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Design and Development of an Insurance Industry Product Model Based on Artificial Intelligence, Blockchain, and the Internet of Things in Iran's Insurance Sector

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ABSTRACT

The rapid advancements in emerging technologies—particularly artificial intelligence (AI), blockchain, and the Internet of Things (IoT)—have propelled the insurance industry toward unprecedented innovations and positioned InsurTech as a driving force in the reconfiguration of the insurance value chain. This study aimed to design and develop a product model for Iran's insurance industry based on these transformative technologies. Employing a mixed-methods research approach (qualitative and quantitative), the study first extracted the initial indicators and components through systematic content analysis and semi-structured interviews with 15 experts in the insurance and information technology sectors. These qualitative data were analyzed using grounded theory via MAXQDA software. In the quantitative phase, a conceptual model was validated using a researcher-made questionnaire administered to a sample of 384 insurance industry customers. Data analysis was conducted using Structural Equation Modeling (PLS-SEM) via SmartPLS software. The findings revealed that emerging technologies significantly impact the performance of the insurance industry through four key components: AI-driven innovation in insurance products, blockchain-based transparency and security, IoT-based risk management and personalized services, and enhanced operational efficiency of insurance companies. The results suggest that by improving personalization, reducing costs, increasing transparency, and optimizing processes, these technologies not only enhance the operational and competitive efficiency of insurance firms but also improve customer experience and the overall sustainability of the industry. The study's recommendations emphasize the development of innovative products, the strengthening of digital infrastructure, and the adoption of mobile applications for customer-oriented services and targeted advertising.

Keywords: Insurance Industry, Artificial Intelligence, Blockchain, Internet of Things (IoT)

Introduction

In recent years, the global insurance industry has entered a phase of profound transformation fueled by rapid technological innovation. The emergence and integration of cutting-edge technologies such as artificial intelligence (AI), blockchain, and the Internet of Things (IoT) have disrupted traditional insurance models and catalyzed the rise of InsurTech—an umbrella term describing the convergence of insurance and technology to enhance, streamline, and democratize insurance services [1, 2]. These technological breakthroughs are not only redefining product offerings and operational models but are also reshaping customer expectations, regulatory landscapes, and competitive dynamics within the insurance sector [3, 4]. The insurance industry in Iran, while historically resistant to innovation, is gradually embracing digital transformation

initiatives, particularly those aligned with global InsurTech developments, in a bid to enhance service efficiency and customer-centricity [5, 6].

The conceptualization of InsurTech encompasses a broad spectrum of innovations, ranging from data-driven decision-making to real-time policy customization and fraud detection mechanisms. These developments are deeply rooted in broader FinTech advancements and are supported by the proliferation of mobile technologies, cloud computing, and big data analytics [7, 8]. AI, in particular, has been instrumental in transforming underwriting and claims management by enabling predictive analytics, behavioral modeling, and automated decision-making processes [9, 10]. Blockchain technology has likewise introduced decentralized trust mechanisms, facilitating secure data sharing, smart contracts, and immutable transaction records, which are particularly valuable in claims processing and risk assessment [2, 11]. The Internet of Things extends this transformation further by enabling real-time monitoring through connected devices, offering insurers unprecedented insights into customer behavior, asset conditions, and risk patterns [12, 13].

The confluence of these technologies has led to the emergence of new product categories and value creation mechanisms. Insurance firms now utilize dynamic pricing models, behavioral-based coverage, and digital distribution channels to attract and retain customers in an increasingly competitive market [4, 14]. InsurTech also enables a shift from reactive to proactive insurance, wherein policies are continuously adjusted based on real-time data inputs, resulting in more accurate risk modeling and individualized services [15, 16]. This dynamic environment has necessitated new approaches to product development, strategic planning, and organizational adaptation, particularly in developing economies such as Iran, where regulatory inertia, technological infrastructure limitations, and cultural resistance remain significant barriers [17, 18].

In the context of emerging markets, the digitalization of the insurance industry holds particular promise for expanding financial inclusion and reducing the protection gap. By leveraging mobile-based applications, peer-to-peer insurance models, and microinsurance platforms, InsurTech enables underserved populations to access affordable and personalized insurance services [19, 20]. Such innovations are not only enhancing customer experience but are also reshaping the core architecture of the insurance business by decentralizing operations and encouraging collaboration between traditional insurers and tech startups [3, 21]. However, realizing these potentials requires coherent digital strategies, supportive policy frameworks, and organizational agility—factors that are not uniformly distributed across all regions and market segments [4, 22].

In Iran, digital transformation in the insurance industry is still at a nascent stage, but momentum is building. State-owned and private insurers are increasingly investing in digital infrastructure, and startup ecosystems are beginning to develop InsurTech solutions tailored to local needs [6, 17]. Nevertheless, the lack of integrated technological models and a coherent strategic framework has limited the scalability and sustainability of these initiatives. Given this context, the present study seeks to design and validate a comprehensive product model for the Iranian insurance industry that integrates AI, blockchain, and IoT technologies. By drawing on both qualitative and quantitative methods, and incorporating insights from insurance experts and technology professionals, this research addresses a critical gap in the current literature and practice [1, 2]. It aims to contribute a practical and theoretically grounded framework for guiding digital product innovation in Iran's insurance sector, enhancing operational efficiency, customer satisfaction, and long-term competitiveness.

In conclusion, the convergence of AI, blockchain, and IoT within the framework of InsurTech is fundamentally altering the structure and strategy of the global insurance industry. While global case studies offer valuable insights, localized research is essential for addressing region-specific challenges and leveraging contextual opportunities. This study is situated within that

imperative—aiming to bridge the gap between international best practices and domestic implementation strategies in the Iranian context.

Methods and Materials

This study adopts a mixed-methods (combined) approach and was conducted in two phases—qualitative and quantitative—in order to comprehensively design and validate a model for insurance industry products based on artificial intelligence (AI) integrated with blockchain and the Internet of Things (IoT). In the qualitative phase, using systematic content analysis and the grounded theory approach, initial indicators and components were extracted through a structured review of domestic and international scientific sources. To enrich the theoretical foundation and ensure the comprehensiveness of the findings, semi-structured interviews were conducted with 15 experts from the insurance industry and specialists in information technology and artificial intelligence within the insurance domain. These individuals were selected purposefully based on criteria such as relevant professional experience (more than 10 years), academic background in insurance, technology, or management, and proficiency in advanced technologies such as blockchain and IoT. The interview analysis process was carried out using MAXQDA software through open, axial, and selective coding to construct a conceptual network of indicators, components, and dimensions for the preliminary model.

In the quantitative phase, to validate the model developed during the qualitative phase, a researcher-made questionnaire was designed based on the findings from the first stage. The face and content validity of the questionnaire were confirmed using the Content Validity Ratio (CVR) and Content Validity Index (CVI), along with expert consultation from 10 specialists. The CVR value was calculated at 0.79, and the CVI at 0.80, indicating satisfactory content validity. To assess the instrument's reliability, Cronbach’s alpha coefficient was applied, and results for all dimensions exceeded 0.70, confirming acceptable reliability. The statistical population in the quantitative section included all active customers of the Iranian insurance industry. Given the population’s unlimited nature, the sample size was calculated as 384 individuals using Cochran’s formula at a 95% confidence level. The final questionnaire was distributed via online tools, and data were collected accordingly.

For data analysis, qualitative data were analyzed using grounded theory methodology in MAXQDA software. In the quantitative phase, analysis was conducted in two stages. Initially, descriptive analyses and normality testing (Kolmogorov–Smirnov test) were performed using SPSS software. Subsequently, to test the conceptual model and examine the relationships between latent variables, Structural Equation Modeling (SEM) was applied using the Partial Least Squares (PLS) approach via SmartPLS software. The PLS approach was selected as the main method for model validation due to advantages such as not requiring normally distributed data, suitability for small sample sizes, and high predictive power. In this method, both the outer model (relationships between indicators and dimensions) and the inner model (relationships among the model’s dimensions) were assessed simultaneously.

Findings and Results

This section outlines the findings obtained from various stages of the study, including open, axial, and selective coding, as well as the implementation of the Delphi method, aimed at designing a product model for the insurance industry based on artificial intelligence (AI), blockchain, and the Internet of Things (IoT) within the Iranian insurance sector.

Within the framework of grounded theory, open coding was employed as an analytical process through which initial concepts were extracted from the collected data and developed based on their characteristics and dimensions. In this study, semi-structured interviews with 15 experts from the insurance industry and information technology specialists were transcribed and analyzed using MAXQDA software. After carefully examining the data, initial codes were generated to segment the text, understand themes, and establish relationships among concepts. These codes facilitated the preliminary organization of categories.

In this phase, 150 initial indicators were identified, derived from both the content analysis of interviews and the systematic review of scientific sources. These indicators encompassed concepts such as risk identification, product personalization, process optimization, operational automation, information security, smart contracts, fraud prevention, and customer behavior analysis. The derived indicators were then submitted to the experts for evaluation and weighting. Indicators that received higher weights reflected greater expert consensus and higher content validity.

During the axial coding phase, the concepts extracted during open coding were categorized around common themes based on literature analysis and theoretical knowledge. This process aimed to elaborate the core category and to establish connections among categories and subcategories. At this stage, indicators with conceptual commonality were organized into main categories.

Ultimately, ten main categories were identified and classified. These categories were linked using the axial coding paradigm, and causal, contextual, and intervening relationships among them were mapped. This led to the formation of a preliminary conceptual model for insurance product design based on emerging technologies.

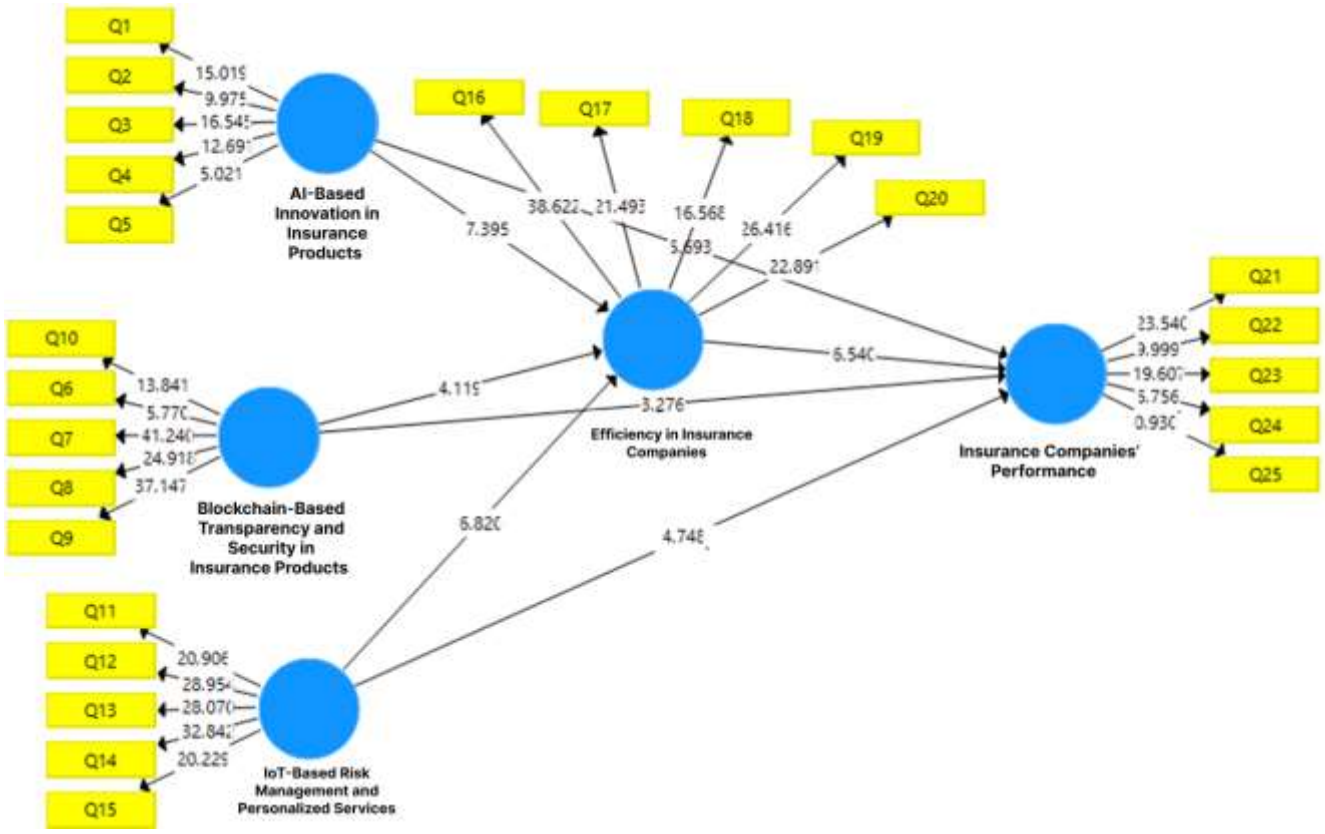
Based on these qualitative findings, the product model for the insurance industry rooted in AI, blockchain, and IoT can be categorized into four primary dimensions: AI-based innovation in insurance products; blockchain-based transparency and security in insurance offerings; IoT-based risk management and personalized services; and the role of technologies in enhancing the operational efficiency of insurance companies.

Missing data were handled using the median imputation method, and the normality of the data was confirmed based on skewness and kurtosis indices (within the acceptable range of ±3 and ±5, respectively). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.694, and Bartlett's test of sphericity ($\chi^2 = 1003.040$) confirmed the adequacy of the sample. Model reliability was verified through Cronbach’s alpha (> 0.7), composite reliability (> 0.7), convergent validity (Average Variance Extracted [AVE] > 0.5), and discriminant validity using the Fornell–Larcker criterion. The overall quality of the model, evaluated using the Goodness-of-Fit (GoF) index, yielded a value of 0.38, indicating strong model fit.

Figure 1 illustrates the significance levels of the path coefficients between the variables in the model. It is noteworthy that significance levels greater than 1.96 or less than -1.96 are considered acceptable.

Figure 1.

The Research Model in Significance Mode



The test statistic values (t-values) for all paths exceed 1.96, and the corresponding path coefficients (β) are all positive. Therefore, it can be concluded that all variables in the model are statistically significant and exhibit positive relationships with one another.

As observed in the figure, the factor loadings of the items exhibit a satisfactory level of significance, as all values exceed 1.96. This indicates that the construct validity and the structure of the items are confirmed. Furthermore, considering the relationships among the components, the corresponding path coefficients and significance levels are summarized in Table 1.

Table 1.

Summary of Relationships Among Components

No.	Independent Variable	Dependent Variable	T-value	R^2	Result
1	AI-Based Innovation in Insurance Products	Efficiency in Insurance Companies	7.39	0.29	Confirmed
2	Blockchain-Based Transparency and Security in Insurance Products	Efficiency in Insurance Companies	4.11	0.21	Confirmed
3	IoT-Based Risk Management and Personalized Services	Efficiency in Insurance Companies	4.74	0.35	Confirmed
4	Efficiency in Insurance Companies	Insurance Companies' Performance	6.54	0.33	Confirmed
5	AI-Based Innovation in Insurance Products	Insurance Companies' Performance	5.69	0.25	Confirmed
6	Blockchain-Based Transparency and Security in Insurance Products	Insurance Companies' Performance	3.27	0.25	Confirmed
7	IoT-Based Risk Management and Personalized Services	Insurance Companies' Performance	4.74	0.51	Confirmed

Discussion and Conclusion

The results of this study revealed significant and positive relationships between technological components—namely artificial intelligence (AI)-based innovation, blockchain-based transparency and security, and Internet of Things (IoT)-based

risk management and personalization—and both the operational efficiency and overall performance of insurance companies in Iran. The path coefficients and t-values confirmed that all relationships were statistically meaningful, with IoT-based personalization and risk management demonstrating the strongest impact on company performance (β = 0.51). This finding aligns with the increasing role of IoT technologies in providing insurers with real-time, data-driven insights that optimize decision-making and risk prediction processes [12, 13]. The positive effect of AI on innovation in insurance products also supports existing literature that identifies AI as a catalyst for transformation across various stages of the insurance value chain—from dynamic underwriting and pricing models to claims automation and fraud detection [9, 10]. These findings affirm the foundational premise that smart technologies are not merely supplementary to traditional operations but are core enablers of systemic innovation and improved customer engagement within the insurance industry.

In particular, the strong relationship between AI-driven innovation and operational efficiency (t = 7.39; R^2 = 0.29) reflects the industry's broader adoption of intelligent automation and predictive analytics to manage vast volumes of data and personalize insurance offerings. These outcomes are consistent with studies highlighting the transformative potential of AI in enabling insurers to enhance both internal operations and customer-facing services [1, 8]. The model validation through PLS-SEM further confirmed that AI allows insurers to shift from reactive, claim-based frameworks to predictive, preventative, and customized solutions. Furthermore, the study revealed that blockchain-based transparency and security significantly influenced both efficiency (t = 4.11) and performance (t = 3.27). This corroborates existing literature emphasizing blockchain's potential in minimizing fraud, enabling smart contracts, and securing transaction histories—thus fostering greater trust among stakeholders [2, 4, 11].

The IoT component demonstrated the highest explanatory power in relation to performance (R^2 = 0.51), signifying its integrative value in improving risk management, asset monitoring, and customer profiling. The real-time collection of behavioral and environmental data facilitates the deployment of usage-based insurance (UBI) models, which are rapidly growing worldwide [14, 19]. Similar to global case studies, the findings from Iran suggest that IoT enables insurers to dynamically assess risk exposure and implement intervention strategies before losses occur. This preventative approach not only reduces claims but also enhances customer satisfaction, as clients benefit from personalized recommendations and lower premiums based on behavioral data [5, 22]. Moreover, the study confirmed that increased operational efficiency mediates the relationship between these technologies and overall company performance, a finding that echoes the theoretical framework proposed by [7] on the evolution of digital financial ecosystems.

The conceptual model proposed and validated in this study, integrating AI, blockchain, and IoT, aligns well with broader theoretical paradigms of technological diffusion in the financial sector. It supports the assertion that organizational adoption of digital tools enhances value delivery and competitive positioning [3, 18]. From a systemic perspective, this model offers an integrative lens for understanding how various technological innovations interact to elevate the capacity of insurance institutions to respond to evolving consumer needs, regulatory pressures, and market uncertainties [15, 21]. Notably, the findings validate that each technological component contributes uniquely to operational optimization and should not be viewed in isolation. Instead, their convergence under a unified digital strategy represents the key to unlocking long-term value, particularly in developing economies seeking to leapfrog traditional development stages [2, 4].

The Delphi results reinforced these quantitative findings, as experts repeatedly emphasized the need for integrated technological infrastructure and cross-functional digital capabilities. Stakeholders highlighted blockchain's potential in

transforming regulatory compliance through transparency, the importance of AI for behavioral modeling in customer segmentation, and the value of IoT in developing context-sensitive microinsurance services [17, 20]. These insights confirm that innovation in the insurance sector is increasingly becoming systemic rather than modular, requiring cross-disciplinary coordination across actuarial science, data engineering, legal frameworks, and behavioral economics [1, 9]. The collective influence of these technologies also supports the notion that InsurTech is not merely a set of tools but represents a paradigm shift in how value is conceptualized, delivered, and sustained in insurance ecosystems [3, 11].

In summary, the study contributes significantly to the literature by proposing and validating a multi-dimensional model that captures the interplay of AI, blockchain, and IoT in shaping innovation, efficiency, and performance in the Iranian insurance industry. It confirms earlier theoretical claims regarding the disruptive role of InsurTech and provides empirical backing for region-specific application models. It also reveals that while each of these technologies contributes independently to operational and strategic outcomes, their integrated implementation creates a synergistic effect that magnifies overall organizational impact. In addition, the research reveals that customer personalization, cost efficiency, process optimization, and service transparency are the central mechanisms through which digital technologies enhance business performance—findings that are consistent with the systemic digital transformation frameworks established in prior global studies [2, 7].

Despite the insightful contributions of this study, several limitations should be acknowledged. First, the scope was limited to the Iranian insurance industry, which may restrict the generalizability of the findings to other developing or developed markets. Second, while the study employed a mixed-methods design, the quantitative sample was confined to 384 customers, which, although statistically adequate, may not fully capture the diversity of perspectives within Iran's insurance consumer base. Third, the rapidly evolving nature of InsurTech implies that the technological configurations analyzed in this study might become outdated as new tools and platforms emerge. Additionally, the study relied heavily on expert opinion in the qualitative phase, which may introduce biases rooted in local industry practices or technological familiarity.

Future studies could extend the current research by applying the validated model to different geographical contexts and institutional environments to test its robustness and adaptability. Comparative analyses across countries with different levels of technological infrastructure could yield valuable insights into the prerequisites and enablers of successful InsurTech implementation. Furthermore, researchers should consider longitudinal studies to examine the long-term effects of these technologies on company performance and customer loyalty. Expanding the research to include additional stakeholders—such as regulators, technology providers, and insurance agents—could also enrich the model. Finally, incorporating new technological dimensions such as generative AI, edge computing, and decentralized autonomous organizations (DAOs) would offer a forward-looking perspective aligned with emerging digital paradigms.

To translate the findings into actionable strategies, insurance companies in Iran should prioritize the development of an integrated digital roadmap that aligns AI, blockchain, and IoT investments with their core business objectives. Emphasis should be placed on building agile technological infrastructures capable of supporting personalized, data-driven insurance products. Firms must invest in talent development, equipping their workforce with the digital competencies necessary to navigate a rapidly evolving landscape. Regulatory bodies should also facilitate innovation through adaptive frameworks that encourage experimentation while ensuring data privacy and consumer protection. Collaborations between incumbents and InsurTech startups should be fostered to accelerate innovation and broaden service outreach.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. Written consent was obtained from all participants in the study.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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