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Bibliometric Analysis of InsurTech

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ABSTRACT

InsurTech, derived from "insurance technology," refers to technology and innovation whose primary goals are to provide better services and technology to the insurance industry in the current progressive technological environment and industrial revolution. That industry increasingly relies on technology to obtain a competitive advantage and it assists decision-makers make better decisions. We use bibliometric analysis to assess the trend in InsurTech. We analyse all InsurTech-related publications on Scopus: 175 articles based on keywords relevant to InsurTech in the articles' titles, keywords, and abstract. Frequency analysis and data visualisation use Microsoft Excel, VOSviewer and the Bibliometric R package. We use standard bibliometric indicators: publication year, document type, source type, source title, language, subject area, keyword analysis, geographical distribution, authorship, and citation analysis. There has been a remarkable increase in the number of publications on InsurTech since 2017. The growing number of InsurTech publications demonstrates the importance of technology in the insurance sector and will undoubtedly affect the economy and society. Keyword analysis indicates that using insurance big data in various studies requires a theoretical link with the InsurTech topic and the insurance contract, which is a potential topic for future study.

1. Introduction

Our daily lives are permeated by technology and the innovation it enables. Since customers have grown accustomed to conducting financial transactions and managing their lives using the internet and mobile devices, they want the same digital experience with insurance. The integration of the financial infrastructure should lead to cost reductions and create a more efficient financial market [1]. Any system of internal control must be adaptable to changes in the business, operational and regulatory environment to meet new and rapidly changing business models, greater use of and reliance on technology, increasing regulatory requirements and audits, globalisation, and other obstacles [2].

The change in insurance's digital experience is merely a portion of the revolution brought about by InsurTech. "Data science," "big data," and "AI" (including machine learning methods such as deep

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learning) began as buzzwords in actuarial science. The concept of exploiting non-traditional data and sophisticated analytics is now widely accepted and viewed as a necessary component of InsurTech.

InsurTech incorporates cutting-edge hardware, software, and user interfaces to address inefficiencies or opportunities in the insurance value chain, which frequently includes technology, data, and analytics [3]. InsurTech targets the evolution/disruption of:- (a) the interaction between insurers and their customers; (b) the automation of processes; and (c) the modification of old or creation of new insurance products [3].

Through the term "InsurTech" is frequently used in conjunction with "InsurTech startups," it encompasses much more; it may refer to an "ecosystem of focused, innovation-driven enterprises." [4]. By defining InsurTech as the intersection of industry specificity and maturity, we can provide a context for the concept [5]. At one end of the industry specificity spectrum, technology solutions can be deployed broadly across different industries, whereas, at the other end, there is a focus on a single insurance product. We observe businesses in terms of maturity ranging from startups to established enterprises that have offered or used technology solutions for decades.

Despite the recent global emergence and application of the InsurTech industry, the literature on InsurTech's bibliometrics is underexplored both theoretically and empirically. Therefore, we aim to present a comprehensive bibliometric analysis of the current state of research on insurance technology, InsurTech, indexes in Scopus. In particular, we analyse bibliometric features based on publishing year and yearly growth, document type, source type, document language, subject area, keyword analysis, country productivity, authorship, active institution, and citation analysis for InsurTech research. From the study's findings, we ascertain the current state of academic study in the field, which can guide future research. Researchers interested in conducting studies in this discipline can determine which themes have received the most attention and which countries/country groups were used as case studies. This will enable researchers to identify critical themes and gaps in the literature.

The paper is organised as follows. Section 2 describes the development of the recent InsurTech industry. Section 3 discusses the literature on bibliometric investigations in various fields. Section 4 discusses the methodology and data collection for the study. Section 5 presents the findings from the data. Section 6 summarises the findings with recommendations for future research.

2. The Development of InsurTech

To comprehend the evolution of InsurTech, it is important to first examine the origins of FinTech. Initially, InsurTech was classified as a subset of FinTech until activities inside the insurance business were prominent and distinct enough to be classified as a separate "category" from FinTech. FinTech was one of the earliest and most well-known members of "EverythingTech" – a family of "-Tech" terms that evolved on the internet [6]. It is a combination of the words "Financial" and "Technology" and refers to the boom in financial services technology innovation that began in the early 2000s and acquired considerable traction around 2014, according to Google Trends. The advent of InsurTech followed a similar pattern – albeit with a two-year lag in terms of internet search attention (see Figure 1).

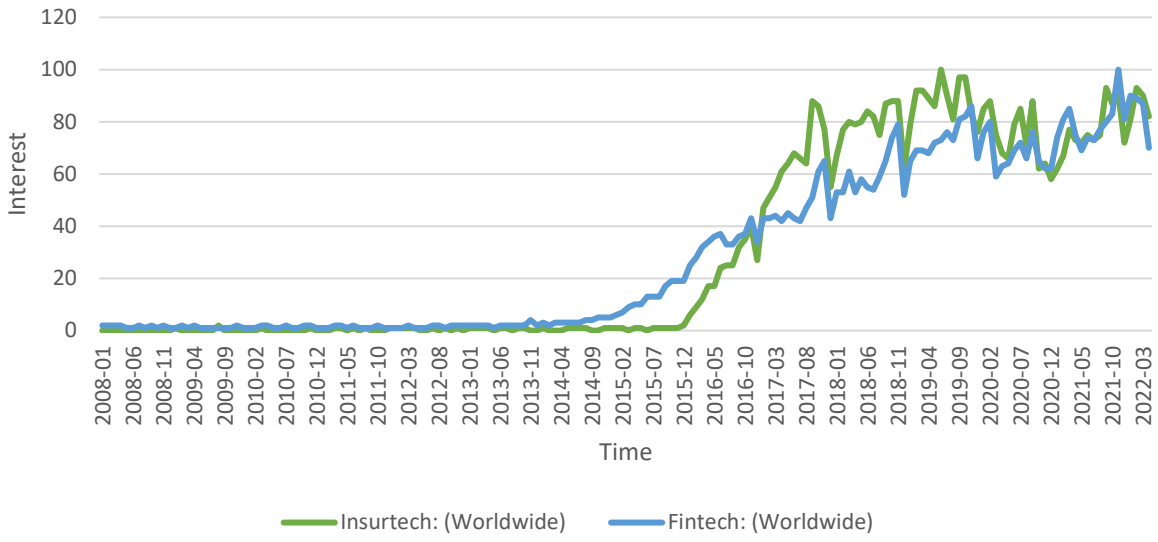


Fig. 1. January 2008 - April 2022 global google trend [7]
Note: Numbers represent global search interest at a given time. A rating of 100 represents the term's highest popularity. A score of 50 indicates that the term is half as popular. A score of 0 indicates that there is no interest in the term.

The phrase “InsurTech” first appeared in the early 2010 and gained widespread adoption by 2015 [3]. We examine InsurTech’s quick growth via the lens of several different indicators, such as historical trends in InsurTech funding, the establishment of numerous InsurTech focused incubators and accelerators, and InsurTech related partnerships with incumbent corporations. Figure 2 shows the Google Trend and Insurtech by country from 2008 to 2021.

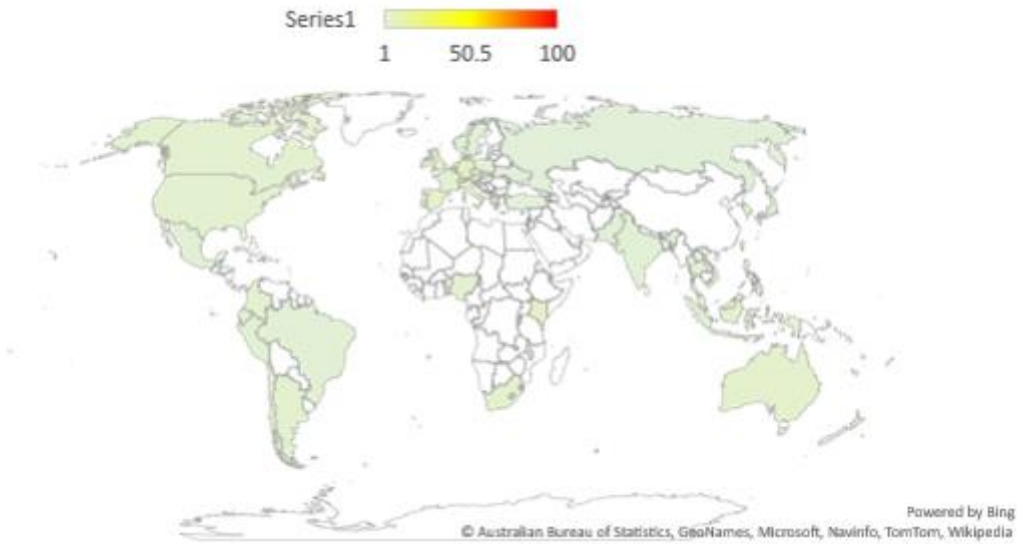


Fig. 2. 2008 – 2022 global google trend by country on InsurTech [7]
Note: Numbers represent global search interest at a given time. A rating of 100 represents the term's highest popularity. A score of 50 indicates that the term is half as popular. A score of 0 indicates that there is no interest in this term.

Since 2012, according to Willis Towers Watson's fourth-quarter 2020 Quarterly InsurTech Briefing, global funding for InsurTech startups has increased dramatically, from $348 million in 2012 to $7.1 billion in 2020. The number of transactions has increased by over 700%, from 46 in 2012 to 377 in 2020 [8] (see Figure 3).

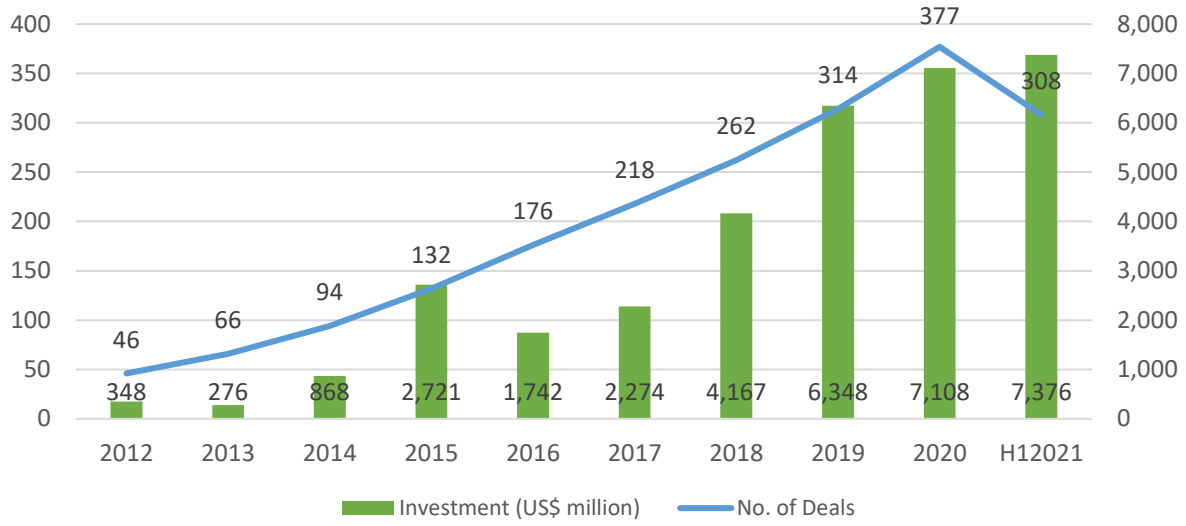


Fig. 3. Annual InsurTech funding ($ million) against the number of InsurTech deals from 2012 to H12021 [8]

3. Literature Review

3.1 Bibliometric Background

Pritchard [9] established the word bibliometrics, which is "the application of mathematical and statistical approaches to books and other forms of communication." According to Rehn *et al.,* [10], "bibliometrics is frequently employed to evaluate scientific research through quantitative evaluations of published research." Bibliometric analyses are based on the idea that most scientific discoveries and research findings are ultimately published in peer-reviewed international journals that can be referenced by other researchers.

Bibliometric analysis began with Eugene Garfield's 1964 Science Citation Index, 1973 Social Science Citation Index, and 1978 Arts & Humanities Citation Index [11]. The opportunity to generate modern bibliometric research began with innovation in evaluating scientific performance.

Bibliometric studies are frequently used to assess the number and quality of published papers to detect trends or patterns in a particular field of study [12]. Bibliometric analysis is gaining prominence in reporting the trends and impact of research [13]. According to Ahmi and Mohamad [13], bibliometric indicators most often include publication classification, citations, authorship, publication impact, and country.

We conduct a bibliometric analysis of papers on SCOPUS related to InsurTech. According to Baas *et al.,* [14], Scopus is a curated database, indicating that content is selected for inclusion in the database following a stringent process: serial content (i.e., journals, conference proceedings, and book series) submitted for possible inclusion in Scopus by editors and publishers is evaluated and chosen based on scientific quality and rigour. This process is carried out by an external Content Selection and Advisory Board (CSAB) comprising editorially independent scientists and specialists in their respective domains. This ensures that only high-quality curated information is indexed in the database, which underlines Scopus's credibility. In addition, Scopus is a curated database based on

rigorous capturing procedures, publisher agreements, and technical infrastructure to ensure comprehensive, accurate coverage of the serial content once the CSAB has selected it.

Bibliometric approaches statistically explain scientific communication by constructing a framework for a field of study and identifying central themes and existing linkages, e.g., through clusters and networks [15]. The purpose of both networking and clustering is to provide insight into the structure of a network; bibliometric and scientometric investigations frequently combine the two approaches. When a networking strategy and a clustering technique are used in the same analysis, it is often preferable that the techniques adhere as closely as possible to comparable principles [16]. This increases the analysis's clarity and helps to avoid excessive technical complexity. In addition, methods based on comparable concepts can avoid conflicts between results obtained by different procedures. A thorough examination of the trajectory of research will aid the critical assessment of the various facets of the scientific landscape inherent in InsurTech.

3.2 *Bibliometric Studies in the Insurance Industry*

The rapid growth of bibliometric research may have been overestimated; hence, it is important to assess recent trends in bibliometric research activity using established literature databases. Milanovic *et al.,* [17] study was the first bibliometrics research on InsurTech. The authors summarise the statistics on journals by topic, author(s), year of publication, size, method, and application of InsurTech. However, the authors did not analyse the source type, type of publications, language, keyword analysis, keyword co-occurrence, and detailed citations of the related publications. Keyword analysis can identify both current and historical research trends. Bibliometric keyword analysis can provide answers to a number of intriguing questions, including

i. What are the most frequent/popular research topics in this journal?;
ii. Are specific keywords associated with an increased likelihood of a cited paper?;
iii. Has the use of specific keywords increased or decreased over time? [18]

Co-word, co-citation, and co-author analyses are gradually becoming the most popular methodologies in scientometrics because they play an increasingly essential role in numerous domains [19]. A co-word network often focuses on the structure of communication of knowledge. It is very helpful in offering an overview of interdependencies between topics.

In addition to bibliometric research on InsurTech, a few bibliometric studies on insurance research have been previously done (see Table 1). These studies established a significant cumulative rise in insurance research as of April 2022. Overall, there is a lack of InsurTech's bibliometric analysis in the current literature. Therefore, we provide an in-depth and up-to-date InsurTech research review that will enable researchers to identify gaps in the literature and critical themes so guiding future studies to more explore promising research fields.

Table 1
Bibliometric studies on insurance

No.	Authors/Year	Title	Domain/Search Strategy	Data Source	Bibliometric Indicator
1.	Nobanee *et al.,* [20]	Green and sustainable life insurance: A bibliometric review	Various keywords related to "sustain", "green", and "insurance"	Cambridge online database	• most interesting journals, countries, authors, subject areas, and organisations • articles by year • cluster analysis
2.	Nobanee *et al.,* [21]	Sustainable medical insurance: A bibliometric review	"sustainab" and "health insurance", "sustainab" and "medical insurance" with a few limited keywords and language.	Scopus	• most prominent journals, authors, articles, countries • bibliographic coupling on keywords analysis • cluster analysis
3.	Syed and Bawazir [22]	Recent trends in business financial risk – A bibliometric analysis	"Financial", "risk", and "business"	Web of Science	• most prominent journals, authors, articles, countries • collaboration among authors and countries • co-occurrence analysis between authors, keywords and journal cluster analysis and thematic analysis
4.	Nobanee *et al.,* [23]	Why do insurance companies use ambiguous language in their policies? A bibliometric review	"insurance" and "ambiguity"	Scopus	• number of publications • articles by citation analysis • the author(s) who contributed to this search literacy • authors ranked by the number of citations • affiliated with the authors • countries of the corresponding authors • keywords ranked by occurrences • cluster analysis
5.	Khan *et al.,* [24]	A bibliometric review of takaful literature	"Takaful", "Islamic insurance", "Insurance and Islamic finance", "Islamic mutual insurance", and "Islamic cooperative insurance."	ISI – Web of Knowledge	• co-citation analysis • citation analysis • co-authorship analysis • content analysis.

No.	Authors/Year	Title	Domain/Search Strategy	Data Source	Bibliometric Indicator
6.	Sung *et al.,* [25]	Two decades of research using Taiwan's national health insurance claims data: Bibliometric and text mining analysis on PubMed	"insurance, health", "national health programs", "nationwide", "population", "health insurance," "national insurance," "claims data*," "claim data*," "insurance claim*," "insurance data*," "administrative data*," "nationwide data*," "national data*," "NHIRD," "LHID," "NHI," and "BNHI."	PubMed	• publication amount • journals, research topics and types • cooperation between authors.
7.	Anderloni *et al*., [26]	Governance and performance in insurance companies: A bibliometric analysis and a meta-analysis	"performance", "governance", and "insurance".	Scopus and WoS	• co-authorship analysis • relationships between ownership and other terms • regression between variables

4. Methodology

Bibliometric analysis comprehensively assesses publications on a given subject or area from a quantitative, objective standpoint [27–30]. Bibliometric analysis aims to evaluate studies' quantifiable methodologies in light of their qualitative categories [31]. Bibliometric studies are recognised as a significant tool for evaluating studies in the social sciences. They enable the description of the dynamics and direction of publications in developing research fields and the evolution a field through time [32].

The data for this study are from the Scopus database as of April 21, 2022. The following keywords are used to find relevant articles on InsurTech: "insurtech" or "insurance technology" or "insurance technologies" or "technology insurance" or "technologies insurance" or "internet insurance" or "internet insurances" or "insurance big data" or "insurances big data". We concentrate on papers' titles, keywords and abstracts because they convey important information about the research area and the study's objectives. Chen [33] reveals that a paper's title should include information that could draw readers' interest, because it is the first point that readers will notice. A total of 175 papers were retrieved in response to the query, allowing us to undertake a bibliometric analysis. There are several tools accessible for a bibliometric analysis. We used

i. Microsoft Excel to calculate the frequencies of published materials and to design the corresponding chart and graph; and
ii. VOSviewer and the R package to build and display bibliometric networks.

VOSviewer and the R package facilitate the visualisation of bibliometric data, mapping, and establishing relationships between pertinent objects [34]. We use VOSviewer and R package to analyse citations and the co-occurrence the keywords of author(s) to link and map relevant author(s). To create bibliographic maps and networks, we first download the complete records of all relevant papers with the selected keywords from the Scopus database. We then use VOSviewer and the R package to process the raw data. The application generates network visualisations in which a circling representation of a label represents elements. Each label and circle in the network has a size that corresponds to its weight in relation to other elements. The lines on the network map indicate the

connections between important articles. Distances between items represent the strength of their associations; shorter distances indicate the strength of the interactions. Additionally, the circles are coloured to correspond to the clusters into which the relevant objects are sorted. Figure 4 presents the methodology's fundamental steps.

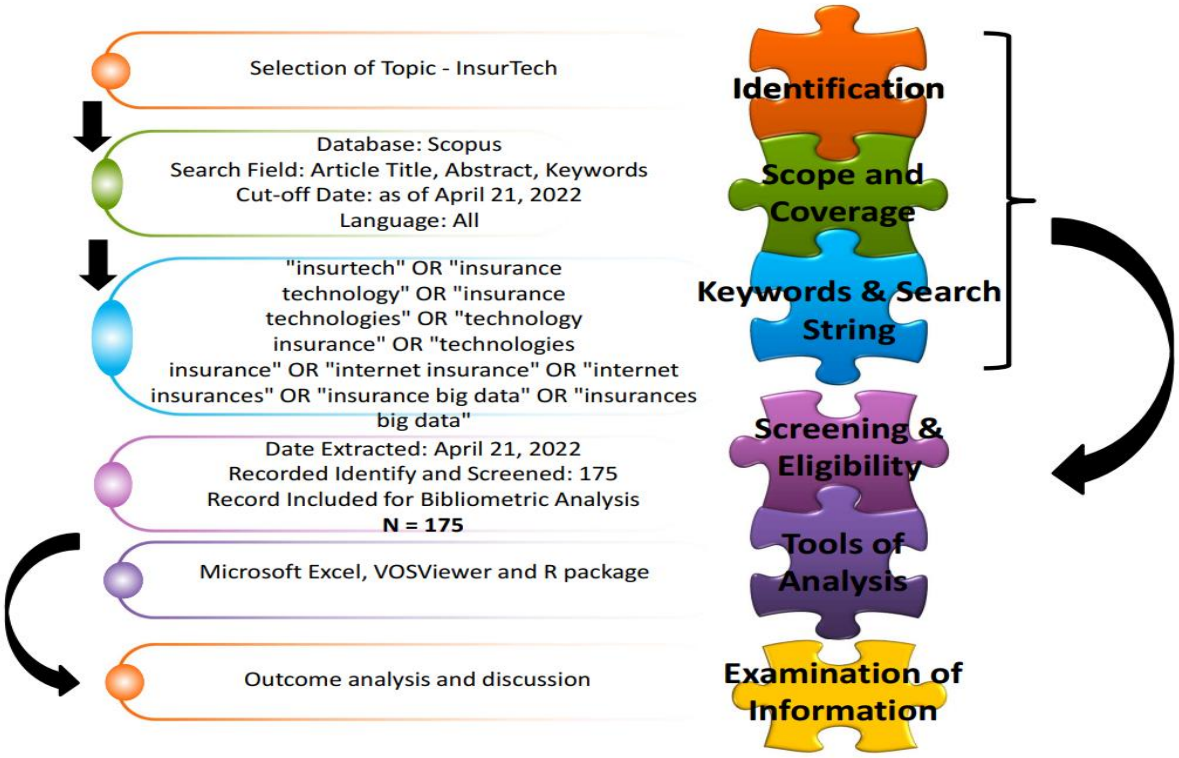


Fig. 4. The research methodology used to extract bibliometric related data from the Scopus database [35]

5. Results

Using the Scopus database, we analyse the bibliometric features of publishing year and yearly growth, document and source type, document language, subject area, keyword analysis, country productivity, authorship, active institution, and citation analysis. The results are presented in frequency and percentage form. We use VOSviewer to map the co-occurrence of the authors' keywords and report citation analysis as citation metrics and the top 10 most referenced articles on InsurTech.

5.1 Publications by Year

The first paper on InsurTech by Gutzwiller [36] examined whether insurance companies should finance a low-cost programme (technology) as part of their policies. There has been very little growth in the number of publications devoted to InsurTech, and for several years, there was just that one paper related to the subject until InsurTech gained popularity in 2017. Since then, the annual number of publications on InsurTech has grown substantially. Table 2 summarises the number of publications, percentages, cumulative percentages, and growth percentages of InsurTech papers. Table 2 and Figure 5 show that the greatest number of papers, so far, on InsurTech was in 2021, 43 publications, about a quarter of total paper on InsurTech. The number is projected to increase in 2022, as industry

revolution 4.0 is happening widely. The application of technology in the financial services industry during the Covid-19 pandemic significantly impacted the insurance business. As a result, insurance players started implementing business continuity plans to preserve the supply of core insurance functions, emphasising the delivery of digital services [37-38].

Table 2
Publications by year and the annual growth of InsurTech subject

Year	No. of Published Documents	Percentage (N=175)	Cumulative Percentage	Growth Rate (%)
1978	1	0.57%	0.57%	0.00%
1986	1	0.57%	1.14%	0.00%
1996	1	0.57%	1.71%	0.00%
1997	1	0.57%	2.29%	0.00%
1998	1	0.57%	2.86%	0.00%
1999	1	0.57%	3.43%	0.00%
2002	1	0.57%	4.00%	0.00%
2003	7	4.00%	8.00%	600.00%
2005	1	0.57%	8.57%	-85.71%
2007	4	2.29%	10.86%	300.00%
2008	3	1.71%	12.57%	-25.00%
2009	3	1.71%	14.29%	0.00%
2010	4	2.29%	16.57%	33.33%
2011	5	2.86%	19.43%	25.00%
2012	2	1.14%	20.57%	-60.00%
2013	3	1.71%	22.29%	50.00%
2014	3	1.71%	24.00%	0.00%
2015	1	0.57%	24.57%	-66.67%
2016	2	1.14%	25.71%	100.00%
2017	9	5.14%	30.86%	350.00%
2018	18	10.29%	41.14%	100.00%
2019	12	6.86%	48.00%	-33.33%
2020	39	22.29%	70.29%	225.00%
2021	43	24.57%	94.86%	10.26%
2022	9	5.14%	100.00%	-79.07%
Total	175	100.00%		

5.2 Documents by Source and Type

We analyse the documents extracted from the Scopus database using the document type, source type, and source title. Document type can be a published paper, a conference paper, a review, a book, a book chapter, an editorial or other. Figure 5 summarises the document type analysis. Published papers account for over half (54.86%) of InsurTech papers, followed by conference papers (26.86%), and books and book chapters (7.43%).

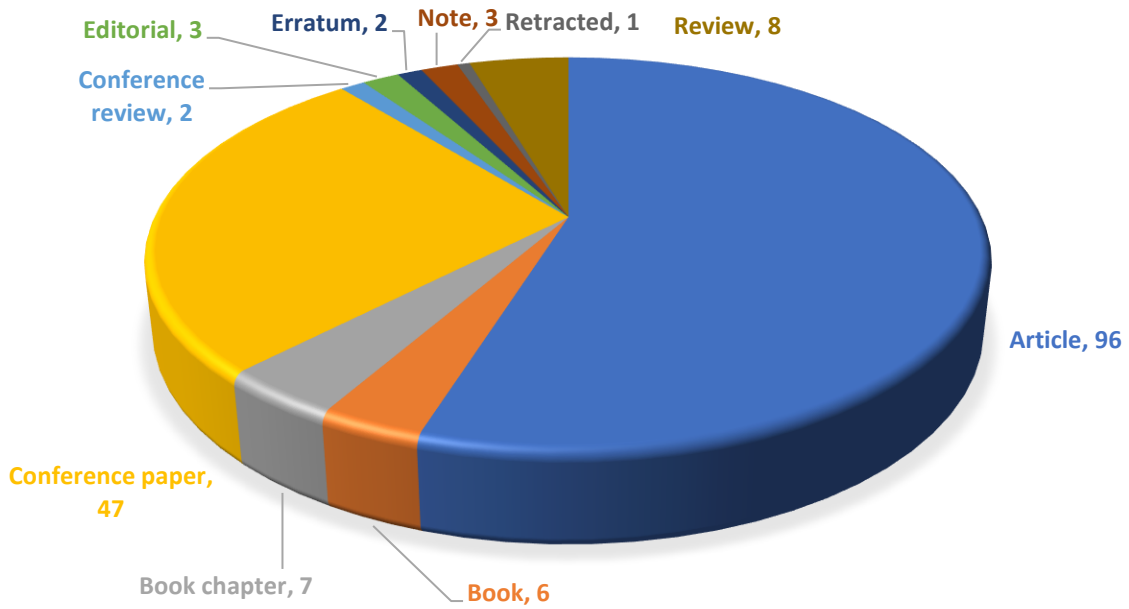


Fig. 5. The distribution of type of published paper on InsurTech

Although there are many different types of published paper on InsurTech, several source-type categories can be identified. Table 3 shows the published journals with total citations according to source type.

Table 3
InsurTech papers by source type

Source Type	No. of Published Documents	Percentage (N=175)	Total Citation by Source Type	Percentage (N=1,149)
Article	96	54.86	722	62.84
Book	6	3.43	32	2.79
Book Chapter	7	4.00	26	2.26
Conference Paper	47	26.86	313	27.24
Conference Review	2	1.14	-	0.00
Editorial	3	1.71	6	0.52
Erratum	2	1.14	-	0.00
Note	3	1.71	-	0.00
Retracted	1	0.57	1	0.09
Review	8	4.57	49	4.26
Total	175	100.00	1,149	79.36

Table 4 lists the top 10 papers based on the source type and number of citations. The top-cited journal article is *An ensemble random forest algorithm for insurance big data analysis* by Lin *et al.,* [39]. The authors use "big data" to analyse the possibility of customers using parallel computing capabilities and memory-caching mechanisms to improve product marketing accuracy compared with the standard artificial technique. The authors obtain information on the insurance industry from China Life Insurance Company. The conference paper, *Secure or insure? A game-theoretic analysis of information security games* by Jens *et al.,* [40] is the most cited article from the 17th International Conference on World Wide Web, in Beijing, China, April 21 to 28, 2008. Cappiello's [41] book titled *Technology and the Insurance Industry: Re-Configuring the Competitive Landscape* is the most cited source under book, book chapters and trade publications. The book examines the influence of technology in the reconfiguration of insurance market competitiveness. It discusses the strategic role

of technology in the development and distribution of insurance services and the evolution of customer relationships following the digitalisation of services offered, focusing on the competitive challenges of InsurTech startups to incumbent insurers.

Table 4
The top 10 InsurTech papers by source type and total citations

Source Type	Author(s)	Title	Total Citations
Journal	Lin *et al.,* [39]	An ensemble random forest algorithm for insurance big data analysis	121
	Marsal-Llacuna [42]	Future living framework: Is blockchain the next enabling network?	81
	Stoeckli *et al.,* [43]	Exploring characteristics and transformational capabilities of InsurTech innovations to understand insurance value creation in a digital world	40
	Wing *et al.,* [44]	New insights into US flood vulnerability revealed from flood insurance big data	39
	O'Malley and Hutchinson [45]	Reinventing prevention: Why did 'crime prevention' develop so late?	36
	Lehtonen and Liukko [46]	The forms and limits of insurance solidarity	33
	Mahesh *et al.,* [47]	A decision table for the cloud computing decision in small business	23
	Bohnert *et al.,* [48]	Digital agendas in the insurance industry: the importance of comprehensive approaches	22
	Elliott [49]	'Scarier than another storm': values at risk in the mapping and insuring of US floodplains	22
	Kim *et al.,* [50]	The correlation of comorbidities on the mortality in patients with COVID-19: An observational study based on the Korean national health insurance big data	19
Conference Papers	Jens *et al.,* [40]	Secure or insure? A game-theoretic analysis of information security games	165
	Fultz and Grossklags [51]	Blue versus red: Towards a model of distributed security attacks	38
	Pal and Golubchik [52]	Analysing self-defence investments in Internet security under cyber-insurance coverage	18
	Styer *et al*., [53]	Factors associated with the use of elective single-embryo transfer and pregnancy outcomes in the United States, 2004–2012	16
	Marafie *et al.,* [54]	Proactive fintech: Using intelligent IoT to deliver positive insurtech feedback	13
	Lin *et al.,* [39]	An ensemble random forest algorithm for insurance big data analysis	13
	Mustafina *et al*., [55]	Digital technology in insurance	10
	Bi *et al.,* [56]	DCDIR: A deep cross-domain recommendation system for cold-start users in insurance domain	9
	Marsal-Llacuna and Oliver-Riera [57]	The standards revolution: Who will first put this new kid on the blockchain?	9
	George and Changat [58]	Network approach for stock market data mining and portfolio analysis	6

Source Type	Author(s)	Title	Total Citations
Book, Book Chapter and Review	Patel [59]	Imagining risk, care and security: Insurance and fantasy	21
	Cappiello [41]	Technology and the insurance industry: Re-configuring the competitive landscape	18
	Yan *et al.,* [60]	InsurTech and FinTech: Banking and insurance enablement	14
	Mahesh *et al.,* [47]	A decision table for the cloud computing decision in small business	10
	Lee *et al.,* [61]	Korea heart disease fact sheet 2020: Analysis of nationwide data	10
	Lee and Deng [62]	Handbook of blockchain, digital finance, and inclusion, volume 1: Cryptocurrency, fintech, insurtech, and regulation	8
	Nobanee [63]	A bibliometric review of big data in finance	7
	Browne [64]	Technology, fertility and public policy: A structural perspective on human egg freezing and gender equality	6
	Gupta and Tham [65]	Fintech: The new DNA of financial services	5
	Bukhtiarova *et al.,* [66]	Modelling of FinTech market development (on the example of Ukraine)	3
	Pressman [67]	Insurance technology strategy: Time to re-evaluate	2

5.3 Source Title

InsurTech papers are published in a variety of journals, conferences, and books. Table 5 lists the top source titles of published InsurTech papers based on a minimum of two publications in a source title. The Geneva Papers on Risk and Insurance: Issues and Practice has, at 12, the most papers on InsurTech.

Table 5
Top InsurTech papers by source title

Source Type	Total Publications	% (N=175)
Geneva Papers on Risk and Insurance: Issues and Practice	12	6.86
Acm International Conference Proceeding Series	6	3.43
Lecture Notes in Networks and Systems	6	3.43
Risks	5	2.86
Advances in Intelligent Systems and Computing	3	1.71
Proceedings of the 32nd International Business Information Management Association Conference Ibima 2018 - Vision 2020: Sustainable Economic Development and Application of Innovation Management from Regional Expansion to Global Growth	3	1.71
Sustainability (Switzerland)	3	1.71
Technological Forecasting and Social Change	3	1.71
Trustee : The Journal for Hospital Governing Boards	3	1.71
Cybernetics and Information Technologies	2	1.14
European Business Law Review	2	1.14
Handbook of Blockchain Digital Finance and Inclusion Volume 1: Cryptocurrency Fintech Insurtech and Regulation	2	1.14
Insurance Markets and Companies	2	1.14
Journal of Physics: Conference Series	2	1.14

5.4 Language

Table 6 shows that English is the most used language in InsurTech publications (167; 95.43%); the others languages include Chinese, German, Farsee, Russian and English-German.

Table 6
Languages used in the publication of InsurTech papers

Language	Number of Published Papers	% (N=175)
English	167	95.43
Russian	2	1.14
German	2	1.14
Chinese	2	1.14
Farsee	1	0.57
English-German	1	0.57
Total	175	

5.5 Subject Area

Table 7 categorises the published material by subject area. Nearly half of InsurTech research cover three areas: Computer Science (49, 18.35%), Business, Management and Accounting (41, 15.36%), and Economics, Econometrics, and Finance (32, 11.99%). Other subject areas such as social sciences, engineering, decision sciences, and mathematics have also produced papers on InsurTech.

Table 7
Subject areas covered in InsurTech publications

Subject Area	No. of Published Papers*	% (N=333)
Computer Science	61	18.32
Business, Management and Accounting	56	16.82
Economics, Econometrics and Finance	46	13.81
Social Sciences	35	10.51
Engineering	32	9.61
Medicine	22	6.61
Decision Sciences	22	6.61
Mathematics	13	3.90
Environmental Science	9	2.70
Earth and Planetary Sciences	6	1.80
Psychology	6	1.80
Arts and Humanities	5	1.50
Materials Science	4	1.20
Energy	4	1.20
Biochemistry, Genetics and Molecular Biology	3	0.90
Physics and Astronomy	3	0.90
Agricultural and Biological Sciences	1	0.30
Chemical Engineering	1	0.30
Chemistry	1	0.30
Health Professions	1	0.30
Multidisciplinary	1	0.30
Nursing	1	0.30

**Some journals are categorised in more than one subject area*

5.6 Keyword Analysis

To begin the keyword analysis, we used WordSift (https://wordsift.org) to create a word cloud of author(s)'s keywords. The word cloud output, with a maximum of 100 words and an √n scale setting,

is shown in Figure 6. The figure shows the top 100 words (or portions of keywords) from the InsurTech papers. The size of each word indicates the total number of times the word appears [68]. Apart from the keyword used to search for the paper's title, the word cloud highlights other developing terms such as datum, risk, technology, blockchain, digital and cyber. Despite their minor size, other keywords are significant since they are included in InsurTech studies. It is important to emphasise that the words shown in Figure 6 are trend terms associated with InsurTech research. As a result, we expect that future research on InsurTech will centre on these terms.

Fig. 6. Word cloud of the author(s)'s keywords

A network analysis was developed to elicit information about the papers'content via keyword co-occurrence. This methodology is particularly well-suited to advance a subset of a topic or research field [69-70]. Choi *et al.,* [71] reveal that keywords indexed in published papers and those included in titles and abstracts are critical for identifying relevant themes in a research area.

We use VOSviewer to further analyse author(s)'s keywords for co-occurrence. VOSviewer is a software application that assists in the construction and visualisation of bibliometric networks. Figure 7 presents a network visualisation of the authors' keywords where the colour, size of the circles, font size, and thickness of connecting lines represent the strength of the associations among the keywords [34]. Frequently, related keywords are listed together, as shown by the same colour. For instance, the graphic implies that the red terms insurance market, game theory and financial market, are tightly related and frequently co-occur.

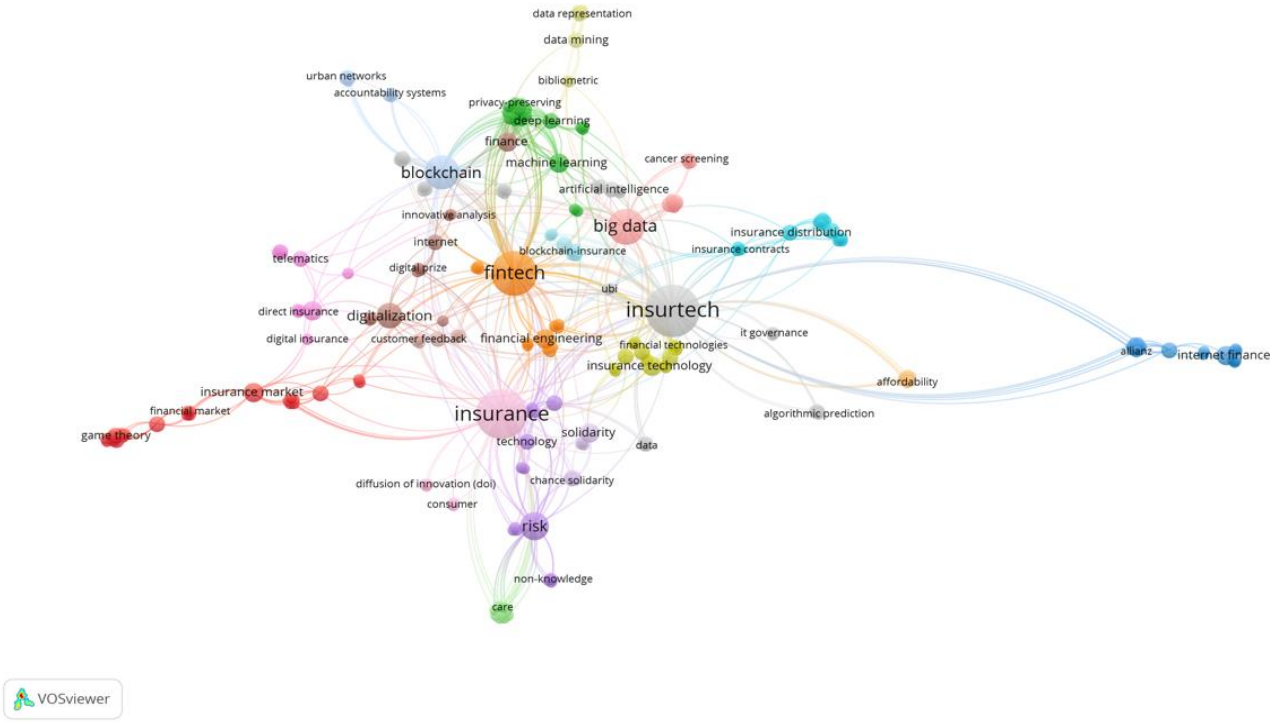


Fig. 7. Co-occurrence analysis of author(s)'s keywords

Keyword co-occurrence analysis examines the relationship between the co-occurrence of terms in a large number of documents to determine the strength of the link in their co-occurrence [72]. The analysis of keyword co-occurrence is based on the number of times a pair of keywords is quoted in the same document; 1,020 keywords were found during this analysis. All keywords that appear in a group of InsurTech papers are analysed to identify a clear representation. The top five keywords with the highest occurrence ratio (OR) and total link strength (TLS) are: insurtech (OR = 21; TLS = 111), insurance (OR = 19; TLS = 99), fintech (OR = 15; TLS = 90), blockchain (OR = 9; TLS = 60), and big data (OR = 10; TLS = 43). Table 8 details the main keywords and their characteristics by co-occurrence and total link strength related to the network.

The size (height of the element on the network) of the nodes [34] representing each keyword and the font size used to write the name of a specific node correspond to the frequency of occurrence of a given term. The most prevalent cluster classified in VOSviewer is a cluster of InsurTech-related concerns (see Table 8). Because of the number of links and their strength, this cluster is the most frequent among those identified that primarily focus on InsurTech. As indicated by the depicted links, the related topic of InsurTech is primarily considered in the context of information technology (IT) and government action, followed by cluster "insurance" and "fintech". Cluster "insurance" is discussed in the consumer group, and the most relevant theory related to InsurTech is "diffusion of innovation". The cluster "fintech" discusses technology structure (financial engineering) in facilitating the financial system and current trends on blockchain

Table 8
The top five most frequent keywords in InsurTech publications and co-occurrences

Cluster	Number of keywords	Main keyword	Max. number of co-occurrence keywords	Max. link strength of keyword	Other top four keywords	Co-occurrence	Max. link strength of keyword
1	92	insurtech	21	111	government arrangement	1	3
					governance	1	3
					decision	1	3
					feedback	1	3
2	78	insurance	19	99	consumer	1	3
					diffusion of innovation	1	3
					electronic services	1	3
					insurtech adoption	1	3
3	72	fintech	15	90	financial engineering	3	15
					financial services	1	6
					blockchain technology	1	5
					emerging trends	1	4
4	54	blockchain	9	60	new urban agenda	1	5
					accountability system	1	4
					adoption mechanism	1	4
					distribution ledger	1	4
5	37	big data	10	43	essemble learning	2	8
					spark	2	8
					random-forest	2	8
					classification algorithms	1	4

Thematic clustering divides a collection of documents into groups whereas clusters are centred on a common topic or theme. Thematic clustering can identify key research areas or help organise a large collection of documents. For example, the R package for bibliometric analysis is used to identify the main themes in InsurTech literature. As discussed in section 4, the papers indexed 935 terms or keywords and 525 author keywords by grouping singular and plural or synonymous phrases. After executing the R package, and a scientific mapping programme with the configured parameters, 15 strategic themes connected to the InsurTech research domain are identified. Table 9 lists the centrality and density of each cluster and the primary documents associated with each cluster. The topics with greater centrality and density are configured as the research domain's engines. "Insurtech," "ai," "peer to peer insurance," "business model," "game theory," and "insurance technology" are among them. The terms "insurance" and "big data", "digital transformation", "internet finance", and "internet insurance" show as fundamental terms and concepts. Thirdly, two fast-developing or isolated themes emerged: "pension industry" and "social insurance," and two rapidly developing or isolated themes emerged: "hypertension" and "insurance contract."

Table 9
Thematic clusters and core documents detected by the R package

Cluster	Quadrat	Centrality	Density	Centrality Rank	Density Rank
insurtech	1	7.73	294.74	31	22
business model	1	0.22	283.33	22	20
peer-to-peer insurance	1	1.49	268.52	26	19
ai	1	1.92	607.14	27	31
game theory	1	0.38	250.00	24	17
insurance technology	1	0.99	250.00	25	17
insurance	2	6.23	211.77	30	15
big data	2	3.51	209.34	28	14
digital transformation	2	3.96	146.91	29	1
internet finance	2	0.06	188.10	18	4
internet insurance	2	0.07	150.00	19	2
social insurance	3	0.00	180.00	9	3
pension industry	3	0.00	200.00	9	9
hypertension	4	0.00	250.00	9	17
insurance contract	4	0.00	290.00	9	21

Given that some labels allocated to various groupings are very broad, their interpretation is expanded to include the set of most representative phrases contained in each and the number of documents in which they appeared (see Figure 8). The motor themes in the first quadrant (Q1) are primarily groupings that contain features and characteristics best suited to the elderly, which is critical for understanding insurance and technology [43,54,66,73-74]. Among the most frequently discussed is "blockchain" [57,71,75-76], "smart contract" [74,75,77], "peer-to-peer insurance" [78-80], "insurance technology" [60,82], "business model" [83-85], and "ai" [81,86-87]. These groups contributed significantly to the development of the domain from its establishment and are still active.

The root and inter subjects are placed in the second quadrant (Q2). They relate to five key topics: "insurance" [43,73,75-77,88-90] and "big data" [39,88,91-94], "digital transformation" [92,95-96], "online finance" [97], and "internet insurance" [98-99]. Among the most prominent groups are those focusing on the use of big data in insurance [93,100-104], such as insurance, digitalisation, innovation, digital technologies and risk, and actions in the field of digital transformation aimed at risk assessment via cloud computing. These themes extend indirectly or transversely through the remaining groupings (Q1, Q3, Q4), complementing the motor themes of the domain, and are crucial for a deeper understanding of the remaining groups.

The emerging or declining themes located in the third quadrant (Q3) are discussed together with the social insurance [93,104] and the pension industry's related characteristics [59,105]. In the final quadrant, highly developed or isolated themes and in-target groups connected to the insurance contract [92,106] and hypertension [107-108] are compiled.

In our study, the insurance contract and hypertension among InsurTech keywords are identified as highly developed and isolated themes. As essential and transdisciplinary themes, we show that insurance and InsurTech are the main keywords discussed by scholars. Considering the number, the subject of game theory is one primary topic in the insurance industry. Finally, the pension industry is categorised as an increasingly forgotten topic in InsurTech. OECD [109] published the new Regulation of Insurance Company and Pension Fund Investment in September 2015 to ensure that assets accumulated to back insurers' and pension funds' obligations to policyholders and/or beneficiaries are handled prudently and in the best interests of policyholders and/or beneficiaries, including quantitative portfolio limits, and market liberalisation, restricting those developments in this study [110] We frequently identified problems with hybrid locations, i.e., those that span two quadrants.

The hypertension (insurance big data) theme, for instance, occupied a spot between emerging or declining themes and highly developed and isolated themes, reflecting the theoretical connections regarding the topic. The need for a shared framework stands between emerging or declining themes and fundamental and transverse themes; insurance and big data stand between motor themes and fundamental and transverse issues.

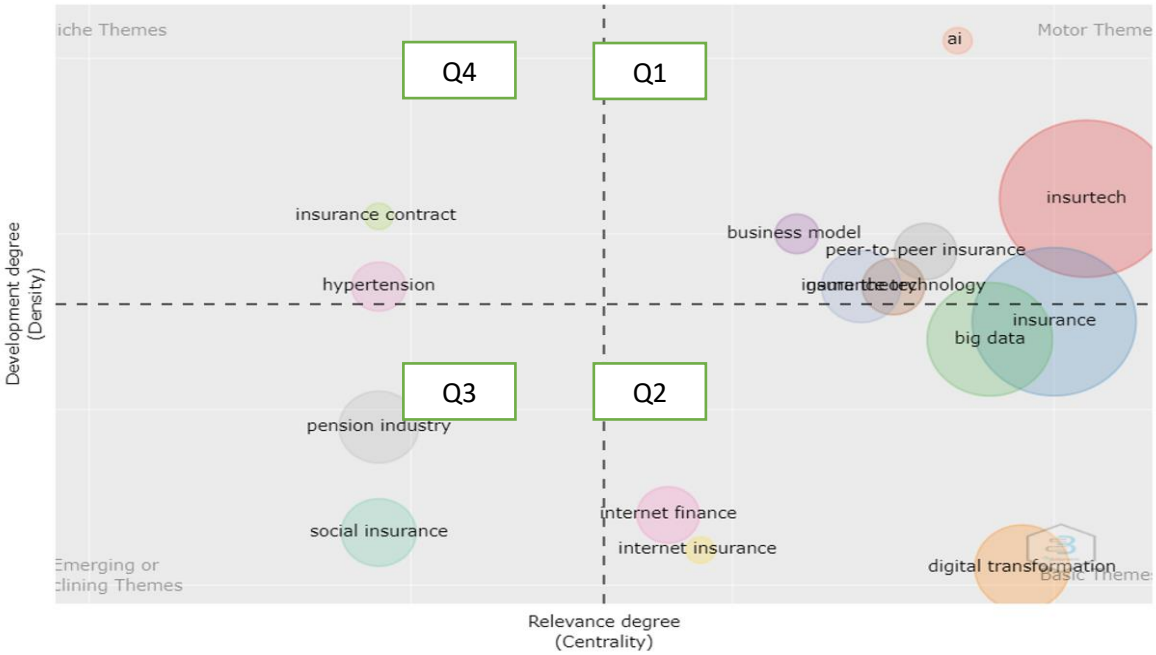


Fig. 8. Matrix diagram depicting the performance of InsurTech research themes

Figure 9, a dendrogram, illustrates the hierarchical link between keywords as a result of hierarchical clustering [111-112]. The figure depicts two lines of study with the colours blue and red. It is used to assign objects to clusters by computing the heights of related objects. The red strand can be separated into three groups, whereas the blue strand consists of only one. Each category represents pertinent concepts and essential terms. According to the findings, the literature flow in InsurTech covered: (1) human well-being in conjunction with innovation in technology; (2) economic and big data; and (3) financial and the use of technology in the insurance industry. The mix of multidisciplinary topics demonstrates that InsurTech is a tool for enhancing various studies through insurance big data.

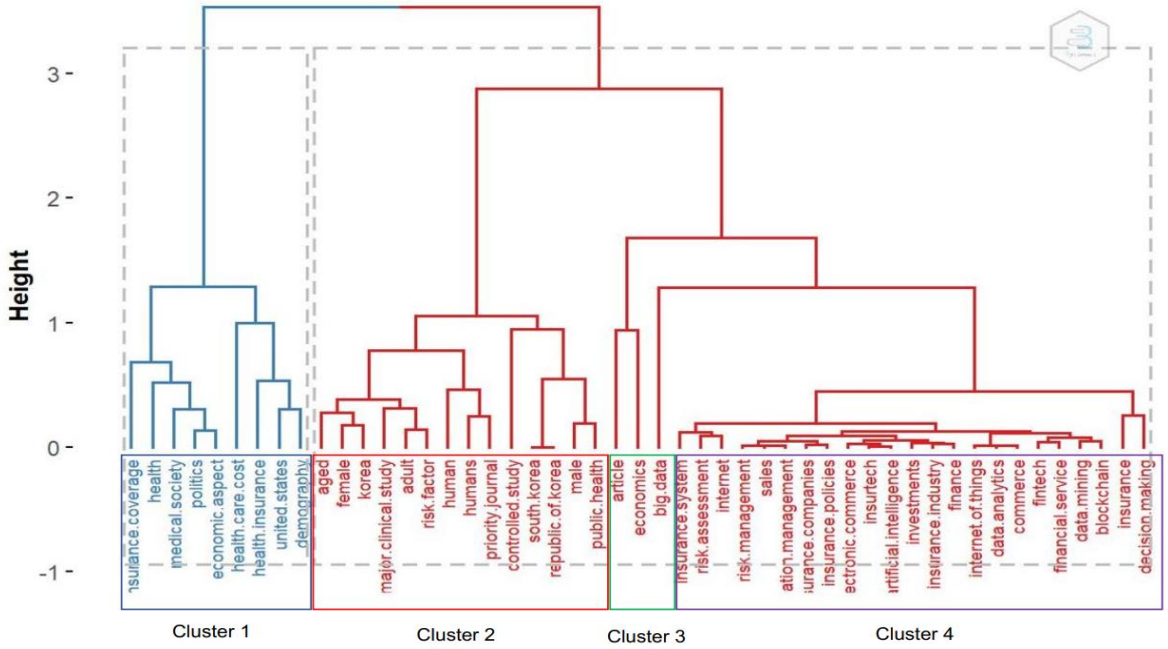
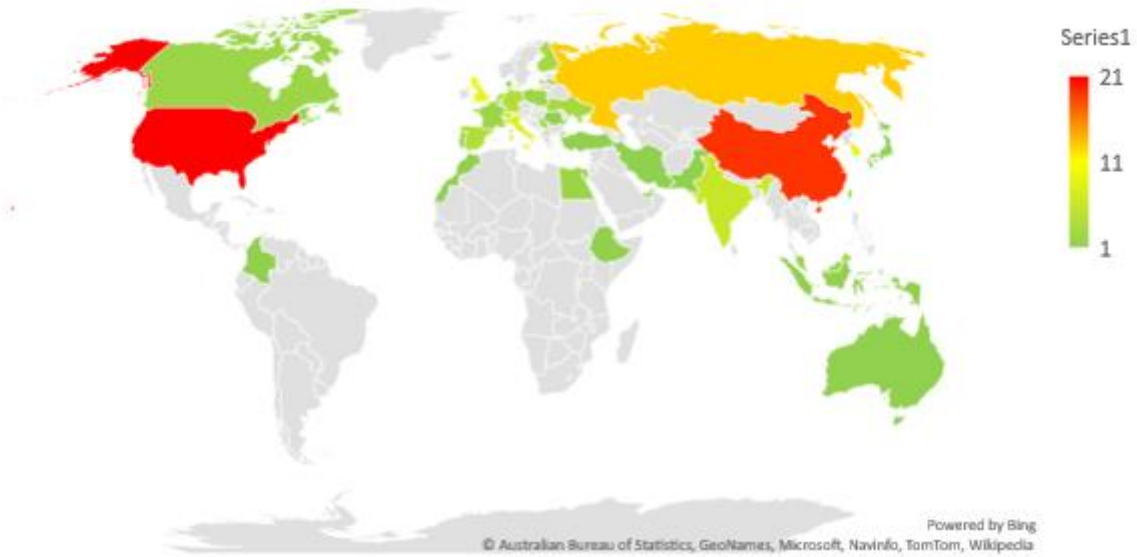


Fig. 9. Topic dendrogram of InsurTech publications

5.7 Geographical Distribution of Publications

Figure 10 shows 39 countries have contributed to InsurTech papers (the country is determined by the author's address). For example, if a paper is co-authored by four authors, two of whom are from the United States and the other two from Malaysia, the United States will be counted as one (1), and Malaysia will be counted as one (1). According to the findings, the United States produced the most publications on InsurTech, followed by China, the Russian Federation, the United Kingdom, South Korea and Italy.



United States	21	Germany	4	France	2	Belgium	1	Liechtenstein	1
China	19	Spain	4	Latvia	2	Colombia	1	Malta	1
Russian Federation	13	Finland	3	Malaysia	2	Denmark	1	Morocco	1
United Kingdom	9	Netherland	3	Poland	2	Ethiopia	1	North Macedonia	1
South Korea	9	Taiwan	3	Serbia	2	Hong Kong	1	Pakistan	1
Italy	8	Ukraine	3	Singapore	2	Indonesia	1	Portugal	1
India	6	Canada	2	United Arab Emirates	2	Iran	1	Romania	1
Switzerland	6	Egypt	2	Australia	1	Japan	1	Turkey	1

Fig. 10. Countries contributing authorship of articles on InsurTech

5.8 Authorship and Author Co-Occurrence

Table 10 shows the number of authors of each paper: 47 (26.86%) of the documents are single-authored, the remainder, 128 (73.14%), are multi-authored publications with the number of authors ranging from two to 17. There are five documents for which the author's name(s) is(are) unavailable or cannot be located in the Scopus database.

Table 10
Number of author(s) per publication on InsurTech

Author count	Frequency	% (N=175)
0*	5	2.86%
1	47	26.86%
2	43	24.57%
3	30	17.14%
4	20	11.43%
5	12	6.86%
6	9	5.14%
7	4	2.29%
8	2	1.14%
9	1	0.57%
> 10	2	1.14%
Total	175	100.00

Figure 11 shows the co-authorship analysis and intellectual structure of InsurTech impact. The size of each cluster indicates the degree to which writers are co-authors and the width of the lines indicates the intensity of the co-authorship interactions.

Based on Figure 11, it is possible to classify four clusters: red, blue, green, and purple are used to distinguish the four subgroups. The purple cluster, consisting of only two bi-univocal co-citations, is deemed an outlier based on its distance from the centre. The first cluster is in red above the centre of gravity; its theme can be summarised as the impact of digitisation in the insurance business. The blue cluster examines innovation in insurance technology and features original research on the application of InsurTech, including studies on mobile phone and automobile insurance. Finally, the green cluster, which evolved beneath the blue one, is defined as macro studies, i.e., market, social, and regulatory topics.

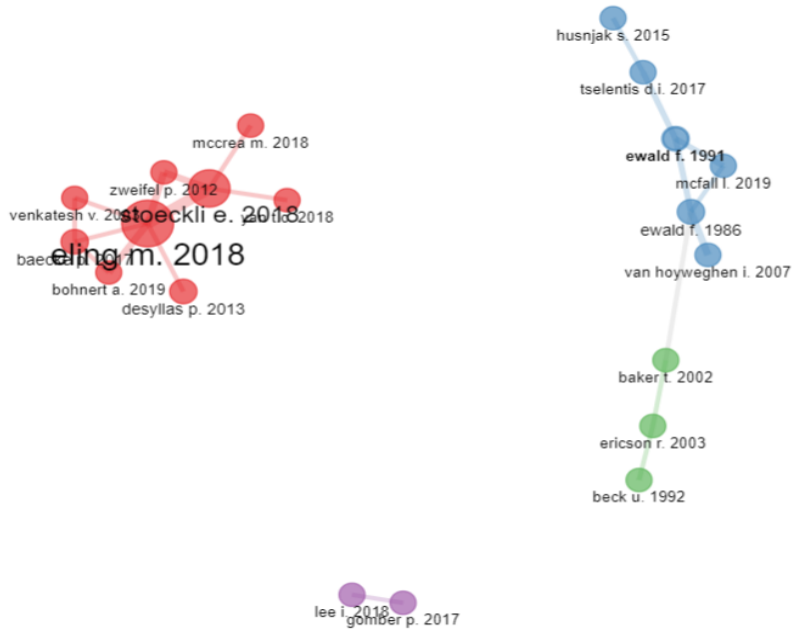


Fig. 11. Co-authorship analysis of papers on InsurTech

5.9 Citation Analysis

Researchers' productivity can also be quantified by the number of citations and citations per year. Table 11 summarises the citation metrics as of April 12, 2022 for the publications retrieved. The table displays the overall number of citations for all retrieved publications and the average number of citations per year. The data in Table 11 show 843 citations registered over 45 years (1978 – 2022) for 175 retrieved publications, with an average of 25.53 citations/year.

Table 11
Citation metrics from InsurTech publications

Metric	Data
Publication years	1978 – 2022
Citation years	45
Papers	175
Citations	1149
Cites/year	25.53
Cites/paper	1.24
Authors/paper	2.46

Table 12 lists the top 10 most referenced publications (based on the number of times cited). Jens *et al.*, [40] publication, " *Secure or insure? a game-theoretic analysis of information security games*", has received the most citations (165 or an average of 11.78 citations per year). However, the most impactful publications in terms of citations per year are the papers by Lin *et al.,* [39], Marsal-Llacuna [42], and Wing *et al.,* [44], which have received 24.20, 20.25 and 19.50 citations per year, respectively.

Table 12
Top 10 most cited journals in InsurTech papers

No.	Author(s)	Title	Cited	Citations /year	Source Title
1.	Jens *et al.,* [40]	Secure or insure? A game-theoretic analysis of information security games	165	11.78	Proceedings of the 17th International Conference on World Wide Web 2008, WWW'08
2.	Lin *et al.,* [39]	An ensemble random forest algorithm for insurance big data analysis	121	24.20	IEEE Access
3.	Marsal-Llacuna [42]	Future living framework: Is blockchain the next enabling network?	81	20.25	Technological Forecasting and Social Change
4.	Stoeckli *et al.,* [43]	Exploring characteristics and transformational capabilities of InsurTech innovations to understand insurance value creation in a digital world	40	10.00	Electronic Markets
5.	Wing *et al.,* [44]	New insights into US flood vulnerability revealed from flood insurance big data	39	19.50	Nature Communications
6.	Fultz & Grossklags [51]	Blue versus red: Towards a model of distributed security attacks	38	2.92	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)
7.	O'Malley & Hutchinson [45]	Reinventing prevention: Why did 'crime prevention' develop so late?	36	2.40	British Journal of Criminology
8.	Lehtonen & Liukko [46]	The forms and limits of insurance solidarity	33	2.75	Journal of Business Ethics
9.	Mahesh *et al.,* [47]	A decision table for the cloud computing decision in small business	23	2.09	Information Resources Management Journal
10.	Elliott [49]	'Scarier than another storm': values at risk in the mapping and insuring of US floodplains	22	7.33	British Journal of Sociology

We next investigate the citation trend and identify the publication theme based on the citations. Co-citation analysis identifies pairs of papers that are cited in the same source paper. When multiple authors cite the same pairs of papers, study clusters begin to form. The papers co-cited in these clusters frequently share the same theme [113]. The co-cited or "core" papers in these clusters have a similar theoretical or methodological, or both, theme [114]. The results from VOSviewwer show four main clusters based on co-citation and references (see Figure 12). The first cluster creates the theme of development (in red) of InsurTech in the insurance industry. This followed by the FinTech

ecosystem (in blue) and the impact of InsurTech (in green). The last cluster creates a theme (in yellow) on a sustainable development goal (SDG) of InsurTech. Table 13 shows the top five citations from each cluster.

Fig. 12. Co-citations and reference cluster on Insurtech

Table 13
Top five "core" papers based on themes cited by InsurTech publications

Theme	Total Citations in the Cluster	Author(s)	Title
Development of InsurTech	36	Barrett *et al.,* [115]	Service innovation in the digital age: key contribution and future directions.
		Hemlata & Gulia [116]	Big data analytics
		Cummins & Venard [117]	Handbook of international insurance: between global dynamics and local contingencies
		Pfeffer *et al.,* [118]	World insurance report 2016: Leading with digital for better customer experience
		Keller and Koetler [119]	A framework for marketing management
FinTech Ecosystem	12	Arner *et al.,* [120]	Fintech and RegTech in a nutshell, and the future in a sandbox
		Gomber & Siering [121]	Digital finance and fintech: current research and future research directions
		Lee & Shin [122]	Fintech: ecosystem business models, investment decisions, and challenges
		Tan *et al.,* [123]	Nurturing a fintech ecosystem: the case of a youth microloan startup in china
		Zachariadis & Ozcan [124]	The API economy and digital transformation in financial services: the case of open banking
Impact of InsurTech	10	OECD [125]	Technology and innovation in the insurance sector
		Desyllas & Sako [126]	Profiting from business model innovation: Evidence from pay-as-you-drive auto insurance
		Dumm & Hoyt [127]	Insurance distribution channels: Markets in transition
		Eling & Lehmann [90]	The impact of digitalisation on the insurance value chain and the insurability of risks
		Mithas *et al.,* [128]	Information technology and firm profitability: Mechanisms and empirical evidence
SDG of InsurTech	10	Arner *et al.,* [129]	The evolution of fintech: A new post-crisis paradigm
		Ba *et al.,* [130]	Balancing it with the human touch: Optimal investment in it-based customer service
		Barrett *et al.,* [115]	Service innovation in the digital age: Key contribution and future directions
		Bitner *et al.,* [131]	Technology infusion in service encounters
		Tan *et al.,* [123]	Nurturing a fintech ecosystem: the case of a youth microloan startup in china

6. Conclusions

We reviewed all scholarly papers on InsurTech published as of April 21, 2022. We report the trends of past studies in the Scopus database using selected bibliometric indicators. That database was used to extract bibliometric information for 175 papers. According to the findings, the study of InsurTech has grown since 2017 and is expected to grown significantly more by 2022. Most papers were published in academic journals and English is the primary language. Through 26.86% of papers are single-authored, the remaining 73.14% had two or more authors. The data also demonstrate that the number of author per paper is increasing with time. The United States has most contributing authors, followed by China, the Russian Federation, the United Kingdom, South Korea, and Italy. Asian countries have made significant contributions to scholarly publications on InsurTech.

InsurTech research topics are primarily derived from business, management, accounting, computer science and economics, econometrics, and finance. Other academic fields, such as social sciences, engineering, decision sciences, and mathematics, are also interested in the topic. Along with increasing the number of publications every year, our analysis shows an increase in the average number of authors per paper. To some extent, this trend indicates more collaboration among authors in the field. The collaboration created four main themes according to co-citation: the development of InsurTech, the FinTech ecosystem, the impact of InsurTech and SDG of InsurTech.

Our findings indicate that the impact of InsurTech on the financial performance of insurance companies and other entities such as insurance brokers, loss adjusters and insurance agents has not been discussed. The analysis of keyword occurrence and paper citations shows that the topic of insurance contracts can be classified as a developing topic to be explored. Therefore, there is potential for future study in this area. InsurTech also plays a role in the development of new insurance contracts. For example, it can be used to create more user-friendly contracts or ones that offer more flexibility. InsurTech could also unite with RegTech to help insurers manage their insurance contracts more effectively. In addition, the requirements of theoretical link of InsurTech with various industries is identified as a potential study topic.

Based on the geographical distribution of publications, we suggest more research on InsurTech in emerging/developing countries is required. A number of factors will determine the success of InsurTech in emerging/developing countries. They include the level of technological literacy among consumers and businesspeople, the availability and quality of data, the regulatory environment, and the overall health of the insurance sector.

Despite the useful insights documented in our study, readers should be aware of it limitations. This study used specified query/keywords to find the initial list of scholars' works published and indexed by Scopus. This method is prevalent in previous bibliometrics-related studies. Although Scopus is one of the most comprehensive online databases for indexing all scholarly papers, it does not cover all available sources. As a result, some omissions from this study are to be expected. Furthermore, no search query is appropriate for gathering all scholarly papers in a field. As a result, false positive and false negative results are expected.

InsurTech is a new terminology that has only recently been developed [125]. There is a probability that previous research on insurance technology centred on the InsurTech topic. However, it was not referred to as InsurTech. Therefore, those studies were excluded from our investigation. Despite these limitations, our analysis provides a starting point for the current global trends in InsurTech research.

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