Analysis of global research trends on FinTech: a bibliometric study

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Abstract

Purpose – The key aim of this study is to highlight current financial technology (FinTech) trends by conducting a bibliometric review of literature derived from the Scopus database.

Design/methodology/approach – A bibliometric analysis was conducted on articles gathered from the Scopus database. Microsoft Excel was used to perform the frequency analysis, VOSviewer for visualising the data, and Harzing's Publish or Perish for the metrics citation.

Findings – According to this investigation, research into FinTech has been consistently increasing since 2008. The results indicate that the most active publisher of FinTech literature is Bina Nusantara University in Indonesia. In terms of country of publication, China is identified as the most active. The most cited author is Buckley, R.P., with Rabbani, M.R., having the most publications. It was also identified that FinTech researches come under three primary domains namely business management, computer science and economics.

Research limitations/implications – The primary limitation of this current study is that it only relied on one data source, i.e. Scopus. Implications wise, researchers and practitioners can gain a deeper understanding of FinTech from this study, which also describes the trend in related publications on the concept. Future studies could significantly benefit from the findings of the present paper.

Practical implications – The outcomes of this study can assist researchers in better comprehending and summarising the key drivers of FinTech. In addition, the findings can help new researchers identify the starting point for their research on FinTech.

Originality/value – As far as the authors are aware, this is the first study that reviews FinTech publications derived from Scopus from 2008 to 2022. Hence, it is a pioneering study into FinTech bibliometric analysis, providing an understanding of the structural knowledge by reviewing the timeline of academic progression in FinTech.

Keywords FinTech, Bibliometric analysis, VOSviewer, Harzing's Publish or Perish, Finance

Paper type Literature review

1. Introduction

One of the most notable recent developments in the financial industry is financial technology (FinTech), which is also a prime illustration of how technological advancements are challenging the established methods of service delivery. In this case, the various software and applications must be designed for competitiveness and complementarity with the traditional financial system as well as for the use of new technology in supplying traditional services (Junior and Cherobim, 2020; Liem *et al.*, 2022). Thakor (2020) and Otieno and Kiraka (2023) asserted that the goal of FinTech is to show more affordable ways to get over obstacles in

financial contracting and reduce the cost of financial services in order to promote consumer welfare. Consumer International (2017) has classified the FinTech development era into three phases, beginning in 1866. Trans-Atlantic cable and telegraph as a form of financial communications were significant during the first phase, which lasted from 1866 to 1967. The second phase, which began in 1967 and ended in 2008, was marked by the development of ATMs and online banking, where financial institutions began integrating information technology into financial services and products. A new competitive environment for financial institutions is brought about by the third phase, which began in 2008 and is characterised by the usage of advanced technologies by emerging competitors with distinct characteristics. According to Palmié et al. (2020) and Al-Shari and Lokhande (2023), the emergence signified a system-level transformation at the industry level that resulted in the development of new actors and the merging of capabilities.

The performance of FinTech largely depends on a number of elements, including access to capital, human resources and regulatory attitudes, but more specifically on the readiness to accept innovation and the ability to be flexible. Furthermore, the success of FinTech is significantly influenced by client risks and client trust in financial services. Without question, the FinTech sector plays a significant role in society and in the day-to-day lives of individuals all over the world. Despite undergoing significant transformations driven by political, geographic and legislative changes, Liu et al. (2020), among others, stated that the rise of FinTech has paved the way for banks and firms. FinTech has been applied in various areas, including mobile payment (Gomber et al., 2018), mobile networks (Gai et al., 2016), blockchain (Iman, 2018), peer-to-peer (P2P) lending (Ge et al., 2017), cloud computing (Castiglione et al., 2015), investment funds, banking services, telecom operators and retail groups (Singh et al., 2020), data analysis (Qiu et al., 2016) and sustainable technology (Akbari et al., 2020).

Indeed, very few attempts have been made to report the trends in FinTech literature, especially with regards to the bibliometric approach, despite increased interest in FinTech research (e.g. Milian et al., 2019; Liu et al., 2020; Sahabuddin et al., 2023). Despite their significance, there is still a need to expand the body of literature on this subject, especially given the recent and noticeable increase in FinTech studies. Hence, this paper's goal is to perform a bibliometric study on academic works about FinTech published between 2008 and 2022. This work differs from previous bibliometric studies for four reasons. First, by studying this phenomenon over a 10-year period, it is possible to identify features that have not been studied before and to analyse more than 3,617 publications in this field. Second, due to the fluctuation in the number of studies per time period, this study also enables a quantitative evolutionary analysis of the FinTech phenomenon. Third, this paper does not focus on a particular region; it examines global FinTech research behaviour worldwide. Lastly, this research also outlines the directions of FinTech research and how they relate and progress in this field.

This paper makes several contributions to the existing literature as follows: (1) By analysing FinTech-related bibliometric research that is included in the Scopus database from 2008 to 2022, the current paper intends to close the existing gap. (2) The current research aims to offer a comprehensive perspective based on the bibliometric analyses of bibliometric FinTech studies; as a result, scholars looking to conduct research in this sector will have insight of the numerous parameters available. (3) This study identifies future directions for FinTech development and analyses existing research hotspots. Practically speaking, this report can point businesses in the direction of viable FinTech technologies and collaborative organisations. (4) By illustrating the study directions for bibliometric analysis, this paper can offer practical insights for assessing FinTech researchers. (5) This paper uses overlay analysis to more intuitively depict the citation process for all FinTech articles and notice dynamic changes in the cited nations, universities, authors, papers and journals based on burst detection analysis. (6) This study can help researchers discover research gaps by

focusing on the most significant publications and papers that have received the most citations. A bibliometric analysis of the present work was carried out to answer these research questions:

RQ1. What is the publication trend (number of articles by year) in this field?

RQ2. Who are the most prolific contributors (authors, funding institutions, influential institutions and countries) in this area?

RQ3. What is the most significant research (subjects and language) in this domain?

RQ4. What are the most important keywords, documents, and source types in this area?

RQ5. Which are the most influential journals, publishers and highly cited articles in this field?

RQ6. What is the future scope of research on FinTech?

RQ7. How did the bibliometric analysis identify gaps in the FinTech literature?

In the following sections, this research presents the related literature in Section 2 and the study methodology in Section 3. The bibliometric results are interpreted in Section 4, while the study implications are discussed in Section 5. Finally, the overall conclusion is presented in Section 6.

2. Related literature
Innovation in the financial sector may entail new forms of financial services, financial products, manufacturing techniques or organisational structures (Frame and White, 2004). It is an inevitable result of the development of information technology with respect to the financial sector. Banks continuously experiment with new ways to offer financial services as they form the backbone of the entire financial system. The development of information technology aids banks in creating a credit system, while advancements in communication technology allow for the execution of financial transactions from any location (Garg *et al.*, 2023). There have been various researches undertaken on FinTech due to the current rise in popularity of bibliometric studies. For instance, the study of Junior and Cherobim (2020), which examined 43 papers and books from various databases, was centred upon three strategies, namely: (1) the procedure for reviewing and publishing those articles; (2) the volume of publications in that journal; and (3) the classification of the FinTech papers, which includes the classification of FinTech itself, the disruptive innovation theory, FinTech and administration or economic theories, as well as the legislative and regulatory aspects. In actuality, their research focuses more on the bibliometric information on FinTech on top of the systematic review of FinTech studies. While, Wu (2017) mapped FinTech articles they found on the ISI Web of Science databases by listing the main journals in the domains of deposit and lending, payments, capital raising, insurance, market provisioning and investment management based on their citation frequency. A scientometric study involving 629 FinTech business model papers derived from the Web of Science database was reported by Liu *et al.* (2017). The papers were examined in terms of the FinTech business model's dynamic evolution of co-cited keywords as well as the overall growth trend, research field, research institutions, major authors, citation network and clusters and core authors. Likewise, Drasch *et al.* (2018) studied FinTechs, consultants and regulators using 136 cases of bank and FinTech collaborations as well as interviews with 12 bank experts. Six separate characteristics were used to categorise the results: cooperation type, innovation maturity, invention type, value chain placement, innovation holder and business ecosystem. A different taxonomy with 15 aspects was provided by Gimpel *et al.* (2018). It was developed from the

examination of 227 FinTechs from various countries that are focused on end consumers (business-to-consumer). Additionally, Still *et al.* (2019) investigation into the development of FinTech ecosystems included a case study of innovation at two of Finland's largest retail banks as well as a presentation of the content and connections in FinTech research. Their findings demonstrate how numerous connections have been made between existing stakeholders in FinTech innovation. Similar to this, Leong *et al.* (2017) investigated the growth of a FinTech business that provides microloans to Chinese university students. They demonstrated how digital technology provides a corporation with strategic competency, how an alternate credit score may be generated using unusual data, and how it is possible to achieve financial coverage of market groups that have not yet been covered. In their investigation of the economic and technological factors motivating business owners to launch projects aimed at reinventing the FinTech industry, Haddad and Hornuf (2019) discovered that the number of FinTech start-ups in a nation increases in direct proportion to how difficult it is for businesses to obtain loans. The volatility connectedness of return series was also explored by Le (2021), who discovered that traditional common stocks and 21st-century technology assets are generally very related. They claimed that FinTech and common stocks are inadequate hedging choices for a single portfolio. According to Du *et al.* (2019), the affordance-actualisation (A-A) theory is the key to the adoption of blockchain technology. Chang *et al.* (2020) investigated the market revolution and effects of FinTech and blockchain. According to their findings, affective, behavioural and cognitive evaluations lead to the expectation of knowledge hiding in blockchain. Tao *et al.* (2022) looked at the environmental effects of FinTech. They demonstrated that after taking into account the necessary control variables, FinTech development can help reduce the emission of greenhouse gas. From a different angle, Gai *et al.* (2018) provided an overview of FinTech by compiling and analysing recent accomplishments that theoretically suggested a framework for data-driven FinTech. Data approaches, security and privacy, hardware and infrastructure, administration and applications and service models were the five technical themes included in the survey.

3. Methodology and data
This investigates utilised data mining to answer its research questions. Several studies in the field of FinTech have already used the Scopus database (Milian *et al.*, 2019). Scopus is the most important citation/abstract database, which covers a wide range of topics. Additionally, Scopus has a large number of excellent peer-reviewed papers (Al-Kofahi *et al.*, 2020; Alfawareh *et al.*, 2021). Scopus is ideal for bibliometric analysis because it has greater coverage than the Web of Science.

This study conducted a bibliometric analysis of articles derived from the Scopus database, i.e. those published from 2008 to 2022. This paper chose the time range of between 2008 and 2022, mainly due to the abundance of research articles available at the time and the development of advanced analytics techniques. In addition, over the 15-year period, FinTech businesses have grown significantly, expanding into new markets like robo-advisors, peer-to-peer lending and mobile payments in addition to traditional banking and payments. Within the span of the study, this diversification has significantly increased the FinTech industry's scope and influence. The authors of this research analysed the term "Fintech" by the article titles, abstracts, and keywords. This approach has been presented and used in other studies to reflect the research area and the purpose of research (e.g. Azzari *et al.*, 2020). The current study also used VOSviewer, one of the most powerful software for constructing map visualisations using the links to the subject under study. The VOSviewer software was used to map "FinTech" through the keyword co-authorship and co-occurrence analysis. In addition, the present study follows past studies (e.g. Shi *et al.*, 2022; Akbari *et al.*, 2020;

Alfawareh *et al.*, 2023) in using Harzing's Publish or Perish for citation metrics and analysis, which can help future research identify avenues for further exploration as well as areas for improvement. Therefore, in Figure 1, we present the steps in bibliometric-based valuations. Besides, the data extraction steps are illustrated in Figure 2.

4. Results

4.1 Annual scientific production

The data used in this investigation are described in this section. Our analysis indicates that the first FinTech-related publication appeared in 2008. Figure 3 and Table 1 show the annual scientific output of articles on the financial applications of FinTech. It is clear that since 2008, the number of FinTech studies in the finance industry has increased, peaking in 2022. In 2020 and 2022, respectively, there were 893 and 933 publications as a result of a sharp increase in the number of articles. There were 891 papers published in the FinTech domain in 2021. This figure illustrates how interdisciplinary FinTech research is, with frequent demands for knowledge in both finance and technology. The research process may become more complicated as a result of this intrinsic interdisciplinary feature, which could result in a slower rate of publication in comparison to 2020 and 2022. However, the recent explosive rise of FinTech is a combination of technological convergence, shifting customer tastes, governmental support and greater investment. FinTech is likely to stay as a dynamic and transformational force in the financial services sector as it develops and innovates further. The rapid rise of FinTech in the literature also reflects how drastically technology has changed finance and the overall economy. Researchers would keep looking at FinTech's many sides as it develops, creating a wealth of academic study and publications. However, post-2013, the volume of citations increased; however, the last six years (2017–2022) have seen an overall increase in citations per year compared to the previous nine years (2008–2016). We anticipate that over the next few years, this number will rise steadily.
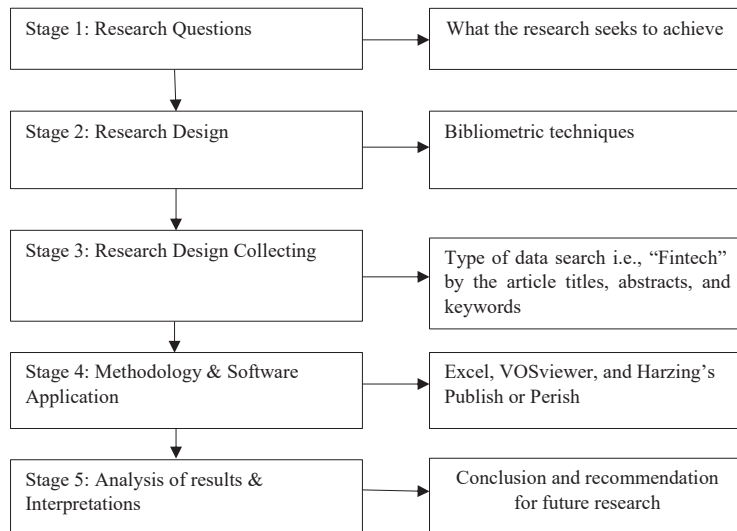
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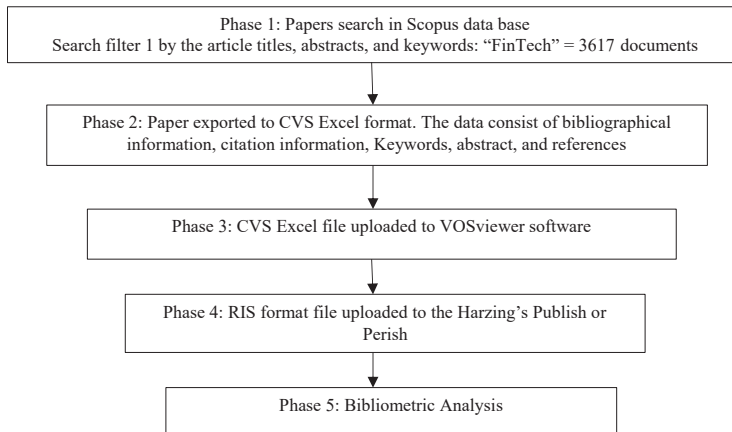
Figure 2.
Data extraction
process

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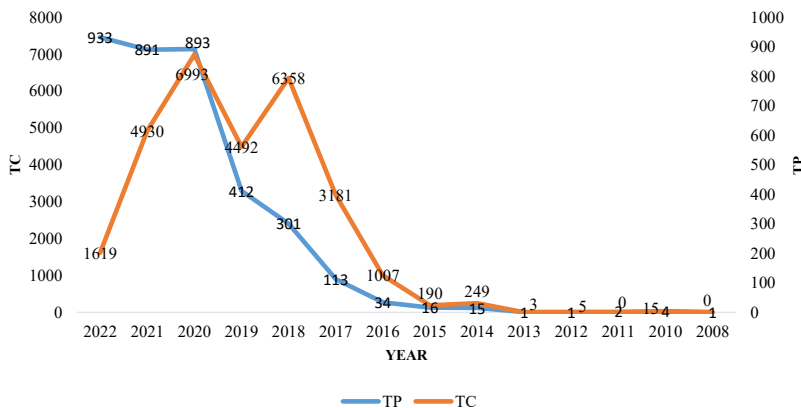
Figure 3.
Annual scientific
production

4.2 Highly cited articles

A publication's value is determined by the number of citations it generates using the citation analysis approach (Khanra *et al.*, 2020). According to Garousi and Fernandes (2016), highly cited publications are recognised as valuable and high-quality indications of the persistence of research. The possible research foci or designs that may garner a lot of interest can be found by analysing the most referenced articles, and as a result, helpful recommendations for future studies can be made (Lai, 2019). Table 2 from the Scopus database lists the top ten FinTech-related papers with the most citations. Lee and Shin (2018) published the top-cited article in FinTech research titled "Fintech: Ecosystem, Business Models, Investment Decisions, and Challenges." The publication had 401 citations. FinTech articles by authors from the citation analysis can be observed in Table 2.

4.3 Authors' impact

The influence and importance of a single researcher's work inside a certain subject is known as an author's research influence in the research domain. One's research output may

Year	TP	%	NCP	TC	C/P	C/CP	h	g
2022	933	25.79%	358	1619	1.74	4.52	17	25
2021	891	24.63%	582	4930	5.53	8.47	29	41
2020	893	24.69%	663	6993	7.83	10.55	38	56
2019	412	11.39%	321	4492	10.90	13.99	34	55
2018	301	8.32%	250	6358	21.12	25.43	42	72
2017	113	3.12%	95	3181	28.15	33.48	31	54
2016	34	0.94%	29	1007	29.62	34.72	14	29
2015	16	0.44%	9	190	11.88	21.11	6	9
2014	15	0.41%	10	249	16.60	24.90	6	10
2013	1	0.03%	1	3	3.00	3.00	1	1
2012	1	0.03%	1	5	5.00	5.00	1	1
2011	2	0.06%	0	0	0.00	0.00	0	0
2010	4	0.11%	3	15	3.75	5.00	2	3
2008	1	0.03%	0	0	0.00	0.00	0	0

Table 1.
Annual scientific
production

Note(s): TP = total publications; NCP = number of cited publications; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = h-index; g = g-index
Source(s): Table created by authors

Year	Authors	Title	Citation
2010	Hao, H.-N.	Notice of Retraction: Short-term forecasting of stock price based on genetic-neural network	12
2014	Haroune, L., Salaun, M., Ménard, A., Legault, C.Y., Bellenger, J.-P.	Photocatalytic degradation of carbamazepine and three derivatives using TiO2 and ZnO: Effect of pH, ionic strength, and natural organic matter	99
2015	Mackenzie, A.	The Fintech Revolution	65
2016	Schueffel, P.	Taming the beast: A scientific definition of fintech	165
2017	Gomber, P., Koch, J.-A., Siering, M.	Digital Finance and FinTech: current research and future research directions	351
2018	Lee, I., Shin, Y.J.	Fintech: Ecosystem, business models, investment decisions, and challenges	401
2019	Haddad, C., Hornuf, L.	The emergence of the global fintech market: economic and technological determinants	179
2020	Thakor, A.V.	Fintech and banking: What do we know?	179
2021	Esmat, A., de Vos, M., Ghiassi-Farrokhfal, Y., Palensky, P., Epema, D.	A novel decentralized platform for peer-to-peer energy trading market with blockchain technology	104
2022	Tao, R., Su, C.-W., Naqvi, B., Rizvi, S.K.A.	Can Fintech development pave the way for a transition towards low-carbon economy: A global perspective	61

Table 2.
Most-cited articles

Source(s): Table created by authors

generally be gauged by the number of research papers one has written or co-written. A researcher's active involvement in the subject may be indicated by a prolific publishing record. However, the top fifteen authors' contributions are shown in the current study, based on the number of publications of each author, as indicated in Table 3. Also, according to Figure 4, Rabbani, M.R. is placed first among all authors whose findings heavily favoured FinTech. This author's h-index and g-index scored the highest points, at 8 and 14, respectively. Arner, D.W., and Reyes-Mercado, P., each with 11 total publications and h-index and g-index values of (7, 9) and (2, 3), respectively, come in second and third. As indicated in

Author name	TP	%	Affiliation	Country	NCP	TC	C/P	C/CP	h	g
Rabbani, M.R.	18	0.50%	University of Bahrain	Bahrain	15	220	12.22	14.67	8	14
Arner, D.W.	11	0.30%	The University of Hong Kong	Hong Kong	9	331	30.09	36.78	7	9
Reyes-Mercado, P.	11	0.30%	Universidad Anáhuac México	Mexico	3	37	3.36	12.33	2	3
Wójcik, D.	10	0.28%	University of Oxford	United Kingdom	9	177	17.70	19.67	8	9
Buckley, R.P.	9	0.25%	UNSW Sydney	Australia	8	325	36.11	40.63	7	8
Hamdan, A.	9	0.25%	Ahlia University	Bahrain	6	62	6.89	10.33	5	6
Giudici, P.	8	0.22%	Università degli Studi di Pavia	Italy	8	116	14.50	14.50	6	8
Hassan, M.K.	8	0.22%	University of New Orleans	United States	7	65	8.13	9.29	4	7
Khan, S.	8	0.22%	Bahrain Polytechnic	Bahrain	7	114	14.25	16.29	6	7
Tan, B.	8	0.22%	UNSW Sydney	Australia	0	0	0.00	0.00	0	0
Ashta, A.	7	0.19%	Burgundy School of Business	France	7	169	28.17	24.14	6	7
Giudici, P	7	0.19%	University of Pavia	Italy	7	180	25.71	25.71	6	7
Surjandy G	7	0.19%	Bina Nusantara University	Indonesia	5	63	9.00	12.60	4	5
Fernando, E.	7	0.19%	Bina Nusantara University	Indonesia	5	63	9.00	12.60	4	5
Schwienbacher, A.	7	0.19%	SKEMA Business School	France	6	305	43.57	50.83	5	6

Note(s): TP = total publications; NCP = number of cited publications; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = h-index; g = g-index
*Only the top 15 productive authors are presented in this Table
Source(s): Table created by authors

Table 3.
Most productive authors
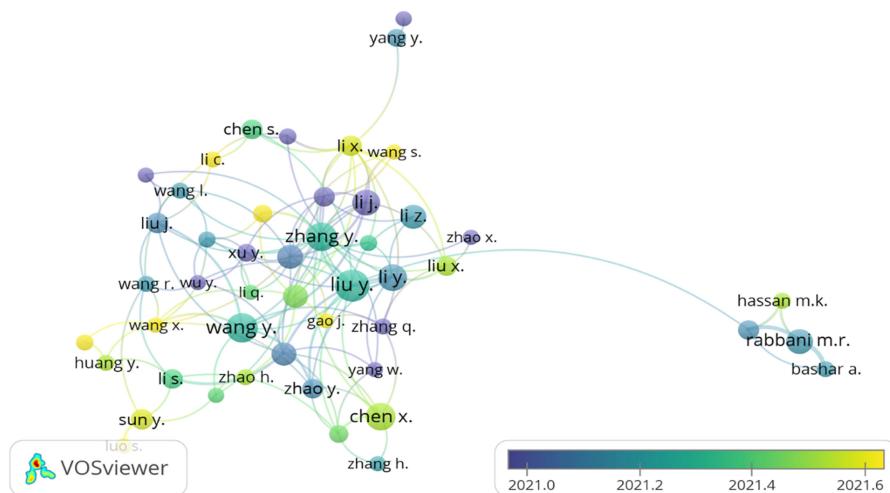
Source(s): Figure created by authors

Figure 4.
Map of authors

Table 3, the remaining authors: Wójcik, D., Buckley, R.P., Hamdan, A., Giudici, P. and Hassan, M.K. contributed 8–10 articles on FinTech. But it is important to note that, as indicated in Table 3, Arner, D.W. obtained the most citations overall, followed by Buckley, R.P., who received over 320 citations compared to other scholars in this domain, as indicated in Table 3. The study uses Lokta's law to describe the quantity of FinTech author publications. According to Lokta's law, there is an inverse correlation between the quantity of articles published and the frequency with which they are produced (Sun, 2021). Nonetheless, the intentions of the researcher, the particular subject of study and the larger societal context all have an impact on the variety of potential forms that research impact can take. With the main objective of expanding knowledge and tackling real-world situations, researchers usually strive to find an equilibrium between quantitative indicators of impact and the qualitative relevance of their contributions.

4.4 Keyword analysis

The outcomes of the cartography study performed using the VOSviewer programme are shown in Figure 5. This kind of analysis aids in locating the keywords associated with each research stream within a given field of study. For each keyword, a minimum scale of co-occurrence of five was chosen. Only 237 of the 4,544 keywords utilised by the authors satisfied the criteria. The size and distance from the bubble determine the density of associational linkages and keyword occurrences. Ten major clusters are connected to these 237 terms. Each colour denotes a group of related keywords connected by associations. The fifteen most used keywords are fintech, commerce, financial markets, blockchain, machine learning, forecasting and investments (see Table 4). All these keywords are somehow linked to 10 organisations namely Bina Nusantara University, UNSW Sydney, Amity University, Ahlia University and the University of Hong Kong, among others. In turn, these organisations are strongly linked to 5 nations, namely Indonesia, Australia, India, Italy and Hong Kong.
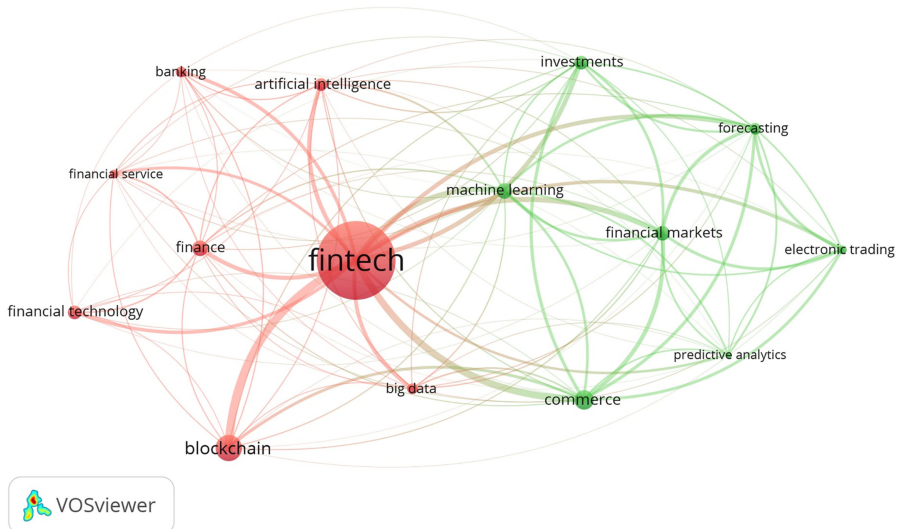

Figure 5.
Map of author's keywords

Source(s): Figure created by authors

Keywords	TP	%
fintech	1225	34%
commerce	192	5%
financial markets	128	4%
blockchain	280	8%
machine learning	140	4%
forecasting	99	3%
investments	116	3%
electronic trading	68	2%
finance	147	4%
artificial Intelligence	108	3%
big data	87	2%
predictive analytics	41	1%
financial technology	124	3%
financial service	64	2%
banking	89	2%

Note(s): TP = total publications; % = per cent
Source(s): Table created by authors

Table 4.
Most frequently used
keywords

4.5 Most active countries

According to the Scopus database, more than 60 countries contributed to FinTech articles between 2008 and 2022. Table 5 shows the top 15 countries with the largest number of publications, while the patterns of each country's publications are shown in Figure 6. Based on the authors' affiliation, the analysis of the contributing nations was calculated. The highest number of papers in this area was published in Asia, North America and Europe. Remarkably, 17.39% of the papers analysed in this study came from China. This can be linked to the Chinese government's proactive support for the development of the FinTech industry (Xu *et al.*, 2023). Innovations and investments in FinTech have been greatly aided by

Country	TP	%	NCP	TC	C/P	C/CP	h	g	Continent
China	629	17.39%	435	5759	9.16	13.24	39	58	Asia
United States	445	12.30%	334	6331	14.23	18.96	40	69	North America
United Kingdom	331	9.15%	238	4100	12.39	17.23	32	54	Europe
India	283	7.82%	163	1227	4.34	7.53	17	27	Asia
Indonesia	233	6.44%	129	878	3.77	6.81	16	23	Asia
Australia	154	4.26%	123	1895	12.31	15.41	23	39	Oceania
Malaysia	140	3.87%	87	693	4.95	7.97	14	20	Asia
South Korea	139	3.84%	106	1829	13.16	17.25	19	40	Asia
Germany	136	3.76%	107	2621	19.27	24.50	24	49	Europe
Italy	136	3.76%	96	1335	9.82	13.91	16	34	Europe
Russian Federation	124	3.43%	86	451	3.64	5.24	12	16	Europe
Taiwan	113	3.12%	71	1431	12.66	20.15	18	36	Asia
Spain	87	2.41%	69	1302	14.97	18.87	20	34	Europe
Hong Kong	81	2.24%	61	1303	16.09	21.36	20	24	Asia
Bahrain	76	2.10%	46	644	8.47	14.00	13	24	Asia

Note(s): TP = total publications; NCP = number of cited publications; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = h-index; g = g-index
*Only the top 15 effective countries are presented in this Table
Source(s): Table created by authors
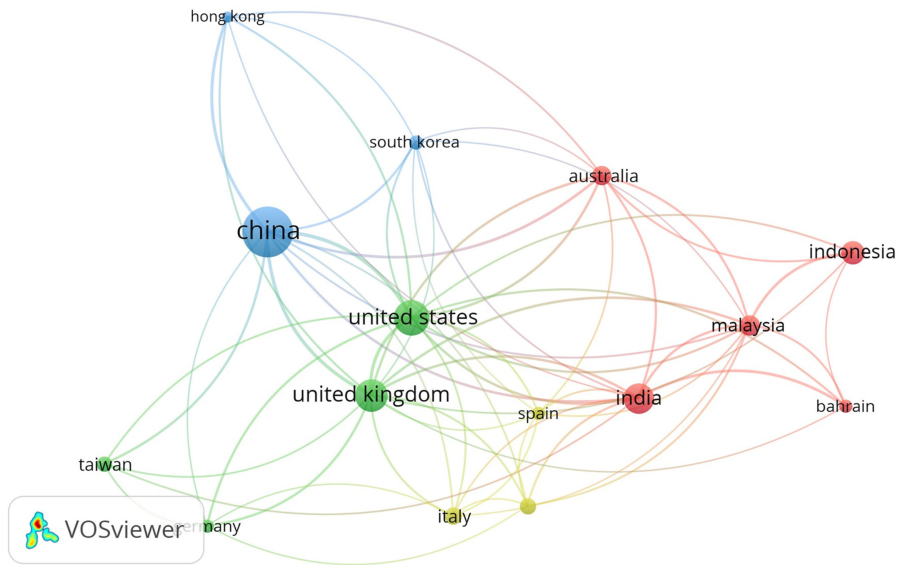
Table 5.
Most active countries

Figure 6.
Map of Most active
countries

Source(s): Figure created by authors

programmes like the "Internet Plus" action plan and the creation of regulatory sandboxes (Qin and Shanyun, 2022). China has also made a significant contribution to its position as among the most active countries in the field of FinTech by making a commitment to enacting regulations that prioritise the FinTech sector's stability and security, while retaining a rather accommodating regulatory setting which promotes experimentation and innovation (Pandiya and Yadav, 2023; Zhu and Zhang, 2023). On the other hand, the United States with 12.30% and the United Kingdom with 9.15%. Moreover, China ranked first with 629 total publications, while the United States has a significant 445 total publications in second place. The United Kingdom is ranked third, followed by India in fourth place with 283 total publications.

4.6 Most active affiliations

Adams *et al.* (2005) found evidential support that institutional collaborations have a significant impact on scientific production and reputation. Therefore, the effect of institutions on researchers' productivity in the FinTech domain was investigated as shown in Table 6. As can be seen, the top research affiliation on FinTech research is the Universities have consistently served as forums for promoting and funding research. Based on publication frequency, Bina Nusantara University is the most productive, followed by UNSW Sydney and Amity University, as indicated in Table 6. Bina Nusantara University contributed 52 articles, UNSW Sydney contributed 34 articles, while Amity University and Ahlia University contributed by 32 and 30 articles, respectively, in the FinTech domain.

4.7 Subject area

The quantity of publications in the field is shown in Figure 7. This includes the fields of biochemistry, genetics, molecular biology, chemical engineering, chemistry, arts and humanities, agricultural and biological sciences; thus, it seems that FinTech is connected

Institution	TP	%	Country	NCP	TC	C/P	C/CP	h	g
Bina Nusantara University	52	1.44%	Indonesia	31	189	3.63	6.10	7	12
UNSW Sydney	34	0.94%	Australia	26	673	19.79	25.88	10	15
Amity University	32	0.88%	India	22	158	4.94	7.18	6	11
Ahlia University	30	0.83%	Bahrain	14	81	2.70	5.79	5	8
The University of Hong Kong	27	0.75%	Hong Kong	19	436	16.15	22.95	9	19
Peking University	27	0.75%	China	21	460	17.04	21.90	10	21
Universitas Indonesia	27	0.75%	Indonesia	22	146	5.41	0.00	6	11
University of Bahrain	26	0.72%	Bahrain	21	138	5.31	6.57	5	11
University of Oxford	26	0.72%	UK	20	285	10.96	14.25	11	16
Singapore Management University	22	0.61%	UK	16	590	26.82	36.88	8	16

Note(s): *Only the top 10 effective affiliations are presented in this Table
Source(s): Table created by authors

Table 6.
Most active affiliations

to many fields outside of its domain. However, due to their connection to the finance industry, the fields of computer science, economics, management and accounting take the top spots on this list. With the advent of FinTech, the financial services sector is anticipated to undergo a major upheaval. The fields of economics and finance have acquired the most research attention, even if machine learning, mathematics, engineering and other fields have similar potential within the FinTech domain. FinTech is a risk for institutions that are unable to adapt to the evolutions in the FinTech world and also a prospect for the finance sector. With the same acuity, traditional financial institutions are also subject to this threat.

4.8 Source title
The significance of specific journals in shaping the landscape of FinTech articles can be attributed to their specialised focus, prestigious reputation, interdisciplinary relevance,
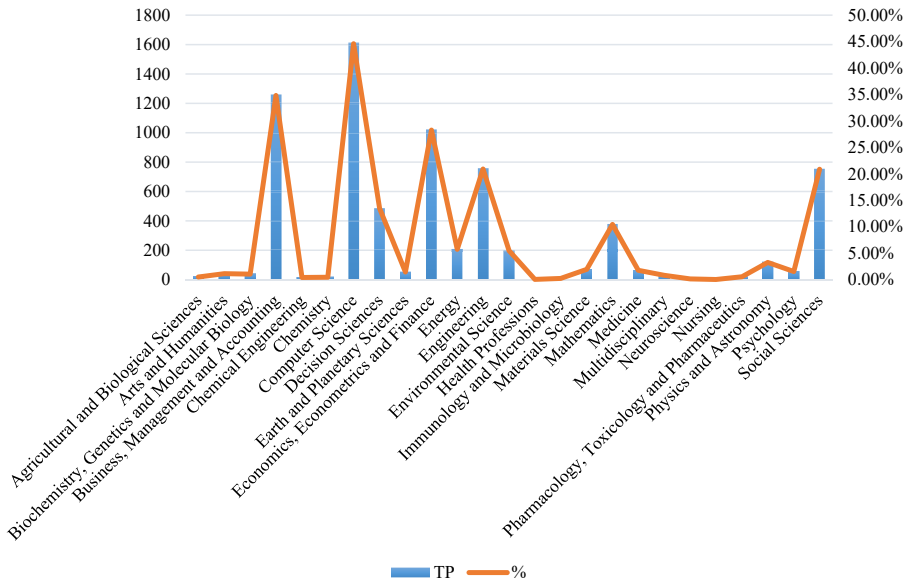
Figure 7.
Number and percentage of publication by subject area

Source(s): Figure created by authors

editorial expertise, global presence, impacts on policy and industry, citation trends and alignment with current research directions, certain journals have a significant impact on the state of FinTech articles. Together, these varied factors position these journals as essential participants to the continuing academic dialogue about FinTech publications. Table 7 illustrates the top source titles of published FinTech articles, which were identified by examining at least 30 publications of each source title. The *ACM International Conference Proceeding Series* hosted the highest number of papers on FinTech, followed by *Advances in Intelligent Systems and Computing*. Similarly, several major journals, such as *Sustainability*, *IEEE Access* and *Financial Innovation*, have done so as well.

4.9 Source and document type
Journals frequently have a global audience, enabling academics to communicate their findings worldwide and give back to the global academic and scientific community. Additionally, publishing in journals can make it easier to connect with other scholars, editors and industry professionals, boosting collaboration and knowledge sharing. As shown in Figure 8, the articles on FinTech were derived from several sources, such as Scopus journals (n = 2095 papers), conference proceedings in journals (n = 881) and book series (n = 344) on FinTech publications since 2008. In contrast, a total of 52.64% of the documents are classified as articles, while another 29.94% are identified as conference papers, as shown in Figure 9.

4.10 The top 10 funding institutions
Figure 10 lists the sponsoring institutions that published FinTech studies. The National Natural Science Foundation of China is the most active sponsor due to the enormous scale and enormous potential of the FinTech business in China, the National Natural Science Foundation of China (NSFC) has emerged as the most active sponsor. Figure 10 reveals that the NSFC's support for FinTech research demonstrates its commitment to supporting innovation and economic development within this key industry. In contrast, Horizon 2020 and the National Office for Philosophy and Social Sciences represent the subsequent phase of sponsorship. Next on the list are the Fundamental Research Funds for the Central Universities and, lastly, the European Commission.

5. Implications of the study
5.1 Theoretical implications
First, this paper gives a summary of bibliometric studies through the lens of FinTech literature. Thus, it has explored FinTech studies as well as its historical evolution. Second, by reviewing the titles and body of the extant literature published in high-ranking journals belonging to various Scopus categories, we identify the literature gaps and add to the body of prior knowledge. Third, the bibliometric analysis of FinTech has aided in the tracking of the evolution of specific technologies within the area, such as artificial intelligence, machine learning, blockchain and mobile payments. Accordingly, understanding the trajectory of these technologies can shed light on their possible effect on financial services. Fourth, this paper discovered that the adoption and growth of FinTech innovations in the financial sector may help researchers learn more about the acceptability and effects of certain innovations (such as peer-to-peer lending, mobile wallets, robot-advisors, and cryptocurrency services) by keeping track of papers relevant to those innovations. Fifth, the current study's co-citation analysis illustrates the co-citation of FinTech in journals in bibliometric studies; as such, this study will serve as a guide for academics new to this field. Finally, the current investigation offers details on the topics that attracted the most scholars over the past decade and offers suggestions for future research on how the pertinent research field is developing.

Source title	TP	%	Publisher	Cite score	SJR 2021	SNIP 2021	NCP	TC	C/P	C/CP	h	g
ACM International Conference Proceeding Series	98	2.71%	ACM	N/A	N/A	N/A	34	107	1.09	3.15	5	8
Advances In Intelligent Systems and Computing	53	1.47%	Springer Nature	N/A	N/A	N/A	33	18	0.34	0.55	2	2
Lecture Notes in Networks and Systems	53	1.47%	Springer Nature	N/A	N/A	N/A	2	17	0.32	8.50	2	2
Sustainability Switzerland	50	1.38%	MDPI	5	0.664	1.31	23	185	3.70	8.04	8	12
Lecture Notes in Computer Science	49	1.35%	ACM	2.1	0.407	0.534	23	185	3.78	8.04	8	1
IEEE Access	36	1.00%	IEEE	6.7	0.937	1.326	15	222	6.17	14.80	8	14
Journal of Physics Conference Series	34	0.94%	IOP Publishing	0.8	0.21	0.395	7	11	0.32	1.57	2	2
E3s Web of Conferences	31	0.86%	N/A	N/A	N/A	N/A	6	13	0.42	2.17	2	3
Financial Innovation	30	0.83%	Springer Nature	6.7	0.937	2.509	24	676	22.53	28.17	12	24
Technological Forecasting and Social Change	29	0.80%	Elsevier	13.7	2.336	3.097	26	854	29.45	32.85	14	26

Note(s): TP = total publications; NCP = number of cited publications; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = h-index; g = g-index; CiteScore = average citations received per document published in the source title; SJR = SCImago Journal Rank measures weighted citations received by the source title; SNIP = source normalised impact per paper measures actual citations received relative to citations expected for the source title's subject field; N/A = not available
Source(s): Table created by authors

Table 7.
Most active source title

Figure 8.
Source type
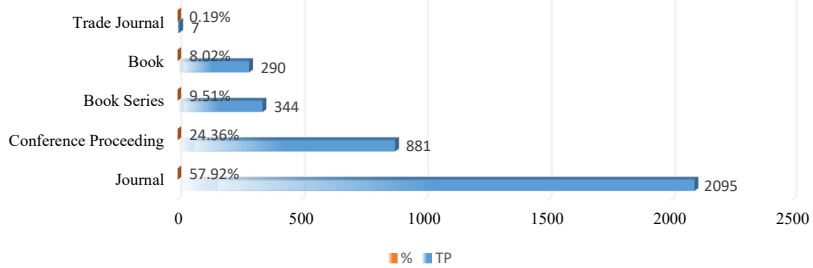
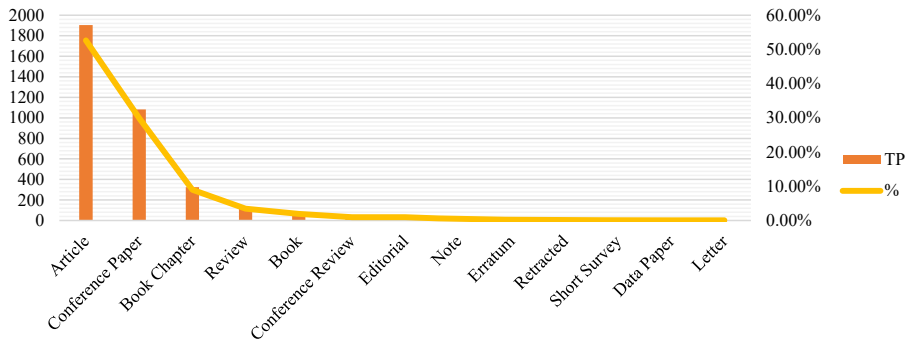

Source(s): Figure created by authors

Figure 9.
Document type

Source(s): Figure created by authors

5.2 Practical implications

The current study will act as a jumping point for future scholars who want to investigate the FinTech area. This FinTech bibliometric analysis enables the researchers to comprehend and summarise the main FinTech factors. For instance, through knowledge maps (e.g. a map of the author's keywords) that show the associations between various study subjects and subfields, researchers can use these maps to identify topics that are underrepresented in the FinTech literature. Academics can also use this study as a reference on how to assess academic outcomes using a variety of variables. Also, the present study has estimated the influence of authors, individual articles and institutions based on factors like citation counts and h-index. Future researchers can use this information to identify influential studies or researchers who have made significant contributions to a particular FinTech field and may uncover areas where further research is needed. Moreover, the bibliometric analysis in the present study may show how several research are connected by examining citation networks. Researchers may recognise key works or seminal publications that have significantly affected the FinTech field. In order to create FinTech legislation for the finance industry, regulators will need to consider every transdisciplinary field of FinTech as offered in the mind map. However, to counteract the rise in FinTech and innovation, stricter regulations must be implemented globally, according to the publications evaluated in this research. In most nations, FinTech legislation remains a work in progress. Developing an appropriate and fair regulatory framework for FinTech operations is the need of the hour. Generally, the findings of research in the FinTech field can update investment strategies and FinTech regulation in FinTech development and policy decisions.
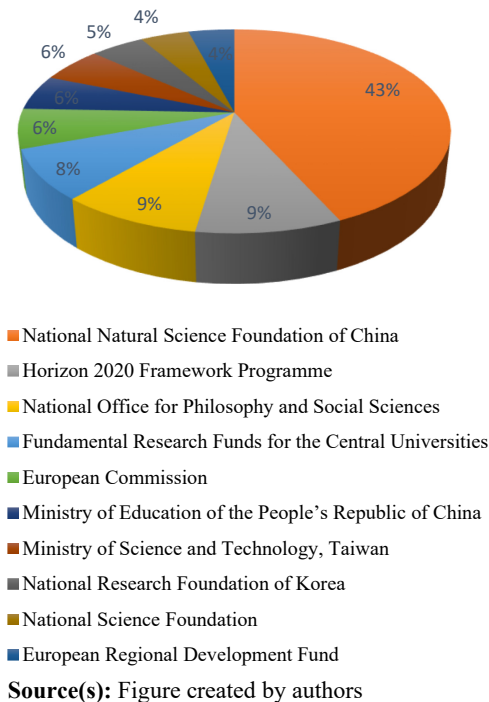
- ■ National Natural Science Foundation of China
- ■ Horizon 2020 Framework Programme
- ■ National Office for Philosophy and Social Sciences
- ■ Fundamental Research Funds for the Central Universities
- ■ European Commission
- ■ Ministry of Education of the People's Republic of China
- ■ Ministry of Science and Technology, Taiwan
- ■ National Research Foundation of Korea
- ■ National Science Foundation
- ■ European Regional Development Fund

Source(s): Figure created by authors

6. Conclusion, limitations and future work

The amount of academic research on FinTech has increased overall. This is a persistent worldwide phenomenon, spurred by the recent growth in technological innovation. The focus on efficiency, automation, data analytics and innovation in FinTech can inspire and inform advances outside of the financial industry, leading to more accessibility, better services, as well as increased productivity and security. Additionally, people and companies can access financial services wherever they are by using FinTech tools like mobile banking and digital wallets. The improvement of accessibility in other industries, like education or healthcare, can be inspired by the financial services industry. As a result, the goal of this study is to fill the gap in the literature by identifying academic works on FinTech in the finance sector, using information from the Scopus databases over the 2008–2022 period. This current inquiry utilises a thorough bibliometric analysis. To compile bibliometric data such as the quantity of publications, subject areas and national contributions, Microsoft Excel 2016 was utilised. Further, the paper used VOSviewer and Harzing's Publish as software tool for performing data mapping, creating better data visualisations, and conducting performance analysis of FinTech literature. The analysis assessed the driving factors, major issues and ongoing trends of FinTech involving the most prolific institutions publishing works in this area, highly cited articles, the top sponsoring institutions, publication growth, document types, publishers, subject areas, authors, keywords and publishing countries. The analysis revealed that Rabbani, M.R., from University of Bahrain is the most active author in this field of research. Among all the institutions, Bina Nusantara University (Indonesia) has published the most articles on FinTech and has the strongest FinTech capabilities. It has produced a total of 52 articles in this domain. Among the nations that participated in FinTech

publications, China recorded the most collaborators. The most important subjects of interest investigated include elements affecting FinTech including "blockchain," "commerce" and "finance" according to the co-occurrence analysis of the key terms in this domain. The paper used a specific query to find the initial list of previous works published as per Scopus' index. The limits and future work suggest that more can be achieved. The Scopus database is the only source utilised in this study. Past bibliometric-related investigations have also made use of the Scopus database. Scopus is one of the largest online databases that indexes all scholarly works; however, it does not include all of the existing sources. Therefore, certain exclusions are definitely expected. No search term can fully capture all the academic articles in this field. Additionally, the lack of data accessibility hinders more comprehensive research. It was challenging for the authors to extract a lot of data during this review. Therefore, to include all the documents that are crucial for the evaluation, future research should collect the bibliometric metadata from several databases (e.g. Google Scholar, Web of Science). Moreover, the paper excluded other tools like CitNetExplorer and RStudio in favour of using VOSviewer and Harzing's Publish for science mapping purposes and conducting a performance analysis of the FinTech literature. Furthermore, as this analysis covered the years from 2008 to 2022, it is possible that the productivity of publications varied by era. As a result, future studies should examine the bibliometric data independently for each period. Also, the investigation was only concentrated on one phrase, such as "FinTech" while excluding other keywords like "Blockchain," "Commerce," "Finance" and "Financial technology," which may have an impact on the search results. Future studies should incorporate the supposed keywords.

References

Adams, J.D., Black, G.C., Clemmons, J.R. and Stephan, P.E. (2005), "Scientific teams and institutional collaborations: evidence from US universities", 1981–1999, *Research Policy*, Vol. 34 No. 3, pp. 259-285, doi: 10.1016/j.respol.2005.01.014.

Akbari, M., Khodayari, M., Danesh, M., Davari, A. and Padash, H. (2020), "A bibliometric study of sustainable technology research", *Cogent Business & Management*, Vol. 7 No. 1, 1751906, doi: 10.1080/23311975.2020.1751906.

Al-Kofahi, M.K., Hassan, H. and Mohamad, R. (2020), "Information systems success model: a review of literature", *International Journal of Innovation, Creativity and Change*, Vol. 12 No. 8, pp. 397-419, available at: https://www.ijicc.net/images/vol12/iss8/12839

Al-Shari, H.A. and Lokhande, M.A. (2023), "The relationship between the risks of adopting FinTech in banks and their impact on the performance", *Cogent Business & Management*, Vol. 10 No. 1, 2174242, doi: 10.1080/23311975.2023.2174242.

Alfawareh, F.S., Al-Kofahi, M., Al-Kofahi, B.'a, Alshirah, M.H., Alshira'h, M. and Ananzeh, H. (2021), "A bibliometric analysis of published articles on management information systems (MIS)", *Information and Knowledge Management*, Vol. 11 No. 4, pp. 142-149.

Alfawareh, F.S., Che Johari, E.E. and Ooi, C.-A. (2023), "A bibliometric analysis of global research trends on CEO compensation: evidence from the Scopus database", *EuroMed Journal of Business*, Vol. ahead-of-print No. ahead-of-print, doi: 10.1108/EMJB-02-2023-0050.

Azzari, V., Mainardes, E.W. and da Costa, F.M. (2020), "Accounting services quality: a systematic literature review and bibliometric analysis", *Asian Journal of Accounting Research*, Vol. 6 No. 1, pp. 80-94, doi: 10.1108/ajar-07-2020-0056.

Castiglione, A., Pizzolante, R., De Santis, A., Carpentieri, B., Castiglione, A. and Palmieri, F. (2015), "Cloud-based adaptive compression and secure management services for 3D healthcare data", *Future Generation Computer Systems*, Vol. 43, pp. 120-134, doi: 10.1016/j.future.2014.07.001.

Chang, Y., Iakovou, E. and Shi, W. (2020), "Blockchain in global supply chains and cross border trade: a critical synthesis of the state-of-the-art, challenges and opportunities", *International Journal of Production Research*, Vol. 58 No. 7, pp. 2082-2099, doi: 10.1080/00207543.2019.1651946.

Consumer International (2017), *Annual Report of the Trustees and Financial Statements*, Consumer-oriented service offerings, Electronic markets, Vol. 28, pp. 1-20.

Drasch, B.J., Schweizer, A. and Urbach, N. (2018), "Integrating the 'Troublemakers': a taxonomy for cooperation between banks and FinTechs", *Journal of Economics and Business*, Vol. 100, pp. 26-42, doi: 10.1016/j.jeconbus.2018.04.002.

Du, W., Pan, S.L., Leidner, D.E. and Ying, W. (2019), "Affordances, experimentation and actualization of FinTech: a blockchain implementation study", *Journal of Strategic Information Systems*, Vol. 28 No. 1, pp. 50-65, doi: 10.1016/j.jsis.2018.10.002.

Frame, W. and White, L. (2004), "Empirical studies of financial innovation: lots of talk, little action?", *Journal of Economic Literature*, Vol. 42 No. 1, pp. 116-144, doi: 10.1257/.42.1.116.

Gai, K., Qiu, M., Tao, L. and Zhu, Y. (2016), "Intrusion detection techniques for mobile cloud computing in heterogeneous 5G", *Security and Communication Networks*, Vol. 9 No. 16, pp. 3049-3058, doi: 10.1002/sec.1224.

Gai, K., Qiu, M. and Sun, X. (2018), "A survey on FinTech", *Journal of Network and Computer Applications*, Vol. 103, pp. 262-273, doi: 10.1016/j.jnca.2017.10.011.

Garg, G., Shamshad, M., Gauhar, N., Tabash, M.I., Hamouri, B. and Daniel, L.N. (2023), "A bibliometric analysis of fintech trends: an empirical investigation", *International Journal of Financial Studies*, Vol. 11 No. 2, p. 79, doi: 10.3390/ijfs11020079.

Garousi, V. and Fernandes, J.M. (2016), "Highly-cited papers in software engineering: the top-100", *Information and Software Technology*, Vol. 71, pp. 108-128, doi: 10.1016/j.infsof.2015.11.003.

Ge, R.Y., Feng, J., Gu, B. and Zhang, P.Z. (2017), "Predicting and deterring default with social media information in peer-to-peer lending", *Journal of Management Information Systems*, Vol. 34 No. 2, pp. 401-424, doi: 10.1080/07421222.2017.1334472.

Gimpel, H., Rau, D. and Röglinger, M. (2018), "Understanding FinTech start-ups–a taxonomy of consumer-oriented service offerings", *Electronic Markets*, Vol. 28 No. 3, pp. 245-264, doi: 10.1007/s12525-017-0275-0.

Gomber, P., Kauffman, R.J., Parker, C. and Weber, B.W. (2018), "On the fintech revolution: interpreting the forces of innovation, disruption, and transformation in financial services", *Journal of Management Information Systems*, Vol. 35 No. 1, pp. 220-265, doi: 10.1080/07421222.2018.1440766.

Haddad, C. and Hornuf, L. (2019), "The emergence of the global fintech market: economic and technological determinants", *Small Business Economics*, Vol. 53 No. 1, pp. 81-105, doi: 10.1007/s11187-018-9991-x.

Iman, N. (2018), "Is mobile payment still relevant in the fintech era?", *Electronic Commerce Research and Applications*, Vol. 30, pp. 72-82, doi: 10.1016/j.elerap.2018.05.009.

Junior, I.C. and Cherobim, A.P.M.S. (2020), "Academic production and technological emergence in finance: bibliometric study on FinTechs", *Innovation & Management Review*, Vol. 17 No. 2, pp. 115-131, doi: 10.1108/inmr-01-2019-0005.

Khanra, S., Dhir, A. and Mäntymäki, M. (2020), "Big data analytics and enterprises: a bibliometric synthesis of the literature", *Enterprise Information Systems*, Vol. 14 No. 6, pp. 737-768, doi: 10.1080/17517575.2020.1734241.

Lai, C.L. (2019), "Trends of mobile learning: a review of the top 100 highly cited papers. British", *Journal of Educational Technology*, Vol. 51 No. 3, pp. 721-742, doi: 10.1111/bjet.12884.

Le, M.T.H. (2021), "Examining factors that boost intention and loyalty to use Fintech post-COVID-19 lockdown as a new normal behavior", *Heliyon*, Vol. 7 No. 8, e07821, doi: 10.1016/j.heliyon.2021.e07821.

Lee, I. and Shin, Y.J. (2018), "Fintech: ecosystem, business models, investment decisions, and challenges", *Business Horizons*, Vol. 61 No. 1, pp. 35-46, doi: 10.1016/j.bushor.2017.09.003.

Leong, C., Tan, B., Xiao, X., Tan, F.T.C. and Sun, Y. (2017), "Nurturing a FinTech ecosystem: the case of a youth microloan startup in China", *International Journal of Information Management*, Vol. 37 No. 2, pp. 92-97, doi: 10.1016/j.ijinfomgt.2016.11.006.

Liem, N.T., Son, T.H., Tin, H.H. and Canh, N.T. (2022), "Fintech credit, credit information sharing and bank stability: some international evidence", *Cogent Business & Management*, Vol. 9 No. 1, 2112527, doi: 10.1080/23311975.2022.2112527.

Liu, C., Huang, W.L. and Yang, C. (2017), "The evolutionary dynamics of China's electric vehicle industry - taxes vs subsidies", *Computers and Industrial Engineering*, Vol. 113, pp. 103-122, doi: 10.1016/j.cie.2017.08.026.

Liu, J., Li, X. and Wang, S. (2020), "What have we learnt from 10 years of fintech research? A scientometric analysis", *Technological Forecasting and Social Change*, Vol. 155, 120022, doi: 10.1016/j.techfore.2020.120022.

Milian, E.Z., Spinola, M.D.M. and de Carvalho, M.M. (2019), "Fintechs: a literature review and research agenda", *Electronic Commerce Research and Applications*, Vol. 34, 100833, doi: 10.1016/j.elerap.2019.100833.

Otieno, G. and Kiraka, R. (2023), "Beyond the innovator's Dilemma: the process and effect of fintech regulatory environment", *Cogent Business & Management*, Vol. 10 No. 2, 2226422, doi: 10.1080/23311975.2023.2226422.

Palmié, M., Wincent, J., Parida, V. and Caglar, U. (2020), "The evolution of the financial technology ecosystem: an introduction and agenda for future research on disruptive innovations in ecosystems", *Technological Forecasting and Social Change*, Vol. 151, 119779, doi: 10.1016/j.techfore.2019.119779.

Pandiya, B. and Yadav, P. (2023), "Financial fraud in the age of FinTech: a bibliometric analysis for future research agendas", in *The Sustainable Fintech Revolution: Building a Greener Future for Finance*, IGI Global, pp. 86-100.

Qin, Z. and Shanyun, X. (2022), "Regulatory experimentation in China's peer-to-peer lending market", *Tsinghua China Law Review*, Vol. 15, p. 59.

Qiu, M., Cao, D., Su, H. and Gai, K. (2016), "Data transfer minimization for financial derivative pricing using Monte Carlo simulation with GPU in 5G", *International Journal of Communication Systems*, Vol. 29 No. 16, pp. 2364-2374, doi: 10.1002/dac.2959.

Sahabuddin, M., Sakib, M.N., Rahman, M.M., Jibir, A., Fahlevi, M., Aljuaid, M. and Grabowska, S. (2023), "The evolution of FinTech in scientific research: a bibliometric analysis", *Sustainability*, Vol. 15 No. 9, p. 7176, doi: 10.3390/su15097176.

Schueffel, P. (2016), "Taming the beast: a scientific definition of fintech", *Journal of Innovation Management*, Vol. 4 No. 4, pp. 32-54, doi: 10.24840/2183-0606_004.004_0004.

Shi, L., Mai, Y. and Wu, Y.J. (2022), "Digital transformation: a bibliometric analysis", *Journal of Organizational and End User Computing*, Vol. 34 No. 7, pp. 1-20, doi: 10.4018/joeuc.302637.

Singh, S., Sahni, M.M. and Kovid, R.K. (2020), "What drives FinTech adoption? A multi-method evaluation using an adapted technology acceptance model", *Management Decision*, Vol. 58 No. 8, pp. 1675-1697, doi: 10.1108/md-09-2019-1318.

Still, K., Lähteenmäki, I. and Seppänen, M. (2019), "Innovation relationships in the emergence of Fintech ecosystems", *Proceedings of the 52nd Hawaii International Conference on System Sciences*, Hawaii, pp. 6367-6376.

Sun, J. (2021), "The mental health of refugees in the USA: changes and the unchanged", *Journal of Public Health*, Vol. 31 No. 2, pp. 1-8, doi: 10.1007/s10389-020-01458-x.

Tao, R., Su, C.W., Naqvi, B. and Rizvi, S.K.A. (2022), "Can Fintech development pave the way for a transition towards low-carbon economy: a global perspective", *Technological Forecasting and Social Change*, Vol. 174, 121278, doi: 10.1016/j.techfore.2021.121278.

Thakor, A.V. (2020), "Fintech and banking: what do we know?", *Journal of Financial Intermediation*, Vol. 41, 100833, doi: 10.1016/j.jfi.2019.100833.

Wu, P. (2017), "Fintech trends relationships research: a bibliometric citation meta-analysis", *Proceedings of the 17th International Conference on Electronic Business*, Dubai, ICEB, pp. 99-105.

Xu, Y., Yuan, L., Lee, H., Baire, S., Nakonieczny, J. and Zhao, X. (2023), "Fintech development and firm technological innovation efficiency: empirical findings in China", *IEEE Transactions on Engineering Management*, pp. 1-11, doi: 10.1109/tem.2023.3239499.

Zhu, H. and Zhang, W. (2023), "Infrastructure of inclusive finance in China", in *Financial Inclusion in China: Policy, Experience, and Outlook*, Springer Nature Singapore, Singapore, pp. 83-104.

Further reading

Arner, D.W., Barberis, J. and Buckley, R.P. (2015), "The evolution of fintech: a new post-crisis paradigm?", *Georgetown Journal of International Law*, Vol. 47 No. 4, pp. 1-45, 1271.

Oehler, A., Horn, M. and Wendt, S. (2022), "Investor characteristics and their impact on the decision to use a robo-advisor", *Journal of Financial Services Research*, Vol. 62 Nos 1-2, pp. 91-125, doi: 10.1007/s10693-021-00367-8.

Rita, P. and Ramos, R.F. (2022), "Global research trends in consumer behavior and sustainability in E-Commerce: a bibliometric analysis of the knowledge structure", *Sustainability*, Vol. 14 No. 15, p. 9455, doi: 10.3390/su14159455.

Zhang, Y. and Soong, B.H. (2004), "Performance evaluation of GSM/GPRS networks with channel reallocation scheme", *IEEE Communications Letters*, Vol. 8 No. 5, pp. 280-282, doi: 10.1109/lcomm.2004.827379.

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