



Dynamic Configuration of the Business Model of Blockchain-Based Retail Platforms: A Scenario-Based Approach to Resilience under Deep Uncertainty

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Abstract

This study aimed to develop a dynamic, scenario-based configuration model for blockchain-based retail platform business models by identifying robust, adaptive, and contingent components that enhance resilience under conditions of deep uncertainty. This applied exploratory mixed-method study was conducted with 36 experts from Tehran selected through purposive criterion-based sampling from the fields of blockchain technology, fintech, retail and e-commerce, platform strategy, technology management, and regulatory policy. Data were collected using semi-structured expert elicitation, an environmental uncertainty assessment questionnaire, a cross-impact assessment matrix, a scenario-construction instrument, and a business model configuration and resilience assessment questionnaire. Data analysis combined directed thematic coding, impact–uncertainty analysis, cross-impact structural analysis, scenario consistency assessment, cross-scenario comparison, and sensitivity analysis to identify critical uncertainties and determine appropriate business model configurations across alternative futures. Regulatory orientation obtained the highest impact–uncertainty score (22.56), followed by blockchain and payment interoperability (20.59), consumer and merchant trust (20.09), and blockchain infrastructure maturity (19.10). Cross-impact analysis identified regulatory orientation as the strongest driving variable, with a direct influence score of 31 and an indirect influence score of 35, while blockchain infrastructure maturity was the second major driver. Four internally coherent scenarios were derived: Institutionalized Blockchain Ecosystem, Regulated Fragmentation, Technological Expansion under Institutional Ambiguity, and Constrained and Distrusted Ecosystem. Their respective resilience scores were 4.63, 4.14, 4.32, and 3.88. Cybersecurity, modular architecture, data integrity, payment redundancy, and continuous monitoring emerged as robust cross-scenario elements, whereas governance, blockchain depth, payment mechanisms, partner structures, and smart-contract intensity were identified as adaptive components. Resilience in blockchain-based retail platforms depends not on maximizing blockchain adoption, but on preserving a robust strategic core while dynamically reconfiguring governance, technological architecture, partnerships, payments, and investment commitments in response to evolving regulatory and technological conditions.

Keywords: Blockchain Retail Platforms; Business Model Configuration; Scenario Planning; Deep Uncertainty; Business Model Resilience; Digital Transformation; Platform Governance

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1. Introduction

The rapid convergence of digital transformation, platformization, artificial intelligence, distributed infrastructures, and data-intensive retailing has fundamentally altered the architecture of contemporary

business models. Retail firms increasingly operate not as isolated organizations but as participants in digitally mediated ecosystems in which value is co-created among consumers, merchants, logistics providers, payment intermediaries, technology vendors, and platform



orchestrators. This transition has shifted competitive advantage away from ownership of discrete physical assets toward the capacity to coordinate information, transactions, relationships, and complementary resources across organizational boundaries. Digital business strategy therefore requires the integration of technological capabilities with organizational design and strategic positioning rather than treating information technology merely as a supporting function [1]. This broader transformation has also intensified the need for firms to reconsider how value is proposed, delivered, captured, and sustained under changing technological and institutional conditions. The business model perspective offers an appropriate analytical lens because it connects customer value, key activities, resources, partnerships, channels, cost structures, and revenue mechanisms within an integrated configuration [2]. However, the increasing turbulence of digital ecosystems means that the central strategic problem is no longer only how to design a viable business model, but how to continuously reconfigure that model when technological trajectories, market structures, institutional requirements, and user expectations remain uncertain.

Digital transformation research has repeatedly emphasized that technological change cannot be reduced to the adoption of individual technologies. Rather, digital transformation involves substantial changes in organizational identity, value creation, structures, processes, and relationships with customers and ecosystem partners [3]. Similarly, multidisciplinary research on digital transformation indicates that firms must simultaneously address customer behavior, competitive dynamics, organizational capabilities, digital resources, and new forms of value creation if they are to sustain performance in digitally disrupted markets [4]. Evidence from business organizations also suggests that technologies associated with digital transformation can contribute to improved business performance when they are effectively aligned with managerial capabilities and organizational processes [5]. At the same time, digital transformation is constrained by numerous barriers, including organizational inertia, skills deficiencies, resource limitations, technological incompatibility, structural rigidity, strategic ambiguity, and regulatory obstacles [6]. These tensions are especially pronounced in retailing because retail platforms operate at the intersection of customer-facing digital services, transactional infrastructures, supply networks, payment systems, data governance, and institutional oversight.

The emergence of smart retail technologies has further intensified this transformation. Retail organizations increasingly rely on digitally integrated systems capable of supporting personalized customer interaction, automated inventory management, real-time demand assessment, digital payments, intelligent logistics, data analytics, and platform-mediated coordination. The implementation of such technologies depends not only on their technical attributes but also on organizational capabilities and the ability of retailers to absorb, integrate, and operationalize them within existing business architectures [7]. Parallel developments in Supply Chain 4.0 demonstrate that artificial intelligence and other digital technologies are increasingly being applied to forecasting, inventory optimization, logistics coordination, demand planning, supplier assessment, and retail decision-making [8]. These developments have created an environment in which competitive retail platforms must manage large volumes of distributed data while maintaining transaction speed, traceability, security, trust, interoperability, and responsiveness. Conventional centralized systems can provide many of these functions, but they also introduce dependence on dominant intermediaries and centralized data repositories, thereby creating concerns related to transparency, data control, security, verification, and asymmetric power within platform ecosystems.

Blockchain technology has therefore attracted growing attention as a potential infrastructure for restructuring digital transactions and interorganizational coordination. Blockchain can be understood as a distributed ledger architecture that allows validated records to be stored across multiple nodes, thereby supporting tamper resistance, traceability, transaction verification, distributed trust, and programmable transactions. Within Industry 4.0, blockchain has been examined as an enabling technology for secure information exchange, automation, traceability, decentralized coordination, and integration with other emerging technologies such as the Internet of Things, artificial intelligence, and cyber-physical systems [9]. Its potential relevance extends beyond financial transactions to supply chains, industrial systems, public services, sustainability initiatives, and platform-based economic activities [10]. In retail ecosystems, these capabilities are particularly significant because transactions frequently involve multiple actors that must exchange data concerning products, payments, inventory, delivery, ownership, identity, warranties, loyalty, and consumer behavior.

One of the most frequently discussed contributions of blockchain to business ecosystems is its capacity to alter the mechanisms through which trust is produced. Traditional retail platforms typically create trust through centralized governance, platform reputation, contractual enforcement, institutional oversight, and control over information. Blockchain introduces a complementary form of technology-mediated or algorithmic trust in which transaction integrity is supported through distributed validation, cryptographic mechanisms, immutable records, and programmable rules. Research has suggested that blockchain may increase trust and transparency in digital ecosystems while functioning, in many contexts, as an incremental rather than wholly disruptive innovation [11]. In marketing, blockchain has similarly been associated with enhanced transparency, new forms of customer data management, changes in trust relationships, and potential improvements in customer experience [12]. Its implications for marketing also include opportunities for product provenance, loyalty systems, consumer privacy, advertising accountability, data ownership, and direct interaction among market actors [13]. These applications indicate that blockchain should not be evaluated solely as a back-end technical infrastructure; its significance lies in the manner in which it reshapes governance, customer relationships, data rights, incentive structures, and the distribution of value among ecosystem participants.

The supply-chain dimension of blockchain is particularly relevant to retail platform business models. Retail systems are strongly dependent on the coordination of suppliers, manufacturers, distributors, logistics providers, warehouses, retailers, financial intermediaries, and consumers. Blockchain has been proposed as a mechanism for increasing traceability, transparency, accountability, and information consistency across supply networks [14]. Smart contracts can further automate predefined transactional conditions and reduce the need for repeated manual verification among participants. Empirical and applied research on blockchain-enabled supply-chain re-engineering has demonstrated the potential of smart-contract-based tracking systems to redesign monitoring and coordination processes [15]. However, the realization of these benefits is not automatic. Blockchain adoption may be constrained by technological complexity, high implementation costs, interoperability problems, inadequate standards, regulatory uncertainty, organizational resistance, ecosystem coordination problems, and limited knowledge among participants [16]. Consequently, the strategic value of

blockchain depends on the broader configuration within which the technology is embedded.

This observation is especially important for retail platforms because blockchain can assume substantially different roles in different business models. In one configuration, blockchain may be used narrowly for product traceability while the platform remains centrally governed. In another, distributed ledgers may support payment processing, identity verification, smart-contract execution, supplier coordination, or customer loyalty. More extensive models may incorporate tokenized incentives, decentralized governance, peer-to-peer transactions, or shared data infrastructures. Each configuration involves different resource requirements, risks, revenue mechanisms, governance arrangements, partner dependencies, and regulatory exposures. Therefore, evaluating blockchain simply in terms of adoption versus non-adoption obscures the configurational nature of the strategic decision. Recent foresight research specifically addressing blockchain retailing has identified multiple technological, institutional, market, and trust-related drivers shaping the future of value creation, with algorithmic trust emerging as a particularly important dimension of prospective blockchain-enabled retail systems [17]. These findings suggest that the future of blockchain retail is likely to be determined by interacting drivers rather than by a linear trajectory of technological diffusion.

Platform-based business environments further complicate this configurational problem. Platforms create value by facilitating interactions among multiple participant groups, coordinating complementary assets, managing data flows, and establishing rules of participation. Their effectiveness therefore depends on ecosystem readiness, institutional compatibility, governance arrangements, digital infrastructure, and the willingness of heterogeneous actors to participate. Research on readiness for platform-based institutional arrangements shows that successful entry into platform structures requires more than technological availability; it requires organizational, institutional, cultural, infrastructural, and governance preparedness [18]. This insight is transferable to retail platforms, where blockchain implementation requires coordination among actors with divergent incentives and capabilities. A technologically advanced blockchain platform may fail if merchants are unwilling to participate, consumers lack trust, payment infrastructures remain incompatible, or regulators restrict particular transaction mechanisms. Conversely, an institutionally supportive environment may not generate

viable adoption if the underlying technology remains expensive, slow, fragmented, or difficult to integrate with conventional retail infrastructures.

The strategic challenge is therefore intensified by deep uncertainty. Deep uncertainty arises when decision-makers cannot confidently specify future states, assign reliable probabilities to those states, or agree on the models that explain how major variables will interact. Blockchain retail platforms are exposed to this type of uncertainty because several of their most consequential environmental variables remain fluid. Regulatory approaches toward distributed ledgers, digital assets, smart contracts, data localization, digital identity, and platform governance continue to evolve. Technological standards and interoperability arrangements are not universally established. Consumer and merchant trust may respond unpredictably to security incidents, institutional endorsement, market experience, and changes in platform reputation. Competitive structures may shift rapidly as incumbent retailers, fintech firms, technology companies, and new platform entrants develop alternative architectures. Under such conditions, traditional planning based on a single expected future may encourage strategic lock-in and produce substantial vulnerability.

Scenario planning provides a suitable approach for addressing this problem because it does not require the selection of one forecast as the basis for strategic action. Instead, it enables researchers and decision-makers to identify critical uncertainties, analyze their interactions, develop internally coherent alternative futures, and examine the robustness of strategic options across those futures. Scenario-based research has been used in Iranian technology and industry contexts to investigate uncertain futures and to provide a structured basis for strategic decision-making. For example, scenario development has been applied to analyze the future of the software industry by identifying major drivers and constructing alternative environmental configurations [19]. A two-level scenario-planning approach has also been proposed to connect industry-level changes with firm-level strategic responses, demonstrating the importance of linking macro-level uncertainty to organizational strategy [20]. Moreover, methodological work in futures studies has emphasized the importance of structured interpretive analysis, the identification of interrelationships among drivers, and methodological rigor in constructing meaningful future-oriented models [21]. These perspectives are particularly relevant to blockchain retail platforms, where technological and institutional forces

must be analyzed not in isolation but as an interconnected system.

The need for a scenario-oriented perspective is reinforced by the fact that resilience under uncertainty differs from static efficiency. A business model designed to maximize performance under one expected environment may be fragile when its core assumptions change. Resilience, by contrast, requires the ability to preserve essential value-creation and value-capture functions while adapting governance, partnerships, technological architecture, customer interfaces, and revenue mechanisms in response to environmental change. In the context of blockchain retail platforms, this may require maintaining modular technological architectures, multiple payment options, flexible partner structures, scalable governance mechanisms, alternative trust arrangements, and reversible investment commitments. Such features allow the platform to alter the depth and location of blockchain integration as regulatory and market conditions evolve. This logic is consistent with the broader digital strategy perspective, in which digital technologies are embedded in dynamic strategic configurations rather than treated as independent operational tools [1]. It is also consistent with digital transformation research emphasizing the need for continuous organizational adaptation as technologies reshape industry structures and value propositions [3, 4].

Despite the expanding literature on blockchain applications, smart retail, digital transformation, supply-chain transparency, marketing implications, and technological adoption, an important research gap remains. Existing studies have largely examined the benefits, barriers, applications, or adoption conditions of blockchain, whereas relatively limited attention has been directed toward how the entire business model of a blockchain-based retail platform should be dynamically reconfigured across multiple plausible futures. Research has provided significant knowledge regarding blockchain-enabled trust [11], supply-chain transformation [14, 15], marketing applications [12, 13], sustainability and adoption constraints [16], and broader industrial applications [9, 10]. Similarly, domestic studies have examined smart retail technologies [7], applications of advanced digital technologies in retail and supply chains [8], digital transformation performance and barriers [5, 6], and the future drivers of blockchain retailing [17]. However, these streams do not yet provide an integrated framework explaining which business model components should remain stable, which should be adapted, and which should be activated only under specific environmental conditions.

A further gap concerns the relationship between scenario analysis and business model configuration. Scenario studies often culminate in descriptions of alternative futures, while business model studies frequently assume a given or relatively stable environment. This separation limits strategic usefulness under deep uncertainty because managers require not only an understanding of what alternative futures may emerge, but also a systematic mapping between those futures and corresponding changes in value proposition, customer scope, governance, blockchain architecture, data arrangements, payment systems, smart-contract use, partnerships, revenue models, cybersecurity, and investment logic. Integrating the business model concept with scenario planning can therefore generate a more actionable framework in which environmental signals trigger specific reconfiguration choices. Such an approach can also distinguish robust components that remain valuable across scenarios from adaptive components that should be modified as conditions change and contingent options that should be activated only when particular technological or institutional conditions are present.

The strategic relevance of this issue is especially pronounced in contexts where institutional development, technological diffusion, infrastructure integration, and regulatory adaptation may progress at different speeds. Under these circumstances, blockchain-enabled retail platforms cannot rely on a single model of technological maturation. A platform may face strong technological capability but weak institutional support, predictable regulation but fragmented interoperability, or favorable ecosystem participation alongside cybersecurity and trust concerns. The resulting combinations create distinct strategic environments, each of which may require a different degree of decentralization, governance openness, investment intensity, payment integration, smart-contract deployment, and partner participation. Accordingly, resilience should be conceptualized as a configurational and dynamic capability rather than as a fixed attribute of the business model. A resilient platform is one that can recognize changes in its environment, interpret those changes through a structured scenario logic, and reconfigure its business model while preserving continuity of value creation.

Therefore, the aim of this study is to develop a dynamic, scenario-based configuration model for blockchain-based retail platform business models that identifies robust, adaptive, and contingent business model components and

explains how they should be reconfigured to enhance resilience under conditions of deep uncertainty.

2. Methodology

This study employed an applied, exploratory mixed-method research design to develop a dynamic configuration model for the business models of blockchain-based retail platforms under conditions of deep uncertainty. The methodological logic combined business model analysis, expert elicitation, environmental scanning, structural analysis of uncertainty, scenario development, and dynamic configuration assessment. A scenario-based design was selected because conventional forecasting methods generally assume that the direction and magnitude of environmental changes can be estimated with an acceptable degree of probability, whereas blockchain-based retail ecosystems are characterized by technological discontinuities, regulatory ambiguity, changing platform governance arrangements, cybersecurity risks, volatility in digital asset and payment infrastructures, evolving consumer acceptance, and uncertain relationships among retailers, technology providers, financial institutions, and regulatory bodies. Accordingly, the study did not attempt to identify a single most probable future. Instead, it sought to determine how alternative combinations of business model components could remain viable and resilient across several plausible futures. The empirical study was conducted in Tehran, Iran, because Tehran represents the country's principal concentration of retail platform companies, fintech businesses, blockchain technology specialists, digital commerce firms, financial institutions, technology consultants, and regulatory and policy expertise relevant to the development of blockchain-enabled retail ecosystems. The study population consisted of senior managers, platform and digital-business strategists, blockchain and distributed-ledger technology specialists, fintech professionals, retail and e-commerce executives, university faculty members specializing in technology management and business strategy, and experts with professional experience in financial regulation and digital transformation. Purposive criterion-based sampling was used to ensure that participants possessed sufficient knowledge of both platform business models and the uncertainties associated with blockchain adoption. To be eligible, participants were required to have at least five years of relevant professional or academic experience, direct involvement in digital platforms, retailing, fintech, blockchain, strategic management, or technology

policy, and familiarity with at least one of the following areas: platform governance, blockchain architecture, digital payments, retail ecosystems, business model innovation, strategic foresight, or uncertainty management. A total of 36 experts from Tehran participated in the study. The participant pool was deliberately heterogeneous to prevent the resulting scenarios from reflecting the assumptions of a single professional community and to incorporate technological, commercial, managerial, institutional, and regulatory perspectives. The same expert pool was retained throughout the principal stages of environmental assessment, evaluation of uncertainties, cross-impact assessment, scenario validation, and evaluation of alternative business model configurations, thereby providing methodological continuity across the scenario-development process. Participation was voluntary, respondents were informed of the purpose of the study, and individual responses were treated confidentially. Data were analyzed at the aggregate level, and no personally identifiable information was reported.

Data collection was conducted through an integrated set of researcher-developed instruments designed to capture the architecture of blockchain-based retail business models, identify the major forces shaping their future environment, distinguish critical uncertainties from relatively predetermined trends, and evaluate the appropriateness of alternative configurations under different scenarios. The first instrument was a semi-structured expert elicitation protocol developed on the basis of the business model literature, platform ecosystem theory, blockchain-enabled value creation, resilience theory, and strategic foresight. The protocol explored the principal components of a blockchain-based retail platform business model, including value proposition, customer segments, participant and complementor relationships, value creation mechanisms, value delivery architecture, platform governance, blockchain infrastructure, data governance, transaction and consensus mechanisms, revenue logic, cost structure, token or incentive arrangements where applicable, trust mechanisms, interoperability, regulatory compliance, cybersecurity, and mechanisms for adaptation and continuity. It also included questions concerning technological, economic, social, competitive, legal, institutional, and geopolitical drivers that could influence the viability of such platforms. The second instrument was an environmental uncertainty assessment questionnaire through which experts evaluated the identified drivers according to their potential impact on the future of blockchain-based

retail platforms and the degree of uncertainty associated with their future development. A five-point Likert-type scale was used for both dimensions. Drivers simultaneously receiving high impact and high uncertainty assessments were treated as candidate critical uncertainties for scenario construction, whereas high-impact factors with relatively low uncertainty were treated as predetermined or comparatively stable elements to be incorporated across the scenarios.

A structured cross-impact assessment matrix was subsequently used to examine the relationships among the selected strategic drivers. Experts assessed the extent to which a change in each driver could influence the remaining drivers, allowing the research team to differentiate variables with strong driving power from variables that were primarily dependent on other changes in the system. This stage was essential because deep uncertainty in a platform ecosystem cannot be adequately represented by examining individual factors independently; regulatory policy, technological maturity, consumer trust, transaction costs, interoperability, platform governance, data regulation, cybersecurity, competitive intensity, and access to digital financial infrastructure may reinforce or constrain one another. Following the structural analysis, a scenario-construction instrument was used to define alternative states for the critical uncertainties and to assess the internal consistency and plausibility of different combinations of those states. Scenario narratives were then developed to represent structurally distinct future conditions rather than simple optimistic, pessimistic, and baseline forecasts. Each narrative described the expected configuration of the regulatory environment, blockchain infrastructure, market acceptance, competitive structure, governance requirements, trust conditions, financial architecture, and technological integration of the retail ecosystem.

The final data collection instrument was a business model configuration and resilience assessment questionnaire. Based on the business model components identified during the preceding stages, alternative strategic configurations were formulated for each scenario. Experts evaluated the suitability of these configurations according to criteria reflecting resilience under deep uncertainty, including adaptability, robustness, modularity, scalability, interoperability, economic sustainability, regulatory flexibility, cybersecurity, data integrity, continuity of value creation, diversification of revenue mechanisms, ecosystem coordination, and the capacity for rapid reconfiguration when environmental assumptions changed. Content validity of the research instruments was assessed through expert

review before their final administration. Items considered ambiguous, overlapping, or insufficiently relevant to blockchain-enabled retail platforms were revised or removed. A pilot assessment was also undertaken to ensure that the wording of the scales and the definitions of the driving forces, scenario states, and business model dimensions were interpreted consistently by participants. Rather than treating resilience as the performance of one fixed business model in one expected environment, the instrument operationalized resilience as the capacity of the platform to preserve essential value-creation and value-capture functions while reconfiguring selected business model components in response to different combinations of external conditions.

Data analysis followed a sequential scenario-based modeling procedure. Initially, the qualitative expert material was subjected to directed thematic coding. Statements relating to value creation, value delivery, value capture, platform governance, blockchain architecture, ecosystem relationships, regulatory conditions, market behavior, and environmental uncertainty were coded, compared, consolidated, and organized into higher-order categories. Conceptually overlapping codes were merged, while factors that represented analytically distinct mechanisms were retained. This process produced an initial architecture of the blockchain retail platform business model and a set of external driving forces capable of affecting its future viability. The identified drivers were then quantitatively screened using the experts' impact and uncertainty scores. Mean scores, dispersion measures, and relative rankings were calculated, and factors exhibiting both substantial potential impact and substantial uncertainty were retained as critical uncertainties. This procedure prevented the scenario model from becoming excessively complex and focused scenario construction on uncertainties capable of producing meaningfully different strategic environments.

The selected drivers were subsequently examined through cross-impact structural analysis. A direct influence matrix was constructed from the experts' evaluations, and the influence and dependence of each variable were calculated to identify driving, dependent, linkage, and relatively autonomous factors. Particular attention was paid to variables with high driving power because changes in these variables were capable of propagating through several dimensions of the platform ecosystem. Indirect relationships were also considered through matrix iteration so that variables whose strategic importance emerged through chains of influence were not excluded solely because their

direct effects appeared moderate. The resulting influence-dependence structure provided the analytical basis for choosing the critical uncertainties used in scenario construction. Alternative states were specified for each selected uncertainty, and logically possible combinations were subjected to consistency assessment. Internally contradictory combinations were eliminated, while combinations demonstrating both structural coherence and strategic differentiation were retained. The retained configurations were transformed into scenario narratives explaining how technological maturity, regulatory orientation, customer and merchant acceptance, ecosystem trust, platform competition, interoperability, cybersecurity, and digital financial infrastructure could interact in alternative futures.

The business model was then treated as a configurable system rather than a static set of elements. For each scenario, the required state of the major business model components was assessed and an appropriate configuration was developed across value proposition, customer and ecosystem architecture, platform governance, blockchain design, transaction mechanisms, data governance, partner structure, key capabilities, revenue logic, cost architecture, and risk-management mechanisms. Cross-scenario comparison was used to distinguish three categories of strategic elements: robust components that remained desirable across virtually all plausible scenarios, contingent components whose appropriateness depended on a particular environmental state, and adaptive components that required deliberate mechanisms for rapid reconfiguration. A cross-scenario resilience assessment was subsequently performed by comparing each alternative configuration against the resilience criteria. Configurations were evaluated not only according to their expected performance within a single scenario but also according to the extent to which they could tolerate unfavorable conditions, preserve critical functions, and transition to an alternative configuration without disproportionate cost or disruption. Sensitivity analysis was used to examine whether changes in the relative importance assigned to resilience criteria materially altered the preferred strategic configurations. The final model was therefore developed as a dynamic configuration framework linking observable environmental signals and scenario conditions to corresponding changes in business model architecture. Instead of proposing one universally optimal blockchain retail business model, the analysis specified a core set of robust elements accompanied by scenario-contingent strategic options and reconfiguration pathways. This

analytical approach allowed the study to operationalize resilience as the ability to anticipate environmental shifts, absorb disruptions, adapt platform arrangements, and reconfigure the mechanisms of value creation, delivery, and capture when the future cannot be represented reliably through a single probabilistic forecast.

3. Findings and Results

The final analytical sample consisted of 36 experts from Tehran with substantial professional or academic experience in blockchain technology, digital platforms, retailing, fintech, business model innovation, strategic foresight, and regulatory policy. Of the participants, 27 were men (75.0%) and 9 were women (25.0%). The mean age of participants was 42.67 years ($SD = 7.81$), with ages ranging from 31 to 59 years. In terms of educational attainment, 9 participants (25.0%) held a master's degree and 27 (75.0%) held a doctoral degree or equivalent advanced professional qualification. Regarding principal professional specialization, 8 experts (22.2%) were active in blockchain

and distributed-ledger technology, 7 (19.4%) in fintech and digital payments, 6 (16.7%) in retail and e-commerce management, 6 (16.7%) in platform strategy and digital business, 5 (13.9%) in technology management and academic research, and 4 (11.1%) in regulation, financial governance, or digital policy. The participants had an average of 13.42 years of relevant professional experience ($SD = 5.36$), while their average direct experience with digital platforms, blockchain, fintech, or digitally mediated retail ecosystems was 8.31 years ($SD = 3.74$). Twenty-nine participants (80.6%) reported direct involvement in at least one blockchain, fintech, e-commerce, or digital-platform project during the previous five years, and 22 (61.1%) had participated in projects involving more than one institutional sector, such as technology firms, retailers, financial institutions, governmental organizations, or research centers. The demographic and professional composition of the panel therefore provided a heterogeneous knowledge base capable of capturing the technological, economic, organizational, regulatory, and ecosystem dimensions of blockchain-based retail platform development.

Table 1. Identification and Prioritization of Strategic Drivers Affecting Blockchain-Based Retail Platforms

Strategic driver	Mean impact	SD	Mean uncertainty	SD	Impact $\times$ uncertainty score	Priority status
Regulatory orientation toward blockchain-enabled retailing	4.78	0.42	4.72	0.45	22.56	Critical uncertainty
Interoperability of blockchain and digital payment infrastructures	4.69	0.47	4.39	0.55	20.59	Critical uncertainty
Consumer and merchant trust in blockchain-based transactions	4.64	0.49	4.33	0.53	20.09	Critical uncertainty
Maturity and scalability of blockchain infrastructure	4.58	0.50	4.17	0.61	19.10	Critical uncertainty
Cybersecurity and resilience of decentralized infrastructures	4.72	0.45	3.92	0.65	18.50	High-impact driver
Availability and stability of digital payment infrastructure	4.61	0.49	3.89	0.62	17.93	High-impact driver
Platform governance and ecosystem coordination capability	4.56	0.50	3.81	0.67	17.37	High-impact driver
Legal status of smart contracts and blockchain records	4.50	0.56	3.83	0.65	17.24	High-impact driver
Data governance and privacy requirements	4.47	0.56	3.78	0.68	16.90	High-impact driver
Intensity of competition among digital retail platforms	4.19	0.67	3.94	0.63	16.51	High-impact driver
Access to blockchain-skilled human capital	4.14	0.68	3.64	0.68	15.07	Supporting driver
Transaction cost efficiency relative to centralized platforms	4.28	0.61	3.47	0.70	14.85	Supporting driver
Merchant willingness to participate in shared ecosystems	4.17	0.65	3.53	0.70	14.72	Supporting driver
Macroeconomic stability and financing conditions	4.06	0.71	3.61	0.69	14.66	Supporting driver
Availability of reliable digital identity mechanisms	4.22	0.64	3.42	0.73	14.43	Supporting driver
Public familiarity with blockchain-based services	3.97	0.70	3.50	0.70	13.90	Supporting driver
Tokenization and digital incentive mechanisms	3.89	0.74	3.53	0.77	13.73	Supporting driver
Access to external technological partnerships	3.94	0.71	3.44	0.73	13.55	Supporting driver

Table 1 presents the initial prioritization of the principal environmental and ecosystem drivers identified through expert elicitation. The results indicate that regulatory orientation toward blockchain-enabled retailing received the highest combined impact–uncertainty score (22.56), reflecting both its direct influence on business model feasibility and the difficulty of anticipating the future regulatory treatment of blockchain infrastructures, decentralized transaction mechanisms, smart contracts, and blockchain-based financial services. Interoperability of blockchain and digital payment infrastructures ranked second with a combined score of 20.59, followed by consumer and merchant trust in blockchain-based transactions with a score of 20.09 and maturity and scalability of blockchain infrastructure with a score of 19.10. These four factors were therefore identified as the primary critical uncertainties around which alternative scenarios could be constructed. The findings also show that several factors had very high perceived impact but relatively lower

uncertainty, including cybersecurity and decentralized infrastructure resilience, digital payment availability, ecosystem governance, legal recognition of smart contracts, and data governance requirements. These variables were treated as structurally important drivers that would affect all scenarios, although their intensity and operational implications would vary across future conditions. By contrast, factors such as skilled human capital, merchant participation, digital identity, tokenization, and access to technological partnerships received moderately lower combined scores and were interpreted as supporting variables whose strategic relevance would depend partly on changes in the more dominant systemic drivers. Overall, the pattern indicates that the future viability of blockchain-based retail platforms is expected to depend less on a single technological capability than on the interaction between regulatory legitimacy, infrastructure interoperability, ecosystem trust, and the capacity of blockchain technology to operate at commercially viable scale.

Table 2. Cross-Impact Structural Analysis of the Principal Drivers

Driver	Direct influence score	Dependence score	Indirect influence score	Structural position	Strategic interpretation
Regulatory orientation	31	16	35	Driving	Principal institutional trigger
Blockchain infrastructure maturity	29	20	33	Driving	Principal technological trigger
Interoperability	28	24	32	Linkage	Connective ecosystem variable
Consumer and merchant trust	27	29	30	Linkage	Highly interactive behavioral variable
Cybersecurity resilience	25	23	29	Linkage	System-wide risk and continuity variable
Platform governance capability	26	25	28	Linkage	Coordination and adaptation mechanism
Digital payment infrastructure	24	25	27	Linkage	Operational enabling mechanism
Smart-contract legal recognition	23	19	26	Driving	Institutional implementation mechanism
Data governance requirements	21	22	24	Linkage	Compliance and legitimacy variable
Competition intensity	20	25	22	Dependent	Market-structure outcome
Merchant participation	19	26	21	Dependent	Ecosystem adoption outcome
Transaction cost efficiency	18	24	20	Dependent	Economic performance outcome
Digital identity availability	18	21	20	Linkage	Trust and access mechanism
Blockchain-skilled human capital	17	17	19	Autonomous/supporting	Capability support variable
Macroeconomic conditions	20	15	22	Driving	External contextual force
Tokenization mechanisms	15	23	17	Dependent	Business model design option

The cross-impact results in Table 2 further clarified the systemic roles of the identified drivers. Regulatory orientation emerged as the strongest driving variable, with a direct influence score of 31 and an indirect influence score of 35, indicating that regulatory decisions could initiate

cascading effects across legal certainty, payment integration, merchant participation, consumer confidence, platform investment, and governance design. Blockchain infrastructure maturity also occupied a strong driving position, demonstrating that technological improvements in

scalability, transaction speed, energy efficiency, integration capability, and reliability would directly alter the commercial viability of blockchain-based retail models. Interoperability, consumer and merchant trust, cybersecurity resilience, platform governance, digital payment infrastructure, data governance, and digital identity were located in the linkage zone, indicating simultaneously high influence and dependence. These factors are particularly important for strategic resilience because they are both affected by other environmental developments and capable of transmitting shocks throughout the ecosystem. Consumer and merchant trust, for instance, showed the highest dependence score of 29, suggesting that trust is strongly conditioned by regulatory legitimacy, cybersecurity

performance, transaction reliability, dispute-resolution mechanisms, and user experience, while simultaneously influencing adoption and transaction volume. Competition intensity, merchant participation, transaction cost efficiency, and tokenization were classified primarily as dependent variables, implying that they are more likely to represent consequences of broader technological and institutional conditions than independent forces determining the future of the ecosystem. The structural analysis therefore confirmed that regulatory orientation and technological maturity should serve as the central axes of scenario differentiation, while interoperability and trust should be incorporated as powerful cross-cutting conditions capable of amplifying or weakening the effects of the two primary uncertainties.

Table 3. Scenario Configuration for the Future of Blockchain-Based Retail Platforms

Scenario	Regulatory environment	Blockchain maturity and interoperability	Trust and ecosystem participation	Dominant platform condition	Overall resilience challenge
Scenario A: Institutionalized Blockchain Ecosystem	Supportive, clear, and adaptive regulation	High scalability and strong interoperability	High trust and broad merchant participation	Integrated multi-actor ecosystem	Scaling without governance rigidity
Scenario B: Regulated Fragmentation	Restrictive but predictable regulation	Moderate maturity with limited interoperability	Moderate trust and selective participation	Permissioned and segmented platforms	Maintaining innovation under compliance constraints
Scenario C: Technological Expansion under Institutional Ambiguity	Uncertain and inconsistently enforced regulation	High technological maturity but uneven institutional integration	Selective trust concentrated among digitally sophisticated actors	Parallel and partially decentralized ecosystems	Managing legal exposure and legitimacy risk
Scenario D: Constrained and Distrusted Ecosystem	Restrictive or unstable regulation	Low-to-moderate maturity and weak interoperability	Low trust and limited merchant participation	Closed, centralized, or hybrid survival-oriented platforms	Preserving continuity and minimizing irreversible commitments

The scenario analysis produced four internally coherent and strategically differentiated future environments, as presented in Table 3. Scenario A, termed the Institutionalized Blockchain Ecosystem, represented the most structurally favorable environment for widespread blockchain retail adoption. In this scenario, regulation is supportive and sufficiently adaptive to accommodate new forms of platform governance, digital identity, smart-contract execution, and blockchain-based payment integration. At the same time, infrastructure reaches a high level of scalability and interoperability, encouraging merchants, consumers, financial service providers, logistics actors, and technology firms to participate in interconnected platform ecosystems. The principal strategic challenge in this environment is not survival but maintaining governance flexibility as the platform scales and becomes more institutionally complex. Scenario B, Regulated Fragmentation, represents an environment characterized by relatively predictable but restrictive regulatory conditions

combined with only moderate technological integration. Blockchain use remains viable, but mainly within controlled, permissioned, or sector-specific ecosystems. Platforms in this scenario face the challenge of balancing regulatory compliance with sufficient innovation and ecosystem openness. Scenario C, Technological Expansion under Institutional Ambiguity, captures a future in which technological development progresses faster than institutional adaptation. Blockchain infrastructure becomes technically capable, scalable, and increasingly interoperable, but regulatory guidance remains inconsistent or incomplete. Such a condition can foster rapid experimentation and niche adoption, while simultaneously increasing legal exposure, contractual uncertainty, and legitimacy risks. Finally, Scenario D, the Constrained and Distrusted Ecosystem, represents the most adverse structural environment, characterized by restrictive or unstable regulation, weak interoperability, limited technological maturity, low user trust, and limited merchant participation. In this scenario,

aggressive irreversible investment would create substantial vulnerability; consequently, business model survival would depend on modularity, limited exposure, reversibility of

technological commitments, and the capacity to operate through hybrid or partially centralized arrangements until environmental conditions improve.

Table 4. Dynamic Business Model Configurations and Resilience Requirements across the Four Scenarios

Business model component	Scenario A: Institutionalized Blockchain Ecosystem	Scenario B: Regulated Fragmentation	Scenario C: Technological Expansion under Institutional Ambiguity	Scenario D: Constrained and Distrusted Ecosystem	Cross-scenario resilience implication
Value proposition	Transparent, interoperable, low-friction retail ecosystem	Compliance-secure and trusted digital transactions	Innovation, transparency, and decentralized access	Reliability, security, and continuity	Preserve core customer utility independent of architecture
Customer scope	Mass consumers, merchants, ecosystem partners	Selected customer and merchant segments	Technology-oriented and early-adopter segments	Narrow, low-risk customer segments	Maintain scalable segmentation capability
Platform governance	Distributed multi-stakeholder governance	Permissioned governance with formal oversight	Adaptive hybrid governance	Centralized or tightly controlled hybrid governance	Governance must be modular and reversible
Blockchain architecture	Public or consortium interoperability	Permissioned or consortium blockchain	Hybrid/public blockchain with selective control	Private or minimal blockchain layer	Avoid architecture lock-in
Data governance	Shared interoperable data standards	Compliance-centered controlled access	Decentralized data with layered safeguards	Minimal data exposure and strict access control	Separate critical data assets from specific ledger design
Payment infrastructure	Integrated digital and blockchain payments	Regulated payment gateways and approved digital instruments	Multiple parallel payment channels	Conventional payments with optional blockchain functions	Maintain payment redundancy
Smart contracts	Extensive automated execution	Limited to legally recognized processes	Selective use with off-chain safeguards	Minimal use in noncritical operations	Preserve manual fallback mechanisms
Revenue model	Transaction fees, ecosystem services, analytics, premium APIs	Service fees and compliant transaction revenues	Diversified experimental revenues	Conservative service-based revenues	Diversification reduces scenario-specific exposure
Partner ecosystem	Open and broad	Selective and certified	Flexible and experimentation-oriented	Small, trusted, contractually controlled	Maintain replaceable and non-exclusive partnerships
Customer trust mechanism	Transparency, traceability, distributed verification	Institutional endorsement and compliance assurance	Technology-based verification plus contractual guarantees	Brand assurance and conventional trust mechanisms	Use multiple trust mechanisms concurrently
Cybersecurity architecture	Distributed resilience and continuous monitoring	Compliance-driven security architecture	Adaptive zero-trust and decentralized controls	Highly controlled defensive security	Cybersecurity remains a robust investment in all scenarios
Investment approach	Expansion and ecosystem scaling	Selective investment	Option-based and staged investment	Minimum irreversible commitment	Use real-option logic for uncertain investments
Strategic posture	Scale and orchestrate	Comply and optimize	Experiment and adapt	Preserve and wait	Shift posture according to observable signals
Resilience score	4.63	4.14	4.32	3.88	Dynamic reconfiguration superior to static optimization

Table 4 demonstrates that no single blockchain retail business model configuration was considered optimal across all four scenarios. Instead, the experts consistently favored a dynamic configuration approach in which a stable strategic core is combined with components that can be adjusted according to environmental signals. Under Scenario A, the

preferred configuration emphasized ecosystem scale, interoperability, distributed governance, integrated blockchain payments, extensive smart-contract automation, open partner participation, and diversified revenue streams. The average resilience assessment of this configuration was 4.63, the highest among the four scenarios, reflecting the

favorable alignment between institutional legitimacy and technological capability. Under Scenario B, the business model required substantially greater control over governance, customer access, partners, data, and payment mechanisms. Permissioned or consortium architectures were preferred because they enabled blockchain-enabled transparency and coordination without violating regulatory constraints. The corresponding resilience score was 4.14. In Scenario C, experts emphasized flexibility rather than maximum decentralization. Although technological maturity allowed more advanced blockchain functions, institutional ambiguity made irreversible commitments hazardous. Consequently, hybrid architecture, staged investment, parallel payment mechanisms, selective smart-contract deployment, diversified partnerships, and contractual safeguards were preferred. This configuration received a resilience score of 4.32, indicating that technological opportunity could be exploited without requiring the platform to assume excessive institutional risk. Scenario D required the most defensive configuration. Experts favored narrow customer segments, controlled partnerships, conventional payment fallbacks, limited blockchain exposure, restricted smart-contract use, conservative revenue mechanisms, and minimum irreversible investment. Its resilience score of 3.88 was lower than those of the other scenarios because weak trust, technological constraints, and restrictive institutional conditions reduced the overall strategic opportunity available to platform firms. However, the configuration was still considered more resilient than a strategy based on continued expansion or technology-intensive commitment under unfavorable conditions.

Cross-scenario analysis showed that several business model elements displayed particularly high robustness and should therefore constitute the stable core of the proposed dynamic model. Cybersecurity capability, modular system architecture, data integrity, payment redundancy, flexible partnership structures, customer trust mechanisms, continuous environmental monitoring, and the ability to revert to alternative transaction arrangements were evaluated as valuable under every scenario. In contrast, the optimal degree of decentralization, smart-contract automation, openness of platform governance, token-based incentives, breadth of ecosystem participation, and degree of blockchain payment integration were strongly scenario-dependent. These elements were therefore classified as contingent rather than universally desirable. The findings further indicated that organizational resilience was associated not with maximum blockchain adoption but with

the ability to change the depth and location of blockchain use within the business model. In other words, the platform's strategic advantage under deep uncertainty derives from preserving architectural and organizational options that allow blockchain functionality to be expanded, reduced, relocated, or combined with conventional mechanisms as conditions evolve.

A sensitivity analysis was subsequently conducted to determine whether the relative attractiveness of the identified configurations depended excessively on the weighting of individual resilience criteria. The baseline evaluation assigned balanced importance to adaptability, robustness, modularity, scalability, interoperability, regulatory flexibility, cybersecurity, economic sustainability, ecosystem coordination, and continuity of value creation. Alternative assessments increased or decreased the relative emphasis placed on regulatory flexibility, technological scalability, cybersecurity, and economic sustainability. The results showed that the principal configuration logic remained stable across the tested weighting conditions. Cybersecurity, modularity, payment redundancy, flexible governance, and reversible investment remained among the highest-priority resilience mechanisms. The main changes concerned the relative intensity of decentralization and ecosystem openness. When regulatory flexibility was assigned greater weight, permissioned and hybrid configurations increased in attractiveness, particularly under Scenarios B and C. When technological scalability and interoperability were assigned greater weight, broader ecosystem architectures became more attractive under Scenarios A and C. When economic sustainability was emphasized, diversified revenue models and staged investment became more prominent. These results strengthened the conclusion that resilience cannot be reduced to the performance of a particular blockchain architecture; rather, it emerges from the platform's capacity to modify its architecture, governance, partner structure, transaction mechanisms, and revenue logic without disrupting the continuity of customer value.

The synthesis of the four scenarios further revealed three distinct categories of business model components. The first category consisted of robust core elements that should be preserved across scenarios, including cybersecurity capability, modular architecture, reliable identity and authentication mechanisms, data integrity, transparent transaction records, customer trust mechanisms, and continuous strategic sensing. The second category comprised adaptive components that should be deliberately

designed for reconfiguration, including platform governance, blockchain architecture, payment infrastructure, smart-contract intensity, ecosystem openness, partnership structures, and data-access arrangements. The third category consisted of contingent options that should be activated only under favorable environmental conditions, including extensive tokenization, highly decentralized governance, broad permissionless participation, aggressive blockchain-based payment substitution, and large irreversible investments in ecosystem-specific infrastructure. This distinction was particularly important because it converted the scenario analysis from a descriptive forecasting exercise into an actionable business model architecture. Rather than asking managers to select one forecast and optimize around it, the model requires them to preserve a robust core while maintaining a portfolio of configuration options that can be activated as observable indicators reveal the direction in which the environment is moving.

The expert assessments also revealed that the transition between scenarios was itself strategically important. Participants emphasized that future conditions should not be interpreted as fixed states occurring independently of one another. Instead, a platform may move gradually from one configuration toward another as regulatory, technological, market, and trust conditions change. For example, an organization operating under the restrictive conditions represented by Scenario D could initially rely on a limited private blockchain layer, conventional payment channels, and tightly controlled partnerships. If regulatory clarity increased without a corresponding increase in technological interoperability, the platform could transition toward the permissioned structure characteristic of Scenario B. If infrastructure maturity subsequently improved, selected

components could be opened progressively, eventually enabling a transition toward Scenario A. Similarly, a platform operating in Scenario C could exploit technological opportunities while preserving contractual and architectural safeguards until institutional certainty increased. This transition-based interpretation reinforced the importance of modularity and reversibility: the key strategic objective is not merely to survive a particular scenario but to minimize the cost, time, and organizational disruption involved in moving from one business model configuration to another.

The final dynamic model therefore conceptualized resilience as a continuous process involving environmental sensing, scenario recognition, configuration selection, performance monitoring, and reconfiguration. Environmental sensing captures weak and strong signals relating to regulation, interoperability, trust, technological maturity, cybersecurity, payment infrastructure, and ecosystem participation. These signals are interpreted through the scenario framework to determine which environmental state is becoming dominant. The corresponding business model configuration is then activated by modifying governance, technology architecture, data arrangements, partner structure, payment mechanisms, smart-contract intensity, and revenue design. Performance and risk indicators are continuously monitored, and new environmental information can trigger further reconfiguration. This architecture differs fundamentally from a static business model approach because the objective is not to identify the configuration with the highest expected performance under one forecast. Instead, it is to preserve sufficient strategic flexibility to maintain value creation and value capture across a range of plausible futures while limiting dependence on assumptions that cannot be reliably predicted under deep uncertainty.

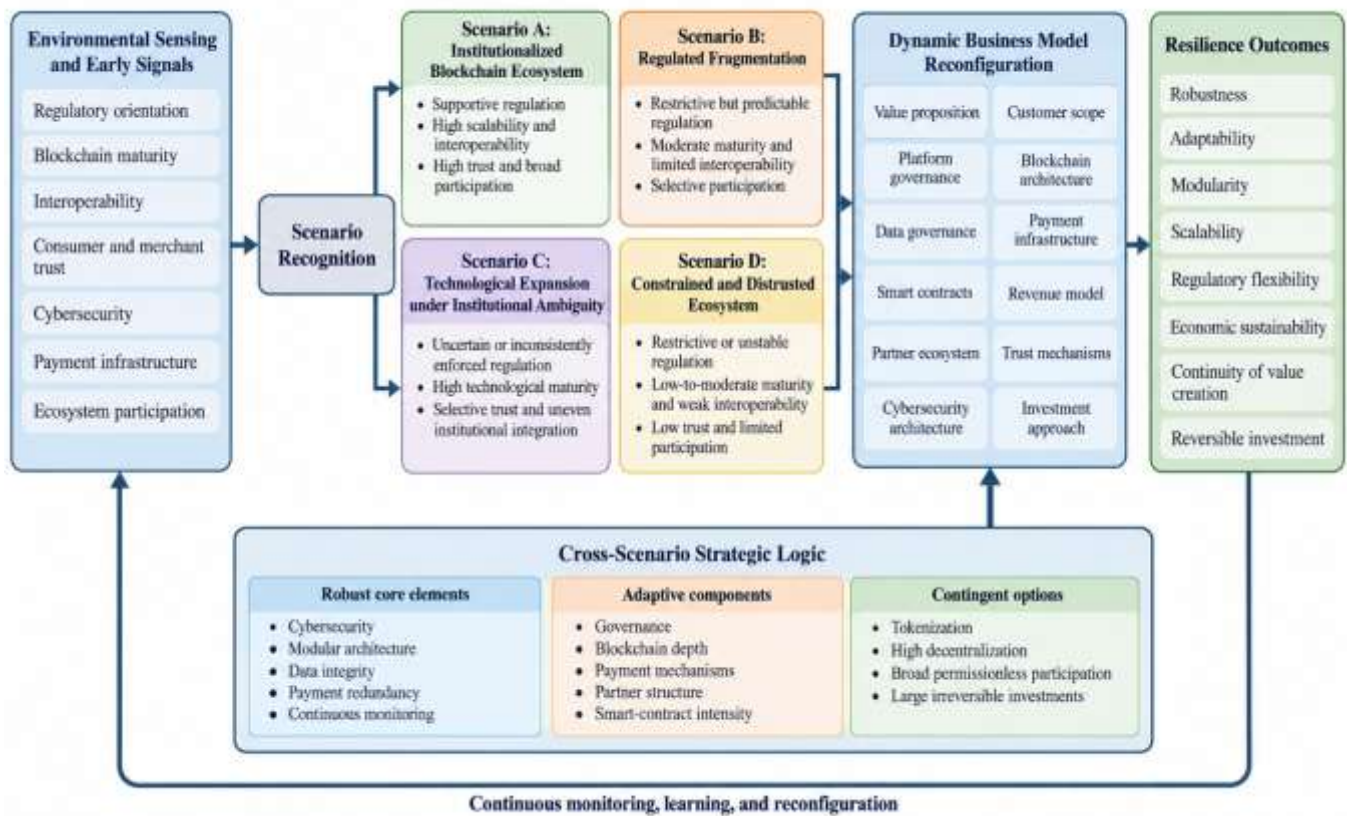


Figure 1. Dynamic Scenario-Based Configuration Model for the Resilience of Blockchain-Based Retail Platform Business Models

4. Discussion and Conclusion

The present study sought to explain how blockchain-based retail platform business models can be dynamically configured to remain resilient under conditions of deep uncertainty. The findings indicate that the strategic viability of these platforms depends on the interaction of regulatory orientation, blockchain infrastructure maturity, interoperability, consumer and merchant trust, cybersecurity, digital payment infrastructure, and ecosystem governance. Among these factors, regulatory orientation emerged as the strongest driving variable, while blockchain infrastructure maturity also demonstrated substantial driving power. Interoperability and trust occupied highly interactive linkage positions, indicating that they are simultaneously influenced by other environmental conditions and capable of transmitting changes throughout the platform ecosystem. These findings reinforce the view that blockchain-enabled retailing should not be understood as a purely technological phenomenon. Rather, its evolution depends on the co-development of institutional arrangements, technological infrastructures, market acceptance, and governance

mechanisms. This interpretation is consistent with research on digital transformation, which emphasizes that technological adoption produces meaningful organizational outcomes only when it is integrated with strategy, structure, capabilities, and ecosystem relationships [3, 4]. It also aligns with the broader digital business strategy perspective, according to which competitive advantage increasingly emerges from the integration of digital technologies with business architecture and strategic logic rather than from technology acquisition alone [1].

The prioritization of regulatory orientation as the most influential source of uncertainty is particularly important. Blockchain-based retail platforms operate across domains such as payments, digital identity, data management, smart contracts, consumer protection, and platform governance, all of which may be exposed to rapidly changing legal and regulatory frameworks. The results therefore suggest that regulatory ambiguity can alter not only compliance requirements but also the entire design of the business model. When regulation is supportive and predictable, platforms can pursue broader ecosystem participation, deeper automation, more open governance structures, and

greater blockchain integration. When regulation is restrictive or unstable, more controlled, permissioned, or hybrid structures become strategically preferable. This finding is compatible with previous research showing that digital transformation barriers frequently arise from institutional, organizational, and structural constraints rather than technological limitations alone [6]. It is also consistent with platform-readiness research demonstrating that effective participation in platform environments requires institutional and governance preparedness in addition to technological capability [18]. Accordingly, regulation should be treated as a strategic design variable rather than as an external compliance issue located outside the business model.

The prominent role of blockchain infrastructure maturity further demonstrates that technological feasibility remains a central determinant of platform configuration. The study showed that scalability, interoperability, reliability, and the capacity to integrate blockchain with payment and retail systems strongly shape the range of viable strategic options. This result corresponds with the literature on blockchain and Industry 4.0, which identifies scalability, integration, security, distributed coordination, and interoperability as critical technical requirements for effective blockchain deployment [9]. It also supports research showing that the usefulness of blockchain across industrial and non-industrial applications depends on the maturity of the broader digital infrastructure in which it is embedded [10]. In retail contexts specifically, the successful application of smart technologies has been shown to depend on the alignment between technological characteristics and organizational capabilities [7]. Thus, technological maturity does not simply determine whether blockchain can be adopted; it influences how extensively it can be embedded in the business model and which governance, transaction, and revenue mechanisms can be supported.

The strong linkage position of interoperability and consumer and merchant trust is another major finding. Interoperability was not only a technological concern but also a strategic ecosystem condition, because blockchain retail platforms must interact with payment systems, conventional databases, logistics infrastructures, identity services, financial institutions, and partner technologies. Weak interoperability can create fragmentation, increase costs, and reduce the value of network participation. The importance of trust was similarly multidimensional. Trust depended on regulation, cybersecurity, service reliability, data integrity, and institutional legitimacy, yet it also directly influenced adoption, ecosystem participation, and

transaction volume. This result strongly aligns with studies that conceptualize blockchain as an infrastructure capable of strengthening transparency and trust in digital ecosystems [11]. It also reflects findings from marketing research showing that blockchain may transform relationships among firms and customers through enhanced transparency, data control, traceability, and new trust mechanisms [12, 13]. The implication is that trust should not be treated as a psychological outcome occurring only at the consumer interface. Instead, it is a system-level property emerging from the interaction of technical architecture, governance, institutional legitimacy, and transaction experience.

The cross-impact analysis also showed that platform governance, cybersecurity, digital payments, data governance, and digital identity functioned as linkage or enabling variables rather than isolated support functions. This finding is consistent with blockchain research emphasizing that the value of distributed ledger technologies is generated through coordinated changes in organizational and interorganizational processes. Studies of blockchain-enabled supply chains demonstrate that transparent records and smart contracts can re-engineer tracking and coordination processes, but these benefits depend on complementary governance structures and reliable integration across participants [14, 15]. Similarly, research on blockchain adoption barriers indicates that organizational resistance, ecosystem coordination difficulties, standards, and interoperability can limit adoption even when the technology itself is available [16]. The present study extends this logic to retail platforms by showing that governance and infrastructure elements operate as interconnected mechanisms that either amplify or constrain the resilience of the business model.

The four scenarios identified in the findings provide further insight into how deep uncertainty changes strategic requirements. Scenario A, the Institutionalized Blockchain Ecosystem, represented an environment of supportive regulation, high technological maturity, broad interoperability, and strong trust. Under these conditions, the most resilient configuration was characterized by open ecosystem participation, distributed or multi-stakeholder governance, extensive smart-contract use, interoperable blockchain architecture, and diversified revenue mechanisms. This pattern is consistent with the business model logic proposed by Osterwalder and Pigneur, in which value proposition, partner networks, channels, customer segments, key activities, and revenue mechanisms must be configured coherently rather than independently [2]. It also

reflects the idea that digital transformation can improve business performance when technologies are integrated with organizational strategy and capabilities [5]. In favorable institutional and technological environments, deeper blockchain integration can therefore become economically and strategically justifiable because the surrounding ecosystem can support its operational requirements.

Scenario B, Regulated Fragmentation, required a different configuration. Although regulation was predictable, it was restrictive, and interoperability remained limited. Under these conditions, permissioned architectures, selective participation, formal oversight, and compliance-oriented governance became more important. The logic of this scenario supports the argument that resilience is not synonymous with maximum decentralization. A blockchain-based platform may achieve greater robustness by limiting openness and adopting controlled governance when institutional constraints demand it. This result is compatible with Treiblmaier et al.'s argument that blockchain often functions as an incremental innovation rather than as a complete replacement for existing institutional arrangements [11]. In other words, the strategic value of blockchain may lie in selectively strengthening transparency, traceability, and coordination within established structures rather than pursuing radical decentralization under all conditions.

Scenario C, Technological Expansion under Institutional Ambiguity, revealed a particularly important configurational logic. In this scenario, technological maturity exceeded institutional readiness, creating substantial opportunity alongside legal and governance risk. The preferred response involved hybrid architecture, staged investment, contractual safeguards, selective smart-contract deployment, and parallel transaction mechanisms. This configuration corresponds closely with scenario-planning principles, because it preserves flexibility rather than optimizing around one assumed institutional trajectory. Previous Iranian futures studies have similarly demonstrated the usefulness of scenario approaches in contexts where technological and industrial developments interact with uncertain external drivers [19, 20]. The present findings suggest that such uncertainty should be addressed through reversible commitments and adaptive architectures. In practical terms, the platform should maintain the capability to scale blockchain functions if institutional conditions become favorable while avoiding lock-in if regulation evolves in a restrictive direction.

Scenario D, the Constrained and Distrusted Ecosystem, generated the most defensive configuration. Low trust, weak

interoperability, unstable regulation, and limited technological maturity reduced the viability of extensive blockchain investment. Consequently, the most resilient business model emphasized tightly controlled partnerships, conventional payment fallbacks, limited blockchain exposure, narrow customer targeting, conservative revenue mechanisms, and minimal irreversible commitments. This finding is consistent with research documenting the barriers that can obstruct blockchain adoption, including technological uncertainty, implementation costs, insufficient standards, regulatory ambiguity, and limited ecosystem readiness [16]. It also aligns with broader digital transformation research showing that the presence of advanced technologies alone does not guarantee successful organizational transformation [3, 6]. Under adverse conditions, resilience therefore derives from preserving continuity and maintaining the option to expand later rather than from forcing technological adoption.

One of the most important contributions of the study is the distinction among robust core elements, adaptive components, and contingent options. Robust core elements included cybersecurity, modular architecture, data integrity, payment redundancy, and continuous monitoring. These elements remained valuable across all scenarios. Their cross-scenario importance supports the literature showing that digital transformation requires foundational capabilities that can sustain multiple strategic configurations rather than technology-specific competencies alone [4]. The central position of cybersecurity is also consistent with blockchain and Industry 4.0 research, which identifies security, reliability, and resilience as persistent requirements irrespective of the degree of decentralization [9]. Similarly, modularity provides an architectural basis for changing components without reconstructing the entire platform, making it especially important under conditions where uncertainty cannot be resolved *ex ante*.

Adaptive components included governance, blockchain depth, payment mechanisms, partner structures, and smart-contract intensity. These dimensions were found to require deliberate adjustment as environmental conditions change. This result extends conventional business model theory by emphasizing temporal and scenario-dependent configuration. Rather than viewing the business model as a stable architecture, the findings suggest that its components should be managed as adjustable design parameters. This interpretation is highly consistent with the dynamic nature of digital business strategy [1] and with the idea that digital transformation restructures how organizations create and

capture value over time [3]. It also provides a direct strategic response to the uncertainty identified in blockchain retail foresight research, where value creation and algorithmic trust have been linked to multiple interacting future drivers [17].

The contingent options identified in the study, including extensive tokenization, high decentralization, broad permissionless participation, and large irreversible investments, were not found to be universally desirable. Their value depended strongly on institutional and technological conditions. This finding is significant because much of the discourse surrounding blockchain implicitly treats decentralization and tokenization as inherently beneficial. The present results instead suggest that these design choices should be activated selectively when the surrounding environment can support them. This conclusion is consistent with marketing and supply-chain research showing that blockchain benefits are context dependent and require complementary organizational and ecosystem conditions [13, 14]. It also supports the incremental innovation perspective, according to which blockchain may add value through selective integration rather than through radical replacement of existing structures [11].

The sensitivity analysis further reinforced the stability of the overall model. Although the relative attractiveness of specific configurations changed when regulatory flexibility, technological scalability, cybersecurity, or economic sustainability were weighted differently, the core logic of dynamic reconfiguration remained stable. Cybersecurity, modularity, payment redundancy, and flexible governance retained high strategic importance across alternative assumptions. This result suggests that the proposed framework is not excessively dependent on one weighting structure and that its principal conclusions remain robust. It also corresponds with futures-studies methodologies emphasizing the importance of examining structural relationships among drivers rather than relying on isolated rankings [21]. By combining scenario differentiation with cross-scenario robustness, the present model provides a more resilient basis for strategic decision-making than approaches that seek one optimal configuration.

Overall, the findings indicate that resilience in blockchain-based retail platforms is best conceptualized as a dynamic capability for reconfiguration rather than as the possession of a specific technological architecture. The platform must continuously sense changes in regulation, technological maturity, interoperability, trust, cybersecurity, payments, and ecosystem participation; interpret those

changes through a scenario framework; and then adjust governance, architecture, partnerships, investment, and value-capture mechanisms accordingly. This conclusion integrates insights from blockchain research, digital transformation, business model theory, and scenario planning into a single configurational framework. It also extends previous research by moving from the question of whether blockchain should be adopted to the more strategically relevant question of how blockchain should be embedded, scaled, reduced, or recombined with conventional mechanisms as conditions evolve.

The study has several limitations that should be considered when interpreting the findings. First, the empirical evidence was derived from a purposive sample of 36 experts based in Tehran, which provided substantial domain knowledge but may limit the transferability of the findings to other national, institutional, and retail contexts. Second, the scenario structure was constructed from expert judgments and therefore inevitably reflects participants' current interpretations of technological and institutional trends. Third, the study focused on strategic configuration rather than longitudinal observation of actual transitions among business model states, meaning that the proposed reconfiguration pathways were analytically derived rather than observed over time. Fourth, the model did not estimate the financial costs associated with moving between configurations, and therefore differences in transition cost, organizational resistance, capability development, and implementation time were not modeled directly. Finally, the study concentrated on major business model components and could not include every possible technological or institutional variable that may affect blockchain-based retail platforms.

Future research should test and extend the proposed framework across different industries, countries, and institutional environments. Comparative studies could examine whether the same critical uncertainties and scenario configurations emerge in retail ecosystems characterized by different regulatory regimes, levels of digital infrastructure, consumer behavior, and financial architecture. Longitudinal research would be particularly valuable for observing how platform firms actually reconfigure their business models as regulatory and technological conditions change. Future studies could also integrate system dynamics, agent-based modeling, real-options analysis, fuzzy cognitive mapping, or simulation techniques to estimate transition costs and evaluate the consequences of different reconfiguration pathways. Quantitative validation of the proposed robust,

adaptive, and contingent components using larger samples could further improve generalizability. Additional research may also examine how artificial intelligence, decentralized identity, central bank digital currencies, tokenized loyalty systems, and privacy-enhancing technologies interact with blockchain retail platforms and reshape their future business model options.

For practice, managers of blockchain-based retail platforms should avoid committing to a single fixed architecture and should instead design the business model around modularity, reversibility, and continuous environmental sensing. Strategic investments should be staged so that the depth of blockchain integration can be increased or reduced without major disruption, and platform governance should be designed to shift between open, hybrid, and controlled forms when institutional conditions change. Managers should preserve multiple payment channels, alternative trust mechanisms, and flexible partnership structures to reduce dependence on a single technological or regulatory pathway. Cybersecurity, data integrity, interoperability, and monitoring capabilities should be treated as permanent strategic investments because they remain valuable across all scenarios. Firms should also define explicit environmental indicators that trigger reconfiguration decisions, such as changes in regulation, transaction costs, interoperability standards, merchant adoption, consumer trust, or technological scalability. By institutionalizing this scenario-based decision logic, blockchain retail platforms can improve their ability to preserve value creation, control risk, and exploit emerging opportunities despite persistent deep uncertainty.

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Declaration of Interest

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All procedures performed in this study were under the ethical standards.

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