

# A Multi-Cloud Architecture for Tokenized Real Estate Property Sales with Focus on Saudi Arabia

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*Abstract- The global real estate market changes its format and evolves to the next level. Tokenization of real estate assets occurs due to the rise in fractional ownership of tangible property assets, represented using blockchain technology. This study will concentrate on how multi-cloud architecture can be used to support tokenization of real estate assets in Saudi Arabia. Its rapidly developing regulation and technological environment make Saudi Arabia attractive for tokenization of real estate assets. Tokenization is a process that needs capabilities that no single cloud can have. In order to conduct tokenization, one should be able to deploy a blockchain infrastructure, custody services, ensure data residency in compliance with local laws, and integrate the solution with the existing property registry. A single cloud service provider introduces a high concentration risk, since it results in vendor lock-in and restricts the choice of the most appropriate blockchain platform. A conscious approach of using a multi-cloud strategy allows addressing all these concerns. The sources that were used in this research include reports from seven different countries, including Saudi Arabia, UAE, Qatar, Oman, India, UK, and US. Also, public sources concerning market performance, regulations, and architectural design were utilized. It is important to note that priority was given to publications prepared by regulatory agencies, such as Real Estate General Authority of Saudi Arabia and Dubai Land Department. The following key points should be mentioned. First, the global market size of tokenization within the field under investigation is estimated to reach USD 3.5 billion in 2024 and USD 19.4 billion in 2033, with a compound annual growth rate (CAGR) of 21%.[1] Moreover, the cumulative market size in the GCC region is forecasted to equal to USD 1.2 billion.[3] Second, Saudi Arabia demonstrates the best results: it has already issued nine technology platforms for tokenization and performed its first tokenization transaction.[11] It was also the first country to develop and publish a national regulatory standard for real estate tokenization.[12] Finally, Saudi Arabia's cloud computing market is forecasted to reach USD 14.55 billion in 2024 and USD 38.23 billion in 2033.[4] According to the suggested solution, the load will be shared between AWS (token execution and custody services), Microsoft Azure (identity and access management and compliance logging as well as*

*integration layer), and Google Cloud (big data analytics). Cross-chain interoperability is achieved using open-source cross-chain bridge protocols. Also, it is assumed that tokenization regulations will be issued in June 2026. This research is valuable to the literature review because it highlights interrelationships between blockchain and cloud technologies that were traditionally studied separately. One should not discuss tokenization and regulation issues of Saudi Arabia market without considering the above topics together.*

## I. INTRODUCTION

Real estate is one of the illiquid assets. It is challenging to buy or sell such assets as the transaction involves lots of time (up to several months), money, and many intermediaries (notaries, lawyers, banks, government agencies). However, the process of tokenizing changes this approach. Thus, tokenizing property allows dividing it into parts represented with digital tokens. For instance, the USD 2 million apartment could be divided into 2,000 tokens that would cost USD 1,000 each. In this way, it becomes possible to invest into the property even with much smaller funds than before. Though tokenization itself existed for years, the growth rate of its adoption has been increasing rapidly since then. Thus, by 2025, the market of tokenizing real-world assets had amounted to USD 24 billion, showing 308% growth during the previous three years.[9] Real estate accounts for the largest part of this market. Twelve percent of all global real estate companies fully adopted tokenization by 2024, while 46% carried out the pilot project with it.[1] According to the study by EY conducted in 2025, 57% of institutional investors are interested in tokenized real estate.[1] The situation in Saudi Arabia is especially intriguing. The Kingdom's program "Vision 2030" aimed at economic and technological diversification and housing market improvement started in 2016. Among others, the document mentions real estate

sector where the use of technologies should help reduce friction and improve transparency. From being just a policy goal to practical steps, the government went ahead and tokenized its first property in 2024. REGA did it and was working on developing regulatory requirements at once.[11][12] Thus, cloud computing is the backbone of the system. It is essential for tokenized real estate platform to work 24/7, process transactions instantaneously, create immutable audit logs, interact with government registries, etc. Saudi Arabia's cloud market grew with the CAGR equaling 25% before 2025 due to such efforts as establishing Cloud Computing Special Economic Zone in Riyadh in April 2023.[5] All major service providers (AWS, Azure, and Google Cloud, among others) either created or committed themselves to creating their regional data centers in the Arabian Gulf. Despite clear relationship between cloud infrastructure and tokenized real estate, there is very limited number of publications that cover both subjects. Typically, technical papers are focused on blockchain only while business papers discuss regulation only. The purpose of this paper is to create a conceptual design of tokenized real estate multi-cloud architecture based on the specificities of Saudi Arabia along with taking examples from six other countries.

## II. LITERATURE REVIEW

### 2.1 Types and Architectures of Tokenization Structures

Real estate tokenization can employ various architectures depending on the specific requirements. The first possible architecture is that of direct ownership tokenization, which is when a token corresponds to an exact portion of an asset. Another architecture makes use of the Special Purpose Vehicle (SPV): the asset is transferred to a legally recognised entity and tokens become its share certificates. The SPV method is considered preferable by regulators since it complies with current legislation. US-based tokenization platform Primior has explained the mechanisms of real estate smart contracts and confirmed that it is already possible to create a blockchain solution that can automatically execute escrows, distribute dividends according to program rules, and perform instant trade of tokens.[22] According to Tokenizer.Estate, the major

challenges for tokenization include regulation issues, valuation criteria for partial interests, liquidity in the secondary market and enforceability of ownership.[28] The GCC region has experienced the world's biggest tokenization deals. In the United Arab Emirates, MAG Group and MultiBank Group agreed to tokenize USD 3 billion worth of real estate in what was called the world's largest real estate tokenization transaction.[7] Over AED 500 billion worth of property deals were processed in Dubai during 2025. Moreover, the Dubai Land Department launched its tokenized real estate regulatory sandbox back in March.[7] The first property listing in this sandbox became fully subscribed just 24 hours after being put up.[13] In Qatar, tokenization is handled through the Qatar Financial Center (QFC) – an independent financial zone with its own legislation and regulation. QFC published the Digital Assets Framework in 2024[14] and the following year proceeded to tokenize over USD 500 million in real estate assets.[8] An analytical article published by Tokenizer.Estate suggests that QFC's framework is quite reasonable, as it accounts for gaps in current laws and regulations and provides a practical way forward.[15] Oman is slower than some other Gulf countries to embrace tokenization. There, blockchain trends are studied, early projects in neighbouring countries are analysed and the legal framework for digital assets is in development.[16] However, the regulators' attitude to innovative projects has been positive. Still, as of early 2026, Oman has not yet created a tokenized real estate sandbox.

## III. FINDINGS AND RECOMMENDATIONS

### 3.1 Market Opportunity and Landscape Analysis

The figures involved are big enough for the infrastructure development to be considered. For instance, the global market size for tokenization of real estate stood at \$3.5 billion as of 2024, with projections indicating that it will increase to \$19.4 billion by 2033 at a CAGR of around 21%.[1] InsightAce Analytic predicts a slightly higher number for 2025 (\$3.73 billion) and an even bigger value in 2035 (\$23.99 billion).[2]

In the GCC market alone, the real estate tokenization industry will be worth about \$1.2 billion in 2024.[3] It is estimated by Ken Research that blockchain

technology implementation could result in the reduction of up to 25% in the costs associated with transactions within GCC real estate.[3]

Table 1: Global Real Estate Tokenization Market Overview

Region	Market Size (2024)	CAGR	Key Drivers
GCC (Saudi, UAE, Qatar, Oman)	USD 1.2 billion	~18-22%	Vision 2030, regulatory sandboxes, high-net-worth investor demand
North America	USD 1.1 billion	~20%	Institutional investor adoption, SEC clarity, DeFi integration
Europe	USD 0.7 billion	~17%	MiCA regulation, fractional ownership demand, green real estate tokens
Asia-Pacific (incl. India)	USD 0.4 billion	~24%	Land registry reform, PropTech growth, digital asset frameworks

Sources: Entralon Hub[1]; InsightAce Analytic [2]; Ken Research [3]

It is Saudi Arabia's cloud computing industry that is the backbone of such an opportunity. Being valued at USD 14.55 billion in 2024 and projected to reach USD 38.23 billion in 2033, the cloud market is big enough to enable enterprise tokenization platforms.[4] The annual 25% growth rate in cloud adoption until 2025[5] is driven by both commercial interest and government initiatives such as the Cloud Computing Special Economic Zone in Riyadh.

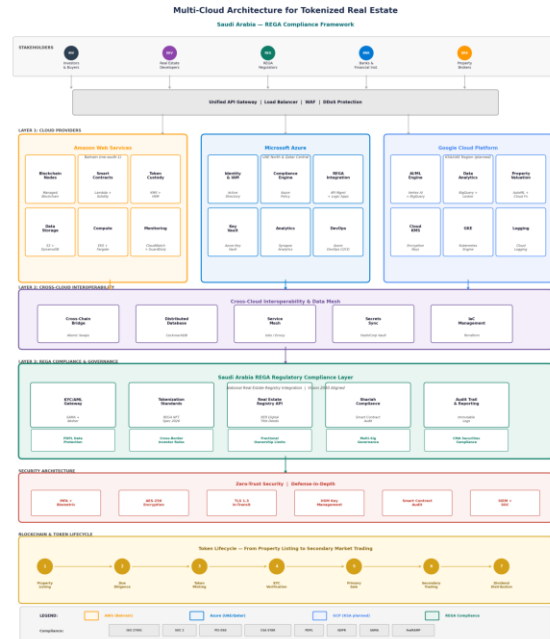


Figure 1: Proposed Multi-Cloud Architecture for Tokenized Real Estate Property Sales – Saudi Arabia Case Study Sources: AWS, Azure, GCP Documentation; REGA Official (rega.gov.sa); Wiz.io Cloud Security Framework

Layer 1: Blockchain & Token Hosting (AWS). Data centers are operated by Amazon Web Services in Bahrain (me-south-1) and the UAE (me-central-1). Measured from Riyadh, this is the closest region with the complete set of services from AWS. Amazon Managed Blockchain supports Hyperledger Fabric, a permissioned blockchain that is appropriate for enterprise use cases, as well as Ethereum, which facilitates integration into DeFi infrastructure. The layer will execute smart contracts for property token creation, transfers, and payment of dividends. AWS Key Management Service (KMS) will manage crypto keys.

Layer 2: Identity & Compliance, Integration With Regulatory Agency (Azure). Data centers are run by Microsoft Azure in UAE North, UAE South, and Qatar Central, with plans to expand further in the Gulf Cooperation Council region. Azure Active Directory (now renamed Entra ID) delivers enterprise identity management, which is critical for compliance with KYC/AML requirements. Azure Confidential Ledger delivers tamper-resistant audit logs that can be shared with regulators. The integration point

between the solution and REGA's national tokenization platform will be run on Azure, leveraging the existing enterprise connections Microsoft has with Saudi Arabia government entities. Leobit's case study of Azure deployment for a blockchain real estate platform showcases the viability of this design.[27]

Layer 3: Market Analytics & Investor Interface (GCP). GCP will provide the foundation for analytics of market insights, property valuation algorithms, and investor reports. BigQuery powers real-time analysis of transactions on the marketplace. An online investor interface including web portal and mobile application will be hosted on this layer with a backing infrastructure provided by Google Cloud Content Delivery Network (CDN), ensuring low latency to investors anywhere across the globe. Machine learning technology delivered by Google Cloud will power the property valuation algorithms and fraud prevention system.

Layers are integrated using an API gateway that enforces the same security policy for requests coming from any cloud provider. An OpenTelemetry-based cross-cloud observability system is deployed across all clouds to deliver centralized logging, monitoring, and alerts. Terraform is used for infrastructure automation in all layers as its multi-cloud support covers all three cloud providers in a single configuration language.

Table 2: Multi-Cloud Provider Comparison for Tokenized Real Estate

Feature	AWS	Microsoft Azure	Google Cloud
Blockchain Service	Amazon Managed Blockchain (Hyperledger Fabric / Ethereum)	Azure Confidential Ledger + Blockchain tokens	BigQuery & Pub/Sub for blockchain data pipelines
Identity Management	AWS IAM + Cognito	Azure Active Directory / Entra ID	Google Cloud Identity & IAP
Data	AES-256 at	AES-256 at	AES-256

Encryption	rest; TLS 1.3 in transit; AWS KMS	rest; TLS 1.3 in transit; Azure Key Vault	at rest; TLS 1.3 in transit; Cloud KMS
Compliance Certifications	ISO 27001, SOC 2, PCI-DSS, CSA STAR	ISO 27001, SOC 2, PCI-DSS, CSA STAR, GDPR	ISO 27001, SOC 2, PCI-DSS, FedRAMP
Middle East Data Centers	Bahrain (me-south-1), UAE (me-central-1)	UAE North & South, Qatar Central	No dedicated KSA/UAE region yet (2025); uses European zones

Sources: AWS documentation; Microsoft Azure documentation; Google Cloud documentation; Wiz.io cloud security framework [26]

The below checklist provides the mapping of Shariah compliance criteria in respect of each of the seven stages of the lifecycle of tokens. Every checklist criterion is based on REGA NFT Specification 2026, SAMA regulatory sandbox, AAOIFI Shariah Standards, and CMA Securities Guidelines. The platform can employ the below checklist as a systematic tool for validation of the process at each stage of the lifecycle either prior to or within the lifecycle process, and each criterion shall be approved by the Shariah supervisory board prior to moving on.

Step 1: Property Listing

Before any property enters the tokenization pipeline, it must pass initial Shariah screening to confirm the asset itself, its income sources, and its intended use are all permissible under Islamic law.

#	Check Item	Validation Criteria	REGA/SAMA Ref.	Status
1.1	Asset Halal Screening	Property must not be used for activities prohibited	AAOIFI No. 21 (Financial Papers)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

		under Shariah (alcohol, gambling, pork-related, etc.)	REGA Asset Standards	
1.2	Ownership Verification	Seller must hold clear legal title registered in the Real Estate Registry (RER) with absolute probative force	REGA NFT Spec 2026 RE Registration Law Art. 5	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
1.3	Income Source Review	All rental and property revenue must come from Shariah-permissible tenants and activities	AAOIFI SS No. 17 (Investment Sukuk) Shariah Board Review	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
1.4	Debt-to-Asset Ratio	Total interest-bearing debt must not exceed 33% of total assets (Shariah screening threshold)	AAOIFI SS No. 21 CMA Screening Guidelines	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
1.5	SPV Structure Compliance	Special Purpose Vehicle must be structured as Shariah-compliant entity with bankruptcy-remote protections	CMA Sandbox Rules White & Case Guidelines 2025	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

### Step 2: Due Diligence

Due diligence validates both the physical property and the proposed token structure against Shariah requirements. This step requires input from independent Shariah scholars alongside standard legal and financial auditors.

#	Check Item	Validation Criteria	REGA/SAM A Ref.	Status
2.1	Independent Shariah Board Review	A recognized Shariah board must review and approve the entire tokenization structure before proceeding	AAOIFI Governance Standard No. 1 SAMA Sandbox Req.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
2.2	Gharar (Uncertainty) Assessment	Token terms must be clear and unambiguous. No excessive uncertainty in ownership rights, returns, or exit mechanisms	AAOIFI SS No. 31 (Gharar Controls) CMA Disclosure Rules	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
2.3	Riba (Interest) Screening	Financing structure must not involve interest-based loans. Use Murabaha, Ijara, or Musharakah alternatives	AAOIFI SS No. 8 (Murabaha) SAMA Islamic Banking	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
2.4	Valuation Method Audit	Property valuation must use transparent, fair-market methods. No speculative inflation of token value	REGA Valuation Standards AAOIFI FAS No. 25	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
2.5	Legal Documentation Alignment	Smart contract code must mirror the legal agreements. Code implements,	CMA Securities Rules REGA NFT Spec 2026 Technical Standards	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

		not replaces, the legal bargain		
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### Step 3: Token Minting

Token minting converts the approved property interest into digital tokens on the blockchain. The minting process must enforce Shariah parameters directly in the smart contract code, making compliance automatic rather than manual.

#	Check Item	Validation Criteria	REGA/SAMA Ref.	Status
3.1	Asset-Backed Token Design	Each token must represent a real beneficial ownership interest in the property, not synthetic or derivative exposure	AAOIFI SS No. 17 REGA NFT Spec (Token-Asset Link)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
3.2	Profit-Loss Sharing Logic	Smart contract must distribute returns based on actual rental income and capital gains, not fixed or guaranteed yields	AAOIFI SS No. 12 (Sharikah/Musharakah) SAMA Guidelines	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
3.3	Purification Mechanism	Contract must include automatic purification (Tazkiyah) for any incidental non-compliant	AAOIFI SS No. 21 Shariah Board Purification Policy	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

#	Check Item	Validation Criteria	REGA/SAMA Ref.	Status
3.4	Registry Linkage	Token must be cryptographically linked to the official REGA Real Estate Registry record at time of minting	REGA NFT Spec 2026 RER Digital Title Deed Standards	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
3.5	Smart Contract Shariah Audit	Independent security firm must audit smart contract code for Shariah-violating logic (hidden riba, etc.)	IFSB Guidelines AAOIFI Governance Standard No. 3	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

### Step 4: KYC Verification

Know Your Customer verification in a Shariah-compliant context goes beyond standard AML checks. It must also confirm investor eligibility under both Saudi securities law and Islamic investment participation requirements.

#	Check Item	Validation Criteria	REGA/SAMA Ref.	Status
4.1	SAMA AML/CTF Compliance	Full Anti-Money Laundering and Counter-Terrorism Financing checks via SAMA-approved systems	SAMA AML/CTF Regulations 2023 FATF Standards	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
4.2	Absher Digital Identity	Saudi investors must be verified through Absher or	SAMA Digital ID Requirements REGA KYC Standards	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

		Nafath national digital identity system		
4.3	Cross-Border Investor Rules	Foreign investors must meet SAMA/CMA eligibility criteria for tokenized real estate ownership in KSA	CMA Foreign Investment Rules REGA Cross-Border Framework	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
4.4	Investor Suitability Assessment	Platform must assess whether the investor understands Shariah-compliant investment risks and profit-sharing model	CMA Suitability Guidelines AAOIFI Governance Standard No. 7	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
4.5	Transfer Restriction Encoding	KYC-gated transfer rules must be encoded in the smart contract to prevent token transfers to non-verified wallets	REGA NFT Spec 2026 SAMA Sandbox Technical Standards	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

**Step 5: Primary Sale**

The primary sale is where tokens are first sold to investors. This step carries the highest Shariah sensitivity because the sale contract must satisfy all requirements of a valid Islamic sale (Bay), including clear pricing, known subject matter, and genuine transfer of beneficial ownership.

#	Check Item	Validation Criteria	REGA/SAMA Ref.	Status
5.1	Valid Sale Contract (Bay)	Sale must meet Islamic contract requirements: offer and acceptance,	AAOIFI SS No. 1 (Trading in Currencies) Shariah Board	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

		known price, identified subject matter		
5.2	No Guaranteed Returns	Marketing and legal documents must not promise fixed or guaranteed returns. Only expected profit ranges allowed	AAOIFI SS No. 12 CMA Advertising Guidelines SAMA Requirements	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
5.3	Constructive Possession (Qabd)	Token delivery to investor wallet must constitute valid constructive possession of the underlying property interest	AAOIFI SS No. 18 (Possession) REGA NFT Spec Digital Qabd	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
5.4	CMA Securities Registration	Token offering must be registered with CMA or conducted under approved sandbox exemption	CMA Securities Regulations CMA Fintech Lab Sandbox License	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
5.5	Escrow & Settlement	Funds must be held in Shariah-compliant escrow (no interest accrual) until sale conditions are met	SAMA Escrow Guidelines AAOIFI SS No. 5 (Guarantees)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

**Step 6: Secondary Trading**

Secondary trading allows token holders to sell their shares on compliant exchanges. Shariah law places specific constraints on secondary trading of asset-backed tokens, particularly the bay al-dayn (debt trading) rules that require the token to represent tangible asset interests rather than pure receivables.

#	Check Item	Validation Criteria	REGA/SAMA Ref.	Status
6.1	Bay' al-Dayn Compliance	If token represents receivables (rent income), secondary sale must follow debt trading rules: spot settlement, no discount	AAOIFI SS No. 62 (Sukuk, draft) Bay al-Dayn Rules	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
6.2	Tangible Asset Threshold	At least 33% of token value must represent tangible assets (not cash or receivables) for free secondary trading	AAOIFI SS No. 21 Shariah Screening Criteria	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
6.3	Price Transparency	Trading platform must display real-time token prices based on actual NAV. No speculation or artificial price manipulation	CMA Market Conduct Rules REGA Fair Trading Standards	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
6.4	Continuous KYC Checks	Each token transfer must verify buyer KYC status. On-chain transfer restrictions enforced at every transaction	REGA NFT Spec 2026 SAMA Continuous KYC Requirements	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
6.5	Registry Synchronization	Every secondary sale must	REGA NFT Spec 2026 RER Real-	<input type="checkbox"/> Pass

		trigger corresponding update in the REGA Real Estate Registry within settlement window	Time Sync Protocol	<input type="checkbox"/> Fail
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### Step 7: Dividend Distribution

Dividend distribution is the final and recurring step in the lifecycle. Under Shariah principles, returns must reflect actual property performance, not fixed interest payments. The distribution mechanism must also handle Zakat obligations and income purification automatically.

#	Check Item	Validation Criteria	REGA/SAMA Ref.	Status
7.1	Actual Profit Distribution	Dividends must reflect real rental income and capital appreciation. No fixed or guaranteed return structures	AAOIFI SS No. 12 (Sharikah) Shariah Board Approval	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
7.2	Proportional Allocation	Returns must be distributed proportionally to each token holder based on their exact ownership percentage	AAOIFI SS No. 17 (Investment Sukuk) Smart Contract Logic Audit	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
7.3	Automatic Purification Deduction	Smart contract must auto-deduct any non-compliant income and route to approved charity (Tazkiyah mechanism)	AAOIFI SS No. 21 Shariah Board Purification Rate Policy	<input type="checkbox"/> Pass <input type="checkbox"/> Fail
7.4	Zakat Calculation Support	Platform must provide Zakat calculation tools based on	AAOIFI SS No. 35 (Zakat) GAZT Saudi	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

		token holding value and duration for investor reporting	Zakat Regulations	
7.5	Transparent Audit Trail	All distribution records must be immutable on-chain with full audit trail accessible to REGA and Shariah auditors	REGA NFT Spec 2026 AAOIFI Governance Standard No. 3 SAMA Audit Rules	<input type="checkbox"/> Pass <input type="checkbox"/> Fail

Sources: REGA Official ([rega.gov.sa](http://rega.gov.sa)); AAOIFI Shariah Standards; SAMA AML/CTF Regulations; CMA Securities Rules; White & Case, "Tokenised Islamic Finance Products" (2025); RWA.io, "Sharia Compliance for Tokenized Assets" (2026); Pinsent Masons, "Saudi Arabia Real Estate Tokenisation Infrastructure" (2025); SettleMint/REGA National Tokenization Framework (2025).

### 3.3 Security Architecture

In the case of tokenized real estate, security is non-negotiable. Tokenized real estate represents legal ownership rights to physical property. If a security breach could facilitate illicit token transfers, this would amount to a fraudulent property transfer – a serious legal issue as well as a reputational concern. The architecture employs a 'defense-in-depth' strategy, consistent with the Wiz.io cloud security framework.[26] This means layers of security control for the network perimeter, the application itself, its data, and its identity. In this way, there should be no single point of failure that will expose the entire system. Identity and Access Management uses a zero-trust principle. Users and systems are never automatically trusted, even those who have gained access to the internal network. All calls to any API must be signed. People need to authenticate using multi-factor methods. The smart contracts must be executed through signature with the cryptographic keys stored in the token owner's wallet. According to the SSRN study on blockchain interoperability, zero-trust networking is the security architecture of choice for multi-cloud blockchains.[24]

Encryption is used throughout. This means AES-256 encryption of all cloud storage data, TLS 1.3 encryption for all data transmission, and homomorphic encryption for sensitive activities like identity verification. The encryption keys are hierarchically managed; the root keys reside in hardware security modules (HSMs), which are physically separated from the cloud network. Security of smart contracts is ensured by means of an obligatory audit. Every smart contract will undergo a pre-deployment review by an independent security auditing firm. The contracts will be upgradable using a dual-signature governance protocol with multi-sig participation from both the platform and REGA.

### 3.4 Regulatory Alignment for Saudi Arabia

The architecture is designed with the goal of regulatory alignment in mind. The formal regulations are expected by June 2026, but the technical standards have already been set. They are incorporated into the architecture in the following manner.

**Data Residency** – all property titles and Know Your Customer information on Saudi Arabian investors should be stored in Saudi Arabia. The architecture sends data to AWS Bahrain and Azure UAE South, both locations close enough to ensure data residency compliance pending the establishment of the in-Kingdom data centers.

**Regulatory Reporting** – the Azure compliance layer generates reports to REGA in a required format. Transaction logs are immutable and will be delivered within a matter of hours after the request is received. Real-time reporting capabilities can be included, should the regulator choose to deploy them.

**Token Standards** – the architecture supports the ERC-1400 token standard, built specifically for security tokens with transfer restrictions. The tokens will be restricted for transferring until REGA registry confirms the transaction, thereby guaranteeing consistency between on-chain and legal records.

### 3.5 Implementation Roadmap for Saudi Arabia

Implementation will follow a phased approach consistent with the regulatory timeline as well as the Vision 2030 milestones.

Phase 1 (Q2-Q3 2026): Foundation – During this phase, the core infrastructure is developed. Cloud accounts will be created in all three cloud providers. Network architecture will be designed, and a security baseline configuration will be put in place. The architecture will be integrated with the REGA's national platform API and the smart contracts will be deployed for a test tokenization of a commercial property in Riyadh. The completion of Phase 1 should coincide with the issuance of REGA regulations in June 2026.

Phase 2 (Q4 2026-Q2 2027): Platform Launch – In this phase, the investor portal will be implemented along with the secondary market functions, automated dividends for income-generating properties, and fiat on/off ramps via cooperation with Saudi Arabian banks. The platform will be launched for a limited number of REGA-registered property developers.

Phase 3 (Q3 2027 onwards): Scale and Expansion – This phase will see the expansion of the platform into the NEOM and Red Sea projects. The cross-border token trading features will be added to allow token transactions with UAE and Qatar platforms. DeFi functionalities will be introduced, allowing the property tokens to act as loan collaterals for token holders.

Table 3: Regulatory Status of Real Estate Tokenization by Country

Country	Regulatory Body	Status	Key Initiative
Saudi Arabia	Real Estate General Authority (REGA)	Active - first global standard launched	Completed first tokenization; approved 9 platforms; formal regulations expected by June 2026
UAE (Dubai)	Dubai Land Department (DLD) + VARA	Active - Regulatory Sandbox launched	First tokenized property subscribed in

		March 2025	<24 hours; MAG Group-MultiBank USD 3B deal
Qatar	Qatar Financial Centre (QFC)	Framework active - Digital Assets Framework 2024	QFC tokenizing USD 500M+ in real estate; PropTech LLC driving fractional ownership
Oman	Capital Market Authority (CMA)	Exploratory - stakeholders studying models	Real estate sector monitoring blockchain trends; no formal sandbox yet
India	Ministry of Electronics & IT + State governments	Pilot stage - blockchain land registry trials	UNDP Panchkula project; Supreme Court referral for blockchain property registration
UK	HM Land Registry + FCA	Pilot complete - Digital Street project	First digital mortgage signed April 2018; R3 Corda platform with Methods
USA	SEC + State regulators	Active - institutional pilots ongoing	Brookfield Asset Management tokenization exploration; JLL blockchain transaction management

Sources: REGA [11,12]; Middle East Briefing [7]; Pinsent Masons [13]; Gate News [14]; Resfix[16]; UNDP [17]; HM Land Registry [20]; Appinventiv[21]

### 3.6 Recommendations

According to the obtained results, the following recommendations can be offered to the stakeholders involved in the development of a tokenized real estate platform in Saudi Arabia.

Firstly, the REGA should be approached as soon as possible. As it was noted above, the regulator continues working on the regulatory regime. In other words, the regulatory regime can be influenced. Participants of consultations will receive the advantage since they will learn how to build compliant software.

Secondly, the multi-cloud strategy should be chosen from the very beginning. Transitioning from a single cloud to a multi-cloud environment might be quite costly after the implementation of the platform. The 30% reduction in costs described in the ScienceDirect article [23] partly explains that the portability was planned earlier.

Thirdly, interoperability must be considered. The tokenized real estate market in the Gulf Cooperation Council countries will not be a collection of separate national markets. The tokens issued in Saudi Arabia should be easily exchangeable with the tokens issued in Dubai and vice versa. The solutions proposed by cross-chain bridges discussed in the SSRN article[24] might be applied for that purpose.

Fourthly, the platform security should be carefully addressed before the launch of the product. There were some security incidents regarding blockchain and fintech solutions. In case of any issues connected with platform security, not only its reputation will suffer, but also the whole tokenization market of the Kingdom.

Fifthly, designing a platform for institutional investors right away. As we can see above, 57% of institutional investors are ready to use tokenized real estate platform.[1] Institutional investors invest large sums of money. However, they have some specific needs which should be satisfied. These solutions will attract institutional investors and make platforms profitable.

### IV. CONCLUSION

In conclusion, it should be mentioned that a multi-cloud solution is critical for tokenized real estate platforms. The requirement to keep some information inside the Kingdom, the necessity to use best-of-breed blockchain and security solutions, and the problem of vendor lock-in make it inevitable for real estate companies to implement a multi-cloud approach. Saudi Arabia possesses all the resources for becoming the leader in the GCC market of tokenized real estate. The Kingdom has the regulatory momentum (the first tokenization project completed and the publication of national standards by REGA), the necessary infrastructure (cloud market growing by 25% per year and data centers of major cloud providers operating in Saudi Arabia), the political will (focus on real estate technologies in the framework of Vision 2030), and an enormous investment pipeline (projects worth one trillion riyals such as NEOM). Evidence from other countries inspires optimism. The project Digital Street carried out by the UK showed that it was possible to conduct property transactions using blockchain. UNDP's experiment in India confirmed that it was also possible to use blockchain to improve land registries. The demand for tokenized real estate was demonstrated in the project implemented in Dubai tokenization sandbox. The first property sold in 24 hours. Evidence presented above is not theoretical, it is practical. Nevertheless, risks should be taken into account. The first and the most important is the regulatory uncertainty. Although Saudi Arabia is expected to publish the final version of regulations in June 2026, their content may influence the opportunities of the platforms. For example, it is quite probable that strict restrictions would be established regarding token standards, transfers, eligible investors, and dispute resolution procedures. Also, the technical risks connected with the security and portability between clouds cannot be excluded. They require considerable expertise and investments. Further researches should concentrate on three aspects. Firstly, empirical investigation of cost-saving achieved while conducting real tokenization transactions in Saudi Arabia (figure 25% in GCC context should be verified). Secondly, the legal future of token ownership disputes in the Saudi judicial system should be examined. Thirdly, the behavior of

retail investors on tokenized real estate platforms should be investigated.

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