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THE EVOLUTION OF GENERAL INSURANCE: A BIBLIOMETRIC ANALYSIS OF RISK MODELING AND DIGITAL INNOVATION AS DRIVERS OF INDUSTRY TRANSFORMATION

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ABSTRACT

This study presents research trends from 2006 to 2025, providing a comprehensive bibliometric analysis of AI applications in the insurance industry. It also aims to identify the intellectual framework, thematic development, and international collaborative networks in this emerging interdisciplinary field. A total of 796 articles published in peer-reviewed scientific journals were systematically selected using the PRISMA framework and the Scopus database. The search strategy used logical search operators to combine important AI terms like "machine learning," "deep learning," "predictive modelling," and "telematics" with insurance-related keywords. We used VOSviewer to look at co-authorship, co-citation, and keyword co-occurrence. The digital transformation of the insurance sector has contributed to a significant increase in publication volume, especially after 2015. Florida Atlantic University and the University of Barcelona lead in institutional output, while the United States, China, and India are the most prolific contributors by country. Notable authors include Montserrat Guillén and Taghi M. Khoshgoftar. Focusing on emerging areas such as climate risk, Medicare fraud, and personal underwriting, thematic analysis reveals a shift from basic AI approaches (such as artificial neural networks) to more advanced AI techniques (such as deep learning and usage-based insurance).This study emphasizes how important interdisciplinary cooperation is becoming and demands that AI research be more thoroughly incorporated into actuarial science and insurance practice, the results guide future strategies for using AI to improve insurance services' creativity, effectiveness, and personalization.

KEYWORDS: General Insurance, Risk Modeling, Digital Innovation, Bibliometric Analysis, Digital Transformation, Artificial Intelligence, InsurTech, Risk Management.

1. INTRODUCTION

Advances in digital technologies, data analytics, and artificial intelligence have profoundly reshaped the general insurance industry over the past decade. Traditional non-life insurance operations—including underwriting, pricing, claims management, fraud detection, and risk assessment—are increasingly driven by data-intensive models and digital infrastructures. The integration of digital transformation initiatives within general insurance markets has accelerated the development of predictive risk modeling frameworks, automated decision-making systems, and technology-enabled customer engagement strategie in the insurance industry. Ellili et al., 2023

Risk modeling, historically grounded in actuarial science and statistical methods, has evolved significantly in response to technological innovation. Contemporary insurers increasingly rely on machine learning algorithms, telematics-based pricing systems, big data analytics, and blockchain-enabled process automation to enhance operational efficiency and risk accuracy. These innovations have not only improved forecasting capabilities but have also redefined competitive dynamics within the property and casualty (P&C) insurance sector. Bhattacharya et al., 2025

Digital innovation has therefore emerged as a central driver of industry transformation. InsurTech firms, artificial intelligence applications, and advanced analytics platforms are reshaping traditional business models and encouraging insurers to adopt agile, data-driven strategies. As digital ecosystems expand, general insurance companies are transitioning from conventional risk management practices toward integrated digital risk intelligence systems. Stoeckli et al., 2018

Despite the growing academic interest in digital transformation and risk analytics within insurance, a comprehensive bibliometric investigation that systematically maps the intellectual structure and thematic evolution of research in general insurance remains limited. Existing studies often focus on specific technologies such as artificial intelligence or telematics without providing an integrated perspective on the broader transformation of the general insurance industry.

To address this gap, the present study conducts a bibliometric analysis of risk modeling and digital innovation in general insurance research from 2015 to 2026. By examining publication trends, influential journals, leading countries, institutional contributions, collaboration networks, and thematic development, this study provides a structured overview of the intellectual and conceptual evolution shaping industry transformation

Based on this, the following research questions have been formulated:

1. What is the annual distribution of publications on risk modelling and digital innovation within the general insurance industry from 2015 to 2026?
2. What are the most relevant journals publishing research on risk modeling and digital innovation in the general insurance industry?
3. Which countries demonstrate the strongest scholarly contributions in risk modelling and digital innovation research within the general insurance industry?
4. What are the most significant educational institutions contributing to research on risk modeling and digital innovation in the general insurance industry?
5. Who are the most prolific authors in the field of risk modeling and digital innovation within the general insurance industry?
6. What are the most cited articles in the field of risk modeling and digital innovation within the general insurance industry?
7. What are the patterns of international collaboration among countries in risk modeling and digital innovation research within the general insurance industry?
8. What are the dominant thematic clusters in risk modeling and digital innovation research within the general insurance industry as revealed by keyword co-occurrence analysis?
9. What is the distribution of corresponding authors across countries in risk modelling and digital innovation research within the general insurance industry?
10. What are the evolving research trends in risk modelling and digital innovation within the general insurance industry over time?
11. What does thematic mapping reveal about the maturity, relevance, and strategic importance of research themes in risk modelling and digital innovation within the general insurance industry?
12. How have the research themes in Artificial Intelligence applications within the insurance industry evolved between 2015–2025.?

2. MATERIALS AND METHODS

The present study adopts a comprehensive bibliometric analysis to examine the intellectual, thematic, and collaborative structure of research on risk modeling and digital innovation within the general insurance industry. This methodological approach enables the systematic mapping of publication trends, influential journals, leading countries and institutions, prolific authors, citation structures, and thematic clusters

shaping the evolution of general insurance research ((Donthu et al., 2021) Bibliometric techniques are particularly effective for analyzing large bodies of scientific literature, uncovering research patterns, identifying dominant themes, and tracing the evolution of scholarly knowledge across disciplines (Aria & Cuccurullo, 2017; Kraus et al., 2020).

The dataset was retrieved from the Scopus database due to its extensive coverage of peer-reviewed journals across business, finance, and technology domains. The initial search, conducted using a Boolean combination of keywords related to general insurance, risk modeling, and digital transformation, yielded 1,051 documents. To ensure methodological rigor and relevance, a structured inclusion and exclusion procedure was applied following the PRISMA protocol (Moher et al., 2010).

The filtering process was conducted in multiple stages. First, the publication period was limited to 2015–July 2026 to capture the contemporary phase of digital transformation in general insurance, reducing the dataset to 924 records. Second, subject areas were restricted to Business, Management and Accounting; Decision Sciences; Economics, Econometrics and Finance; Computer Science; and Social Sciences, resulting in 719 documents. Third, only journal articles were retained, narrowing the dataset to 352 publications. After limiting the source type to journals and excluding non-English documents, the final sample comprised 345 peer-reviewed journal articles.

To analyze the dataset, VOSviewer software was employed to construct bibliometric networks, including co-authorship maps, co-citation structures, and keyword co-occurrence networks. These visualization techniques facilitate the identification of dominant research themes, global collaboration patterns, and the evolving intellectual architecture of general insurance research(Aria & Cuccurullo, 2017)The analytical framework applied in this study is particularly suitable for capturing how digital innovation—such as artificial intelligence, machine learning, big data analytics, telematics, blockchain, and automation—has reshaped traditional risk modeling, underwriting, pricing, fraud detection, and claims management practices in the general insurance sector.

The final dataset of 347 publications constitutes the empirical basis of this bibliometric investigation. The filtering stages are summarized in Table 1 and illustrated through the PRISMA flow diagram presented in Figure 1.

2.1. *Prisma Framework*

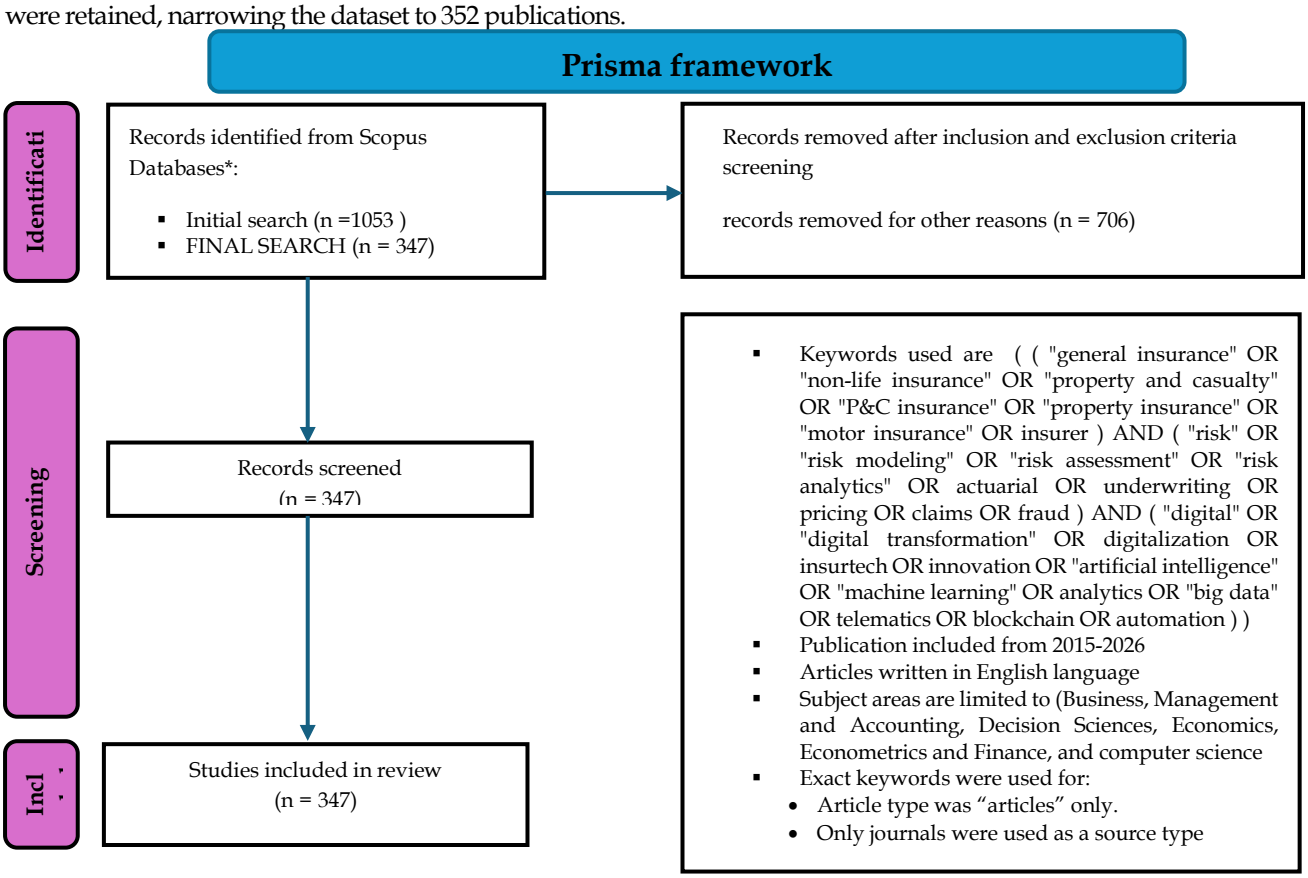

Figure 1: Prisma Framework for This Review.

2.2. *Identification Database Selection*

This review was conducted on February 16, 2026.

The Scopus database was selected as the primary source for data retrieval due to its extensive coverage of high-quality peer-reviewed publications across business, finance, decision sciences, and technology-oriented disciplines. Scopus is widely recognized for its rigorous indexing standards, comprehensive citation tracking system, and strong international academic reputation, making it a reliable and authoritative platform for bibliometric investigations (Van Eck & Waltman, 2010; Donthu et al., 2021). Its multidisciplinary scope is particularly appropriate for capturing the intersection of general insurance, risk modeling, and digital innovation, thereby ensuring a comprehensive and methodologically robust dataset for analysis) Singh et al., 2021).

2.3. Inclusion and reporting

The keywords used in the search strategy included terms related to "general insurance," "risk modeling," and "digital innovation," generating an initial dataset of 1,051 documents. After applying the predefined inclusion and exclusion criteria—limiting the results to English-language journal articles published between 2015 and April 2026 within selected subject areas—the dataset was refined to a final sample of 345 publications, resulting in the exclusion of 706 records. The selection process is summarized in Table 1 and visually illustrated through the PRISMA flow diagram (Moher et al., 2010). (Moher et a.,2010).

Table 1: Filtering Process for Risk Modeling and Digital Innovation Literature in the General Insurance Industry.

Keywords (("general insurance" OR "non-life insurance" OR "property and casualty" OR "P&C insurance" OR "property insurance" OR "motor insurance" OR insurer) AND ("risk" OR "risk modeling" OR "risk assessment" OR "risk analytics" OR actuarial OR underwriting OR pricing OR claims OR fraud) AND ("digital" OR "digital transformation" OR digitalization OR insurtech OR innovation OR "artificial intelligence" OR "machine learning" OR analytics OR "big data" OR telematics OR blockchain OR automation))	
Initial results	1053
Inclusion and exclusion criteria (automatic filtering)	
Publication year	
Including years from 2015 to July 2026	924
Subject area	
Business, Management and Accounting, Decision Sciences, Economics, Econometrics and Finance, computer science and Social Sciences	719
Document type	
articles only	352
Source type	
Only journal	351
Language	
English	347

The search query was constructed using a Boolean combination of terms representing three core dimensions: general insurance, risk-related functions, and digital innovation technologies.

Specifically, the search string was structured as:

(("general insurance" OR "non-life insurance" OR "property and casualty" OR "P&C insurance" OR "property insurance" OR "motor insurance" OR insurer) AND ("risk" OR "risk modeling" OR "risk assessment" OR "risk analytics" OR actuarial OR underwriting OR pricing OR claims OR fraud)AND("digital" OR "digital transformation" OR digitalization OR insurtech OR innovation OR "artificial intelligence" OR "machine learning" OR analytics OR "big data" OR telematics OR blockchain OR automation)).

The initial search yielded 1,053 documents. A multi-stage filtering procedure was subsequently applied to ensure academic rigor and thematic relevance:

Temporal Scope: Publications were limited to the period from 2015 to February 2026, reflecting the accelerated phase of digital transformation in the general insurance industry. This step reduced the dataset to 924 articles.

Subject Area Filtering: To maintain disciplinary focus, results were restricted to Business, Management and Accounting; Decision Sciences; Economics, Econometrics and Finance; Computer Science; and Social Sciences. This refinement reduced the dataset to 719 articles, ensuring alignment with both managerial and technological perspectives.

Document Type Constraint: Only peer-reviewed journal articles were retained to preserve academic quality, excluding conference papers and other non-article formats. This step reduced the dataset to 352 articles.

Source Type and Language Filtering: The final selection retained only English-language publications from journal sources, resulting in a final dataset of 347 articles.

This structured filtering strategy demonstrates

methodological rigor and thematic precision. By progressively narrowing the dataset through clearly defined criteria, the study ensures that the final sample is both comprehensive and closely aligned with the research objectives. The layered filtration process also adheres to established best practices in bibliometric research consistent with the PRISMA protocol.

3. RESULTS

This section presents a comprehensive and structured bibliometric analysis of the Scopus dataset, aligned with the thirteen research questions guiding this study. The analysis begins by examining the annual distribution of publications from 2015 to February 2026 (RQ1), capturing the temporal growth and increasing scholarly attention toward risk modeling and digital innovation within the general insurance industry. It then identifies the most relevant journals (RQ2), providing insight into the leading academic outlets that publish research on insurance transformation, risk analytics, and technological innovation.

The geographical dimension is explored through the identification of the most influential countries (RQ3) and the most productive academic institutions (RQ4), reflecting global research contributions and institutional engagement in general insurance studies. In parallel, the analysis highlights the most prolific authors (RQ5) and the most cited articles (RQ6), revealing the key intellectual contributors and foundational works shaping the evolution of digital transformation and risk research in the non-life insurance sector.

To assess collaboration patterns, the study investigates international research partnerships among countries (RQ7), uncovering global scholarly networks and cross-border cooperation in general insurance innovation research. This is followed by a keyword co-occurrence analysis (RQ8), which identifies dominant research themes, conceptual clusters, and emerging areas at the intersection of risk management and digital technologies.

Furthermore, the analysis examines the intellectual linkages between core research themes, leading authors, and productive institutions (RQ9), offering insights into the structural coherence and knowledge integration of the field. The geographic distribution of corresponding authors (RQ10) is also analyzed to understand spatial patterns of authorship and academic influence.

In addition, the study explores emerging and evolving research trends over time (RQ11), supported by trend topic visualizations that illustrate shifting thematic priorities in general insurance research. The thematic mapping analysis (RQ12) evaluates the positioning of research themes in terms of centrality and maturity, while the thematic evolution analysis (RQ13) traces the development, consolidation, or decline of specific topics across the periods 2015–2020 and 2021–2026.

Collectively, these analytical components provide an integrated overview of publication dynamics, thematic development, collaboration networks, and intellectual structures that define the contemporary evolution of risk modeling and digital innovation in the general insurance industry.

3.1. What Is the Annual Distribution of Publications on Risk Modelling and Digital Innovation Within the General Insurance Industry From 2015 To 2026?

The annual publication trend from 2015 to 2026 reflects a progressive consolidation of research on risk modeling and digital innovation within the general insurance industry. In the early phase (2015–2018), output remained relatively limited, suggesting that digital transformation had not yet become a central focus within general insurance scholarship. Research during this stage was largely exploratory and conceptually oriented. (Vial, G. 2019)

A structural shift becomes evident from 2019 onward, marked by a significant rise in publication volume. This increase indicates a growing recognition of digital technologies as integral to core insurance functions such as underwriting, pricing, fraud detection, and claims management. The acceleration observed between 2021 and 2022 further demonstrates a deepening engagement with predictive analytics, artificial intelligence, and data-driven risk assessment models. (Gürcan, F., & Kahraman, S. 2023)

Despite a temporary decline in 2023, the strong rebound in 2024 and the pronounced peak in 2025 suggest that the field has entered a mature phase characterized by intensified scholarly attention and methodological refinement. The partial figure for 2026 reflects incomplete yearly data rather than a substantive downturn.

Overall, the trajectory illustrates a clear transition from preliminary conceptual discussions to systematic integration of digital risk modeling within general insurance research, underscoring its growing role as a structural driver of industry transformation.

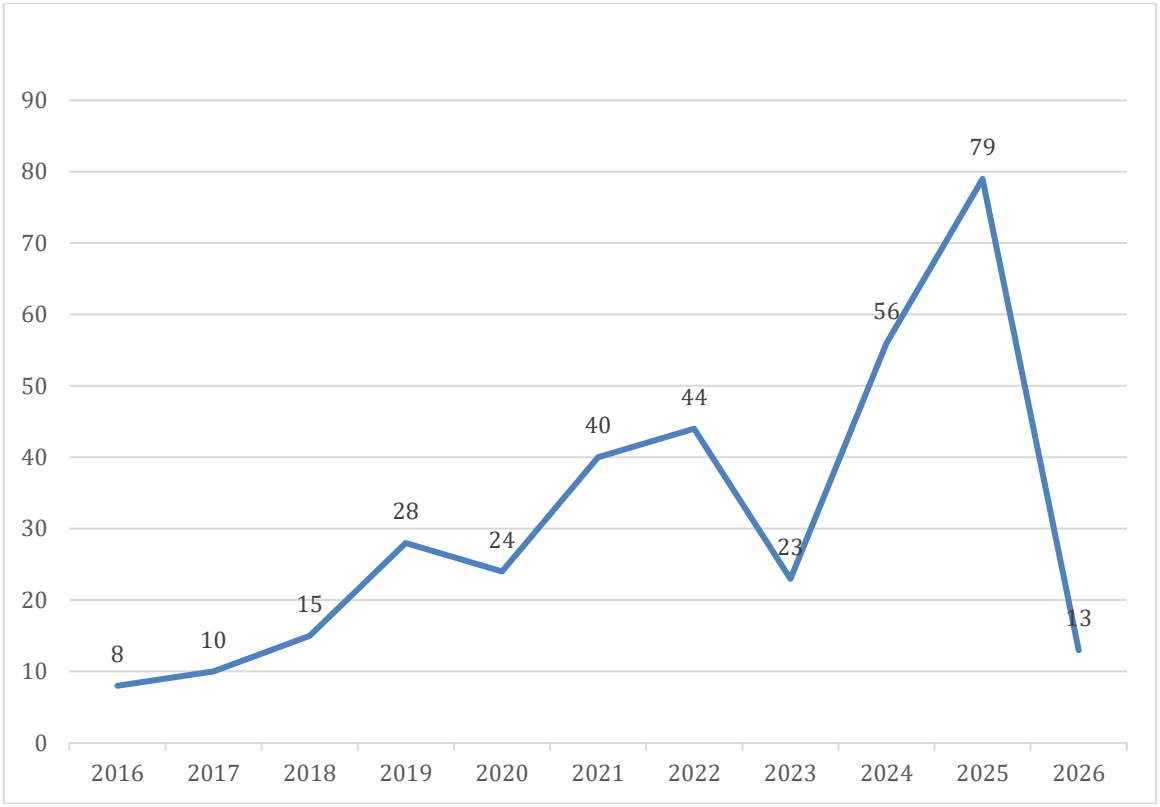

Figure 2: Annual Publication Trends in Risk Modelling and Digital Innovation Within the General Insurance Industry (2015–2026).

3.2. What Are the Most Relevant Journals Publishing Research on Risk Modeling and Digital Innovation in the General Insurance Industry?

Figure 3 displays the distribution of publications across the ten most productive journals, revealing the disciplinary foundations of research on risk modeling and digital innovation in general insurance. A strong concentration appears in Risks, which leads with 36 publications, underscoring its central role in advancing actuarial and quantitative perspectives within digitally evolving insurance frameworks.

The North American Actuarial Journal follows with 18 publications, reaffirming the sustained influence of actuarial scholarship in discussions of technology-driven risk assessment. Similarly, ASTIN Bulletin, The Geneva Papers on Risk and Insurance, and Insurance: Mathematics and Economics, each contributing 10 articles, highlight the continued relevance of mathematically rigorous and economics-based approaches in analyzing digital transformation within insurance systems.

The presence of Big Data and Society (7 publications) reflects the growing integration of insurance research with broader debates on data governance and analytics. Meanwhile, journals such as the European Actuarial Journal, Insurance Markets and Companies, Risk Management and Insurance Review, and Annals of Actuarial Science (5–6 publications each) indicate a diversified yet interconnected scholarly landscape. **Barry, L., & Charpentier, A. (2020)**

Overall, the journal distribution suggests that digital innovation in general insurance is being incorporated into established actuarial and risk management traditions rather than emerging as an isolated technological field. This pattern reinforces the integrative nature of the industry's ongoing structural transformation.

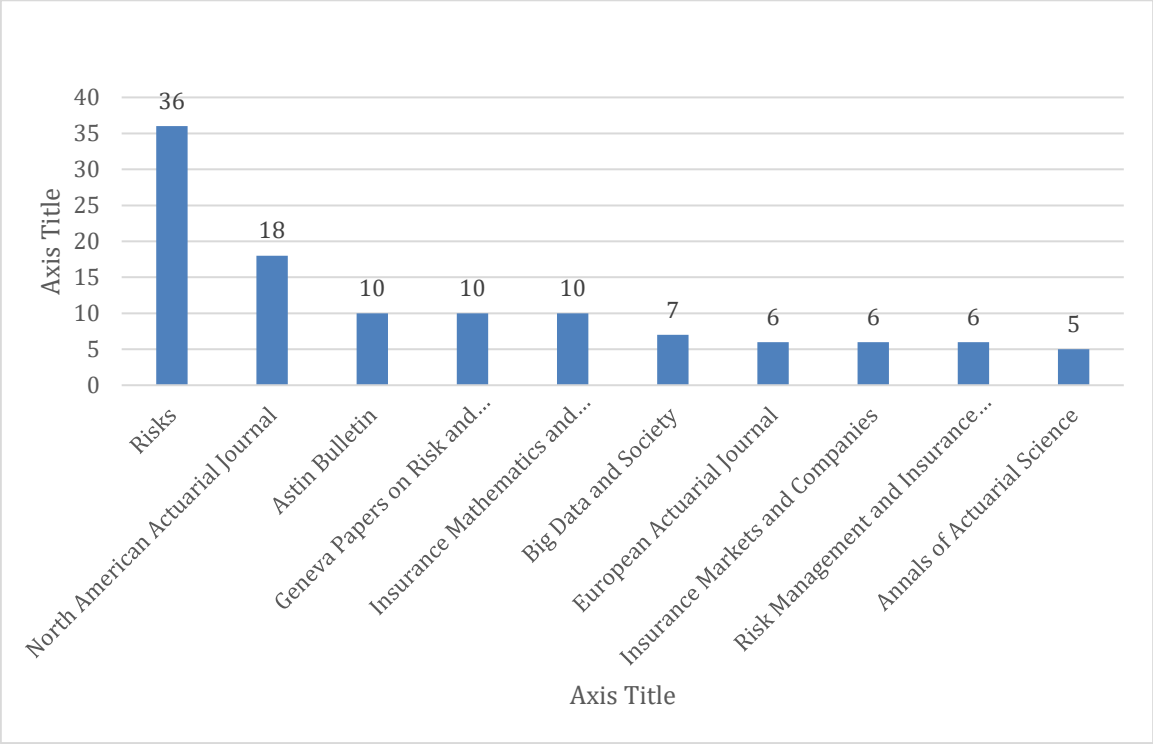

Figure 3: Top 10 Journals Contributing to Research on Risk Modeling and Digital Innovation in General Insurance (2015–2026).

Table 2 presents a structured overview of the principal academic journals contributing to research on risk modeling and digital innovation in the general insurance industry. One notable pattern is the strong presence of Q1-ranked journals, reflecting the growing positioning of this research stream within high-impact and internationally recognized publication outlets.

Risks stand out as a leading platform, supported by a substantial publication volume (TP = 902) and a cumulative citation count (TC = 3,903). The visibility of highly cited contributions—particularly studies on telematics-based motor insurance prediction (140 citations) (Pesantez-Narvaez et al., 2019)—highlights the journal's role in promoting applied, data-driven approaches to risk assessment. This prominence signals the consolidation of quantitative modeling and digital analytics within core insurance scholarship.

In parallel, Geneva Papers on Risk and Insurance: Issues and Practice (Q1, CiteScore 7.3) and Big Data and Society (Q1, CiteScore 9.3) represent complementary orientations within the field. While the former situates digital transformation within insurance market structures and business model evolution, the latter extends the discourse to broader themes of data governance and personalization. The strong citation performance of articles addressing on-demand insurance and personalization further indicates expanding scholarly attention to structural innovation beyond conventional underwriting frameworks.

At the same time, actuarially oriented journals—including North American Actuarial Journal, ASTIN Bulletin, and Insurance: Mathematics and Economics—retain a significant role. Their most cited works, particularly those focused on telematics-driven pricing and machine learning-supported tariff design, reveal a transition toward dynamic and behavior-based pricing models. This pattern suggests that digital innovation is reshaping actuarial methodologies rather than displacing them.

Overall, Table 2 reflects a structurally integrated research landscape in which digital technologies are embedded within established actuarial and insurance traditions. The distribution of journals reinforces the view that digital transformation in general insurance is advancing through disciplinary integration rather than technological substitution.

Table 2: Leading Academic Journals in Risk Modeling and Digital Innovation Research Within the General Insurance Industry.

Journal	Quartile	*TP	**TC for journal	Citate score	Most cited article	Time cited	Publisher
Risks	Q1	902	3903	4.3	Predicting motor insurance claims using telematics data—XGboost versus logistic regression	140	Multidisciplinary Digital Publishing Institute (MDPI)
North American Actuarial Journal	Q2	146	404	2.8	Boosting Insights in Insurance Tariff Plans with Tree-Based Machine Learning Methods	46	Taylor & Francis
ASTIN Bulletin	Q2	124	441	3.6	IMPROVING AUTOMOBILE INSURANCE CLAIMS FREQUENCY PREDICTION WITH TELEMATICS CAR DRIVING DATA	23	Cambridge University Press
Geneva Papers on Risk and Insurance: Issues and Practice	Q1	127	926	7.3	On the (future) role of on-demand insurance: market landscape, business model and customer perception	23	Springer Nature
Insurance: Mathematics and Economics	Q2	327	1121	3.4	The added value of dynamically updating motor insurance prices with telematics collected driving behavior data	34	Elsevier
Big Data and Society	Q1	382	3558	9.3	Personalization as a promise: Can Big Data change the practice of insurance?	78	SAGE
European Actuarial Journal	Q3	224	295	2.6	Investing in your own and peers' risks: the simple analytics of P2P insurance	29	Springer Nature
Insurance Markets and Companies	Q2	64	159	2.5	Transformation of insurance technologies in the context of a pandemic	64	LLC CPC Business Perspectives
Risk Management and Insurance Review	Q3	85	243	2.9	Cream Skimming: Innovations in Insurance Risk Classification and Adverse Selection	16	John Wiley & Sons
Annals of Actuarial Science	Q1	97	208	2.1	Multivariate credibility modelling for usage-based motor insurance pricing with behavioural data	42	Cambridge University Press
***TP = Total publication, **TC= total citation**							

3.3. Which Countries Demonstrate the Strongest Scholarly Contributions in Risk Modelling and Digital Innovation Research Within the General Insurance Industry?

Figure 4 illustrates the geographical distribution of scholarly contributions in risk modelling and digital innovation within the general insurance sector, revealing a clear concentration of research activity in technologically mature and innovation-driven economies. The United States stands out prominently with 61 publications, significantly surpassing other countries. This dominance reflects its advanced data analytics ecosystem, strong collaboration between academia and the insurance industry, and the early integration of predictive modelling and digital risk frameworks into general insurance operations.

China (32) and the United Kingdom (31) follow, demonstrating substantial engagement in digital risk research. China's position can be associated with its rapid digital transformation, expansion of data-driven financial services, and strategic emphasis on technological modernization. (Shi et al., 2022) Meanwhile, the United Kingdom's strong output is likely linked to its well-established insurance market, particularly the London insurance hub, and its active research community in actuarial science and financial technology (Thottoli & Menon, 2023).

Mid-tier contributors such as Belgium (25), Canada (25), and France (24) indicate a diversified European and North American presence in the field. These countries benefit from structured regulatory environments and growing investments in digital underwriting, predictive analytics, and risk optimisation models. Spain (23), Australia (21), and India (19) demonstrate expanding research engagement, reflecting increasing adoption of digital risk assessment tools and broader digital transformation agendas within their insurance

markets. Italy (17), while comparatively lower, still represents meaningful scholarly participation.

Overall, the distribution suggests that countries with advanced digital infrastructures, mature insurance industries, and supportive regulatory or innovation policies tend to lead research production in digital risk modelling.

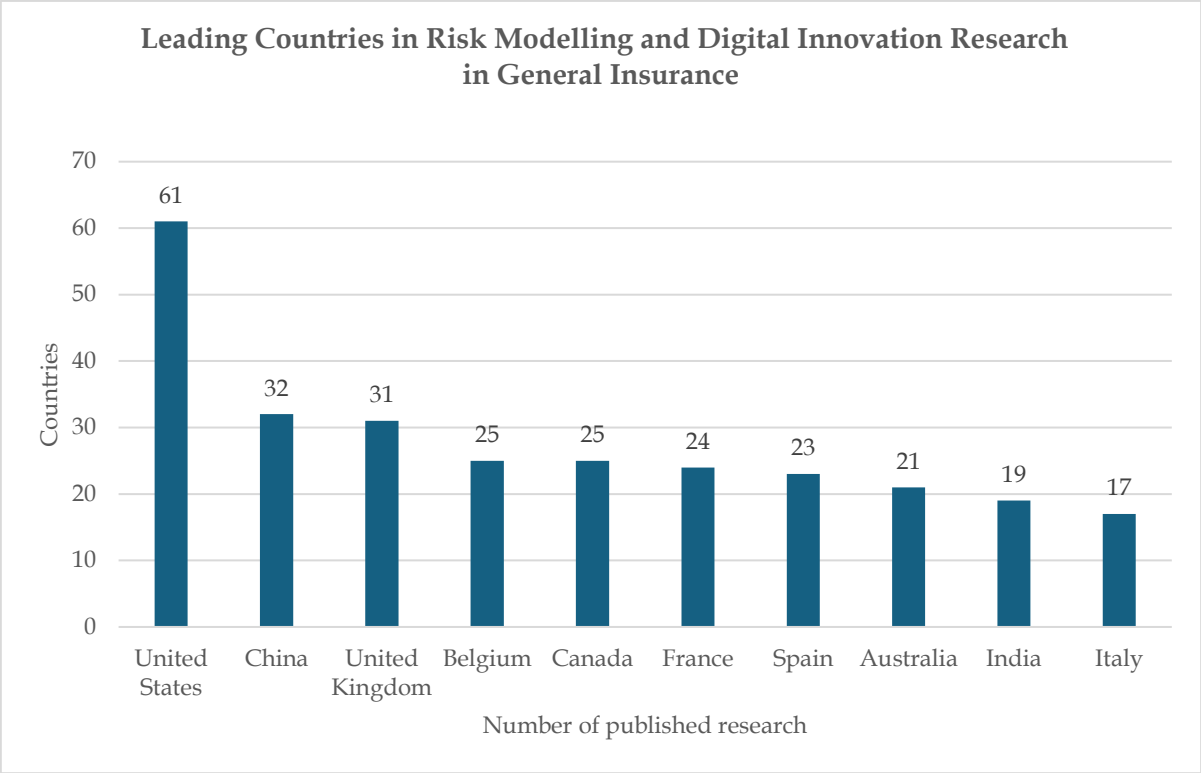

Figure 4: Top 10 Countries by Research Output on Risk Modelling and Digital Innovation in General Insurance.

3.4. What Are the Most Significant Educational Institutions Contributing to Research on Risk Modeling and Digital Innovation in the General Insurance Industry??

Table 3 identifies the leading academic institutions contributing to research on risk modeling and digital innovation in the general insurance industry. The distribution reveals both institutional concentration and geographic diversity, indicating that expertise in this domain is regionally anchored yet internationally diffused.

KU Leuven leads with 18 publications, positioning Belgium as a notable center for digitally oriented risk research. Universitat de Barcelona follows closely with 17 publications, highlighting Europe's strong engagement in integrating technological innovation with insurance analytics. Institutions such as the University of Limerick and Université du Québec à Montréal further demonstrate that contributions extend beyond traditional financial hubs, reflecting the expanding global scope of digital insurance research.

Additional representation from the Netherlands, France, Switzerland, Australia, and the United States underscores the transnational character of the field. Although publication volumes beyond the top institutions are moderate, the collective distribution suggests a networked academic environment rather than dominance by a single region.

Overall, the institutional landscape reflects a globally interconnected research ecosystem in which actuarial expertise and digital analytics converge to support the ongoing transformation of the general insurance sector.

Table 3: Top Educational Institutions in Risk Modeling and Digital Innovation Research Within the General Insurance Industry.

Educational institution	*TP	country
KU Leuven	18	Belgium
Universitat de Barcelona	17	Spain
University of Limerick	9	Ireland

Université du Québec à Montréal	8	Canada
Universiteit van Amsterdam	7	Netherlands
UCLouvain	6	Belgium
Université Claude Bernard Lyon 1	6	France
University of St. Gallen	6	Switzerland
UNSW Sydney	6	Australia
University of Wisconsin-Madison	6	United States

***TP: Total Publication**

3.5. Who Are the Most Prolific Authors in the Field of Risk Modeling and Digital Innovation Within the General Insurance Industry?

The table presents a structured overview of the most influential scholars contributing to research on risk modeling and digital innovation in the general insurance sector. By combining topic-specific publication counts with broader impact indicators—total publications (TP), citation totals (TC), and h-index—the table enables a comprehensive assessment of both specialization within the field and overall academic standing.

Guillen, Montserrat emerges as the most prominent contributor, with 15 publications directly related to the research topic. Her broader academic profile is equally substantial, with 217 total publications (TP), an h-index of 39, and 4,230 total citations (TC). Affiliated with Universitat de Barcelona in Spain, her profile reflects sustained intellectual leadership and strong integration of actuarial analytics with digital methodologies in insurance research.

Murphy, Finbarr ranks second in topic-specific productivity with 8 publications. His academic metrics—94 total publications, an h-index of 30, and 2,635 citations—indicate both specialization and recognized scholarly influence. Based at the University of Limerick in Ireland, his contributions reinforce the growing role of Irish institutions in advancing digitally enhanced risk modeling frameworks.

Antonio, Katrien follows with 7 publications in the research domain. With 53 total publications, an h-index of 22, and 1,212 citations, and affiliated with KU Leuven in Belgium, her work reflects a consistent engagement with actuarial modeling and data-driven insurance analytics. This aligns with Belgium's broader institutional prominence in quantitative insurance research.

Shi, Peng contributes 6 topic-related publications and maintains 49 total publications, an h-index of 17, and 978 citations. As a faculty member at the University of Wisconsin–Madison in the United States, his profile illustrates the integration of statistical modeling and advanced analytics into contemporary insurance risk research within North American academic environments.

Overall, the author profile reflects a research domain marked by both specialization and academic maturity. Established actuarial scholars are progressively integrating digital analytics into traditional risk frameworks, illustrating that transformation within general insurance research is driven by methodological integration *(Waltman & van Eck, 2015)*.

Table 4: Most Prolific Authors in Risk Modeling and Digital Innovation Research in General Insurance.

Autor	Number of papers related to to the research topic	*TP	h-index	**TC	Current affiliation	country
Guillen, Montserrat	15	217	39	4,230	Universitat de Barcelona The institution	Spain
Murphy, Finbarr	8	94	30	2,635	University of Limerick	Ireland
Antonio, Katrien	7	53	22	1,212	KU Leuven	Belgium
Shi, Peng	6	49	17	978	University of Wisconsin-Madison	United States
Denuit, Michel M.	5	215	37	5,623	UCLouvain	Belgium
Pérez-Marín, Ana Maria	5	34	17	821	Universitat de Barcelona	Spain
Sheehan, Barry	5	36	17	1,228	Kemmy Business School	Ireland
Charpentier, Arthur	4	62	17	1,061	Université du Québec à Montréal	Canada
Eling, Martin	4	117	37	4,229		
Nielsen, Jens Perch Erch	4	124	31	3,137		

***TP = Total Publication, **TC= Total Citation**

3.6. What Are the Most Cited Articles in the Field of Risk Modeling and Digital Innovation Within the General Insurance Industry?

Table 5 delineates the Top 10 Most Cited Articles in risk modeling and digital innovation research within the general insurance industry, ranked by total citation counts (TC). These highly cited contributions represent the intellectual cornerstones of the field, exerting substantial influence on its theoretical advancement, methodological development, and strategic orientation.

1. **"Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough?"** by Gatteschi et al. (2018) stands among the most influential contributions in digital innovation within insurance research, with a strong citation trajectory reflecting its foundational role in shaping scholarly debate. Published in Future Internet (Q1), the study critically examines the technological readiness of blockchain and smart contracts for insurance applications. Rather than adopting a purely optimistic stance, the authors conduct a structured evaluation of operational use cases—such as claims automation, fraud mitigation, peer-to-peer insurance, and pay-per-use models—while simultaneously addressing scalability, regulatory, and governance constraints. The paper's impact stems from its balanced analytical framework, particularly the integration of a SWOT analysis that systematically assesses strengths, weaknesses, opportunities, and threats associated with blockchain adoption in insurance. By positioning technological enthusiasm within a maturity and feasibility discourse, the study provides a conceptual benchmark for subsequent research on digital transformation in general insurance. (Gatteschi et al., 2018)
2. **The article titled "Leveraging Deep Learning with LDA-Based Text Analytics to Detect Automobile Insurance Fraud**" by Wang and Xu (2018), published in Decision Support Systems, proposes an advanced fraud detection framework that combines deep neural networks with Latent Dirichlet Allocation (LDA)-driven text mining techniques. Addressing a notable limitation in prior insurance fraud studies, the authors incorporate unstructured textual claim descriptions alongside structured numerical and categorical variables. LDA is utilized to extract latent thematic patterns embedded within claim narratives, and these topic-based features are integrated into a deep learning architecture to enhance predictive performance. Empirical evaluation using real-world automobile insurance data demonstrates that the hybrid LDA–DNN model significantly surpasses traditional machine learning approaches such as Random Forest and Support Vector Machines in terms of accuracy, precision, and F1-score. The findings highlight the methodological strength of combining semantic text representation with deep feature abstraction, offering a more robust mechanism for identifying complex and concealed fraudulent behaviors in non-life insurance operations (Wang & Xu, 2018).
3. **Predicting Motor Insurance Claims Using Telematics Data—XGBoost versus Logistic Regression" by Pesantez-Narvaez, Guillén, and Alcañiz (2019)** represents one of the most influential contributions in data-driven risk modeling within general insurance. Published in Risks, the study evaluates the predictive performance of XGBoost relative to traditional logistic regression for forecasting motor insurance claims using telematics-based driving behavior data .Drawing on real-world PAYD (pay-as-you-drive) insurance data, the authors demonstrate that while XGBoost offers marginal improvements in predictive accuracy under certain configurations, logistic regression remains highly competitive due to its interpretability and regulatory transparency. The findings underscore a critical tension in digital insurance innovation: advanced machine learning techniques may enhance predictive capacity, yet traditional actuarial models retain strategic value in contexts where explainability and pricing justification are essential. Consequently, the study advances the discourse on methodological integration, suggesting that digital risk analytics in general insurance evolves not through model substitution, but through the calibrated coexistence of interpretable statistical frameworks and high-performance machine learning algorithms (Pesantez-Narvaez et al., 2019)
4. "**The Value of Vehicle Telematics Data in Insurance Risk Selection Processes" by Baecke and Bocca (2017)** is among the most influential contributions in telematics-driven insurance analytics. Published in Decision Support Systems (Q1) by Elsevier, the study systematically evaluates how sensor-generated driving behavior data enhance traditional motor insurance risk assessment

models. Using a large-scale European dataset, the authors compare logistic regression, random forests, and artificial neural networks to measure the incremental predictive power of telematics variables over conventional customer, vehicle, and claims-history predictors. The findings demonstrate a statistically significant improvement in model performance—particularly when telematics data are integrated with traditional actuarial inputs—while also highlighting the added benefit of expert-engineered behavioral features. Importantly, the study shows that three months of telematics data are sufficient to achieve optimal predictive gains, reinforcing the operational feasibility of usage-based insurance (UBI) implementation. Collectively, the article establishes telematics as a structurally transformative component in modern risk selection and dynamic premium design (Baecke & Bocca, 2017).

5. **"MaCRA: A Model-Based Framework for Maritime Cyber-Risk Assessment" by Tam and Jones (2019)** proposes a structured analytical framework designed to quantify and visualize cyber risks within the maritime sector. Published in WMU Journal of Maritime Affairs, the study introduces the MaCRA model, which evaluates cyber threats across three integrated dimensions: system vulnerability, ease-of-exploit (EoE), and attacker reward. By modeling attacker attributes (e.g., type, resources, objectives) alongside target characteristics (e.g., system vulnerabilities, defensive capacity, operational context), the framework enables multidimensional risk projection and scenario-based assessment. The authors demonstrate how MaCRA can support decision-making for operators, insurers, and regulators by identifying high-risk system–attacker combinations and prioritizing mitigation strategies. The study's contribution lies in operationalizing maritime cyber-risk analysis through a scalable, model-based approach that bridges technical system vulnerabilities with behavioral threat modeling, thereby advancing structured cyber-risk evaluation in increasingly digitized maritime environments (Tam & Jones, 2019).
6. **"Automobile Insurance Classification Ratemaking Based on Telematics Driving Data" by Huang and Meng (2019**) is one of the influential contributions in telematics-driven insurance analytics. Published in Decision Support Systems, the study develops a comprehensive pricing framework for usage-based insurance (UBI) by integrating telematics-derived driving behavior variables into risk classification and claim frequency modeling. The authors employ logistic regression alongside advanced machine learning techniques—such as Support Vector Machines, Random Forests, XGBoost, and Artificial Neural Networks—to predict accident probability, while Poisson regression is used for claim frequency estimation. A key innovation of the study lies in the application of a regression tree–based variable binning approach to construct interpretable tariff classes without sacrificing predictive accuracy. Empirical results based on real-world data from a Chinese property and casualty insurer confirm that telematics variables—particularly those related to mileage, speed exposure, and critical driving events—significantly enhance pricing precision compared to traditional rating factors (Huang & Meng, 2019).
7. **"Improving Automobile Insurance Claims Frequency Prediction with Telematics Car Driving Data" by (Meng et al., 2021)** is among the most influential contributions in telematics-based insurance analytics. Published in Astin Bulletin, the study proposes a supervised risk-scoring framework based on a one-dimensional Convolutional Neural Network (1D-CNN) to evaluate individual driving trips using time-series telematics data. The generated trip-level risk scores are aggregated through a limited fluctuation credibility model and incorporated into a Poisson Generalized Linear Model (GLM) for claims frequency prediction. Empirical results demonstrate that integrating credibility-adjusted telematics risk scores significantly improves out-of-sample predictive performance compared to traditional actuarial models based solely on classical risk factors. The findings underscore the strategic value of deep learning and credibility theory in enhancing risk differentiation, pricing fairness, and portfolio segmentation within the automobile insurance industry (Meng et al., 2021).
8. **"Personalization as a Promise: Can Big Data Change the Practice of Insurance?" by Barry and Charpentier (2020)** critically examines whether Big Data and telematics technologies

genuinely enable a paradigmatic shift toward individualized insurance pricing. Published in Big Data & Society (Q1), the article challenges the widespread assumption that predictive analytics can fully replace traditional actuarial classification systems. Drawing on a conceptual and epistemological analysis, the authors argue that although telematics introduces behavioral and dynamic variables into pricing models, current practices largely reinforce refined segmentation rather than true individual-level risk determination. The study demonstrates that, despite the rhetoric of personalization, actuarial frameworks remain structurally grounded in collective risk pooling. Consequently, the article significantly contributes to the debate on digital transformation in insurance by distinguishing between technological enhancement and genuine epistemological change in risk modeling *(Barry & Charpentier, 2020)*.

9. **"Machine learning algorithms for fraud prediction in property insurance: Empirical evidence using real-world microdata" by Severino and Peng (2021)** ranks among the influential studies in AI-driven insurance fraud detection. Published in Machine Learning with Applications (Q1, Elsevier), the study evaluates nine machine learning models using real-world microdata from a major Brazilian insurer to predict fraud in residential and business property insurance claims. The authors demonstrate that ensemble methods—particularly Random Forest and Gradient Boosting—significantly outperform traditional logistic regression across multiple performance metrics, while Deep Neural Networks achieve the highest recall, minimizing false negatives. Beyond predictive comparison, the study incorporates permutation-based feature importance and SHAP (Shapley Additive Explanations) analysis to enhance interpretability, identifying prior claims history and premature claim timing as the most influential predictors. The findings provide both methodological rigor and practical decision-support insights, reinforcing the strategic value of explainable AI in insurance risk management (Severino & Peng, 2021).
10. **"Designing Cyber Insurance Policies: The Role of Pre-Screening and Security Interdependence" by Khalili, Naghizadeh, and Liu (2018)** represents one of the most influential contributions to cyber risk and insurance design research. Published in IEEE Transactions on Information Forensics and Security, the study develops a contract-theoretic framework to analyze how pre-screening mechanisms and security interdependence shape optimal cyber insurance contracts. The authors demonstrate that interdependent security environments generate a profit opportunity for insurers by correcting agents' underinvestment in protection. Through the integration of pre-screening assessments, insurers can design incentive-compatible contracts that simultaneously enhance profitability and improve overall network security. The findings offer a rigorous analytical foundation for understanding how cyber insurance can function not only as a risk-transfer mechanism but also as a governance instrument that aligns private incentives with systemic security outcomes (Khalili et al., 2018).

Collectively, the top 10 most cited articles delineate the core intellectual architecture of research on risk modeling and digital innovation within the general insurance industry. They span complementary thematic pillars, including telematics-driven underwriting, machine learning–based fraud detection, blockchain-enabled operational transformation, cyber risk contract design, and data-driven personalization frameworks. Methodologically, these studies reflect a progressive shift from traditional actuarial and statistical models toward hybrid analytical ecosystems that integrate deep learning, ensemble methods, credibility theory, and structured risk assessment frameworks. At the same time, several contributions critically interrogate the limits of technological determinism, emphasizing issues of interpretability, regulatory feasibility, governance, and systemic interdependence. Taken together, these highly cited works demonstrate that digital transformation in general insurance is not merely technological substitution, but rather a multidimensional reconfiguration of risk evaluation, pricing logic, and institutional design—thereby establishing the conceptual and methodological foundations for subsequent scholarly and industry advancements.

Table 5: Top 10 Most Cited Articles in Risk Modeling and Digital Innovation Research Within the General Insurance Industry.

Paper title	(Authors)/Year	TC	Journal	Publisher	Rank

Blockchain and smart contracts for insurance: Is the technology mature enough?	Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C., & Santamaría, V. (2018)	441	Future Internet	Multidisciplinary Digital Publishing Institute (MDPI)	Q1
Leveraging deep learning with LDA-based text analytics to detect automobile insurance fraud	W ang, Y., & Xu, W. (2018)	281	Decision Support Systems	Elsevier	Q1
Predicting motor insurance claims using telematics data—XGboost versus logistic regression	Pesantez-Narvaez, J., Guillen, M., & Alcañiz, M. (2019).	140	Risks	Multidisciplinary Digital Publishing Institute (MDPI)	Q1
The value of vehicle telematics data in insurance risk selection processes	Baecke, P., & Bocca, L. (2017)	129	Decision Support Systems	Elsevier	Q1
MaCRA: a model-based framework for maritime cyber-risk assessment	Tam, K., & Jones, K. (2019)	116	WMU Journal of Maritime Affairs	Springer Nature	Q1
Automobile insurance classification ratemaking based on telematics driving data	Huang, Y., & Meng, S. (2019)	100	Decision Support Systems	Elsevier	Q1
Improving automobile insurance ratemaking using telematics: incorporating mileage and driver behaviour data	Ayuso, M., Guillen, M., & Nielsen, J. P. (2019)	100	Transportation	Springer Nature	Q1
Personalization as a promise: Can Big Data change the practice of insurance?	Barry, L., & Charpentier, A. (2020).	78	Big Data and Society	SAGE	Q1
Machine learning algorithms for fraud prediction in property insurance: Empirical evidence using real-world microdata	Severino, M. K., & Peng, Y. (2021)	59	Machine Learning with Applications	Elsevier	Q1
Designing cyber insurance policies: The role of pre-screening and security interdependence	Khalili, M. M., Naghizadeh, P., & Liu, M. (2018)	58	IEEE Transactions on Information Forensics and Security	IEEE	Q1

3.7. What Are the Patterns of International Collaboration Among Countries in Risk Modeling and Digital Innovation Research Within the General Insurance Industry?

Figure 5 illustrates the international co-authorship network in risk modeling and digital innovation research within the general insurance industry, revealing a structurally interconnected yet regionally clustered collaboration landscape. The visualization indicates that the United States occupies a central and highly connected position, functioning as the primary hub linking multiple regional clusters. Its extensive collaborative ties with Canada, China, France, Belgium, and the United Kingdom suggest a bridging role in facilitating transcontinental knowledge exchange.

A second prominent cluster emerges around France, Belgium, and Canada, reflecting a strong European–North American collaboration axis. This grouping appears particularly cohesive, indicating sustained institutional partnerships and shared research agendas in actuarial analytics and digital risk frameworks. Similarly, the United Kingdom and India form another collaborative nucleus, demonstrating active engagement between established insurance research centers and emerging markets.

The network also highlights China's strategic intermediary role, connecting East Asian contributors—such as South Korea and Singapore—with Western research hubs. This positioning suggests increasing Asian participation in digital insurance scholarship, particularly in technologically driven subfields.

Notably, countries such as Saudi Arabia and South Africa appear more peripheral, reflecting emerging but comparatively limited integration within the broader collaboration structure. Their presence, however, signals gradual geographic diversification of research activity.

Overall, the collaboration map underscores that research in risk modeling and digital innovation within general insurance is characterized by a hybrid

global structure: a core of highly interconnected Western economies complemented by expanding participation from Asia and selected emerging regions. This pattern reflects both the maturity of actuarial research centers in Europe and North America and the accelerating diffusion of digital insurance technologies across global markets.

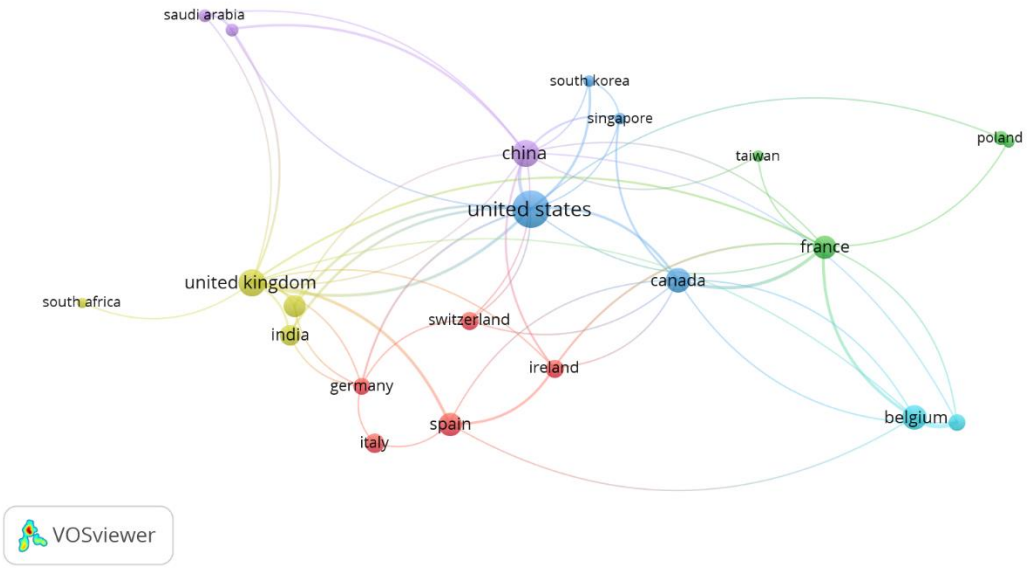

Figure 5: Country Collaboration Map Based on Co-Authorship in AI And ML Applications in the Insurance Publications.

3.8. What Are the Dominant Thematic Clusters in Risk Modeling and Digital Innovation Research Within the General Insurance Industry as Revealed by Keyword Co-Occurrence Analysis?

Figure 6 presents the keyword co-occurrence network derived from publications on risk modeling and digital innovation within the general insurance industry. The map, generated using VOSviewer, visualizes the structural relationships among the most frequently occurring keywords, where node size reflects term frequency and link thickness indicates the strength of co-occurrence. Distinct color-coded clusters reveal the thematic architecture of the field, highlighting interconnected yet conceptually differentiated research streams (Zupic & Čater, 2015).

Red Cluster – Machine Learning–Driven Insurance Analytics

Key Terms: machine learning, deep learning, forecasting, fraud detection, claims management, health insurance.

This cluster represents the methodological core of the domain. It emphasizes predictive modeling and algorithmic approaches applied to fraud identification, claims optimization, and risk forecasting. The prominence of deep learning and forecasting suggests increasing reliance on advanced computational models to enhance predictive accuracy and operational efficiency in insurance processes.

Green Cluster – Risk Assessment, Big Data, and Cyber Insurance

Key Terms: risk assessment, big data, cyber insurance, cyber security, risk management, insurtech.

This cluster reflects the expansion of digital infrastructures in insurance risk governance. The integration of big data analytics with cyber risk themes signals a growing orientation toward emerging technological threats and digital ecosystem vulnerabilities. The presence of insurtech further indicates structural transformation driven by data-centric innovation (Eling et al., 2024).

Blue Cluster – Predictive Modeling and Behavioral Risk Analytics

Key Terms: predictive analytics, data mining, decision trees, logistic regression, driving behaviour.

This grouping captures the quantitative modeling stream rooted in actuarial and statistical traditions. The emphasis on driving behaviour and predictive

modeling highlights the operationalization of telematics and behavior-based underwriting within general insurance pricing frameworks.

Yellow Cluster – Artificial Intelligence, Telematics, and Pricing Mechanisms

Key Terms: artificial intelligence, telematics, pricing, non-life insurance, discrimination.

This cluster connects core AI concepts with premium calculation and fairness considerations. The co-occurrence of pricing and discrimination indicates ongoing scholarly engagement with ethical and regulatory dimensions of algorithmic risk classification.

Purple Cluster – Blockchain and Insurance Governance

Key Terms: blockchain, smart contracts, insurance policies, trust, economic and social effects.

This thematic stream centers on distributed ledger technologies and their implications for contractual automation, transparency, and institutional trust. It reflects research exploring governance innovation rather than purely predictive modeling.

Overall, the network reveals a research landscape structured around three interrelated pillars: (1) advanced computational modeling, (2) digital infrastructure and cyber risk governance, and (3) behavioral and pricing-based innovation in underwriting. The prominence of "insurance," "machine learning," and "risk assessment" as central nodes indicate a tightly integrated intellectual ecosystem where digital technologies are embedded within established actuarial and risk management frameworks rather than operating as isolated technological domains.

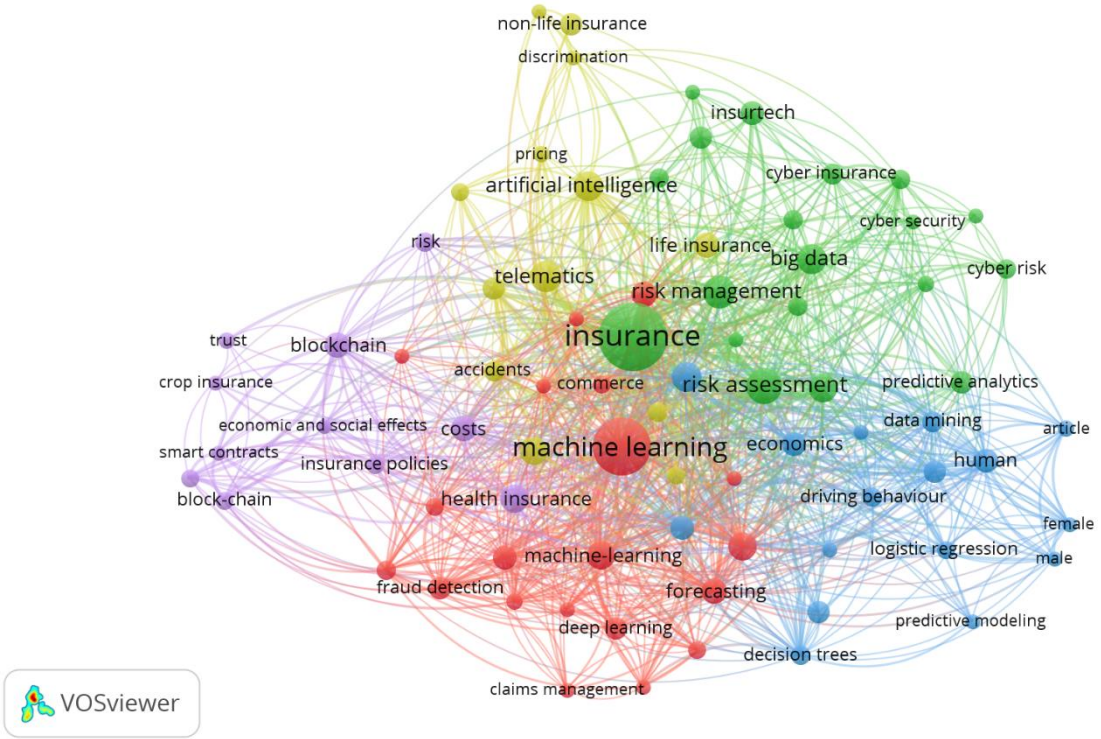

Figure 6: Keyword Co-Occurrence Network in AI And ML Applications in the Insurance Research (2006–2025).

3.9. What Is the Distribution of Corresponding Authors Across Countries in Risk Modelling and Digital Innovation Research Within the General Insurance Industry?

Figure 8 illustrates the country-level distribution of corresponding authors in risk modeling and digital innovation research within the general insurance industry, differentiating between single-country (SCP) and multi-country publications (MCP). The United States leads decisively, with a strong share of internationally collaborative output, confirming its central role in global knowledge coordination. China follows with substantial productivity and growing international integration.

European countries—particularly Belgium, Spain, the United Kingdom, and France—demonstrate balanced patterns of domestic capacity and cross-border collaboration, reinforcing Europe's

established position in actuarial and digital insurance research. Meanwhile, countries such as India, Australia, and Italy show moderate output largely embedded within international partnerships.

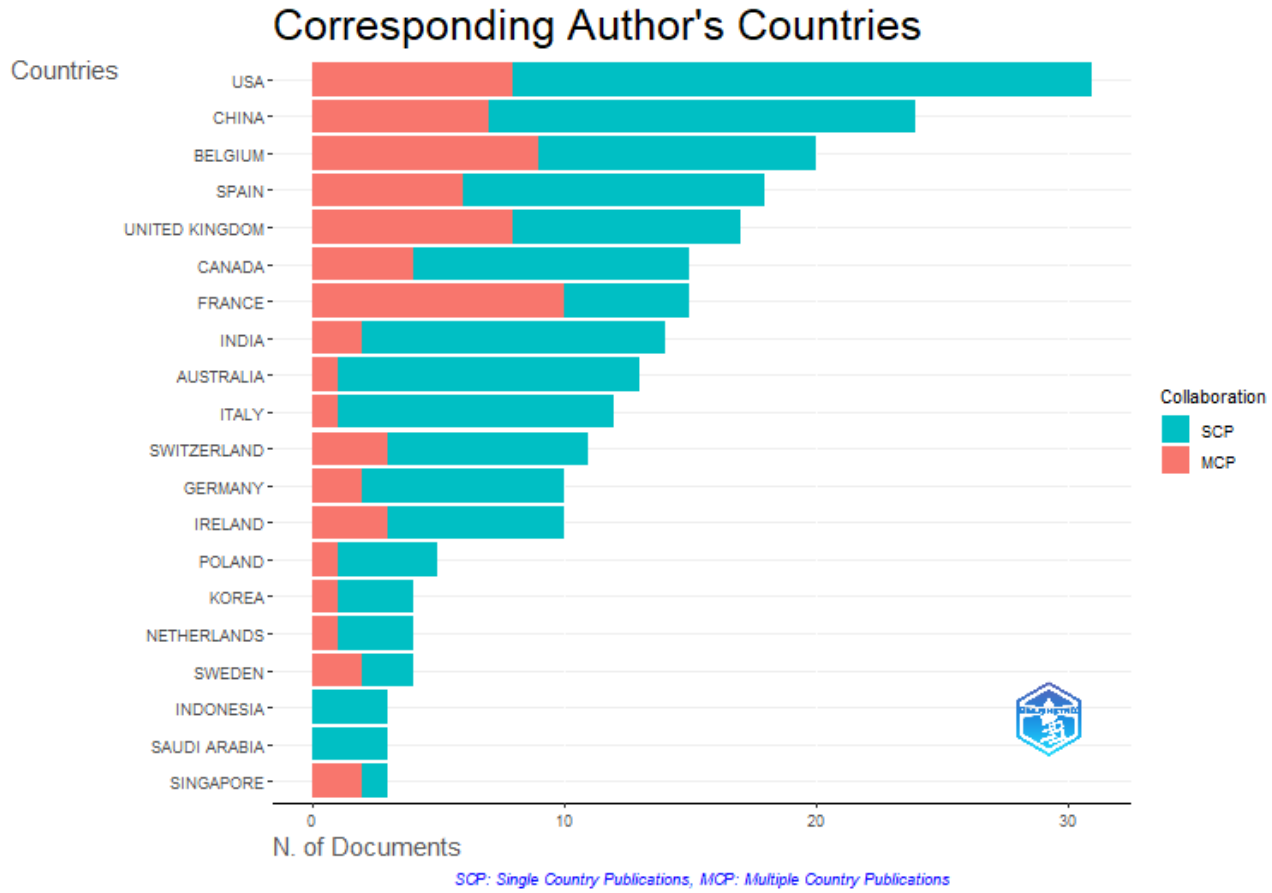

Figure 8: Distribution of Corresponding Authors by Country and Type of Collaboration in Risk Modelling and Digital Innovation Research Within the General Insurance Industry.

3.10. What Are the Evolving Research Trends in Risk Modelling and Digital Innovation Within the General Insurance Industry Over Time?

Figure 9 presents the updated trend-topic analysis illustrating the temporal evolution of key research themes in risk modeling and digital innovation within the general insurance industry from 2016 to 2025. The horizontal span reflects the duration of thematic presence, while bubble size indicates frequency, allowing for an assessment of both continuity and intensity.

In the earlier phase (2019–2021), foundational modeling approaches such as logistic regression, risk, and cyber risk appear prominently, signaling the continued reliance on traditional statistical frameworks and early attention to emerging digital threats. During this period, telematics and big data gain visibility, reflecting the consolidation of data-driven underwriting and behavior-based pricing mechanisms (Biener et al., 2015).

Between 2021 and 2023, the thematic landscape shifts toward more advanced computational paradigms. Machine learning emerges as a dominant and highly frequent term, accompanied by deep learning and insurtech, indicating deeper integration of AI-driven analytics into insurance operations. The expansion of motor insurance and non-life insurance within this timeframe highlights the sector-specific operationalization of digital risk models (Bohnert, Fritzsche, & Gregor, 2019)..

From 2023 onward, the discourse evolves further toward governance and ethical dimensions. The increasing prominence of artificial intelligence, fairness, and fraud detection—particularly in the most recent years—signals growing scholarly attention to transparency, algorithmic bias, and regulatory accountability. Additionally, the sustained presence of health insurance suggests the diversification of digital risk applications beyond motor and non-life segments.

Overall, the revised trend analysis reveals a clear progression from statistical modeling and data

infrastructure toward advanced AI integration and ethical governance concerns. This trajectory underscores the maturation of digital innovation in general insurance, where predictive sophistication is increasingly coupled with considerations of fairness, risk governance, and sustainable technological deployment.

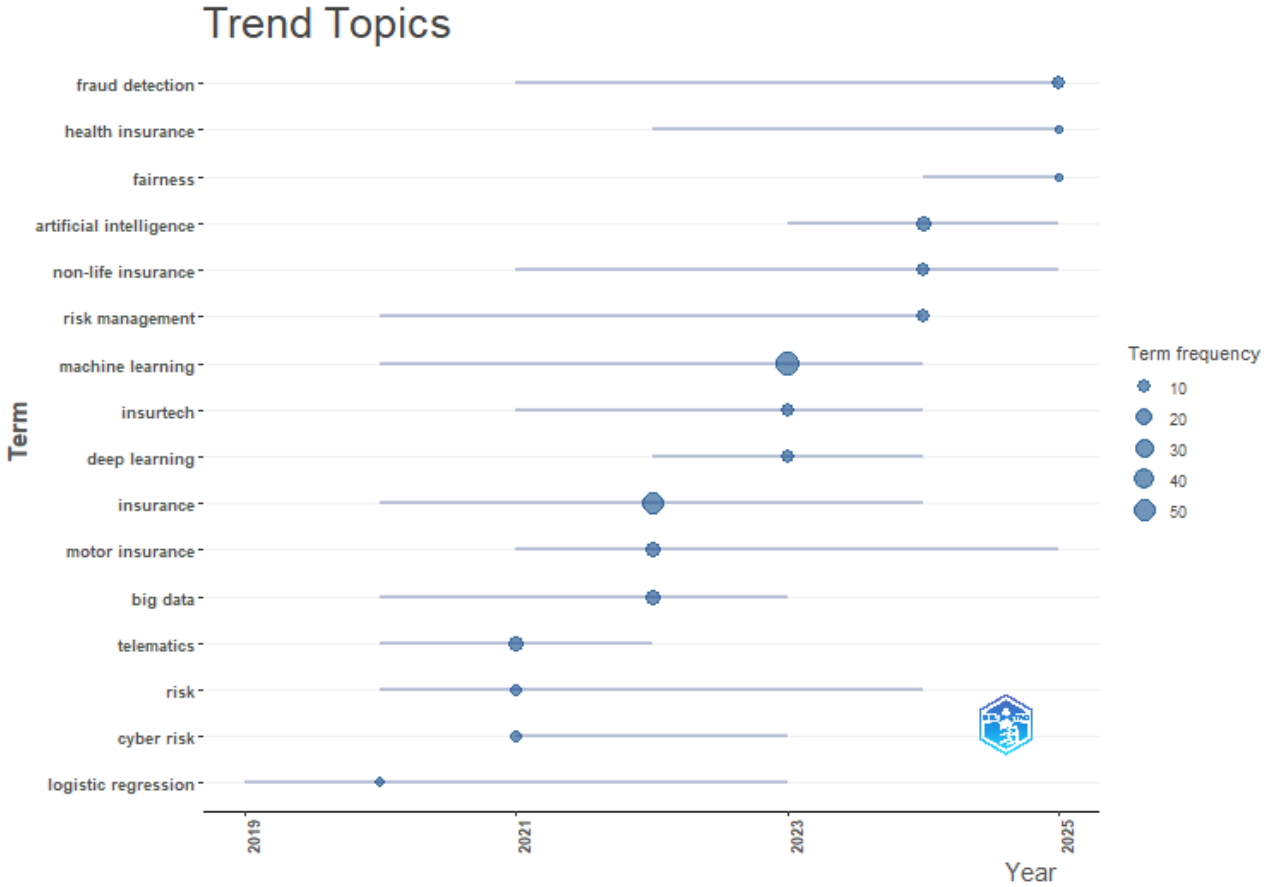

Figure 9: Temporal Evolution of Key Research Topics in Risk Modeling and Digital Innovation Within the General Insurance Industry.

3.11. What Does Thematic Mapping Reveal About the Maturity, Relevance, And Strategic Importance of Research Themes in Risk Modelling and Digital Innovation Within the General Insurance Industry?

Figure 10 presents the thematic map of research on risk modelling and digital innovation within the general insurance industry, positioning clusters according to their degree of development (density) and relevance (centrality). This two-dimensional structure enables the identification of motor, basic, niche, and emerging or declining themes, thereby offering insight into the intellectual maturity and strategic importance of different research streams.

In the Motor Themes quadrant (high centrality and high density), fraud detection, logistic regression, and predictive modeling appear as well-developed and structurally influential topics. Their position indicates strong internal cohesion and high integration within the broader research network. Similarly, themes such as digitalization, risk classification, and adverse selection demonstrate both conceptual maturity and systemic relevance, reflecting the ongoing transformation of underwriting and pricing mechanisms in general insurance (Aria & Cuccurullo, 2017).

The Basic Themes quadrant (high centrality but lower density) includes insurance, big data, and artificial intelligence, alongside machine learning, deep learning, non-life insurance, motor insurance, and telematics. These themes are highly connected to the overall research structure but remain less internally consolidated, suggesting that while they form the conceptual backbone of the field, their subtopics continue to evolve and diversify. Notably, telematics and usage-based insurance signal sustained expansion in behavior-driven risk analytics.

Within the Niche Themes quadrant (high density

but lower centrality), topics such as climate risk, property insurance, and risk-taking exhibit strong internal development yet limited integration with the dominant research core. These areas may represent specialized subfields with growing technical depth but narrower systemic influence. Similarly, discussions surrounding algorithmic bias and financial risk suggest emerging ethical and sector-specific refinements within digital risk modeling(Verbelen, Antonio, & Claeskens, 2018)..

Finally, the Emerging or Declining Themes quadrant includes game theory, positioned with low centrality and density. This placement may indicate either early-stage conceptual exploration or a reduction in thematic prominence relative to more data-intensive approaches.

Overall, the thematic map reveals a field anchored by predictive analytics and fraud detection as mature drivers, supported by foundational AI and big data frameworks, while simultaneously expanding into governance, climate-related risks, and behavioral insurance models. This configuration reflects a maturing research ecosystem in which methodological sophistication, sector-specific applications, and regulatory considerations are increasingly intertwined in shaping the evolution of general insurance scholarship.

Figure 10: Thematic Map of Risk Modeling and Digital Innovation Research Within the General Insurance Industry: Based on Centrality and Density.

3.12. How Have the Research Themes in Artificial Intelligence Applications Within the Insurance Industry Evolved Between 2015–2025.

Figure 11 illustrates the thematic evolution of research in risk modeling and digital innovation within the general insurance industry across two periods: 2015–2022 and 2023–2026. The visualization highlights how dominant themes have persisted while others have evolved into more specialized strands.

In the earlier period (2015–2022), research was primarily centered on *machine learning*, *insurance*, *non-life insurance*, and *cyber insurance*. The prominence of *machine learning* reflects the early integration of algorithmic approaches into underwriting and claims analytics, while *telematics* and *driving behavior* indicate the rise of behavior-based pricing models. Attention to *cyber risk* also marked the initial expansion toward digitally induced threats (Baecke & Bocca, 2017).

In the later period (2023–2026), thematic development becomes more technically refined. Core

concepts such as *insurance* and *non-life insurance* remain stable, yet *machine learning* expands into more specific subthemes including *deep learning*, *machine learning algorithms*, and *neural networks*. The increasing visibility of *fraud detection*, *insurtech*, and *innovation* signals a shift toward operational optimization and broader digital transformation discourse.

Overall, the evolution demonstrates a transition from foundational digital adoption toward advanced AI specialization and innovation-driven applications, reflecting the growing maturity of digital transformation in general insurance research.

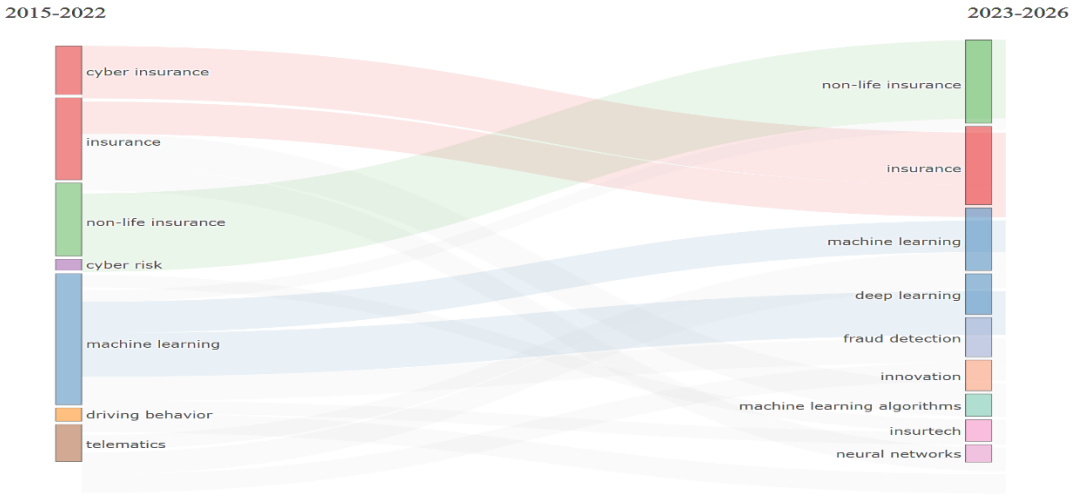

Figure 11: Longitudinal Evolution of Key Research Themes in Risk Modeling and Digital Innovation in the General Insurance Sector (2015–2026).

4. SUMARY

4.1. Publication Trends

The analysis indicates a steady and accelerating growth in publications on risk modeling and digital innovation within the general insurance industry between 2015 and 2026. While output remained moderate during the early years, a clear expansion emerged after 2019, with a pronounced increase from 2020 onward. This upward trend reflects the intensifying integration of digital technologies—such as advanced analytics, telematics, artificial intelligence, and blockchain—into non-life insurance operations.

The sustained rise in annual publications suggests that digital transformation has become a core analytical and strategic focus within contemporary general insurance research, marking the consolidation of this field as a mature and expanding scholarly domain.

4.2. Leading Countries and Institutions

The geographical distribution highlights strong European leadership, particularly from Spain and Belgium, with additional contributions from Ireland, the United States, Canada, and Switzerland. This pattern reflects the international scope of research on digital transformation in general insurance. at the institutional level, KU Leuven and Universitat de Barcelona emerge as leading research hubs, followed by the University of Limerick and Université du Québec à Montréal. Overall, the findings indicate that digital innovation in general insurance is driven by established actuarial research centers while expanding through broader international collaboration.

4.3. Journal Distribution

The journal distribution reveals a strong concentration of publications within high-impact, Q1-ranked outlets, indicating the academic maturity of research on risk modeling and digital innovation in general insurance. Journals such as Risks, Geneva Papers on Risk and Insurance, and Big Data & Society serve as primary dissemination platforms, reflecting both actuarial depth and digital innovation perspectives.

In parallel, actuarially oriented journals—including North American Actuarial Journal, ASTIN Bulletin, and Insurance: Mathematics and Economics—maintain a significant presence,

underscoring the methodological rigor of the field. Overall, the journal landscape demonstrates a hybrid research ecosystem where quantitative risk modeling and digital analytics converge within internationally recognized scholarly venues.

4.4. Keyword Co-Occurrence and Thematic Clusters

The keyword co-occurrence analysis identifies five interconnected thematic clusters shaping research on risk modeling and digital innovation in general insurance.

Cluster 1 – Machine Learning and Insurance Analytics: Focused on predictive modeling, fraud detection, claims management, and deep learning, representing the methodological core of the field.

Cluster 2 – Risk Assessment and Cyber Insurance: Integrating big data, cybersecurity, and insurtech, reflecting the growing importance of digital risk governance.

Cluster 3 – Behavioral and Actuarial Modeling: Emphasizing predictive analytics, telematics, and driving behavior within pricing and underwriting systems.

Cluster 4 – AI and Pricing Dynamics: Linking artificial intelligence with premium calculation and fairness considerations in non-life insurance.

Cluster 5 – Blockchain and Governance Innovation: Exploring smart contracts, transparency, and institutional trust through distributed ledger technologies.

Overall, the thematic structure highlights a tightly integrated research landscape where advanced analytics, digital infrastructure, and pricing innovation converge within established actuarial frameworks.

4.5. Thematic Evolution

The thematic evolution shows a clear shift in research priorities over time. In the early phase (2015–2018), studies focused mainly on traditional actuarial models and foundational predictive analytics.

From 2019 onward, attention moved toward machine learning, telematics, and usage-based insurance, reflecting deeper integration of behavioral and real-time data. In the most recent period (2021–2026), themes such as cyber insurance, blockchain, and digital transformation became more prominent.

Overall, the field has evolved from conventional statistical modeling toward a technology-driven and data-intensive research agenda aligned with the digital restructuring of general ***insurance.***

4.6. Co-Authorship And Collaboration Networks

The co-authorship network indicates a structured yet moderately interconnected research landscape. Strong collaborative clusters are concentrated around leading European institutions, particularly in Belgium and Spain, highlighting the influence of established actuarial research centers.

Simultaneously, partnerships involving Ireland, the United States, Canada, and Switzerland reflect growing international engagement. Overall, the collaboration pattern suggests that while the field is anchored in specialized academic hubs, it is increasingly supported by cross-border research networks that enhance methodological and thematic development

5. CONCLUSIONS

This bibliometric study provides a comprehensive overview of the intellectual, thematic, and collaborative structure of research on risk modeling and digital innovation within the general insurance industry between 2015 and 2026. The findings confirm a sustained and accelerating growth in scholarly output, particularly after 2019, reflecting the increasing centrality of digital technologies in reshaping non-life insurance operations.

The analysis demonstrates that the field is anchored in high-impact journals and driven by leading European and North American institutions, with strong contributions from established actuarial research centers. Thematic clustering reveals a research landscape structured around advanced machine learning applications, telematics-based pricing, cyber risk governance, fraud analytics, and blockchain-enabled insurance models. Importantly, thematic evolution indicates a clear transition from traditional statistical risk modeling toward more complex, data-intensive, and technology-driven analytical frameworks. This emphasizes how crucial technology is becoming to improving risk assessment precision and operational effectiveness in the insurance sector. It also emphasizes how practitioners and legislators must adjust to these developments in order to maintain their competitiveness and guarantee efficient regulation.

Collaboration patterns further highlight the presence of specialized academic hubs complemented by expanding international partnerships, suggesting a maturing and globally integrated research domain. This illustrates how more institutions are sharing resources and exchanging knowledge, which improves the caliber and creativity of research. It also suggests that encouraging international cooperation can hasten the spread of cutting-edge techniques and industry best

practices.

Overall, the evidence indicates that digital innovation in general insurance is not displacing actuarial foundations but rather augmenting and recalibrating them. The convergence of computational intelligence, behavioral data analytics, and digital infrastructure governance signals a structural transformation in how risk is assessed, priced, and managed. Future research is expected to deepen integration between explainable artificial intelligence, regulatory compliance, cyber risk modeling, and ethical algorithmic pricing, reinforcing the strategic evolution of general insurance in the digital era. This change facilitates more flexible, client-focused insurance options and improves decision-making accuracy. To preserve trust and regulatory consistency, it also highlights the necessity for businesses to strike a balance between innovation, transparency, and justice.

6. RECOMMENDATIONS

Based on the bibliometric findings, several strategic recommendations can be proposed for researchers, practitioners, and policymakers within the general insurance sector.

First, future research should advance the integration of explainable artificial intelligence (XAI) within risk modeling frameworks. As machine learning and deep learning models become increasingly embedded in underwriting and pricing systems, ensuring transparency, interpretability, and regulatory compliance will be essential for maintaining institutional trust and market stability.

Second, greater attention should be directed toward cyber risk modeling and systemic digital vulnerabilities. Given the rising prominence of cyber insurance and digital infrastructures, interdisciplinary research combining actuarial science, cybersecurity, and network risk analysis is necessary to address emerging interconnected risk exposures.

Third, scholars should expand investigations into fairness, discrimination, and underwriting. As telematics and behavioral analytics reshape premium calculation, regulatory and ethical considerations must be incorporated into model development to ensure equitable risk classification practices.

Fourth, enhanced international collaboration is recommended to strengthen comparative research across regulatory environments and insurance markets. Cross-border partnerships can accelerate methodological innovation and facilitate the development of globally adaptable digital insurance frameworks.

Finally, closer collaboration between academia and industry is encouraged. Applied research using real-world insurance datasets will improve model robustness, operational feasibility, and strategic relevance, thereby bridging the gap between theoretical advancement and practical implementation.

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