



Exploring Research Mapping Trends and Innovation in The Takaful Industry

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Abstract

The takaful industry is one of the fastest growing industries and innovations in various areas such as but not limited to product development, business models, digital technology. The purpose of this study is to systematically review the literature, identify key research topics, highlight gaps, and reflect the intellectual structure of takaful research. This research uses bibliometric analysis of the literature using the scientific mapping tool biblioshiny. According to the data collected, Malaysia ranks first in the country with the highest number of authors with more than 100 published articles. The journals with the highest impact are International Journal of Islam and Middle Eastern Finance and Management and Journal of Islamic Marketing, both with an h-index of 10. This study provides valuable information for researchers and policymakers seeking to improve the development and implementation of takaful products and services.

Keywords: Takaful, Islamic insurance, biblioshiny

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1. Introduction

Takaful, an Islamic insurance system, operates on principles of mutual assistance, shared responsibility, and cooperative risk-sharing. It is derived from the Arabic word '*kafala*' meaning '*guaranteeing each other*'. Participants contribute to a common pool of funds, which is then used to support members in need due to specified losses or damages, ensuring compliance with *Shariah* law by avoiding elements like interest (*riba*), excessive uncertainty (*gharar*), and gambling (*maysir*) (Billah, 2007).

From a historical point of view, the development of takaful research dates back to the early 20th century. In 1836, Ibnu Abidin was the first Islamic scholar to define the definition, idea, and legal basis of Islamic insurance contracts. This concept was subsequently recognized in the mid-20th century, especially in the 1970s and 1980s, when the first insurance companies were established in Sudan and the United Arab Emirates (Alam et al., 2023). The modern insurance industry officially developed at the end of the 20th century, with the establishment of the Sudanese Islamic Insurance Company in 1979, marking the beginning of a *Shariah*-compliant insurance product (Khan & Bhatti, 2008). Since its creation, the takaful industry has grown considerably, especially in Muslim-dominated regions such as Southeast Asia and the Middle East. For example, Malaysia has become a pioneer in developing comprehensive regulatory frameworks and fostering an environment conducive to industry growth. This expansion is prompted by a growing awareness of *Shariah*-compliant financial products and a growing demand for ethical financial solutions (Razak & Ismail, 2011).

The growth of takaful research accelerated in the 21st century, with a significant increase in publications on the subject. This surge in research can be attributed to the increasing popularity of Islamic finance and the need for more comprehensive understanding of takaful products and their applications. In terms of current trends, takaful research is focused on various aspects, including the development of takaful products, the efficiency of takaful companies, and the impact of takaful on the economy. There is also a growing interest in

the application of takaful in different regions and countries, particularly in Asia and the Middle East (Alam et al., 2023). Although progress has been made, there is still a significant need for further research in the takaful industry. By applying biblioshiny to takaful research, this study aims to systematically review the literature, identify key research themes, uncover gaps, and visualize the intellectual structure of takaful research. This methodological approach enhances our understanding of the past, present, and future trajectories of takaful research. It enables researchers to analyze publication trends, authorship patterns, citation networks, and thematic evolution within a specific field (Aria & Cuccurullo, 2017).

Based on this background, the author is interested in analyzing the development of research trends and identifying themes and areas of innovation in the takaful industry. This study will provide valuable insights for researchers, and policymakers who seek to improve the development and implementation of takaful products and services. The following are the details of the research questions in this study.

RQ 1: How are the developments and trends of research in the takaful industry?

RQ 2: Along with the evolution of the financial industry, what are the areas of innovation in the takaful/Islamic insurance industry?

2. Literature Review

2.1 Definition and Operations of Takaful

Etymologically, takaful comes from the Arabic word '*kafl*' which means to guarantee, secure, and fulfill someone's needs (Khan et al., 2020). More clearly, takaful can be defined as the process of agreement of a group of people who face certain risks so that each of them contributes to providing compensation to anyone among them for the losses that they will face when the risk occurs, according to the agreement (COMCEC, 2019).

The basic principle of takaful is the concept of mutual assistance and shared responsibility, where participants contribute to a common fund and share the risks and benefits of the fund. In its operation, takaful is based on Islamic principles that do not contain elements of *gharar*, *maisir*, and usury (Alhammadi, 2023). Meanwhile, for its transactions, takaful uses various contracts with various implementation models including *takaful ta'awuni* (non-profit model), *mudharabah* model, *wakalah* model, mixed model (*mudharabah-wakalah*), *wakalah* model with waqf fund, and family takaful (Akhter, 2012).

2.2 Development of Takaful Globally

Modern takaful insurance first started in Sudan in 1979. Its operations must comply with *Shariah* law and operate under the supervision of a Shariah Supervisory Board (Hassan, 2020). Over the past three decades, takaful has grown rapidly, with the market expanding from West Asia and Southeast Asia to Africa and even parts of Europe and North America (Rahman, 2009).

Malaysia is known as the largest takaful market in Southeast Asia and has even contributed greatly to the establishment of regulatory practices in the takaful industry (Lee et al., 2019). Countries such as Saudi Arabia, UAE, and Qatar have well-established takaful markets. Regulatory frameworks and *Shariah* compliance are key factors driving growth in the region (Thanasegaran & Shaiban, 2014). In African countries such as Nigeria and Kenya, their takaful focuses on regulatory frameworks and raising awareness among the population. The takaful window model is popular here, which allows conventional insurance companies to offer takaful products (Alshammari et al., 2021). Even takaful is slowly entering the Western market, driven mainly by the need to serve the Muslim population in the region. The industry faces challenges related to regulatory harmonization and consumer awareness (Rahman, 2009).

3. Methodology

3.1 Methods and Analysis Tools

This study uses bibliometric analysis relying on the biblioshiny scientific mapping tool. Biblioshiny through R programming is used for bibliometric analysis, developed by Massimo Aria from the University of Naples Federico (Huang et al., 2021). Bibliometrix R will import bibliographic databases from Scopus or Web of Science, saved as Bibtext (.bib) or Plain Text (.txt) files (.txt) (Buyamin et al., 2023). Through the biblioshiny quantitative approach, clear and complete research field information will be obtained and effective in identifying the latest topics and leading research trends. Through the database import process, a series of visual maps will be produced that are able to explore document sources, the number of citations in documents, authors,

publication affiliations, author countries, and so on (Wang & Jia, 2023).

To identify the main topics in takaful research, the author uses a content analysis approach supported by the bibliometric software Biblioshiny. The stages of analysis begin with an initial review of the literature from the Scopus database to recognize general patterns and identify dominant topics in takaful research. Topics that are rarely discussed are categorized as potential research gaps. Each stage is repeatedly analyzed to ensure data validity and reliability.

3.2 Sample Selection

The database used comes from Scopus. According to Parlina et al. (2020) Scopus is the largest international database and holds a good academic reputation. In addition, Scopus also provides many research references from various multidisciplinary fields that play an important role in providing perspective in the analysis process (Chin & Chew, 2021; Suprpto et al., 2021). In collecting data, 4 keywords were used including ‘takaful’, ‘islamic insurance’, ‘sharia insurance’, and ‘cooperative insurance’ in TITLE-ABS-KEY to extract the desired literature during the period 1937-2023. Filters were also applied to several options including language, document type and publication type. From this process, 449 final documents were produced that were ready for biblioshiny analysis.

Table 1: Sample selection on Scopus database

Category	Criteria	No. of documents
Keyword and Search String, extracted on 25 May 2024	TITLE-ABS-KEY (“takaful” OR “islamic insurance” OR “sharia insurance” OR “cooperative insurance”)	607
Years	Including all years. Removed article for 2024 (1937-2023)	585
Subject Area	All subject area	585
Document Type	Limiting the documents to Article (433) and Proceedings Paper (50)	483
Language	Limiting to english (461) and indonesian language (1)	462
Publication Stage	Final published only	449
Final documents for Biblioshiny Analysis		449

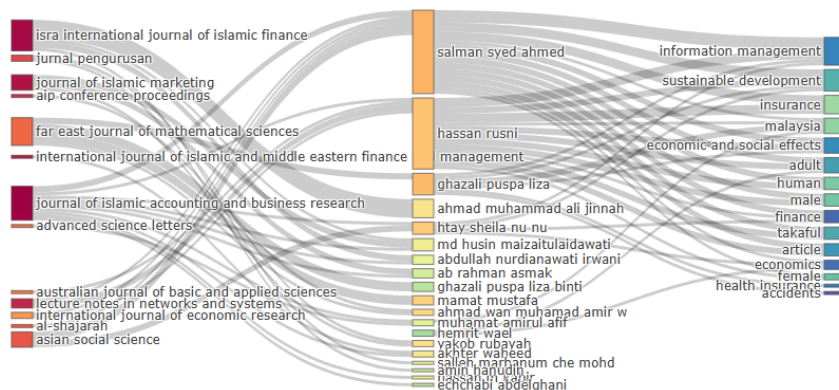
Source: Created by Author, sorted from Scopus database

4. Results and Discussion

4.1 Research Development and Trends Progressed on Takaful Industry

4.1.1. Result Analysis

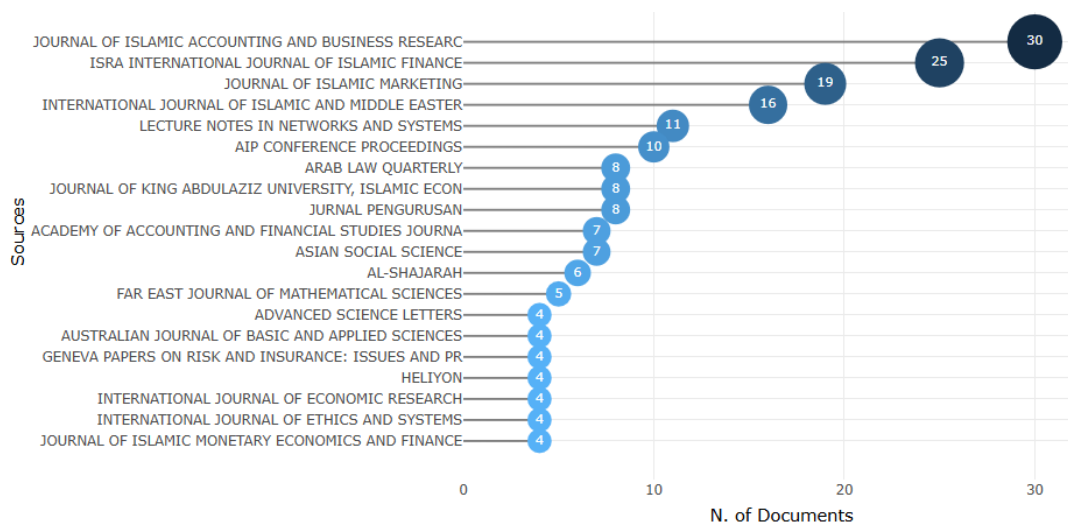
Figure 1: Three fields plot



These findings indicate that most takaful research is published in the *Journal of Islamic Accounting and Business Research*, which has a primary focus on Islamic finance. This shows a reliance among academics on this journal to expand knowledge in takaful, while other journals could be explored to broaden insights further. Additionally, identifying prominent authors such as Salman Syed Ahmed and Hassan Rusni highlights a concentration of knowledge within a specific group of researchers, which could serve as a reference for other researchers to build collaborations or pursue further studies. Thus, these findings not only provide insight into the distribution of literature but also guide strategies for building research and publication networks.

In the middle of the image, there are two elements: the name of the author, with 19 authors associated with the author's name and the theme/topic. The most published author is Salman Syed Ahmed, who publishes themes/topics in the fields of Takaful, Islamic Insurance, *Sharia* and Cooperative Insurance. The next authors who have published most are Hassan Rusni and Gazali Puspa Liza. Finally, the third element explains the subject of research (right data). Each topic is associated with an author who writes a lot about the related topic. Based on the previous image, 15 keywords are listed. Of all the topics that appear, the words information management, sustainable development and insurance appear frequently. This shows that these words are closely related to research into Takaful, Islamic Insurance, *Sharia* and Cooperative Insurance.

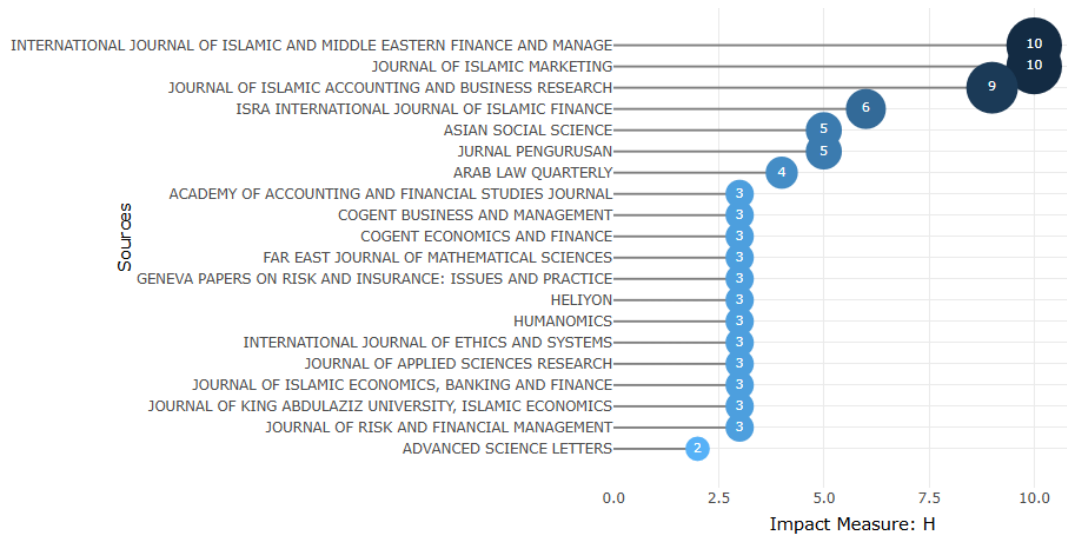
Figure 2: Number of research documents published by journal



The figure above shows the number of research documents published by each journal based on their relevance to the topics of Takaful, Islamic Insurance, *Sharia* Insurance and Cooperative Insurance. The data shows the names of the most frequently published journals and the intervals of documents published in blue circles. The darker the circle, the greater the number and relevance of the research theme, and the number of documents published in all journals is between 0 and 30. The number of publications listed in the most relevant data sources is 20.

Journal of Islamic Accounting and Business Research, which has the largest number of published documents displayed in dark blue circles and circles compared to other journals. This is because the journal is related to the subject of discussion. At the bottom of the journal are 4 publications, with 7 bright blue journals. This shows that there is still a lack of quantity and relevance to the themes of Takaful, Islamic Insurance, *Shariah* Insurance and Cooperative Insurance.

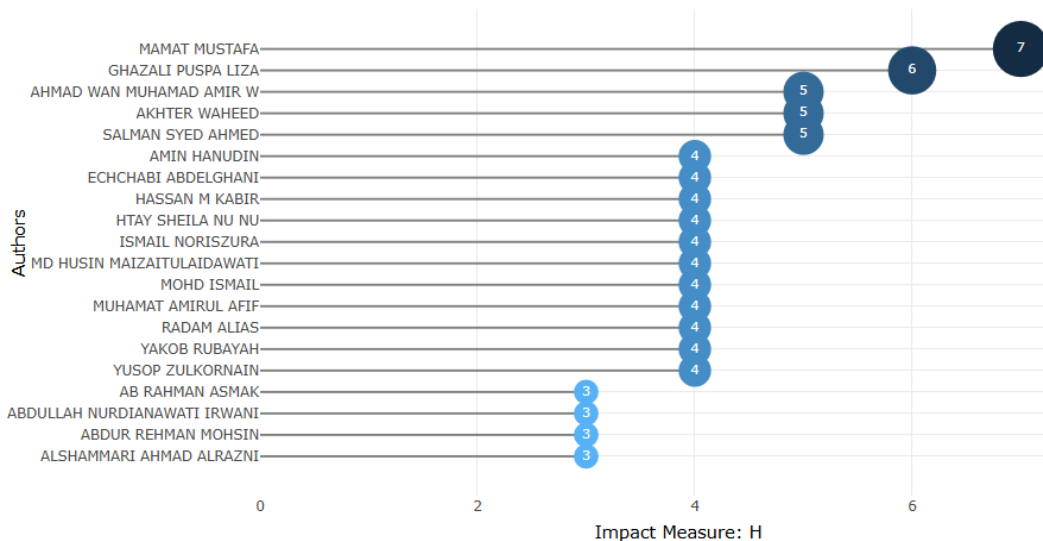
Figure 3: The impact of the publishing journal



Journal calculations can be seen not only from the quantity or relevance of the output. However, this study also shows that each journal whose paper on the topics of Takaful, Islamic Insurance, *Sharia* Insurance and Cooperative Insurance still lacks impact. The calculation is based on the h-index of the journal shown in the blue circle. The darker the blue in the circle, the more impact the magazine has.

The above image shows the Islamic and Middle Eastern Journal of Finance and Management in the top position, with the h-index of 10 on the dark blue circle. Second, the Journal of Islamic Marketing has the same index as the first, 10 points. Both journals have the greatest influence on the themes of research. Meanwhile, the lower-right magazine is Advanced Science Letters, whose h-index is 2 and marked with a bright blue circle. This indicates the low impact of the magazine.

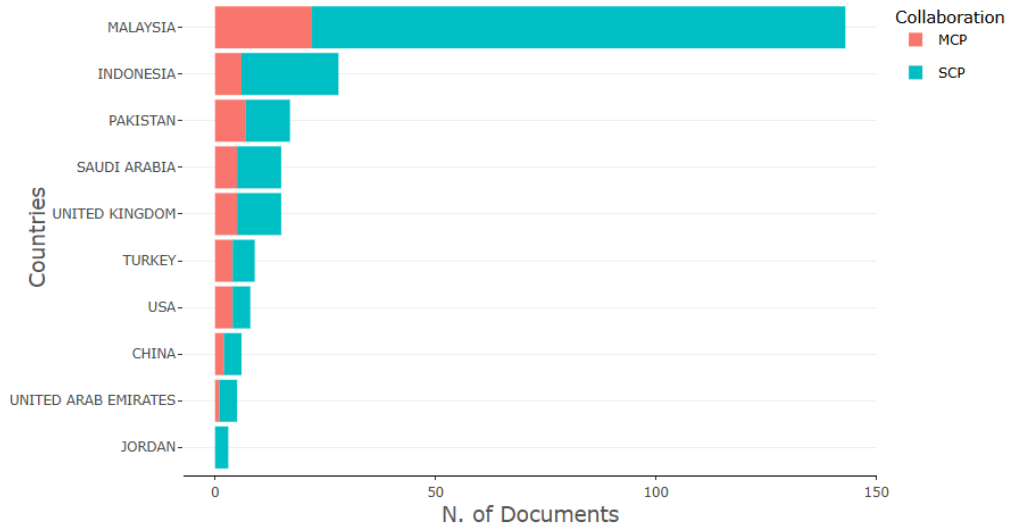
Figure 4: The impact of the authors



Authors who have published their papers can also be classified on the basis of the h-Index-based impact generated. In this study, the value of the h-index is between 0 and 7. The size of the impact is indicated by a dark blue circle above. The above image shows the author with the highest h-index is Mamat Mustafa, with an

h-index of 7 indicating the maximum impact and a dark blue circle. Although the lowest-ranking authors obtained 3 and the lowest impact level were Ab Rahman Asmak, Abdullah Nurdianawati Irwani, Abdur Rehman Mohsin, and Alshammari Ahmad Alrazni.

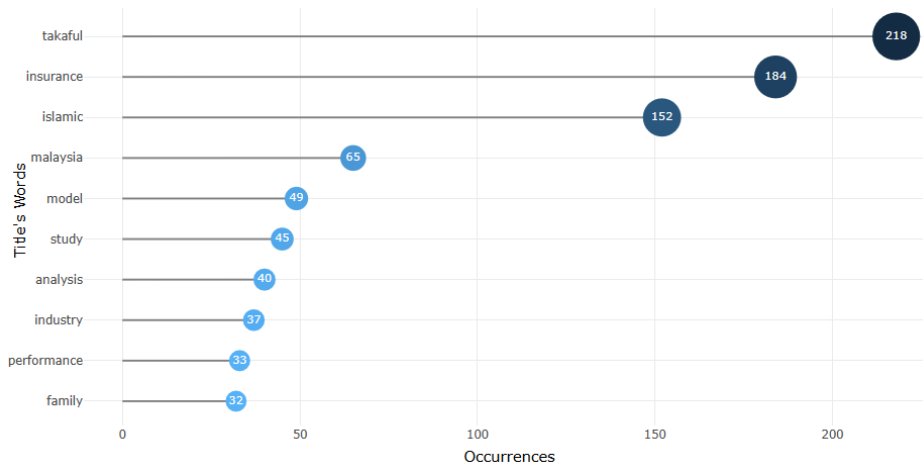
Figure 5: Corresponding author's country



The figure above shows the country of the author's correspondence in each document, and calculates the total form of collaboration between SCP (Single Country Collaboration) or one country, MCP (Multiple Country Collaboration) or several countries. The data show 10 of the leading countries, with a period of document quantity from 0 to over 100 published paper documents covering topics such as Takaful, Islamic Insurance, *Sharia* Insurance and Cooperative Insurance.

The bibliometric analysis results indicate that Malaysia leads in the number of publications and author collaborations related to Takaful research. This is significant as it highlights the academic strength and dominance that can serve as an example for other countries. For instance, policymakers in developing countries could emulate Malaysia's strategies to advance their Takaful industry. These findings also suggest a broader potential for international collaboration to bridge existing research gaps. Indonesia follows with fewer than 50 papers, while Jordan has 3 papers.

Figure 6: Most relevant words



This study also counts relevant words used in the document collection that is the subject of the study. The words displayed range from 0 to 200 times. The word list is marked with blue lines and circles showing the number of times each word is used and its relevance to Takaful, Islamic Insurance, Sharia Insurance and Cooperative Insurance. The most common words that appear in this study are the 218 times used ‘Takaful’, and the top word is marked with dark blue circles that relate to the theme of the study. This shows that the theme of Takaful, Islamic Insurance, Sharia Insurance and Cooperative Insurance is closely related to the words often mentioned. The second word is ‘insurance’, which appears 184 times.

Figure 7: World Tree Map

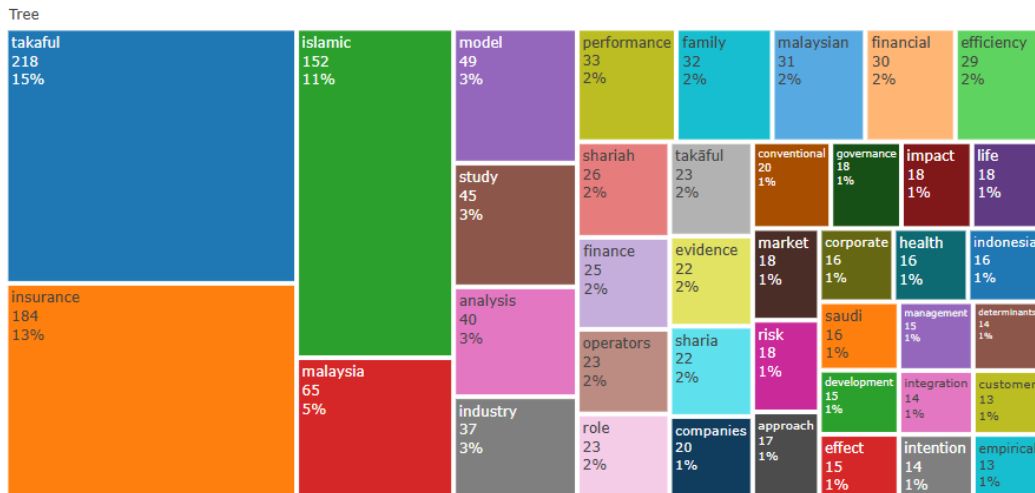
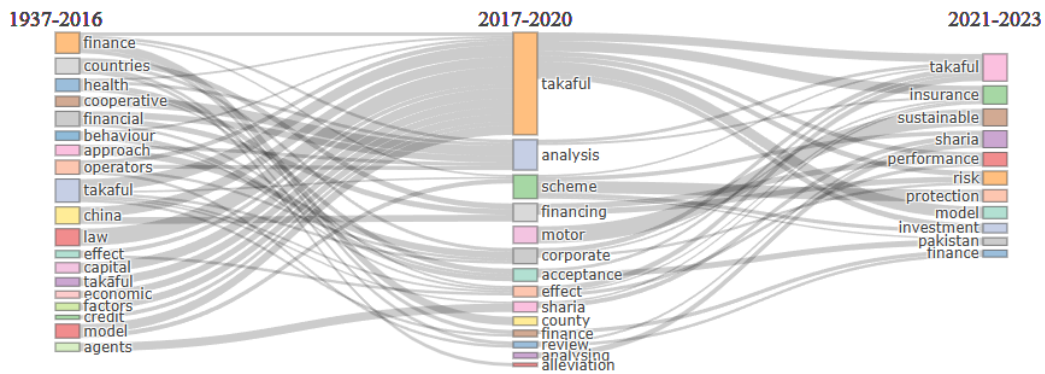


Figure 8: Word Cloud



The above Word Tree Map and Word Cloud are words that frequently appear in a study group related to the subjects of Takaful, Islamic Insurance, Sharia Insurance and Cooperative Insurance. The result displayed is the same as the above image, i.e. the word ‘takaful’ most often appearing. The word ‘insurance’ is second, and the word ‘islamic’ is third. Word Tree Maps show the words commonly used in boxes. The more words appear, the larger the boxes that appear. Word Clouds show words in various sizes. Words are placed randomly, but often used words are displayed in the center and larger sizes. The more frequently used words are used, the larger the word appears in the word cloud.

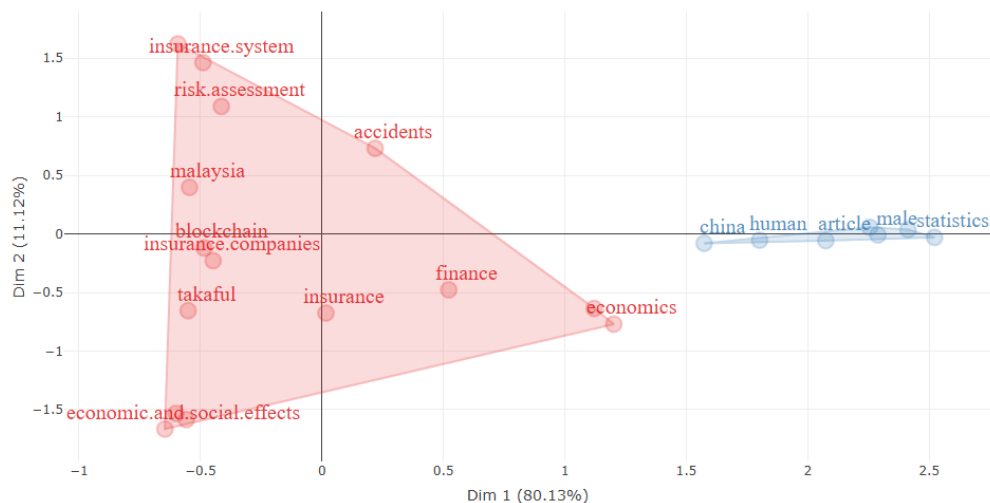
Figure 9: Thematic Evolution



The evolution of the theme can be seen in the image above. The topics used in the research papers have changed over time. The above data show several words that are widely used as sub-themes. On the left are some words that were widely used between 1937 and 2016. There are 19 themes, with boxes of different sizes depending on the number of words used. The theme 'finance' was first, followed by 'countries' and 'health' in second and third places.

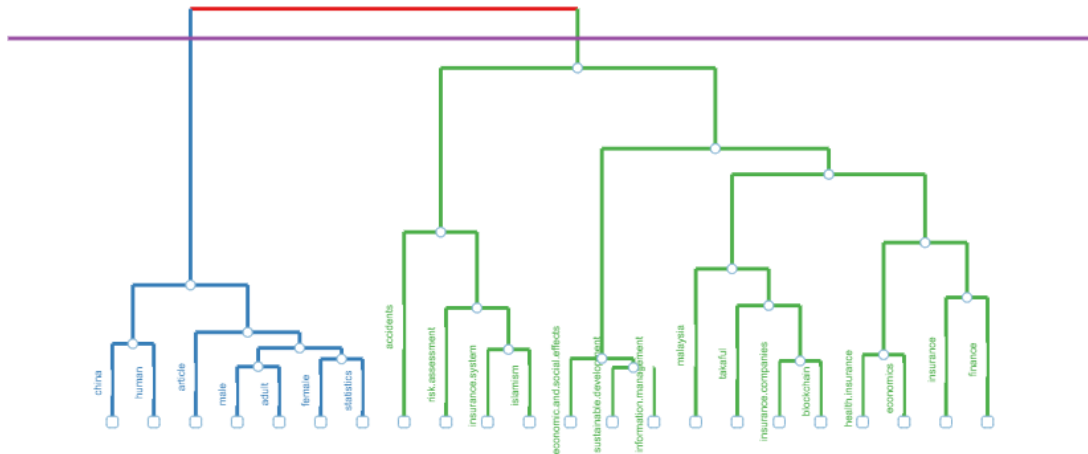
The second part in the middle of the above image shows several themes that are widely used from 2017 to 2020. The themes that appeared during this period were the evolution of the earlier used themes, and were related to the word 'takaful', which evolved from the form of 'finance'. In this section, the most widely used theme is 'Takaful'. The third section on the right of the above picture shows the themes that will be widely used between 2021 and 2023. First, the theme of 'takaful' followed the theme of 'insurance' and 'sustainable'.

Figure 10: Conceptual structure map



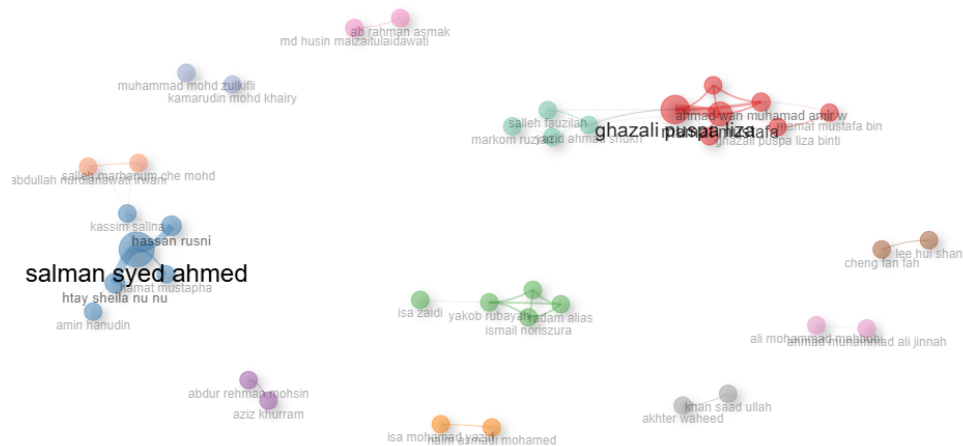
The above image is a conceptual structure map of each word or a contextual structure map that appears frequently in Takaful, Islamic Insurance, Sharia Insurance, and Cooperative Insurance papers. The image above shows two areas, red and blue. Each region contains interrelated words, which can be illustrated by the mapping of the relationship between words through the area map. The red area shows more interconnected words based on the data. This shows that many papers link the words listed in the area.

Figure 11: Dendrogram diagram



The image above is a dendrogram diagram showing the most used topics and their relationships with other topics, as well as the classification of the topics shown in blue and green. This diagram shows the division of the relationship between the elements of a group by data analysis. The diagram above shows that there are two types of topics. This shows that the relationship between the green classification topic and the blue classification topic is similar. Each classification is divided into several clusters, subclusters, etc. Some subjects are part of a group that illustrates the relationship between topics.

Figure 12: Collaboration network



The above image is a network of collaboration between the authors of papers dealing with the topics of Tanakaf, Islamic insurance, Sharia insurance and cooperative insurance. It can be seen that some authors are related and others are not. The relationship between authors can be demonstrated by the existence of similar color groups and lines between names. 11 groups of authors collaborate with each other and two major groups are examined. The first group is blue and the second group is red.

4.1.2. Findings

This study utilizes biblioshiny to perform bibliometric analysis on papers indexed by the Scopus database, linking publication journals, authors, and research themes/topics in takaful, Islamic insurance, sharia insurance, and cooperative insurance. The data reveals that 13 journals predominantly publish papers on the theme of takaful. The Journal of Islamic Accounting and Business Research leads in the number of publications and is

associated with several active authors in this field, such as Salman Syed Ahmed and Hassan Rusni. Among the 19 authors linked to the journal and research topic, Salman Syed Ahmed has the highest number of publications on takaful, Islamic insurance, sharia insurance, and cooperative insurance. The study identifies 15 keyword topics, with the most frequently used being Information Management, Sustainable Development, and Insurance, all of which are closely related to the study.

The number of documents published by each journal is categorized based on the relevance of themes such as takaful, Islamic insurance, sharia insurance, and cooperative insurance. The Journal of Islamic Accounting and Business Research leads in document count, highlighted with dark blue lines and circles. Journal impact is measured using the h-Index, with the International Journal of Islamic and Middle Eastern Finance and Management and the Journal of Islamic Marketing both having the highest h-Index of 10, indicating their significant influence on research in these themes.

Authors are ranked by their impact, as measured by the h-Index. Mamat Mustafa has the highest h-Index of 7. An analysis of author correspondence reveals that Malaysia ranks first, with over 100 papers, followed by Indonesia with fewer than 50 papers, and Jordan with 3 papers. This data highlights the need for increased publications in countries with lower output to enhance research in these areas.

The most frequently occurring and relevant word to the research theme is 'takaful,' appearing 218 times, followed by 'insurance,' which appears 184 times. Word Tree Map and Word Cloud visualizations demonstrate the dominance of these terms in research related to takaful, Islamic insurance, sharia insurance, and cooperative insurance. The theme evolution image indicates that 'finance' was a prevalent theme from 1937 to 2016, while 'takaful' began to dominate from 2017 onwards, continuing to grow through 2023. 'Takaful' ranks first in prominence, followed by 'insurance' and 'sustainable'.

The conceptual structure map highlights two major clusters (red and blue) that depict the relationships between words in the research. The red cluster contains more related words, signifying a higher intensity of research in that area. The dendrogram diagram classifies the research topics into two main groups (blue and green), showing that topics in the green cluster are closely related to those in the blue cluster. The author collaboration network reveals 11 groups of interconnected authors, with the largest groups highlighted in blue and red, indicating the presence of primary collaboration networks within this research field.

4.2. Innovation in The Takaful Industry

Along with the significant progress of Islamic finance, various innovations have been made to meet the increasingly diverse needs of consumers and to keep the Islamic finance industry competitive in the era of economic progress. The takaful industry is one of the industries that has experienced significant growth and innovation in various domains, including product development, business models, and digital technology.

4.2.1. Product Development

The takaful industry provides various products to meet the needs of the community while adhering to Islamic principles. Over time, various new risks have emerged due to technological advances and environmental changes in various sectors. These risks encourage insurance groups to develop new products that are expected to be able to overcome existing new risks (Sharif, 2004). Here are some of the main products and innovation products of the takaful industry that currently exist.

- i. Family takaful is a product that provides financial protection to individuals and their families against various risks such as death, permanent total disability and other unforeseen events. (Ismail & Fisol, 2020).
- ii. Travel is a product that offers travel insurance protection to tourists, as well as providing protection against various travel-related risks, one of which is during the Hajj pilgrimage (Nasir & Rahman, 2022).
- iii. General takaful is a product that provides comprehensive protection for various risks and hazards, including risks to life, health and property (Alnemer, 2012).
- iv. Agriculture takaful is a product that is specifically targeted at the agricultural sector with the aim of providing financial protection to farmers against various risks such as the threat of climate change, natural disasters, diseases, and pest and insect attacks. The existence of agriculture takaful will help ensure the stability and sustainability of agricultural operations (Aziz et al., 2015).

- v. Micro takaful is a type of takaful that focuses on providing financial protection for micro businesses and low-income families. Micro takaful is an alternative to reduce poverty and promote social security networks in lower-level communities (Ahmed, 2016).
- vi. Green takaful is a takaful concept that focuses on environmentally friendly and sustainable practices. Micro takaful aims to promote environmentally friendly investments and reduce the environmental impact of takaful operations. Green takaful encourages investment in renewable energy, energy efficiency projects and other environmentally friendly initiatives, which are in line with global sustainability goals. Specific studies on green takaful are limited, but it is seen as a potential growth area in the takaful industry (Malik & Sulaiman, 2023).
- vii. Funeral takaful is a type of takaful product that provides financial assistance to families in the event of death. This product helps ease the financial burden of funeral costs. This takaful is also an initiation of the micro-takaful type (Muhamed et al., 2020).

4.2.2. Business Model

In the early days of Islam, takaful in society used the concept of ‘*Aqilah*’ (a system of sharing risks) to help each other overcome financial difficulties. This system was implemented in Islamic insurance institutions in 1979 in Sudan with the establishment of the Sudanese Islamic Insurance Company, which is referred to as the tabarru takaful concept. Tabarru' takaful also called Donation-Based Takaful is a type of takaful that focuses on providing financial assistance to individuals and families in times of need which are participants contribute a portion of their premiums as a donation (tabarru') to a fund that is used to help those who have suffered losses. Contributions are considered donations, not premiums for guaranteed returns. This helps eliminate the elements of uncertainty (gharar) and gambling (maysir) which are prohibited in Islamic finance. (Ali et al., 2015). Tabarru' takaful generally uses the qardul hasan contract where the takaful operator provides financial assistance to participants when needed. Participants pay their contributions, which are then used to help those in need. The takaful operator manages the funds and distributes assistance based on the needs of the participants (Alnemer, 2012).

As the global economy develops, the need for insurance becomes more complex. There is a need to manage funds more efficiently and professionally while still complying with sharia principles. Therefore, *tijari takaful* which is identical to the commercial concept developed. A commercial takaful model that operates on a profit-sharing basis. *Tijari takaful* participants deposit premiums into a common fund, which is then managed by the takaful operator. The profits generated from this fund are divided between participants and operators based on a previously agreed ratio. This concept uses the *mudharabah* and *wakalah* contracts. In *mudharabah*, the takaful company acts as the *mudharib* (fund manager) and participants as *rabbul maal* (fund owners). Investment profits are divided between the company and participants according to the agreement. While in *wakalah*, the company acts as an agent who manages participant funds and receives a fee as a reward for services.

4.2.3. Digital Technology

The takaful industry has undergone a significant transformation towards its current modern state, which is heavily influenced by the emergence of financial technology (FinTech). The shift to modern takaful began with the integration of digital platforms and technologies. FinTech innovations such as online portals, mobile applications and electronic payment systems have made takaful services more accessible and efficient (Abdullah et al., 2018). Takaful insurance operators have embraced digital disruption by adopting innovative strategies to stay competitive. Collaboration with technology companies and development of digital marketing strategies have expanded market reach and increased customer engagement (Wati & Manaf, 2019). In fact, to expand reach and improve service delivery, takaful operators partner with major technology companies such as Google, Facebook, Apple and Amazon (Hemed et al., 2021).

Takaful products are increasingly being offered online, making it easier for customers to access and purchase these products. This shift to digital platforms is driven by the need to remain competitive in the rapidly evolving insurance market. Takaful Companies in Malaysia are using social media marketing to reach a wider audience and increase customer engagement. Their collaboration with software companies like Fusionex has resulted in a significant increase in sales through digital platforms (Wati & Manaf, 2019). Currently, many studies are assessing the potential of blockchain technology to be implemented in the takaful industry.

Blockchain technology is used to ensure transparency, security and integrity of takaful transactions. This decentralized architecture is in line with the principles of mutual guarantee and cooperation inherent in takaful. Blockchain enables decentralized and tamper-proof record-keeping, enhancing trust among participants and ensuring compliance with *Shariah* principles (Abdeen et al., 2019).

The discussion on innovation in the takaful industry explains how innovation in the takaful industry, such as product innovation, business model development, and digitalization, has developed based on existing research trends. Innovation development can increase the attractiveness and competitiveness of takaful services, create products that are more in line with consumer needs, and utilize technology to improve operational efficiency and customer service. In addition, these findings provide an overview of the changes and challenges faced by the takaful industry in responding to technological developments and market needs. These findings can also be a reference for further research. For example, in terms of business models, in general, takaful only explains in general about the *tabarru'* and *tijarri* models, so that it can be explored further by conducting research by examining more inclusive business models, for example through a collaborative approach with non-traditional partners or using a community-based approach.

5. Conclusion

This study was conducted to explore the development of takaful research and what innovations had accompanied it, from 1937 to 2023. 449 documents used in this study show that research with the theme of takaful has increased every year. From the results of the research trend analysis, it is known that the writer who often examines this theme is Salman Syed Ahmed and the Journal of Islamic Accounting and Business Research as the most banayk journal publish articles about takaful. The keywords used in this study are takaful, Islamic insurance, *Shariah* insurance and cooperative insurance. Some innovations that occur along with the evolution of the takaful industry include the development of products that are tailored to the increasingly complex problems, business models according to the needs and development of the field of technology to increase the efficiency and operation of the takaful industry.

As a limitation of this study, literature in the form of books and other significant publications outside of Scopus has not been included. This may affect the results and scope of the research, as books often provide in-depth discussions on the concept of takaful. The author identifies this as a methodological limitation that should be noted in future studies.

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