the risk of sandbox manipulation or unfair competition (Johnson, 2024; Gromova & Ferreira, 2025; Chen, 2023; Chen et al., 2024). The priority development direction is a multi-rooted model that integrates open data, AI/IoT, legalizing responsibility, standardizing measurement, and enhancing the transparency of governance activities (OECD, 2023; Truby et al., 2022).

3. Methodology

Based on a systematic literature review (SLR), the established evidence-synthesis protocols and comparative public policy analysis have been grounded. Both qualitative and quantitative evidence have been integrated to examine the evolution, institutional design, and performance of regulatory sandboxes worldwide (Allen et al., 2022; Snyder, 2019; Alaassar et al., 2021; Tranfield et al., 2003). To ensure methodological transparency, reproducibility, and comparability, the SLR procedures in combination with theoretical frameworks from innovation governance and adaptive regulation were conducted in this study (OECD, 2023; Truby et al., 2022; Dolowitz & Marsh, 2012).

3.1. Research design

Based on the PRISMA 2020 guidelines, with an expanded scope to capture experimental regulatory tools. The dataset was collected systematically, including peer reviewed publications, industry organizational reports, regulatory documents, and policy reviews releaseed by central banks, financial institutions, and international organizations (Cornelli et al., 2024; Cornelli et al., 2023; OECD, 2023; MAS, 2019). The evidence from multiple sources was combined together to facilitate a more comprehensive comparison of sandbox models across different sectors, governance frameworks, and levels of economic growth (OECD, 2023; Ahern, 2021). The SLR process comprises five stages (Figure 1): (1) Identifying the problem and formulating the research question; (2) Systematic searching and filtering on Scopus, Web of Science, SSRN, Google Scholar, and institutional sources (OECD, BIS, MAS, FCA, World Bank); (3) Extracting and coding data, combining conceptual

and empirical dimensions; (4) Quantitative assessment of sandbox models and performance metrics; (5) Synthesizing and translating policy lessons, linking empirical models with adaptive governance theory. This design ensures that the assessment is both methodologically rigorous and policy aligned.

3.2. Identify and select sources

The source selection and screening process strictly adheres to PRISMA standards: clear search sequence; documented source archive; defined time boundaries; predefined eligibility criteria; standardized extraction forms and transparent quality assessment process (Allen et al., 2022; Fahy, 2022; Alaassar et al., 2021). The assessments cover the period 2016-2025, corresponding to the global spread of regulatory sandboxes. Eligibility criteria include: full text availability; empirical or theoretical analysis of regulatory sandboxes; clear methodological description; relevance to innovation governance, legal testing, or adaptive policy planning. In addition to academic literature, this review synthesizes important interdisciplinary regulatory documents, including sandbox guidelines, documents, and assessments from the OECD, BIS, World Bank, MAS, FCA, and DFSA *(xem Phụ lục 1 online).*

3.3. Analytical framework

The study uses a two level coding strategy: (i) conceptual coding (inductive) to systematize the theory of adaptive experiment governance, policy learning, and multi stakeholder, iterative coordination (Chaffin et al., 2014; Sabel & Zeitlin, 2012); (ii) empirical coding (deductive) divides the data framework into five dimensions: sandbox model type, governance structure, performance KPIs, legal regulations, and practices.

3.4. Quantitative components and data validation

Key quantitative indicators include the number of global sandboxes, the number of sectors deployed, and KPIs such as pilot success rates, number of graduated projects, pilot duration, investment capital attracted, policy change rates, and post audit effectiveness (Cornelli et al., 2024; Allen et al., 2022; Schilling de Carvalho, 2022; Cohn et al., 2024). Data validation is always multidimensional: it involves the comparison of empirical databases, institutional reports, and new peer reviewed academic research, supplemented by an analysis of regulatory lags, policy response/transition speeds, and the adaptive capacity of individual ecosystems (Ahern, 2021; OECD, 2023).

3.5. Data synthesis and integration

Synthesize data by thematic mapping and cross tabulation, and identify a chain of practical solutions, including collaborative learning, management reflection, data linkage, multidisciplinary interaction model, and community impact (Barany et al., 2024). Through analysis, we evaluated the relationship between governance type/organizational mechanism, practical performance, SLAs comparison, and sandbox scalability.

3.6. Eligibility and limitations

Validation consists of three layers: (i) internal with a coding/cross checking cycle among researchers; (ii) a structure based on the theoretical framework of adaptive governance, innovation, and policy experimentation (Truby et al., 2022; Alaassar et al., 2021); and (iii) external comparison of results with Big Data/ OECD/BIS/WB surveys. The main limitations are uneven data availability across countries, a lack of field experts, some reports that are not up to date, a small scale that reduces the possibility of absolute matching, and the risk of duplication between sandboxes/new regulatory tools (Zakharova-Goodman, 2024; OECD, 2023; World Bank, 2024). This methodology provides a solid foundation for the in-depth analysis presented in the following sections (Tranfield et al., 2003; Cornelli et al., 2024; Snyder, 2019; OECD, 2023; Barany et al., 2024).

4. Research results

4.1. Types of Global Management Sandbox

Regulatory sandboxes have developed into versatile regulatory instruments that balance innovation with risk mitigation. Their structure, objectives, and scope of operation vary considerably depending on management capacity, market maturity, and national priorities (Allen et al., 2022; Alaassar et al., 2021; Zetzsche et al., 2017). The World Bank and OECD classify sandboxes into four main types: product/innovation focused, policy focused, thematic, and cross border (World Bank, 2020; Buckley et al., 2020).

Most sandboxes originate in FinTech and gradually expand to payments, digital banking, InsurTech, and blockchain (Cornelli et al., 2024; MAS, 2019). The UK (FCA) and Singapore (MAS) is a prime example of multi sectoral expansion, extending into e wallets, digital identities, AI, and data governance (OECD, 2023). More recently, specialized sandboxes have emerged in sectors such as HealthTech (AI diagnostics), EnergyTech (smart grids), and education, particularly in Singapore, the UAE, and Australia (Aydın & Yardımcı, 2024; OECD, 2023; Leckenby et al., 2021). These models allow regulators to tailor requirements to specific risks while supporting innovation and protecting consumers (Beckstedde et al., 2023).

Types of institutions and governance

There are three main governance models: (1) a centralized coordination unit (United Kingdom), with clear responsibilities but lacking flexibility; (2) a collaborative multi agency (MAS Singapore, IMDA connection), leveraging expertise but prone to fragmentation; and (3) a combined multi stakeholder advisory/ council (UAE DFSA/ADGM), adding experts and multi faceted coordination (OECD, 2023; Allen et al., 2022; Ford & Ashkenazy, 2024). Modern sandboxes increasingly focus on dispute resolution mechanisms, data security and privacy protection, and responding to new technological risks (Gromova & Ferreira, 2025).

Policy orientation

There are three prominent orientations: (1) sandboxes promoting rapid commercialization (United Kingdom, Singapore); (2) inclusive social sandboxes prioritizing financial inclusion and protecting vulnerable groups (MAS, UAE; BIS, 2023); (3) policy learning sandboxes, using experiments as preparation for legal reform (SBV Vietnam, Raudla et al., 2025). Mature ecosystems (the United Kingdom and Singapore) have high graduation rates, large project scales, and the ability to legislate experimental results, while emerging countries, such as Vietnam, mainly share experiences and improve governance (World Bank, 2024).

There are some new sandbox models that play a role in controlling privacy and facilitating the transfer of innovations such as artificial intelligence (AI), digital assets, and cybersecurity (Vouvoutsis et al., 2025; Barany et al., 2024; Chen et al., 2024; Zakharova-Goodman, 2024). Among them, cross border sandboxes allow businesses to facilitate enhanced collaboration and receive support in expanding their operations in the finance, insurance, and education sectors (Truby et al., 2022).

Besides, some challenges must be dealt with, including the dispute validation, inter sectoral coordination responsibilities, process transparency, and the risk of innovation monopolies if regulations are not flexible (McCarthy, 2023; Brown & Piroska, 2022; Ahern, 2021). On the other hand, the coordination of sandbox models with innovation centers and cross border testing is strongly emphasized for practical recommendations. And standardization of post audit indicators and increased transparency are necessary to ensure sustainable spillover effects (World Bank, 2024; Cohn et al., 2024; OECD, 2023).

Global comparative quantitative overview

Sandboxes are effective tools for managing innovation, but their success depends on national governance capacity. Data aggregation from the BIS, World Bank, and OECD indicates that nations such as the UK and Singapore exhibit substantial participation numbers, elevated graduation rates, and effective integration of test outcomes into policy, attributable to proficient governance and significant transparency (Cornelli et al., 2024). While emerging markets (Vietnam, Malaysia, and Indonesia) exhibit caution, are limited in scale, and possess restricted resources, but possess significant potential (World Bank, 2024; Beckstedde et al., 2023). The fields of digital assets, artificial intelligence, and big data have particularly contributed to the role of sandbox models in mitigating risk and protecting the interests of small enterprises and users (Brown & Piroska, 2022; Truby et al., 2022). Public private partnership (PPP) models in sandbox environments help policymakers collect empirical data and facilitate timely modifications.

Main typologies and policy implications

Depending on the objective management and governance methods, sandboxes can be categorized into four prominent model types, including "Industry Adaptive" model type: HealthTech requires data protection, and EnergyTech needs a multi tiered risk management framework (Aydın & Yardımcı, 2024; Leckenby et al., 2021). The "Coordinated Governance" model, as seen in Singapore and the UAE, prioritizes interdisciplinary approaches, cooperative and shared regulations, while avoiding fragmentation (Ford & Ashkenazy, 2024; OECD, 2023). The "Integrated Policy" model prioritizes sustainable social goals that promote financial inclusion and improve social welfare (Cornelli et al., 2023; Allen et al., 2022). Meanwhile, the "Scalable Potential" model focuses on well developed experimental models that provide governance standards, practical outputs, and policy feedback loops (Cornelli et al., 2024; World Bank, 2024). Recognizing this approach allows managers to optimize three objectives: innovation, market stability, and social impact (Barany et al., 2024; OECD, 2023; Beckstedde et al., 2023).

4.2. Governance structure: international analysis

The UK Financial Conduct Authority (FCA) operates on a centralized model, responsible for everything from assessment and supervision to auditing. Implementation is closely coordinated with the Royal Treasury (Allen et al., 2022). Good transparency: all tests are reported, helping to update policies promptly. Singapore: The MAS combines the role of the central coordinator of the multi stakeholder advisory council, prioritizing risk monitoring, academicizing the reporting process, and prioritizing knowledge sharing across the ecosystem (MAS, 2019; OECD, 2023). UAE: Multi regional, multi agency model; flexible licensing; strong cross-sectoral coordination (DFSA, ADGM); good experimentation with both digital services and AI.

Vietnam: The SBV leads a centralized sandbox for fintech, digital payments, and basic coordination among ministries. The disclosure process is incomplete, mainly based on internal reports and workshops (Pham et al., 2025; World Bank, 2024). The comparison shows that the centralized model has an advantage in terms of responsibility, the multi stakeholder model balances creative control, and the multi regional model requires strong internal coordination. Vietnam needs to increase transparency and inter sectoral cooperation to implement good practices (Thinh, 2019; Beckstedde et al., 2023) *(xem Phụ lục 2 online).*

Comparative data emphasizes an integrated solution: a centralized and multidisciplinary

model helps balance innovation control, should combine process transparency mechanisms, public disclosure of principles, and empirical results to increase social trust, protect public interests/policy learning (OECD, 2023; Cornelli et al., 2024; Fahy, 2022). Inter sectoral coordination needs to be strengthened in multi sectoral/federal countries to optimize risk assessment (Allen et al., 2022; Ranchordas & Vinci, 2024). Vietnam needs to invest heavily in digital infrastructure, professional teams, and improve public processes to stabilize sandbox operations (Thinh, 2019; Beckstedde et al., 2023). Governance is a decisive variable: the United Kingdom FCA focuses on helping to develop policies quickly, and the combined model is rich in knowledge/reflexivity. Developing countries need to enhance coordination and transparency to improve governance quality (Brown & Piroska, 2022).*(xem Phụ lục 3 online).*

4.3. Key operational processes, regulatory challenges, and policy implications

A regulatory sandbox is a structured environment that supports the testing of new fintech products under supervision to ensure safety and improve the effectiveness of innovation governance (Cornelli et al., 2024; Allen et al., 2022; Zetzsche et al.

Sandbox participation lifecycle

The standard process consists of 5 steps: (1) Candidate profiles are evaluated based on criteria such as business model, technology potential, risk management and market impact; (2) Accept and receive conditional approval, establish testing and operational goals, and transparent reporting procedures; (3) Pilot testing under real time KPI monitoring, typically lasting 6-18 months, with periodic reporting every 1-4 weeks (MAS, 2019; OECD, 2023; BIS, 2023; Alaassar et al., 2021; Leckenby et al., 2021); (4) Evaluation/post evaluation reviews results, decides to "graduate", extend or terminate; (5) Post exit monitoring to monitor long term market impacts and adjust policies flexibly (Cornelli et al., 2024; Cohn et al., 2024).

Risk management and compliance monitoring

Advanced Risk Layered Sandbox: Tier 1: business operations and security; Tier 2: market/consumer protection; Tier 3: legal risks due to technological innovation (Alaassar et al., 2021; Zetzsche et al., 2020; Vouvoutsis et al., 2025). Automated digital/KPI monitoring dashboard technology allows for early warnings and immediate adjustments when deviations are detected (Cornelli et al., 2024). nternational sandbox practices show that developed countries often leverage automation and streamlined reporting cycles, ensuring support for innovation without compromising control.

Knowledge dissemination and feedback loops

Knowledge dissemination, workshops, case study publications, and lesson archives are key to creating a continuous learning ecosystem for both regulators and businesses (OECD, 2023; McCarthy, 2023; Gil Garcia et al., 2016). In particular, rapid and continuous feedback mechanisms during testing help to adjust the model promptly, thereby increasing transparency and management efficiency.

Data on Performance and Efficiency

Global sandbox experience shows that in places with clear governance models and multi tiered risk-controlled testing cycles, graduation rates and innovation quality are high (World Bank, 2024; Cornelli et al., 2023; Beckstedde et al., 2023). Developing countries often lack transparency, have weak digital oversight, and experience sluggish testing processes.

Legal challenges

Three groups of challenges: Resource intensive operations in emerging fields such as big data/artificial intelligence; Difficult to define legal liability, ambiguous immunity, and inadequate cross border coordination;

Balancing innovation and risk control strategies, avoiding "softening" or "over support" in regulation (Ranchordas & Vinci, 2024; Allen et al., 2022; OECD, 2020).

Policy implications

Essential pillars: (i) Strengthening institutional capacity and investing in digital governance systems; (ii) Enacting clear laws on exemptions/liabilities for sandboxes, especially in emerging fields such as artificial intelligence and blockchain; (iii) Standardizing inter sectoral coordination (learning from the UAE/Singapore); (iv) Data transparency, internal training, and building market trust; (v) Strengthening international relations and promoting cross border sandboxes. In short, the success of a sandbox model must be based on good governance, continuous knowledge acquisition and feedback, automated control tools, and a solid legal framework. Furthermore, the ability to effectively integrate international experience to promote agile innovation is extremely important (Cornelli et al., 2024; World Bank, 2024; Barany et al., 2024; OECD, 2023; Allen et al., 2022).

4.4. Performance Measurement and Evaluation of Legal Sandboxes

Sandbox performance measurement is crucial for optimizing innovation policy and risk management, enabling stakeholders to build responsible innovation ecosystems (Zetzsche, Buckley, Arner, & Barberis, 2020; Leckenby et al., 2021; Cornelli et al., 2024). The evaluation framework not only reflects operational efficiency but also provides data to support design adjustments, transparent development, and continuous improvement of management (OECD, 2023; Beckstedde et al., 2023).

Key performance indicators

KPIs should be set in three phases: design, testing, and post test. The design phase focuses on adoption processes, consumer protection standards, data security, and unified metadata/ API standards for cross platform comparison (Cornelli et al., 2024; Barany et al., 2024). Operational phase: KPIs run automatically through dashboards, early warnings, and periodic analysis of real data to adjust the process to identify new rules. Post audit: Determine "graduation", monitor long-term impact with 6, 12, and 24-month milestones, evaluate innovation effectiveness, and protect consumers (BIS, 2023; Allen, Gu, & Jagtiani, 2022) *(xem Phụ lục 4 online).*

Comparing performance across jurisdictions

The platform KPIs include inputs (number of applications, processing time, costs), operations (number of alerts, number of KPI adjustments, reporting quality), outputs (graduation rate, speed to market), and ecosystem performance (user adoption, investment capital, regulatory impact). Qualitative assessments of social impact are collected through structured surveys/questionnaires (Leckenby et al., 2021; Lauren, 2022). Cross-disciplinary capabilities are key: legal, risk management, data, AI, and economic teams conduct independent monitoring (Cornelli et al., 2024; Fahy, 2022). In addition, multilateral bilateral agreements for cross border sandboxes are the new norm (OECD, 2023; Truby et al., 2022), especially for big data, fintech, blockchain, and anti money laundering. Ethics, support for vulnerable groups, and control of algorithmic bias must be integrated into operating procedures (Allen et al., 2022; Chen et al., 2024).

Mature sectors (United Kingdom and Singapore) have a large number of candidates, a success/market entry rate of 65-75%, standardized operations, a vast investor network, and continuous updates of new policies (Cornelli et al., 2024; MAS, 2019; Beckstedde et al., 2023). In contrast, emerging sandboxes (Southeast Asia, the Middle East, Africa) are still at a narrow experimental level,

with many cases having a success rate of only 20-30%, and not having a significant impact on policy or the market (BIS, 2023; World Bank, 2024; Aydın & Yardımcı, 2024).

Positivism, standardization, and horizontal learning

The United Kingdom (FCA) has an open data structure and clear accountability through regular public reports, while Singapore demonstrates flexible policy responses. Vietnam and many emerging countries are weak in KPI design, monitoring processes, and reporting, which is not transparent, resulting in untimely policy responses (World Bank, 2024; Thinh, 2019; Cohn et al., 2024). Best practices: standardized cross-industry reflective target measurement; continuous KPI calibration, feedback from businesses/users; increased soft skills training (Thinh, 2019; Leckenby et al., 2021; Barany et al., 2024; Fahy, 2022).

Challenges in value assessment

Difficulties include: (1) KPI standardization is uneven and lacks a unified definition; (2) Difficult to attribute sandbox impact to market fluctuations; (3) Historical data is thin, especially with AI/blockchain and multi industry; (4) Trade/confidentiality restrictions reduce open experimentation (World Bank, 2024; Brown & Piroska, 2022).

Table 1. Comparative Performance Indicators of National Regulatory Sandboxes

Nation	Applicants/ Year	Acceptance rate	Average evaluation time	Successful launch	Attracting investment	Reaching consumers	Policy impact
United Kingdom	300	60%	6-8 weeks	70%	150 million USD	High	High
Singapore	120	50%	3 5 weeks	65%	100 million USD	Medium	Medium
Australia	80	55%	4-6 weeks	60%	50 million USD	Medium	Medium
United Arab Emirates	50	40%	6-8 weeks	50%	30 million USD	Short	Medium
Canada	40	45%	5 7 weeks	55%	25 million USD	Short	Short
Hong Kong	60	50%	4-6 weeks	60%	40 million USD	Medium	Medium

Implications for policy and governance

Performance measurement must be central, including selecting KPIs that are closely aligned with the target, coordinating quantitative and qualitative assessments, standardizing cross-regional processes, building post audit systems, promoting open data, and fostering community monitoring. This is what makes sandboxes a driver of innovation, promoting governance transparency, optimizing policy learning, and increasing sustainable value across the ecosystem (Leckenby et al., 2021; Cornelli et al., 2024; OECD, 2023; World Bank, 2024; Ranchordas & Vinci, 2024).

4.5. Challenges, Limitations, and Strategic Considerations of Management Sandbox

Regulatory sandbox models are becoming a cornerstone for fintech innovation in emerging and developing countries. Alongside their advantages, significant challenges remain to be overcome to increase effectiveness and reduce policy risks (OECD, 2023; Allen et al., 2022; Zetzsche et al., 2020).

Management challenges

Governance is crucial, but many experimental models in Singapore, the UAE, and Canada suffer from fragmentation, authority conflicts, or delayed decisions due to differences in organizational culture and priorities among ministries and sectors (Ranchordas & Vinci, 2024; Allen et al., 2022; MAS, 2019). Centralized sandbox models like the FCA and HKMA ensure accountability but lack in-depth expertise in emerging fields such as AI and cross border data; therefore, additional independent consultations, international contacts and institutions, or academic and technological networks are needed (Barany et al., 2024; Zetzsche et al., 2020). Furthermore, there is a risk of conflicts of interest and bias within advisory councils if not properly controlled. In addition, the data disclosure transparency can affect trade secrets; however, if information is not transparent, it will reduce the value of learning and policy adjustments (OECD, 2023; Fahy, 2022).

Operational challenges

Sandboxes require significant investment in digital information, inter sectoral coordination, and risk control. Many developing countries face challenges in investing in blockchain and artificial intelligence (AI) due to limited human resources, technology, and finance (World Bank, 2024; Beckstedde et al., 2023). The sandbox phase typically lasts 6-12 months, making it difficult to meet the long-term innovation cycle of AI/big data. Many businesses withdraw midway due to compliance costs and weak capabilities (MAS, 2019). Standardizing processes creates close oversight but reduces opportunities for innovation, while excessive customization increases operational risk and makes it difficult to learn policies (Brown & Piroska, 2022).

Challenges in measuring performance

Performance measurement encounters: (1) The quality and availability of data are often low; (2) The complexity of resource allocation makes it difficult to distinguish the sandbox effect from market factors; (3) Long term data and KPIs are not standardized, weakening international comparability (World Bank, 2024; Leckenby et al., 2021); (4) For Vietnam and many emerging markets, there is a lack of sufficiently long and publicly available data series to assess sustainability (Cornelli et al., 2024; Beckstedde et al., 2023).

System and market constraints

The success of the sandbox depends on market forces such as infrastructure, partners, user acceptance, international competition, and cross border legal barriers. However, the lack of international data standards, coordination in anti money laundering/anti terrorism financing, and legal credibility reduces the operational efficiency of multinational corporations (World Bank, 2024; OECD, 2023; Truby et al., 2022). Furthermore, legal differences arise from the lack of divestment mechanisms, creating legal "loopholes." Additionally, high sandbox costs and conditions lead to challenges and difficulties in market access for startups and emerging industries (Aydın & Yardımcı, 2024).

Experience and solutions to minimize

Solutions include: combining centralized governance with multidisciplinary consulting, upgrading digital management, investing in human resources and testing technology, and coordinating processes for sharing multidimensional data/reporting (Cornelli et al., 2024; Barany et al., 2024; Beckstedde et al., 2023). Regulatory test/exit design, standardization of KPIs, and transparency of reporting to facilitate international learning/comparison (Brown & Piroska, 2022). International cooperation,

mutual recognition of testing, data standards, coordinated AML/CFT, and security controls will reduce multinational risks (OECD, 2023; Truby et al., 2022).

Policy implications

Localities implementing sandboxes need to choose a suitable governance model, ensure team capacity, digital/financial resources, flexible and transparent operations, standardize KPIs, increase post test monitoring, and support small startups. At the same time, increase coordination with the global network, standardize expanded testing, and update new technologies. The process of reviewing, upgrading, standardizing, and continuous learning helps sandboxes truly become a driving force for innovation, protecting users, expanding access, and adapting well to new technologies (Allen et al., 2022; OECD, 2023; World Bank, 2024; Beckstedde et al., 2023).

4.6. Future Trends and Strategic Recommendations for Legal Sandbox

Emerging trends in the legal sandbox

The global sandbox ecosystem is evolving in response to five key trends. First is digitalization and automation: AI, big data, and cloud computing have helped many countries, such as the United Kingdom, Singapore, UAE, automate review processes, monitor compliance, forecast, and manage risks more sophisticatedly (Schilling de Carvalho, 2022; Allen et al., 2022; MAS, 2019; Barany et al., 2024). Second, cross border cooperation and sandboxes are expanding through joint testing agreements, data sharing, and recognition of results between the FCA (United Kingdom), MAS (Singapore), and ASIC (Australia)... are increasing, helping businesses test simultaneously in multiple markets and promoting cross border legal standardization (Truby et al., 2022). Third, specialized sandboxes are booming in digital health, renewable energy, open data, and digital assets. The UK, Singapore, and the UAE are all expanding the capacity for controlled testing of AI, blockchain, and digital platform applications into patient data and credit scores, as proposed by Aydın and Yardımcı (2024), Ranchordas and Vinci (2024), OECD (2023), and Leckenby et al. (2021). In Vietnam, Government Decree 94/2025/ND-CP officially initiates controlled testing of digital finance in three core areas to create momentum for long-term innovation. Fourth, sustainability orientation: prioritizing the financial sector, supporting small and medium sized enterprises and vulnerable groups, and integrating ESG into testing criteria, as proposed by Cornelli et al. (2023), Brown and Piroska (2022). Fifth, according to Cornelli et al. (2024) and Barany et al. (2024), propose integrating innovation labs and pilot models: many countries integrate pilot models with innovation research centers, creating a continuous policy loop from idea to practice.

Table 2. Risk matrix and mitigation measures

Risk group	Describe	Level	Ability	Mitigation measures
Administration	Overlapping authority	High	Medium	The coordination process, the first link
Work	Slow browser time	Medium	High	SLA-specific, dashboard monitoring
Efficiency	Inconsistent KPI measurement	Medium	Medium	Standardized KPI Dictionary
System	System-wide risk	High	Short	Scope limit testing, stress testing

International lessons	Terms/Resolution 98	Host/Co-host Institution	Recommended KPIs	Itinerary (month)
Digital sandbox monitoring dashboard	Publicly disclose results	Ho Chi Minh City People's Committee; Department of Information and Communications; State Bank branches	Limit reporting accuracy; Approval time	0 6: design; 6 12: experiment; 12 24: operation
Specialized coordination mechanism	Field management coordination	People's Committee; State Bank; Ministry of Information and Communications; Ministry of Planning and Investment	Version Number; SLA Processing Diagram	0 3: regulation; 3 12: development; 12 24: optimization
Test result declaration	Accountability	People's Committee; Department of Information and Communications	Number of publications: Stakeholders receive a high level of feedback	6 12: process; 12 24: maintain

Note: *The risk categories and mitigation measures in this matrix are adapted from international regulatory sandbox guidelines and toolkits, including the World Bank's practical guide to regulatory sandboxes, regional sandbox guidelines, and central bank sandbox frameworks.*

Recommendations

The study draws the following seven recommendations: (i) Enhanced governance towards flexibility is needed. Accordingly, flexible sandbox models should be coordinated in a centralized or multi sectoral manner depending on the specific field, while strengthening independent consultation (OECD, 2023; Allen et al., 2022); (ii) Increased promotion of digitalization and automation: The entire evaluation process, real time monitoring and reporting, and the development of dynamic multi tier KPIs need to be automated; (iii) Expanded measurement and enhanced monitoring: Requires setting appropriate goals, combining quantitative and qualitative measures, increasing transparency, and conducting post testing effectiveness checks; (iv) Create a comprehensive "priority pathway" for pilot models, from advisory support, capital support, and inputs for small and medium sized enterprises and emerging startups, focusing on underserved areas (Lauren, 2022; Tran Quoc Thinh, 2019); (v) Promote global cooperation: Expand multinational agreements, commit to data security and AML/CFT, connect international pilot models, and organize cross regional training as Truby et al. (2022) suggested; (vi) Enhance knowledge and policy dissemination: According to Barany et al. (2024), publish case studies, interdisciplinary webinars, and foster broad collaboration between government and business research; (vii) Prioritize testing emerging technologies: Enhance the integration of AI/ML, blockchain, and digital twin models to evaluate complex

models, and improve control over data leaks/ system risks.

Impacts

Simultaneous application of these recommendations helps shorten innovation timelines, promote flexible governance, enhance investor confidence, and create sustainable advantages for the national ecosystem. Sandboxes not only create a corridor for technology testing but also serve as a platform for socio economic innovations and prepare for the digital asset market, as proposed by Vouvoutsis et al. (2025), Cornelli et al. (2024), Barany et al. (2024), and Aydın and Yardımcı (2024).

Implementation challenges

However, for successful implementation, countries need to invest in digitalization, security, and AI; in international standards; in addressing the shortage of specialized personnel; and in complex oversight requirements for AI and digital assets (Vouvoutsis et al., 2025; Barany et al., 2024; OECD, 2023; MAS, 2019).

Policy implications

Localities and countries need to focus on four groups of solutions: developing multidisciplinary human resources; updating technological skills to meet new technologies; adaptive governance to quickly adapt to change; strengthening multinational cooperation and integrating pilot models with innovation centers (World Bank, 2024; Ranchordas & Vinci, 2024; OECD, 2023; Tran Quoc Thinh, 2019). The synchronized implementation of these solution groups will transform pilot models into solid "catalysts" for the development of modern institutions and technologies, helping them adapt to the digital market and global competitiveness.

4.7. Discussion

The research results show a positive correlation between strong governance mechanisms and the superior performance of controlled trial models in both key quantitative and qualitative indicators. Countries need clear institutions, multi layered risk management, digital oversight, and systematic public reporting similar to the UK and Singapore, which tend to exhibit high trial application volumes and higher graduation rates. Policy adoption in these countries is based on trial results and active investor and user participation, compared to emerging markets, where governance is fragmented or lacks transparency. These models demonstrate that clarity of accountability, procedural transparency, and data driven oversight are crucial determinants for achieving KPIs and the long term effectiveness of regulated trial models.

In the cases considered in this study, several operational components consistently proved effective and applicable. A structured five stage lifecycle from input assessment, conditional authorization, supervised testing, closing decision, and post closing follow up combined with real time dashboard based KPI and risk monitoring, provides a good framework for diverse fields and management capabilities. Furthermore, the standardization of inputs, processes, outputs, and ecosystem level KPIs, the integration of quantitative and qualitative assessments, and formalized feedback and learning cycles between regulators and participants emerge as core features that facilitate cross country comparisons, reduce design costs for subsequent participants, and support continuous improvement of the testing model practice.

For Ho Chi Minh City, the study's findings indicate a sandbox strategy that requires "selective adaptation," prioritizing short term feasibility while building a foundation for long term institutional learning. A feasible roadmap within the next two years is to maintain a centralized governance model but integrate a multi sectoral advisory mechanism, pilot a digital

monitoring dashboard, and apply concise, transparent KPIs to several priority areas, especially digital finance, data driven services, and AI powered applications. Simultaneously, the gradual adoption of international best practices on data disclosure, but in an appropriately aggregated manner, post audit evaluation, and collaboration with innovation labs can accelerate digital transformation in Ho Chi Minh City, while maintaining regulatory oversight and strengthening Vietnam's position in the regional innovation network.

5. Conclusion and recommendations

5.1. Conclusion

The controlled experiment model has affirmed its central role in balancing the dual goals of promoting innovation and ensuring regulatory compliance (OECD, 2023; Allen et al., 2022). Over the past decade, this model has expanded from the fintech sector to finance, healthcare, digital identity, and energy, contributing to a more sustainable innovation ecosystem (OECD, 2023; Fahy, 2022). Globally, the four main governance models, including centralized power, multi sectoral coordination, independent advisory councils, and innovation labs, all emphasize transparency, clear allocation of responsibilities, flexible control, and limiting fragmentation and conflicts of interest (OECD, 2023; Allen et al., 2022; Fahy, 2022).

Effective operational processes focus on multi layered risk management, digital monitoring, regular reporting, and clearly defined "graduation" outcomes (Leckenby et al., 2021). Best practice outcomes emphasize transparency, continuous learning, and flexible policy adjustments, supported by performance measurement frameworks that combine quantitative indicators (applicants, graduates, investment) with qualitative aspects (adoption, market impact, innovation quality) (Barany et al., 2024; Cornelli et al., 2024; Lauren, 2022). Sandbox models in the UK and Singapore demonstrate that strong governance systems and robust data infrastructure are crucial foundations, scalable and well integrated, for delivering effectiveness (Cornelli et al., 2024; Lauren, 2022).

However, alongside positive outcomes, controlled testing models still face challenges such as regulatory fragmentation, conflicts of interest, limited resources, inconsistent data, inadequate long-term monitoring, and cross border barriers (OECD, 2023; Brown & Piroska, 2022; Fahy, 2022). Identifying these limitations, along with proactively standardizing measurement methodologies and enhancing transparency, is essential to sustaining innovation, protecting consumers, and strengthening international competitiveness (OECD, 2023; Brown & Piroska, 2022). In the context of Ho Chi Minh City and Vietnam, the proposed roadmap may face challenges from hierarchical decision making, loose coordination or concerns about data sharing, and weaknesses in capacity for digital monitoring and KPI design, which could slow implementation and reduce policy learning (World Bank, 2024; Beckstedde et al., 2023; Tran Quoc Thinh, 2019).

To address these obstacles, pilot implementations in priority areas, formal coordination mechanisms, investment in specialized human resources, and clear incentives are needed. These will be key factors in overcoming the challenges and becoming an effective testing ground in Ho Chi Minh City (World Bank, 2024; Beckstedde et al., 2023).

5.2. Implications for policy and practice

Currently, sandboxes are playing an increasingly strategic role in enhancing regulatory flexibility, fostering innovation, proactively adopting new technologies, overcoming barriers to entry, and expanding consumer access, while also creating

opportunities for investors and startups (OECD, 2023; Allen et al., 2022). Operational data is fundamental to policy learning, improving the quality and speed of adaptation to new regulations.

Define responsibilities for each stage from the start of the trial to the completion of post audit monitoring. Establish an effective control system. Conduct periodic post audit assessments every 6, 12, and 24 months, analyze policy impacts, and digitize reporting processes. Promote cross border sandbox collaboration through memoranda of understanding, mutual recognition, data sharing, and verification.

5.3. Limitations and future research directions

This research relies primarily on publicly available and secondary data sources. The lack of long-term empirical data, particularly in technology sectors, limits the ability to fully capture the sustainable impacts of the sandbox and establish key performance indicators (KPIs) applicable across different national contexts. These limitations may reduce the generalizability of the findings, especially for emerging markets with less developed innovative ecosystems. Future research should prioritize increased openness and primary data, developing standardized and transparent performance dashboards. Expanding longitudinal and controlled studies across multiple sectors will be essential to better understand the broader socio economic and environmental impacts.

Declaration for using AI

During the preparation of this manuscript, the authors partially used Grammarly to assist with language editing. The authors have carefully reviewed and revised the content and take full responsibility for the final version of the articles.

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