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Identifying and Prioritizing the Factors Affecting Longevity Swaps from a Risk Perspective in the Insurance Industry

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ABSTRACT

The issuance of insurance-linked securities associated with longevity risk is one of the most efficient methods for financing and risk hedging in financial institutions. However, identifying and prioritizing the factors affecting the application of innovative instruments such as the "longevity swap" from a risk-management perspective, particularly under changing economic conditions, remains a serious challenge. The present study was conducted with the aim of identifying, validating, and ranking the key factors affecting the application and development of longevity swaps from the perspective of risk management in the Iranian insurance industry. This research was carried out within a qualitative framework using the grounded theory research method. In the qualitative phase, an initial set of factors was first extracted through a review of the specialized literature and interviews with 10 individuals selected through purposive sampling. This stage contributed to clarifying the conceptual dimensions and determining the initial research framework. Then, in the quantitative phase, a Delphi questionnaire was designed and validated in several rounds based on expert opinions. In the second stage, experts were selected based on criteria such as specialization, experience, academic position, and relevant professional background. In the third stage, the Delphi process was implemented in two rounds to collect expert opinions and achieve consensus. In the fourth stage, using the defuzzification method, fuzzy numbers were converted into crisp values, and the final ranking of the factors was conducted. The results showed that factors such as insurance laws and regulations, capital risk management, political and economic stability, and information transparency had the greatest weight and influence in the longevity swap process. This finding indicates that the institutional and regulatory environment plays a vital role in controlling and managing the risks associated with longevity swaps, and without appropriate legal and supervisory infrastructures, the sustainable development of this financial instrument will be limited.

Keywords: qualitative phase, Delphi method, longevity swap, risk, expert consensus, policymaking

Introduction

The insurance industry operates at the intersection of uncertainty, long-term financial commitment, demographic transformation, and institutional regulation. Unlike many financial sectors in which liabilities are short-term or market-adjusted with relative speed, insurance companies, particularly life insurers, are exposed to risks that unfold gradually over long horizons. These risks include mortality and longevity risk, interest-rate volatility, capital adequacy constraints, liquidity pressure, investment-return fluctuations, regulatory uncertainty, and operational

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vulnerabilities. In this context, risk-management instruments have become increasingly central to the strategic sustainability of insurers, because they allow companies to identify, measure, transfer, and mitigate exposures that may otherwise undermine solvency and long-term performance. The growing complexity of insurance markets has therefore intensified the need for advanced financial instruments capable of redistributing risk between insurers, reinsurers, capital-market participants, and other financial institutions. Among these instruments, longevity swaps have attracted growing attention as mechanisms through which insurers and pension-related institutions may transfer the financial consequences of unexpected changes in survival patterns and life expectancy (1, 2). A longevity swap is not merely a financial contract; rather, it is an integrated risk-management arrangement requiring reliable actuarial modeling, regulatory support, transparent information flows, institutional trust, and sufficient market infrastructure.

Longevity risk has become particularly significant because improvements in life expectancy can create a mismatch between expected and actual liabilities in life insurance and annuity portfolios. When policyholders live longer than projected, insurers may face higher-than-anticipated payment obligations, thereby increasing pressure on reserves, capital buffers, investment strategies, and solvency margins. This issue is not confined to actuarial calculations; it also affects enterprise risk management, portfolio governance, financial planning, and regulatory compliance. The effective use of longevity swaps therefore requires a multidimensional assessment of risk factors. The experience of insurance firms in different markets shows that risk management is closely associated with financial performance, profitability, and institutional resilience. Studies on insurance companies emphasize that sound risk-management practices can improve financial outcomes and strengthen organizational capacity to withstand uncertainty (3, 4). Accordingly, the application of longevity swaps must be examined not only as a technical actuarial decision but also as a strategic management decision embedded within broader financial, institutional, and regulatory systems.

The rationale for longevity swaps can be understood through the broader logic of derivative instruments and risk-transfer mechanisms. Swaps are designed to exchange uncertain future cash flows under specified contractual conditions, thereby allowing institutions to hedge exposures that cannot be managed efficiently through traditional balance-sheet tools. Research on interest-rate swaps demonstrates that swap markets can play an important role in transmitting monetary and financial conditions across institutions, particularly under different market quantiles and stress conditions (5). Similarly, studies on weighted variance swaps show that swap-based instruments can be structured to hedge against specific forms of financial exposure in emerging and complex asset environments (6). Although longevity swaps differ from interest-rate or variance swaps in terms of underlying risk, pricing logic, and actuarial inputs, these studies demonstrate the broader principle that swap contracts are increasingly used to manage contingent and difficult-to-diversify risks. In the insurance sector, the same logic is especially relevant because longevity risk is systematic, long-term, and difficult to diversify solely within the insurer's portfolio.

Traditional insurance risk-transfer mechanisms, such as reinsurance, remain important for managing extreme losses and reducing volatility. However, reinsurance alone may not fully address the unique structure of longevity risk, particularly where liabilities are long-dated and influenced by demographic, medical, social, and economic trends. Research on stop-loss reinsurance thresholds under dependent risks highlights the importance of carefully determining transfer limits, thresholds, and dependency structures when designing risk-sharing arrangements (7). This insight is relevant for longevity swaps because the design of such instruments requires precise attention to contractual triggers, benchmark populations, payment formulas, counterparty risk, and the degree to which

transferred risk reflects the insurer's actual exposure. Therefore, before such instruments can be implemented effectively, insurers must identify the risk factors that influence their feasibility and rank these factors according to their strategic importance.

One of the most important dimensions in the application of longevity swaps is actuarial capability. Actuaries play a central role in assessing financial risks, estimating liabilities, modeling mortality and longevity trends, and supporting risk-based decision-making in insurance companies (8). Longevity swaps require advanced actuarial modeling because the value of the contract depends on assumptions about survival probabilities, mortality improvement rates, demographic composition, policyholder behavior, and the long-term interaction between claims, reserves, and investment returns. The importance of claims data and predictive modeling is also reflected in studies on elderly long-term care, where insurance claims data have been used to predict care-needs levels among older populations (9). Such evidence underscores the significance of high-quality data infrastructures in insurance-related prediction. For longevity swaps, weak data systems, fragmented historical records, and insufficient mortality or policyholder databases can seriously limit the accuracy of pricing and risk assessment.

In addition to actuarial expertise, internal risk-management quality is a decisive factor in determining whether insurers can use longevity swaps effectively. Risk management is not limited to the identification of hazards; it also involves measurement, monitoring, reporting, governance, and strategic response. Studies on insurance company performance indicate that risk management can contribute to improved operational and financial performance when it is systematically embedded in organizational structures (10). In the context of longevity swaps, this means that insurers must possess the capacity to monitor contract performance, update risk models, evaluate deviations between projections and realized outcomes, and maintain internal controls over data, reporting, and decision-making. Without such systems, even well-designed financial instruments may create additional operational and governance risks instead of reducing exposure.

Enterprise risk management has also become increasingly important in response to severe and novel crises. Recent crisis experiences have demonstrated that insurance firms must develop organizational resilience, not merely isolated technical risk controls. Organizational resilience is considered a key property of enterprise risk management because it enables firms to respond to severe disruptions, adapt to unexpected changes, and maintain core functions during periods of instability (11). This perspective is particularly relevant for longevity swaps because such contracts may be affected by crises that alter mortality trends, investment conditions, political stability, regulatory responses, and public confidence. Epidemics, pandemics, financial crises, geopolitical shocks, and technological disruptions can all influence the assumptions underlying longevity-related contracts. Therefore, identifying the risk factors affecting longevity swaps requires attention to both ordinary actuarial uncertainty and extraordinary environmental disruption.

Digitalization has further transformed the insurance industry by changing how risks are measured, priced, reported, and managed. The COVID-19 pandemic accelerated digital transformation in insurance markets and revealed both the opportunities and challenges of digitization, including changes in customer interaction, data processing, operational continuity, and technological readiness (12). Digitalization can support longevity-swap implementation by improving data collection, claims analysis, predictive modeling, and reporting transparency. However, it may also introduce new risks, such as cyber threats, system incompatibility, data-governance weaknesses, and digital-culture barriers. Research on artificial intelligence in insurance markets shows that AI can improve cost efficiency, but its benefits depend on the quality of implementation, data availability, and organizational

readiness (13). Similarly, research on financial risk and profitability management in insurance companies under digitalization highlights the importance of adapting financial management systems to technological change (14). These findings suggest that technology-related capabilities are not peripheral but central to the effective management of complex financial instruments such as longevity swaps.

Cyber risk and legal risk are also relevant because modern insurance instruments increasingly depend on digital infrastructures, data exchange, and contractual transparency. Cyber insurance research indicates that digital trade and digital operations generate legal risks that require specialized insurance and risk-transfer responses (15). For longevity swaps, cyber and legal risks may emerge through data breaches, inaccurate reporting, model manipulation, confidentiality failures, or disputes over contractual interpretation. The legal and regulatory environment is therefore one of the most important foundations for the application of longevity swaps. Without clear rules concerning contract enforceability, disclosure standards, solvency treatment, accounting recognition, counterparty obligations, and supervisory approval, insurers may hesitate to enter such arrangements. Regulatory uncertainty can increase transaction costs, weaken market confidence, and reduce the willingness of counterparties to participate in longevity-risk transfer.

Sustainability has become another central concern in modern insurance management. The insurance industry is increasingly expected to demonstrate not only financial strength but also long-term social, environmental, and governance responsibility. Research on the sustainability of the insurance industry raises fundamental questions about whether insurers can remain sustainable under increasing pressure from climate risk, demographic change, regulatory expectations, and evolving stakeholder demands (1). In a related line of research, sustainability reporting in the insurance industry has been examined as a mechanism for improving transparency, accountability, and stakeholder trust (16). Longevity swaps are relevant to this sustainability agenda because they may help insurers stabilize long-term liabilities and manage demographic exposure. However, they can contribute to sustainable insurance development only if they are supported by transparent reporting, responsible governance, and reliable regulatory oversight.

Corporate governance is another critical factor shaping the feasibility of longevity swaps. Insurance firms require governance structures that enable effective oversight of risk-taking, investment decisions, capital allocation, and strategic innovation. Research on corporate governance, insurance and takaful, stock returns, and risk management suggests that governance mechanisms interact with risk-management practices and can influence the financial outcomes of insurance companies (17). In the case of longevity swaps, governance quality affects whether managers can evaluate complex contracts, understand long-term consequences, select counterparties, and align risk-transfer decisions with the firm's solvency and strategic objectives. Weak governance may result in inappropriate pricing, excessive reliance on external counterparties, insufficient due diligence, or failure to monitor exposure after the contract is concluded.

Market behavior and customer-related risks also matter. Insurance markets are shaped not only by institutional decisions but also by customers' risk perceptions, preferences, awareness, and behavioral tendencies. Research on automobile insurance coverage decisions shows that risk perception and behavioral characteristics can influence insurance decision-making (18). Although longevity swaps are primarily institutional instruments, policyholder behavior still affects the underlying life-insurance portfolio. Changes in surrender behavior, demand for life-insurance products, customer trust, policyholder awareness, and demographic composition can all influence liability projections and the effectiveness of risk-transfer arrangements. Therefore, any model for identifying factors

affecting longevity swaps should include market and customer dimensions alongside actuarial, financial, and regulatory dimensions.

The competitiveness of financial insurance companies has also become increasingly dependent on innovation, risk-based decision-making, and the capacity to adapt to environmental change. Research on strategies to enhance the competitiveness of financial insurance companies emphasizes that insurers must strengthen strategic capabilities, improve management systems, and respond proactively to market changes (19). Longevity swaps may provide a competitive advantage for insurers by enabling more efficient capital management and reducing exposure to demographic uncertainty. However, this advantage depends on the insurer's ability to integrate the instrument into broader portfolio management, investment planning, product development, and regulatory strategy. If implemented without sufficient analytical and institutional capacity, longevity swaps may increase complexity and reduce transparency rather than improve competitiveness.

The link between risk and incentives is also relevant to the broader management context. Research on firm performance pay as insurance against promotion risk demonstrates that risk-sharing mechanisms can be embedded in organizational and contractual designs to reduce uncertainty and align incentives (2). Although this literature focuses on organizational compensation rather than insurance derivatives, it highlights a broader management principle: institutions often design contracts to allocate risk more efficiently among parties with different capacities to absorb uncertainty. Longevity swaps operate according to a similar principle at the institutional level, transferring longevity exposure from insurers or pension-related entities to counterparties willing and able to bear or diversify that risk. Thus, the study of longevity swaps requires an understanding of how contractual structures, incentives, and institutional capacities interact within risk-management systems.

Despite the strategic potential of longevity swaps, their successful implementation in the insurance industry is contingent on a wide range of factors, including legal and regulatory clarity, capital risk management, liquidity and financial strength, macroeconomic stability, mortality and longevity modeling, portfolio quality, market information, technological infrastructure, internal risk-management quality, and policyholder-related dynamics. These factors are interdependent. For example, poor information transparency can weaken actuarial modeling, regulatory uncertainty can increase counterparty concerns, insufficient digital infrastructure can reduce data reliability, and macroeconomic instability can affect investment returns and cash-flow predictability. Therefore, studying longevity swaps from a risk perspective requires an integrated approach capable of capturing both technical and institutional dimensions. A mixed-methods design is particularly suitable for this purpose because qualitative inquiry can identify context-specific risk factors through expert insight, while fuzzy Delphi analysis can support validation, consensus-building, and prioritization among specialists.

In the Iranian insurance industry, the need for such an integrated analysis is especially important because the development of innovative financial instruments depends on the alignment of regulatory structures, actuarial expertise, market maturity, financial capacity, digital infrastructure, and institutional trust. Longevity swaps may offer a pathway for improving the management of long-term life-insurance liabilities, yet their application requires careful assessment of risk factors before operational implementation. Without prioritizing these factors, insurers and policymakers may lack a clear roadmap for determining which institutional, financial, technological, and regulatory conditions should be strengthened first. Accordingly, a systematic identification and ranking of the factors affecting longevity swaps can contribute to both theoretical development in insurance risk management and practical decision-making for insurers, regulators, and financial-market participants.

The aim of this study is to identify, validate, and prioritize the key factors affecting the application and development of longevity swaps from a risk-management perspective in the insurance industry.

Methods and Materials

The research method of this study is exploratory mixed-methods, conducted in two qualitative and quantitative phases. In the qualitative phase, the factors affecting longevity swaps from a risk perspective are identified using thematic analysis and semi-structured interviews with insurance industry experts and financial specialists. The collected data are analyzed through open, axial, and selective coding, and the initial conceptual framework of the study is extracted. In the quantitative phase, the fuzzy Delphi method is used to validate and reach consensus on the identified factors. A questionnaire based on the results of the qualitative phase is developed and distributed to experts, and the data are examined through fuzzy Delphi analysis. Finally, the final research model will be developed and presented based on the integrated results of the two phases.

In the qualitative phase, the main objective is to identify the factors affecting the application of longevity swaps from a risk perspective. For this purpose, thematic analysis is used. Data will be collected through semi-structured interviews with experts, senior managers in the insurance industry, and financial specialists. The interviews will continue until theoretical saturation is reached, and the data will then be analyzed through open, axial, and selective coding. The outcome of this stage will be the extraction of main and sub-themes, namely dimensions and indicators, which will form the initial framework of the conceptual research model. In the quantitative phase, the objective is to evaluate, confirm, and validate the factors identified in the previous stage. For this purpose, the fuzzy Delphi method is used so that expert opinions regarding the importance and validity of each factor can be collected accurately and systematically. The questionnaire designed based on the qualitative findings is prepared and distributed to experts. Through fuzzy Delphi analysis, factors with a high level of consensus will be identified and confirmed. By integrating the findings of the two phases, the final research framework is developed. The mixed-methods approach in this study enables the use of both the analytical depth of qualitative data and the quantitative precision required for validating the factors. This methodology allows the researcher to present a scientific, valid, and reliable model for applying longevity swaps in risk management within the insurance industry.

The statistical population of this study includes experts, senior managers, and specialists in the fields of risk management and life insurance who have sufficient experience and knowledge regarding longevity swaps and innovative financial instruments in the insurance industry. These individuals include risk managers, technical managers of life insurance, specialists in insurance finance and investment, and faculty members or researchers active in the fields of risk management and derivative instruments. In the qualitative phase, purposive sampling is used based on criteria such as professional background, specialization, and familiarity with the research topic. The sample size in this stage was determined to be 10 participants based on theoretical saturation. In the quantitative phase, the statistical population is the same group of experts; however, in order to validate the identified factors through the fuzzy Delphi method, a sample of 15 experts is selected.

Findings and Results

In this study, the stage of familiarization with the data began with the accurate and complete transcription of the interviews conducted with experts, risk managers, and specialists in the insurance industry. All conversations were recorded verbatim to preserve detailed and subtle content-related points. This provided a basis for gaining a deep

understanding of the participants' views, experiences, and attitudes toward longevity swaps and their associated risks. After transcription, the collected data were reviewed several times to identify patterns, key terms, and implicit themes. This repeated reading enabled the researcher to understand the interview content beyond the lexical level and to reveal conceptual links between the participants' statements. At this stage, the focus was on extracting latent and recurring meanings rooted in the practical experiences and specialized views of the participants. Finally, initial concepts referring to the factors affecting the application of longevity swaps from a risk perspective were extracted and recorded. These concepts were organized into analyzable meaning units to serve as the basis for the next stage of thematic analysis. Thus, the familiarization stage provided a coherent foundation for entering the coding process and constructing the conceptual framework of the study.

Table 1. Research Participants

No.	Gender	Age	Education	Occupation / Specialization	Work Experience (Years)
1	Male	42	Master's degree	Information Technology Unit Manager	15
2	Female	35	PhD	University Professor	10
3	Male	29	Bachelor's degree	Digital Marketing Specialist	5
4	Female	38	Master's degree	Senior Human Resources Specialist	12
5	Male	45	PhD	Digital Policy Researcher	18
6	Male	33	Master's degree	Risk and Insurance Manager	8
7	Female	40	PhD	Insurance Product Development Manager	14
8	Female	31	Bachelor's degree	Life Insurance Affairs Specialist	7
9	Male	36	Master's degree	Digital Innovation Manager	11
10	Male	50	PhD	Professor and Researcher in the Insurance Industry	20

In the open coding stage, after becoming fully familiar with the data, the researcher first identifies the meaning units in the interview texts or qualitative data with precision. At this stage, each phrase, sentence, or section of speech that carries meaning related to the research topic is considered a meaning unit. These units may include key terms, important statements, or the personal experiences of participants. The main objective of this stage is to extract all potential concepts from the data without any theoretical presuppositions. In the second step, each identified meaning unit is assigned a label or "initial code." These codes represent the main concepts embedded in the data and help the researcher create an organized structure from the content of the interviews. This stage is carried out carefully and through continuous review to ensure full coverage of the data and to prevent key points from being overlooked. In fact, open coding serves as a foundation for the subsequent stages of thematic analysis. The identified initial codes are compared and combined so that similar or related codes are categorized into broader conceptual groups. This process converts a large volume of textual data into a set of meaningful and organized concepts. This initial structure provides a basis for entering more advanced stages of analysis, such as axial and selective coding, and paves the way for the formation of the main themes of the study.

Table 2. Open Coding

No.	Meaning Unit Extracted from the Data	Initial Code	Conceptual Explanation
1	The importance of accurate risk assessment in insurance contracts	Accurate risk assessment	Emphasis on the need for comprehensive risk analysis before contract conclusion
2	Increasing complexity of insurance products	Product complexity	Indicates the need for advanced analytical tools
3	Changes in policyholders' behavior over time	Customer behavior dynamics	Necessity of anticipating changes in customer behavior
4	The necessity of accurately determining surrender value	Surrender value valuation	Prevention of potential losses for the insurance company
5	Lack of an integrated standard for longevity swaps	Lack of standardization	Challenge in the uniform implementation of processes

6	The need for accurate modeling to control risk	Risk modeling	Increasing decision-making accuracy in product design
7	The effect of interest-rate fluctuations on contract value	Interest-rate volatility	Necessity of considering macroeconomic variables
8	The importance of historical data in risk prediction	Historical data	Improving prediction accuracy through past data
9	The challenge of calculating the future value of insurance obligations	Value of future obligations	Necessity of developing accurate computational models
10	Lack of advanced analytical tools	Weak analytical tools	Limitation in identifying actual risk
11	Changes in life expectancy	Changes in life expectancy	Direct effect on the duration and value of the longevity swap contract
12	Fluctuations in mortality rates	Mortality-rate volatility	One of the key factors in life-insurance risk calculations
13	The need for specialized teams for risk analysis	Analytical team expertise	Importance of specialized human resources in decision-making processes
14	Lack of a centralized database	Lack of database	Challenge in the integration of insurance information
15	The effect of demographic variables on contracts	Demographic variables	Demographic variables play an important role in risk calculations
16	The importance of cooperation between insurance companies	Inter-organizational cooperation	Data and experience exchange to reduce risk
17	The effect of insurance laws and regulations	Legal environment	Role of legal frameworks in shaping contracts
18	Lack of early risk-warning systems	Lack of risk alerts	Increased probability of financial losses
19	The need for advanced technologies in data analysis	Analytical technology	Use of modern tools to improve accuracy
20	The challenge of lack of transparency in insurance information	Lack of data transparency	Barrier to evidence-based decision-making
21	The role of human-resource training in improving risk assessment	Specialized training	Skill enhancement to reduce errors
22	The importance of predictability of cash flows	Cash flow	Key factor in the financial stability of contracts
23	Economic changes and their effect on long-term contracts	Economic risk	Importance of considering macroeconomic conditions
24	The necessity of continuous monitoring of contract performance	Continuous monitoring	Reducing deviation from financial plans
25	Use of different scenarios for risk assessment	Scenario analysis	Increasing decision-making accuracy
26	The challenge of adapting risk models to real market conditions	Model mismatch	Gap between prediction and reality
27	The importance of customer trust in the success of insurance contracts	Customer trust	Key factor in contract sustainability
28	Lack of specified key performance indicators	Lack of KPIs	Difficulty in measuring the effectiveness of risk management
29	The need for flexible policymaking in risk management	Policy flexibility	Capacity for rapid response to environmental changes
30	The importance of continuous evaluation of the efficiency of risk models	Model review	Increasing the stability and accuracy of risk calculations

In the third stage of thematic analysis, the axial themes identified and categorized in the previous stages are systematically integrated and combined in order to extract final and overarching themes. At this stage, by repeatedly reviewing the codes and initial and intermediate themes, the researcher seeks to identify deeper conceptual relationships and semantic patterns. This process leads to the formation of a limited and coherent set of main themes that comprehensively represent the semantic structure of the qualitative data. The final themes, in fact, represent the conceptual core of the study and provide the theoretical and analytical framework required for interpreting the findings.

Table 3. Categorized Themes

Basic Themes	Organizing Themes	Overarching Themes
Interest-rate fluctuations	Financial risk	Macroeconomic risks

Inflation and economic instability		
Exchange-rate changes		
Capital-market volatility		
Changes in macro-level insurance policies	Regulatory risk	
Weakness of supervisory structures		
Lack of regulatory transparency		
Changes in tax laws		
Error in calculating obligations	Operational risk	Organizational risks
Weakness of internal control processes		
Deficiencies in support processes		
Human error in information processing		
Lack of an efficient risk-management system	Organizational risk	
Weakness of specialized human resources		
Lack of integration in information systems		
Resistance to change		
Customer uncertainty	Market risk	Market and customer risks
Changes in policyholders' preferences		
Decline in public trust		
Intensity of competition in the insurance market		
Changes in the target population	Customer risk	
Increase in life expectancy		
Behavioral changes among insured individuals		
Lack of policyholder loyalty		
Weakness of technological infrastructures	Technology risk	Technological risks
Cyber threats		
Inconsistency in system updates		
Disruption in data exchange		
Lack of digital innovation		
Weakness of digital culture		
Sanctions and international restrictions	Political risk	Environmental risks
Domestic political instability		
Regional geopolitical developments		
Occurrence of natural disasters	Environmental risk	
Climate change		
Epidemic and pandemic hazards		
Weakness of relations with financial institutions	Institutional risk	
Lack of alignment with development policies		
Changes in international relations		

In the first stage of the quantitative phase, the Delphi questionnaire is designed and developed with the aim of identifying and measuring expert views regarding the factors affecting the research topic. At this stage, the researcher uses the results obtained from the qualitative phase and the extracted themes to identify and organize a set of relevant indicators and items. These indicators form the basis of the questionnaire design and must be arranged in a way that ensures clarity, comprehensiveness, and adequate coverage of the dimensions of the research problem. In the next step, the questionnaire is developed in a structured and standardized form so that respondents, namely experts, can present their views using appropriate scales, particularly fuzzy scales. The questions must be designed clearly, precisely, and without ambiguity to prevent different interpretations and to ensure their suitability for statistical and fuzzy analysis. In addition, the logical order and sequencing of topics in the questionnaire are highly important so that respondents can answer each question progressively and coherently. The initial version of the questionnaire is provided to several experts to be evaluated and revised in terms of content validity, clarity, and the relevance of the items to the research objectives. This stage increases the accuracy of the measurement instrument and improves the quality of the data collected in subsequent stages. After the required

revisions are made, the final version of the questionnaire is prepared for implementation among the experts selected for the Delphi process.

In the second stage of the quantitative phase, the main focus is on selecting and identifying experts as the primary source of data collection. At this stage, the researcher determines specific criteria for selecting experts according to the research topic. These criteria usually include specialized and academic background in the field under study, relevant work experience, participation in similar projects, and mastery of theoretical and practical concepts. The purpose of this selection is to obtain valid, accurate, and deeply knowledge-based expert opinions in order to enhance the validity and quality of the Delphi results. After determining the criteria, the process of identifying and selecting experts begins. This can be done through methods such as reviewing research and professional records, recommendations by specialized institutions, or purposive sampling. In the Delphi method, 15 experts are usually selected to maintain diversity of perspectives while also facilitating consensus-building. At the end of this stage, the final list of experts is prepared for the subsequent stages, particularly questionnaire distribution and data collection.

At this stage of the study, the fuzzy Delphi method was used to achieve expert consensus and prioritize the factors affecting the research topic. After designing and developing the questionnaire, expert opinions were collected and analyzed in two rounds. In the first round, the mean scores and the initial level of agreement were extracted. In the second round, feedback was provided to the experts in an attempt to increase convergence and consensus. The purpose of this process was to identify the most important and influential factors from the perspective of specialists and to establish a scientific and valid basis for subsequent analyses. Table 4 presents the results of the two rounds of the fuzzy Delphi method, including the mean scores and agreement percentages in each round, as well as the final status of each factor. These results serve as the basis for the next stage, namely defuzzification and final ranking of the factors.

Table 4. Delphi Results

No.	Proposed Factor	Mean Expert Score in Round 1	Agreement in Round 1 (%)	Mean Expert Score in Round 2	Agreement in Round 2 (%)	Final Status
1	Capital risk management	3.85	72	4.20	90	Confirmed
2	Liquidity and financial capacity of the insurance company	3.60	68	4.10	88	Confirmed
3	Macroeconomic conditions	3.45	65	3.80	82	Confirmed
4	Interest-rate changes	3.10	55	3.50	75	Confirmed
5	Insurance laws and regulations	3.90	78	4.25	92	Confirmed
6	Quality of internal risk management	3.70	70	4.05	86	Confirmed
7	Financial innovation and technology	2.95	52	3.40	73	Confirmed
8	Capital-market risks	3.30	60	3.65	80	Confirmed
9	Information transparency and reporting	3.75	74	4.15	89	Confirmed
10	Mortality rate and longevity	3.50	66	3.95	85	Confirmed
11	Demographic changes	3.45	65	3.90	84	Confirmed
12	Supervisory policies and supervision by the Central Insurance Authority	3.60	69	4.00	87	Confirmed
13	Exchange-rate fluctuations	3.10	58	3.60	78	Confirmed
14	Investment return rate	3.40	63	3.85	83	Confirmed
15	Quality of portfolio management	3.95	79	4.30	91	Confirmed
16	Level of competition in the insurance market	3.05	57	3.55	76	Confirmed

17	Access to market information	3.65	68	4.10	88	Confirmed
18	Marketing and sales capability for life insurance	3.50	66	3.95	85	Confirmed
19	Level of policyholder awareness	3.45	64	3.80	82	Confirmed
20	Political and economic stability	3.85	72	4.20	90	Confirmed

At this stage of the study, after data collection and analysis through the fuzzy Delphi method, fuzzy values must be converted into crisp values so that the final prioritization of the factors becomes possible. For this purpose, the defuzzification process was used. By removing the ambiguity of fuzzy numbers, this process provides a specific and comparable value for each factor. This stage plays a key role in decision-making because, based on the defuzzified values, the most important and influential factors can be identified, thereby providing the basis for designing the final model or presenting practical strategies. The following table presents the results of this stage and shows the final rank of each factor based on the highest crisp score.

Table 6. Ranking of Factors

No.	Proposed Factor	Fuzzy Value	Defuzzified Value	Final Rank
1	Insurance laws and regulations	(0.75, 0.85, 0.95)	0.85	1
2	Capital risk management	(0.70, 0.82, 0.90)	0.81	2
3	Political and economic stability	(0.68, 0.80, 0.88)	0.79	3
4	Information transparency and reporting	(0.66, 0.78, 0.86)	0.77	4
5	Liquidity and financial capacity of the insurance company	(0.65, 0.77, 0.84)	0.76	5
6	Quality of portfolio management	(0.64, 0.76, 0.83)	0.75	6
7	Supervisory policies	(0.63, 0.75, 0.82)	0.74	7
8	Demographic changes	(0.60, 0.73, 0.80)	0.71	8
9	Investment return rate	(0.58, 0.72, 0.78)	0.69	9
10	Macroeconomic conditions	(0.56, 0.70, 0.77)	0.68	10
11	Mortality rate and longevity	(0.54, 0.68, 0.75)	0.66	11
12	Access to market information	(0.53, 0.67, 0.74)	0.65	12
13	Level of policyholder awareness	(0.52, 0.66, 0.72)	0.63	13
14	Financial innovation and technology	(0.50, 0.65, 0.70)	0.62	14
15	Level of competition in the insurance market	(0.48, 0.64, 0.69)	0.60	15
16	Interest-rate changes	(0.46, 0.62, 0.67)	0.58	16
17	Exchange-rate fluctuations	(0.44, 0.60, 0.66)	0.56	17
18	Capital-market risks	(0.42, 0.59, 0.65)	0.55	18
19	Marketing and sales capability for life insurance	(0.40, 0.58, 0.64)	0.54	19
20	Quality of internal risk management	(0.38, 0.56, 0.62)	0.52	20

Discussion and Conclusion

The present study aimed to identify, validate, and prioritize the factors affecting the application and development of longevity swaps from a risk-management perspective in the insurance industry. The findings of the fuzzy Delphi process indicated that all proposed factors reached expert consensus and were confirmed after two Delphi rounds. However, the final defuzzification and ranking stage showed meaningful differences in the relative importance of these factors. Insurance laws and regulations obtained the highest rank, followed by capital risk management, political and economic stability, information transparency and reporting, liquidity and financial capacity of the insurance company, quality of portfolio management, supervisory policies, demographic changes, investment return rate, macroeconomic conditions, mortality rate and longevity, access to market information, policyholder awareness, financial innovation and technology, level of competition in the insurance market, interest-rate changes, exchange-rate fluctuations, capital-market risks, marketing and sales capability for life insurance, and quality of internal risk management. This hierarchy demonstrates that the successful application of longevity swaps depends

primarily on institutional, regulatory, financial, and informational conditions rather than only on technical product design.

The first and most important finding was the prioritization of insurance laws and regulations as the highest-ranked factor affecting longevity swaps. This result indicates that experts considered the legal and regulatory environment to be the fundamental prerequisite for the implementation of longevity-risk transfer instruments. Longevity swaps are complex contractual instruments that require clear rules regarding contract enforceability, disclosure obligations, solvency treatment, counterparty responsibilities, accounting recognition, risk transfer, and supervisory approval. Without a reliable legal framework, insurers may face uncertainty in pricing, implementation, reporting, and enforcement. This result is consistent with research emphasizing that insurance markets require strong governance, risk regulation, and institutional supervision to support financial innovation and sustainability (1, 16). It also aligns with studies highlighting the role of legal risk reduction in digitally mediated insurance and financial transactions, where regulatory clarity can reduce uncertainty and improve confidence in innovative contractual mechanisms (15).

The second-ranked factor was capital risk management, showing that experts viewed longevity swaps primarily as a mechanism connected to solvency, capital adequacy, and long-term balance-sheet stability. Longevity risk can impose substantial pressure on insurers when actual survival rates exceed actuarial expectations, thereby increasing future liabilities and reducing capital flexibility. Therefore, before entering into longevity swap contracts, insurance companies must determine whether such instruments improve risk-adjusted capital efficiency and reduce exposure to adverse demographic developments. This finding is supported by prior studies showing that risk management is closely linked to the financial performance and stability of insurance companies (3, 4). It is also consistent with research on the role of actuaries in assessing financial risks, because accurate capital risk management depends on actuarial estimation, liability valuation, stress testing, and scenario analysis (8).

Political and economic stability ranked third, indicating that experts considered the broader environmental context highly influential in the feasibility of longevity swaps. Such instruments involve long-term contractual commitments, and their effectiveness may be weakened by inflation, exchange-rate volatility, regulatory changes, geopolitical uncertainty, or instability in financial markets. Political and economic instability can increase counterparty risk, affect investment returns, reduce the reliability of long-term assumptions, and complicate the valuation of future cash flows. This finding is compatible with studies showing that enterprise risk management must account for novel and severe crisis events, as organizational resilience is essential for maintaining stability under unpredictable conditions (11). It also corresponds with research emphasizing the impact of financial risk, profitability management, and digitalized financial environments on insurance-company performance under changing economic conditions (14).

Information transparency and reporting ranked fourth, confirming that reliable data and transparent disclosure are essential for implementing longevity swaps. A longevity swap cannot be designed, priced, monitored, or evaluated effectively without accurate mortality data, policyholder information, cash-flow projections, and portfolio-level reporting. Transparency is also necessary for counterparties and regulators to assess whether the transaction genuinely transfers longevity risk or merely restructures financial exposure. This finding aligns with sustainability-reporting research in the insurance industry, which highlights the role of disclosure, accountability, and transparency in improving stakeholder confidence and institutional credibility (16). It is also supported by studies on artificial intelligence and insurance cost efficiency, which show that technological and analytical gains depend on the availability and quality of data (13). Similarly, evidence from predictive modeling using insurance claims data demonstrates that data quality is central to accurate prediction in elderly-related insurance contexts (9).

Liquidity and financial capacity of the insurance company ranked fifth, suggesting that experts viewed financial strength as a core condition for participating in longevity swap arrangements. Although longevity swaps are designed to hedge long-term liabilities, they may still generate collateral requirements, periodic settlement obligations, valuation adjustments, and liquidity pressures. An insurer with weak liquidity or limited financial capacity may be unable to manage these obligations effectively, even if the swap reduces long-term longevity exposure. This finding is consistent with studies that identify financial structure, profitability, and risk-management capacity as determinants of insurance-company performance (3, 4). It also corresponds with research on stop-loss reinsurance thresholds, which shows that risk-transfer arrangements must be designed in relation to the insurer's financial capacity and the dependency structure of underlying risks (7).

Quality of portfolio management ranked sixth, indicating that longevity swaps should be understood as part of integrated asset-liability and portfolio management rather than as isolated derivative contracts. Insurance companies must assess how longevity swaps interact with investment returns, reserve adequacy, asset allocation, duration matching, and capital planning. A poorly managed investment portfolio may reduce the benefits of longevity-risk transfer, while a well-structured portfolio can enhance the stabilizing function of the swap. This finding is aligned with research on financial-risk and profitability management in insurance companies, which emphasizes the importance of integrating risk control with financial planning and digitalized management tools (14). It is also conceptually consistent with studies on swap instruments showing that derivatives can be effective hedging tools when they are designed and managed in relation to the underlying exposure (5, 6).

Supervisory policies ranked seventh, reinforcing the importance of institutional oversight in the implementation of longevity swaps. This result complements the top ranking of insurance laws and regulations but highlights the operational role of regulatory agencies in monitoring, approving, and guiding the use of innovative instruments. Effective supervision can help ensure that longevity swaps are used for genuine risk mitigation rather than regulatory arbitrage or excessive risk-taking. This finding is consistent with studies emphasizing corporate governance and risk management in insurance and takaful companies, where governance quality influences financial outcomes and risk-related decision-making (17). It also aligns with the broader view that the sustainability of insurance markets requires regulatory systems capable of responding to emerging financial, demographic, and technological pressures (1).

Demographic changes, mortality rate, and longevity were also confirmed as important factors, although they ranked below institutional and financial variables. This does not mean that demographic and actuarial risks are unimportant; rather, it suggests that experts considered them necessary but not sufficient conditions for implementing longevity swaps. Longevity swaps are directly linked to changes in life expectancy and mortality patterns, but the ability to manage these risks depends on whether insurers possess adequate data, actuarial models, regulatory support, and financial capacity. The importance of demographic and mortality-related modeling is supported by research on claims-data prediction for elderly long-term care, which illustrates how population aging and care needs can be modeled through insurance data (9). It is also reinforced by actuarial-risk literature emphasizing that actuaries play a central role in evaluating financial and demographic risks in insurance firms (8).

Macroeconomic conditions, investment return rate, interest-rate changes, exchange-rate fluctuations, and capital-market risks were confirmed as relevant but received medium to lower rankings in the final prioritization. These findings indicate that experts recognized the importance of financial-market conditions but did not consider them more fundamental than legal, regulatory, capital, and transparency-related factors. Interest-rate fluctuations

are especially relevant because they affect discount rates, liability valuation, investment returns, and the present value of future obligations. Prior research on interest-rate swaps shows that swap markets are closely connected to monetary policy transmission and financial-system dynamics (5). Moreover, studies on insurance-company profitability and financial performance confirm that macroeconomic and financial variables influence insurers' results (4). However, in the present study, these variables were ranked below institutional factors, suggesting that in the context of longevity swaps, market risks can be managed more effectively only when the legal and organizational infrastructure is already in place.

Financial innovation and technology ranked fourteenth, while quality of internal risk management ranked twentieth. The relatively lower ranking of these factors is notable because modern insurance innovation is increasingly dependent on digital infrastructure, artificial intelligence, data analytics, and internal enterprise risk-management systems. One possible interpretation is that experts regarded technology and internal risk management as enabling mechanisms rather than primary external prerequisites. Nevertheless, previous research suggests that these factors should not be underestimated. Digitalization has created both opportunities and challenges for insurance companies, especially after the COVID-19 pandemic accelerated the need for technological adaptation (12). Artificial intelligence can improve cost efficiency in insurance markets when appropriately integrated into operations and decision-making (13). Cyber and digital-trade risks also show that technological development requires legal safeguards and risk-control mechanisms (15). Therefore, although technology and internal risk management ranked lower in this study, they remain important operational foundations for the long-term success of longevity swaps.

Market-related factors, including level of competition in the insurance market, access to market information, policyholder awareness, and marketing and sales capability for life insurance, were also validated by experts. Their confirmation shows that longevity swaps are indirectly influenced by market maturity and customer behavior. Although these instruments are usually negotiated at the institutional level, their underlying exposure originates from life-insurance portfolios shaped by policyholder behavior, customer trust, product demand, surrender decisions, and risk perception. This interpretation is consistent with research showing that insurance coverage decisions can be influenced by risk perception and behavioral characteristics (18). It also aligns with studies on the competitiveness of financial insurance companies, which emphasize the need for strategic adaptation, innovation, and market responsiveness (19). In this sense, the effectiveness of longevity swaps depends not only on actuarial assumptions but also on the behavioral and competitive conditions that shape the insurance portfolio.

Overall, the results demonstrate that longevity swaps should be analyzed through a multidimensional risk-management framework. The highest-ranked factors—insurance laws and regulations, capital risk management, political and economic stability, and information transparency—show that experts prioritize institutional reliability, solvency protection, macro-level stability, and data transparency. This pattern is theoretically meaningful because longevity swaps are complex, long-term, and highly information-sensitive instruments. They require alignment among legal systems, supervisory authorities, actuarial departments, financial managers, technology infrastructures, and market participants. The results also suggest that the development of longevity swaps in the insurance industry should proceed gradually and strategically. Before focusing on advanced product structuring or market expansion, insurers and policymakers must first strengthen the legal, regulatory, informational, and capital-management foundations necessary for the safe use of this instrument.

The findings are broadly consistent with previous research showing that risk-management capability is a determinant of insurer performance, that sustainability and transparency are increasingly central to insurance-market development, and that digitalization, actuarial expertise, and governance mechanisms shape the future of insurance innovation (1, 3, 13, 17). They also extend prior literature by showing that in the specific case of longevity swaps, institutional and regulatory factors may be perceived as more important than narrow actuarial or market factors. This contribution is important because many discussions of longevity swaps emphasize mortality modeling and financial engineering, whereas the present findings show that legal infrastructure, regulatory confidence, information transparency, and capital-management capacity may be the decisive conditions for practical implementation.

The present study has several limitations. First, the research relied on expert judgment, and although the fuzzy Delphi method is appropriate for consensus-building, the findings may still reflect the professional experiences, institutional positions, and subjective evaluations of the selected experts. Second, the sample size was necessarily limited because the target population consisted of specialized experts familiar with insurance risk management and longevity-related financial instruments. Third, the study was conducted in the context of the insurance industry and may not be fully generalizable to pension funds, capital-market institutions, or reinsurance markets. Fourth, because longevity swaps are relatively complex and less developed in many insurance markets, some expert evaluations may have been based on conceptual understanding rather than extensive practical experience with implemented contracts.

Future research should examine longevity swaps using larger and more diverse expert panels, including actuaries, reinsurers, regulators, investment managers, legal specialists, and capital-market participants. Comparative studies across different countries or insurance-market structures could also clarify how regulatory maturity, capital-market depth, and demographic conditions influence the feasibility of longevity swaps. Future studies may also develop quantitative models for pricing, stress testing, and scenario analysis of longevity swaps under different mortality, inflation, interest-rate, and exchange-rate assumptions. In addition, longitudinal research could examine how changes in demographic trends, technological infrastructure, and supervisory policies affect the practical adoption of longevity-risk transfer instruments over time.

From a practical perspective, insurance companies should prioritize the establishment of strong legal, regulatory, and reporting foundations before entering into longevity swap contracts. Regulators should provide clear supervisory guidelines regarding contract approval, solvency treatment, disclosure requirements, counterparty risk, and risk-transfer recognition. Insurance companies should also strengthen their actuarial teams, improve mortality and policyholder databases, develop integrated risk-management systems, and enhance portfolio-management capabilities. Moreover, investment in digital infrastructure, analytical technologies, and transparent reporting systems can improve the reliability of pricing and monitoring processes. Finally, the successful development of longevity swaps requires coordination among insurers, supervisory authorities, reinsurers, financial institutions, and technology providers to create a stable and trustworthy market environment.

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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

All ethical principles were adheried in conducting and writing this article.

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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