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Bibliometrics Analysis of Hardware Wallet: Patterns and Trends for Academic Research

Wan Mohd Hirwani Wan Hussain^{1,*}, Siti Daleela Mohd Wahid¹, Perengki Susanto²

¹ Graduate School of Business, Universiti Kebangsaan Malaysia, Selangor, Malaysia

² Faculty of Economics and Business, Universitas Negeri Padang, Padang, Indonesia

ARTICLE INFO	ABSTRACT
<p>Article history: Received 7 July 2025 Received in revised form 23 August 2025 Accepted 7 September 2025 Available online 14 September 2025</p> <p>Keywords: Hardware wallet; cryptocurrency bibliometrics; cyber security; VOSViewer; scopus database</p>	<p>This study provides a bibliometric analysis of academic works on hardware wallets published between 2017 and 2023. The report attempts to shed light on current research directions, significant contributors, and the significance of this area in relation to cybersecurity and cryptocurrencies. The Scopus database was used to find and examine a total of 37 pertinent scholarly papers. An overview of the publication patterns for the given time period is given before starting the bibliometric analysis. It shows a consistent increase in the quantity of publications on hardware wallets, demonstrating that researchers are becoming more and more interested in this subject. To pinpoint the major contributors and their geographic distribution, the research further investigates the distribution of publications across various years, authors, institutions, and nations. When it comes to academic researchers, the analysis identifies a number of productive academics who have significantly advanced the subject of hardware wallets. Their knowledge and reliable publication output have made significant contributions to the understanding and creation of secure cryptocurrency storage solutions. Additionally, the analysis emphasises networks and collaboration between authors and institutions, illuminating the collaborative character of this field of research.</p>

1. Introduction

The necessity for strong security measures to secure digital assets has become critical in the ever changing cryptocurrency world. People and organisations must ensure the secure management and storage of their cryptographic keys, which provide access to their funds, as digital currencies become more widely accepted and valued. The hardware wallet is one of the most successful solutions to this problem that has been developed.

A hardware wallet is a physical device created to store cryptocurrency private keys safely offline, adding an extra layer of defence against potential risks like malware and hacking attempts. Hardware

* Corresponding author.

E-mail address: wmhwh@ukm.edu.my

wallets keep the keys segregated inside a tamper-resistant hardware device, as opposed to software wallets that store them on a computer or mobile device. Through this isolation, the risk of theft and unauthorised access is greatly diminished because the private keys are never made accessible to potentially vulnerable devices or networks [1-5]. The idea behind a hardware wallet is based on the concept of "cold storage," where the private keys are generated and kept offline, without any internet connectivity. By using this method, the risk of online attacks is reduced, and hardware wallets are made to be extremely difficult to hack remotely. By guaranteeing that the keys never leave the hardware wallet [6,7], transactions started using a hardware wallet are signed inside the device, adding an extra layer of protection.

Hardware wallets frequently provide a user-friendly interface that makes managing cryptocurrencies simple in addition to their main purpose of securely storing keys. Users can easily access their account balances, start transactions, and communicate with different blockchain networks through a computer or mobile device connection. Another key benefit is the adaptability of hardware wallets, which often handle many cryptocurrencies and help users manage various digital assets with a single device [1]. When choosing a hardware wallet, security and trust are crucial factors. The maximum level of security is ensured by the use of stringent security procedures by reputable hardware wallet manufacturers, including safe chip technologies, encryption algorithms, and firmware integrity checks. The community can independently analyse and validate the security aspects of the device thanks to some manufacturers' provision of open-source firmware.

Hardware wallets must have backup and recovery capabilities [8-10]. Users develop a recovery seed—a mnemonic phrase made up of many words—during the initial setup procedure, which acts as a backup. In the event that the hardware wallet is misplaced, stolen, or reset, this seed can be used to regain access to the cash. Despite the great level of protection that hardware wallets provide, it is essential to be watchful and follow appropriate security procedures. Users should be wary of phishing efforts, make sure their firmware is current, and safeguard their recovery seed by keeping it in a safe and secure area.

As a trustworthy and safe method for managing and storing cryptocurrency, hardware wallets have become increasingly popular [1,11]. Hardware wallets offer consumers and organisations peace of mind in an increasingly digital and linked financial landscape thanks to their offline storage, strong security features, and user-friendly interfaces. Hardware wallets are a dependable way to store digital assets and preserve them against unauthorised access by combining the power of encryption and cold storage.

2. Literature Review

This section will explain about the literature review related to bibliometrics analysis technique in this research.

2.2 Bibliometric Analysis

A subfield of scientometrics known as bibliometrics, which has its origins in the 19th century, uses mathematical and statistical techniques to examine scientific activity within a particular research field. Leading trends, research hotspots, links between nations, regions, institutions, research disciplines, and author collaboration are all identified by this approach [12-15]. The use of bibliometric analysis has grown quickly, and researchers have conducted bibliometric research in a variety of fields, including finance [16-20] big data [21-24] supply chain management [25-27]. Descriptive and evaluative bibliometric research have been separated into two categories by

academics; the former analyses authors, journals, location, time, and discipline, while the latter looks at citations and references. Co-word analysis, which investigates the relationship between research topics in a particular field by examining the co-occurrence of topic words in literature, is the most widely employed technique in bibliometric analysis. With the aid of software like VOSviewer, Gephi, Bibexcel, CiteSpace II, Science of Science (Sci2) Tool, and SciMAT, one can undertake scientific mapping—a process closely linked to co-word analysis—which demonstrates the structure and dynamics of a scientific area. By spatially depicting the conceptual organisation of a research field, it facilitates understanding of conceptual links and developments. In this work, we use VOSviewer to map scientifically and examine patterns and trends [28-33].

The term "bibliometrics" was first used by Allen Richard in 1969 to replace the phrase "statistical bibliography." One of the numerous advantages of bibliometric analysis is the capacity to perform in-depth assessments of certain research topics by assessing citations, co-citations, geographical distributions, and word frequency [14]. By calculating the scientific value and influence of works and sources, it evaluates the progress of knowledge in a particular topic. It is possible to use bibliometric analysis using a variety of approaches based on qualitative and quantitative data, which can help academics understand the trends and patterns in international research in particular fields. Additionally, it enables researchers to assess the depth of scientific investigation in a particular area. By appropriately reflecting the research analysis carried out in academic communities in relation to the study topic, the implementation of bibliometric analysis lowers bias and improves the review process. Bibliometric analysis entails a number of steps, such as sample selection, citation analysis of the literature, document co-citation analysis to understand the study field's subdomains, text analysis to understand the literature's patterns and trends, and text analysis to understand potential domain research in the future [34-38].

The following phases are included in the analytical process while performing bibliometric analysis [39]:

1. Sample selection and literature citation analysis.
2. Document co-citation analysis to comprehend the subject field's subdomains.
3. Using text analysis to comprehend the literary trends and patterns.
4. Text analysis to comprehend prospective future field study.

The goal of this study is to gather, locate, and assess scholarly works that are pertinent to the subject at hand and are included in Scopus. By identifying all academic research articles that have been published in the Scopus database over the years and the patterns within them, this study uses bibliometric methodology to provide insights into the hardware wallet research literature. By doing this, it is possible to better understand what is currently known about hardware wallet academic research.

3. Research Question

This study will be based on a bibliometric analysis data from the Scopus Database. The current study gets an understanding of the research questions established for this analysis, which is as follows:

RQ1: How has Hardware Wallet evolved and spread?

By responding to this RQ1, we can gain a deeper understanding of the growth and distribution of Hardware Wallet throughout the year.

RQ2: What are the patterns and trends in Hardware Wallet research?

By responding to this RQ2, researchers can gain insight into the research trends and patterns in the field of Hardware Wallet. This can also serve as a model for future academic research by identifying influential Hardware Wallet subjects.

RQ3: Who are the highly cited researchers and institutions in the field of Hardware wallet?

By responding to RQ3, researchers will be able to identify key players and institutions with which they can collaborate on Hardware wallet research. This is essential for young researchers because it enables them to plan and strategize research directions. By answering these research questions, we'll gain a comprehensive understanding of the scope, pattern, and trends of this Hardware wallet study. This method enables readers to comprehend and become familiar with the Hardware wallet method. The remaining sections of this essay are organised as follows. The second section discusses the research methodology and the developed research topics. The findings of the Scopus Database-based bibliometrics research are presented in Section III. The discussion and conclusion are located in Section IV. Section V provides a summary of the research and discusses future directions.

4. Methods

The publication of scientific articles in peer-reviewed journals has significantly increased the significance of academic research [40]. To comprehend the trends and patterns in academic research, new methods are necessary, especially given the abundance of data and information. Bibliometrics is a quantitative method for evaluating academic research conducted in various nations, universities, and publications. It evaluates the quantity of academic work produced by scholars to determine their level of production [30], and it is becoming an increasingly valuable tool for assessing the quality and productivity of scholarship.

Bibliometrics is a collection of techniques for analysing and quantifying studies based on scientific articles stored in or indexed by large bibliographic databases. In bibliometrics, performance analysis and science mapping are the two primary methods used to investigate a research field. This study utilised bibliometric analysis in conjunction with quantitative and statistical analysis to comprehend the patterns of distribution of research papers across specific themes and historical periods, with a focus on hardware wallet related academic studies. In the beginning, the bibliometrics research method adhered to the PRISMA guidelines [41,42]. The Scopus Database was chosen as the data source for this study because it is widely regarded as one of the world's premier scientific citation indexes [41,43,44] containing high-quality research publications such as prestigious journals, books, conference proceedings, and review papers. It has been identified as a primary source for academic publications and allows users to search for and discover new publications. After selecting Scopus as the search engine, the query string "**Hardware Wallet**" was employed to retrieve data from the database. Fig. 1 displays the initial results based on the PRISMA steps [44] while Fig. 2 identifies 37 academic papers. The results were then analysed and synthesised, and the findings and analysis were presented in the final report. The study aims to provide researchers with meaningful insights on the trends in hardware wallet publications, which can be used as a foundation for future studies and discussions to further develop this area of study.

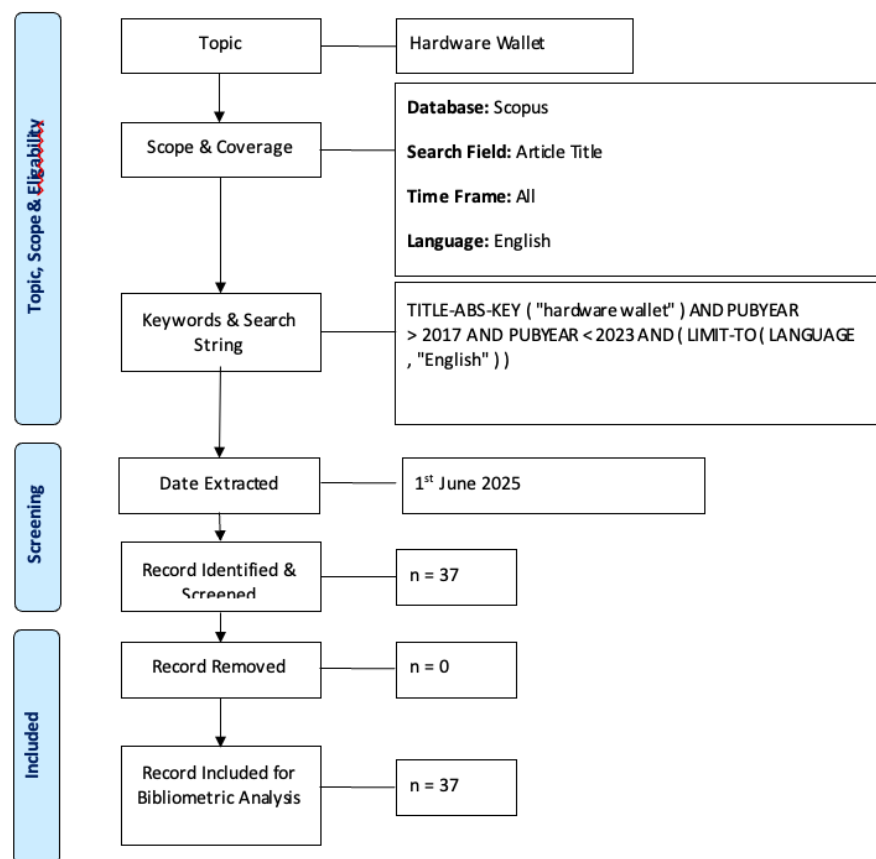


Fig. 1. Flow diagram of the search strategy.
Source: [30,45]

5. Results

This section explains the results obtained from the bibliometric analysis based on the research questions that been explained above.

5.1 RQ1-The Evolution and Dissemination of Hardware Wallet Research

To address this research question, this study will analyse the following data: a) number of publications by year, b) source types, c) document type and d) most active source title.

Publications by year: The examination of publishing metrics reveals important patterns and historical effects of hardware wallet research. The data show significant changes in the number of publications and citations, showing the field's changing popularity and significance. When compared to the other years considered, 2019 is a particularly important one for studying hardware wallets. It saw the most papers, which suggests a rise in research activity and an increased focus on the creation and security of hardware wallets. The highest number of referenced articles, which further demonstrates that this year's study has attracted the attention of the academic community, supports the increasing attention.

In addition, 2018 stands out as a notable year in terms of the total number of citations. Even though there was only one publication, it was cited a lot, demonstrating the importance and effect of the study done at the time. This demonstrates the value of high-quality research output and its capacity to have an impact both within and outside of the academic community. The h-index and g-

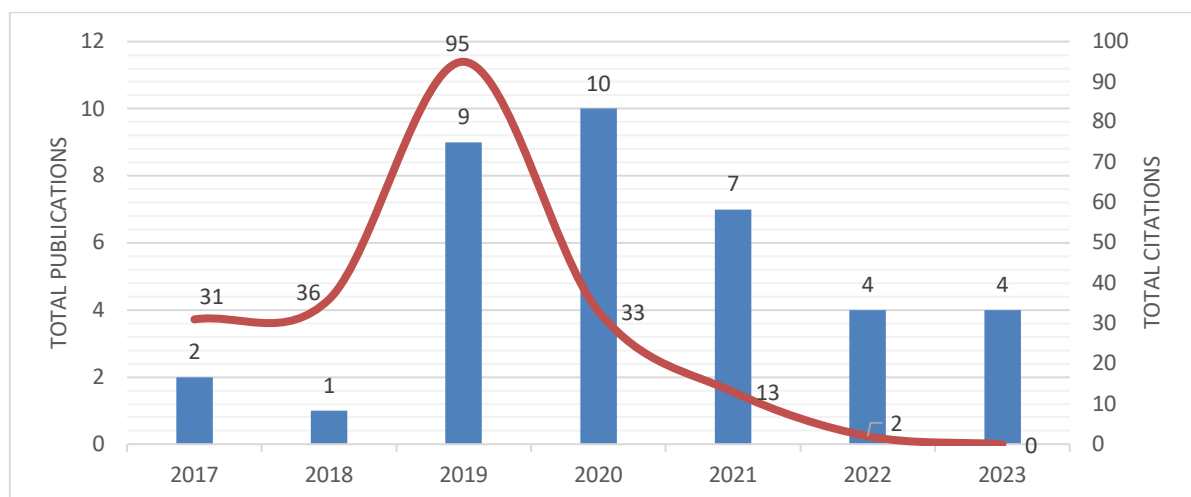
index are taken into account to further evaluate the influence of particular scholars. Based on the quantity of publications and citations an author has received, the h-index calculates the impact of that author. In this analysis, the year 2019 has the greatest h-index (6), indicating the presence of significant researchers in the hardware wallet field at that time. Additionally demonstrating the overall influence of research efforts within the area, the g-index, which considers publications and citations, reaches its greatest value of 9 in 2019.

Table 3

Year of Publication

Year	TP	NCP	TC	C/P	C/CP	<i>h</i>	<i>g</i>
2017	2	2	31	15.50	15.50	2	2
2018	1	1	36	36.00	36.00	1	1
2019	9	8	95	10.56	11.88	6	9
2020	10	7	33	3.30	4.71	3	5
2021	7	5	13	1.86	2.60	2	3
2022	4	2	2	0.50	1.00	1	1
2023	4	0	0	0.00	0.00	0	0
Total	37	25	210	5.68	8.40		

Notes: TP=total number of 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; and *g*=g-index.



Sources and document types. The majority of the publications on hardware wallets (62.16%) were conference proceedings, which were followed by journal articles and book series, each of which made up around 18.92% of the total publications, according to the study of source categories. Reflecting the dynamic character of the area, conference proceedings provide a prominent forum for scholars to present their work. Book series give thorough treatment of hardware wallet themes, while journal articles offer a rigorous peer-review process to ensure high-quality research. The variety of source types shows that there is a wealth of useful and interesting literature available for researchers and practitioners interested in improvements to hardware wallets. Examining articles from many sources can provide you a thorough overview of the most recent advancements in this sector, which is always changing.

Table 3

Source type

Source Type	Total Publications (TP)	Percentage (%)
Conference Proceeding	23	62.16%
Journal	7	18.92%
Book Series	7	18.92%
Total	37	100.00

Next, An examination of document types in hardware wallet publications is shown in Table 4, which reveals that conference papers make up the majority of all publications (72.97%), followed by articles (18.91%) and conference reviews (8.10%). The major venue for disseminating original research and participating in academic debates, conference papers reflect the ever-evolving nature of the discipline. Articles that have undergone thorough peer review offer in-depth research and comprehensive insights into particular hardware wallet elements. Conference reviews provide summaries and evaluations of the conference proceedings and a summary of the research that was presented. The many document categories illustrate the complexity of hardware wallet literature and provide scholars and practitioners with a wealth of useful tools for staying up to date on the most recent developments and debates in the area.

Table 4

Document type

Document Type	Total Publications (TP)	Percentage (%)
Conference Paper	27	72.97%
Article	7	18.91%
Conference Review	3	8.10%
Total	37	100.00

Source titles. The most popular source titles in hardware wallet research are shown in Table 5, which also includes publisher information, the total number of publications (TP), total citations (TC), average citations per publication (C/P), average citations per cited publication (C/CP), h-index, and g-index. With 4 publications and a total of 20 citations, the indicated source title Lecture Notes in Computer Science from Springer Publication stands out as the most active. It shows an average of 5.00 citations per publication and 6.67 citations per publication that is cited, resulting in an h-index of 3 and g-index of 4. Following closely behind with 3 publications and 40 citations, IEEE Access has an amazing average of 13.33 citations for each publication that it has cited. It achieves a g-index of 3 and an h-index of 2, demonstrating its influence in the field. ACM International Conference Proceeding Series features just one article, yet it obtains 22 citations, giving it a high average of 22.0 citations per article and referenced article. It has a value of 1 for both the h- and g-indices. The remaining source titles, such as CEUR Workshop Proceedings and Communications in Computer and Information Science, have no citations, therefore their C/P and C/CP values are zero, and their h-index and g-index are also zero.

Overall, IEEE Access and Lecture Notes in Computer Science from Springer Publication stand out as the most active source titles in hardware wallet research, with high average citation counts per publication and referenced publication. Their contributions are essential for developing knowledge and comprehension in the discipline. The fact that some source titles included in Table 5 have not yet earned citations, suggesting their relatively lesser impact and visibility within the academic community, must be taken into consideration.

Table 5

Most active source title

Source Title	TP	TC	Publisher	C/P	C/CP	h	g
Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	4	20	Springer Publication	5.00	6.67	3	4
IEEE Access	3	40	IEEE Access	13.33	13.33	2	3
ACM International Conference Proceeding Series	1	22	ACM Publication	22.00	22.00	1	1
CEUR Workshop Proceedings	1	0	Aachen University	0.00	0.00	0	0
Communications in Computer and Information Science	1	0	Springer Publication	0.00	0.00	0	0

Notes: TP=total number of 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; and g=g-index.

5.2 RQ2-Pattern and Trends in Hardware wallet Academic Research

The key areas of hardware wallet research were analysed on the basis of i) main subject areas, ii) keyword frequency and iii) country analysis.

Subject areas. Table 6 analyses the topics addressed in hardware wallet publications and shows the quantity of papers and their corresponding percentages. Computer science appears as the most prevalent topic, accounting for 35 documents, or 94.59% of all publications. This emphasises the computer science community's substantial emphasis on hardware wallet research. Engineering comes in second with 17 documents, or 45.95% of the total. Following that, with 13 and 8 documents each, decision sciences and mathematics demonstrate their importance and contributions to the topic. A smaller percentage of the publications are in other fields, which reflects the interdisciplinary nature of hardware wallet research. These fields include Economics, Econometrics and Finance, Business, Management and Accounting, Materials Science, Medicine, Health Professions, Social Sciences, Energy, and Physics and Astronomy. As a whole, computer science stands out as the main topic area for hardware wallet papers, highlighting its crucial role in advancing learning and innovation in this industry. But the inclusion of numerous topics highlights the multidisciplinary nature of hardware wallet research, bringing in insights from other disciplines like engineering, math, economics, and more. The understanding and advancement of hardware wallet technologies are further enhanced by this interdisciplinary partnership.

Table 6

Subject area

Subject Area	Number of documents	Percentage (%)
Computer Science	35	94.59%
Engineering	17	45.95%
Decision Sciences	13	35.14%
Mathematics	8	21.62%
Economics, Econometrics and Finance	4	10.81%
Business, Management and Accounting	3	8.11%
Materials Science	3	8.11%
Medicine	3	8.11%
Health Professions	2	5.41%
Social Sciences	2	5.41%
Energy	1	2.70%

Physics and Astronomy	1	2.70%
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Keywords analysis. The network visualization in Figure 2 displays the author keywords that had a minimum of 10 occurrences. To map authors' keywords, this study employed VOSviewer, a software tool for building and visualizing bibliometric networks (VOSviewer, 2020). The colour and the diameter and text size show that the connection with other terms. **Cluster 1 (Red)**: This cluster includes keywords such as (a) hardware wallet, (b) blockchain, (c) cryptocurrency, (d) personal computing and (e) private key. These keywords seems to be related to the demographic and cyber security issue related characteristics of hardware wallet individuals. **Cluster 2 (Blue)** which is (a) network security, (b) hardware security, (c) authentication. Then, **Cluster 3 (Green)** that contains (a) bitcoin, (b) computer hardware, (c) electronic money, (e) side channel attack, and (f) cryptography. This keyword could be related to the financial technology in cryptocurrency and the importance of this technology.

The top 20 search terms for hardware wallets are listed in Table 7. The keywords are shown together with the total number of publications (TP) and the percentage of publications where they appear. "Blockchain" is the most common keyword, appearing in 45.95% of the publications. With each appearing in 32.43% of the publications, "Cryptocurrency" and "Hardware Wallet" are close behind. With appearances in 27.03% and 29.73% of the publications, respectively, "Bitcoin" and "Private Key" are also important terms. Other notable terms are "Electronic Money" (24.32%), "Authentication" (18.92%), "Block-chain" (18.92%), "Cryptography" (18.92%), and "Hardware Security" (18.92%). In 16.22% of the papers, the term "Network Security" is referenced. There are other terms that pertain to the technological aspects of hardware wallet research, such as "Computer Hardware" (13.51%) and "Personal Computing" (13.51%). Additionally, keywords like "Side Channel Attack" (13.51%), "Digital Storage" (10.81%), "Smart Cards" (10.81%), and "Wallet" (10.81%) reveal particular areas of interest. Keywords "Chromium Compounds" and "Data Sharing," which only appear in 8.11% of the publications, are less commonly used keywords. With an emphasis on the importance of blockchain technology, cryptocurrencies, security, and the wider technological background, these keywords offer an overview of the main focal areas and themes within hardware wallet research.

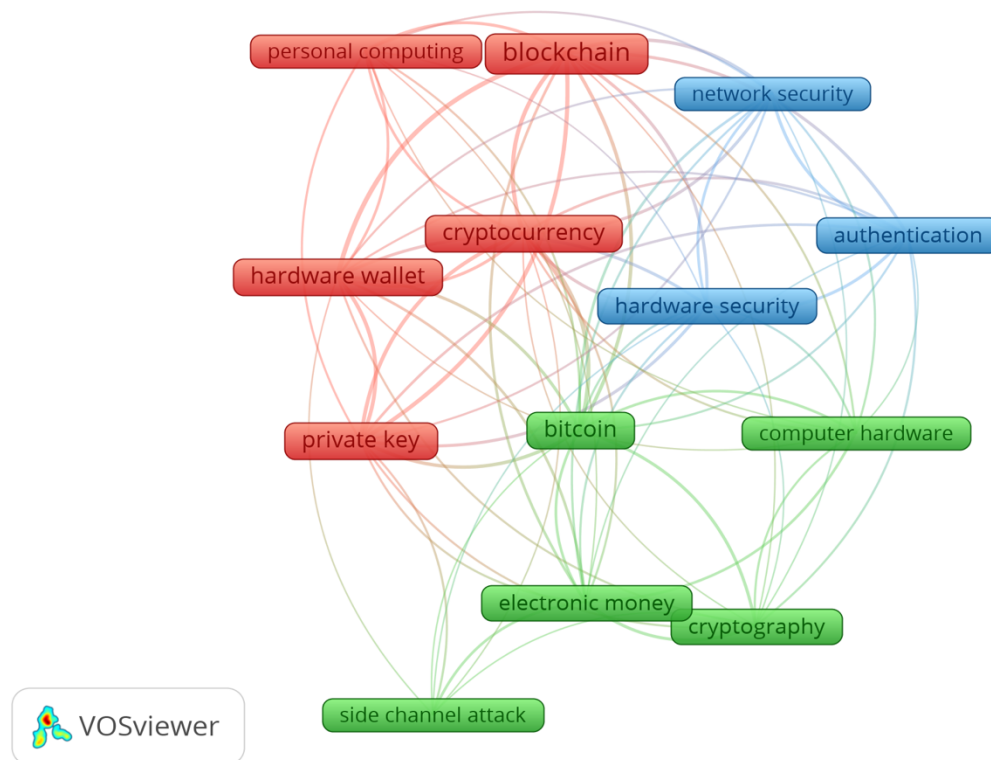


Fig. 2. Network visualization map of the author keywords with at least 10 occurrences

Table 7

Top 20 keywords

Author Keywords	Total Publications (TP)	Percentage (%)
Blockchain	17	45.95%
Cryptocurrency	12	32.43%
Hardware Wallet	12	32.43%
Private Key	11	29.73%
Bitcoin	10	27.03%
Electronic Money	9	24.32%
Authentication	7	18.92%
Block-chain	7	18.92%
Cryptography	7	18.92%
Hardware Security	7	18.92%
Network Security	6	16.22%
Computer Hardware	5	13.51%
Personal Computing	5	13.51%
Side Channel Attack	5	13.51%
Digital Storage	4	10.81%
Smart Cards	4	10.81%
Wallet	4	10.81%
Chromium Compounds	3	8.11%
Data Sharing	3	8.11%

5.3 Major Players and Collaboration in Hardware wallet Research

In this section, we explored a) the countries with the highest research contribution, b) the research institutions involved in hardware wallet studies, c) authorship analysis, and d) citation analysis to analyse the characteristics of scientific collaboration concerning hardware wallet.

Countries contributing most to Hardware wallet research. The information shown displays the total publications (TP) for various nations. The United States has the most publications (9), followed by the United Kingdom (6 publications), and China (3 publications). There are two publications from each of Pakistan, the Czech Republic, India, and Ireland. The remaining nations, which include Singapore, Saudi Arabia, Hong Kong, the Netherlands, Austria, Belgium, Denmark, Estonia, Finland, and France, each have one magazine. Given that it has the most publications, the data indicates that the United States has a significant presence in academic research on the subject at hand. With respect to publications, the United Kingdom and China have also made major contributions to the discipline. It is important to note that the data offers no further context for the nature or calibre of these articles. The distribution of publications throughout numerous nations, however, points to a widespread interest in and involvement with the research topic. The individual contributions made by researchers in various locations could be better understood with further investigation of the research findings published in each nation. Additionally, taking into account elements like the authors' affiliations, networks of collaboration, and the influence of the publications may help to create a more complete view of the academic environment around this topic.

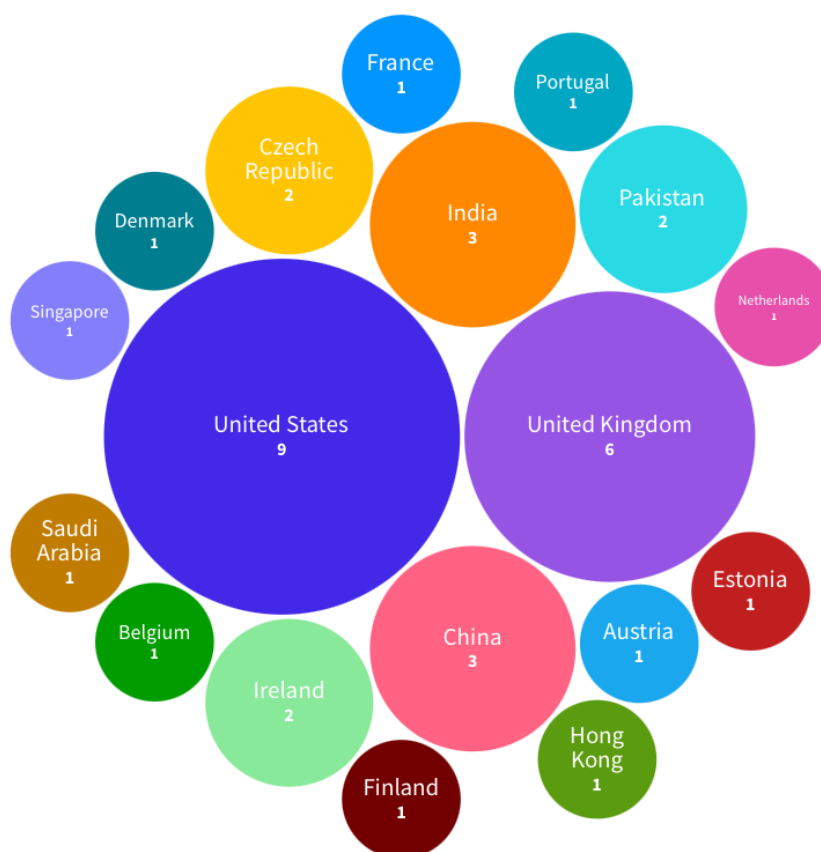


Fig. 3. Top countries contributed most to the publications

Main institutions. The offered data includes a list of numerous affiliations and the Total Publications (TP) numbers that correlate to each connection. The distribution of publications among various institutions and organisations is shown by the study of this data. The University of Central Florida in the United States stands out among the listed affiliations as having the most publications, with a total of 4. With three publications, the University of Edinburgh in the UK comes in second, followed by the University of Suffolk in the UK and Athlone Institute of Technology in Ireland. In addition to Technological University of the Shannon, a number of additional associations have one publication each, including Midlands Midwest TUS in Ireland, SBA Research in Vienna, and the University of California in the United States. This information suggests that a variety of institutions and organisations from many nations have contributed to scholarly research on the subject. The affiliations listed are from universities, research organisations, and business associations, demonstrating the interdisciplinary character of the topic and the teamwork required to produce the articles. Additional investigation could focus on each institution's unique areas of specialisation or research concentration, its partnerships with other affiliations, and the influence of its publications. These revelations would offer a more thorough comprehension of the academic environment and the international networks of collaboration in this particular field of research.



Fig. 4. Top institutions contributed most to the publications

The top 20 authors in hardware wallet research are included in Table 8, along with their total publications (TP) and associated percentages (%). The most prolific authors, with a combined contribution of 10.81% between them, are Rezaeighaleh, H., and Zou, C.C., who each have 4 publications. Following closely are Arapinis, M., Asghar, M.N., Fleury, M., Gkaniatsou, A., Herbst, M.,

Kanwal, N., Kiayias, A., and Lee, B., each with 2 publications and a proportion of 5.41%. These writers have made major contributions to hardware wallet research, demonstrating their skills and commitment to expanding knowledge and understanding in this field.

Table 8

Most 20 Productive Author in Hardware wallet Research

Author Name	TP	%
Rezaeighaleh, H.	4	10.81%
Zou, C.C.	4	10.81%
Arapinis, M.	2	5.41%
Asghar, M.N.	2	5.41%
Fleury, M.	2	5.41%
Gkaniatsou, A.	2	5.41%
Herbst, M.	2	5.41%
Kanwal, N.	2	5.41%
Kiayias, A.	2	5.41%
Lee, B.	2	5.41%

Based on Figure 5 it shows that the network visualization map of the co-citations based on the countries. The countries with the documents and at least five citations were considered based on this analysis. The results show that the red cluster which is authors from the country United States and United Kingdom always been cited based on their research related to hardware wallet.

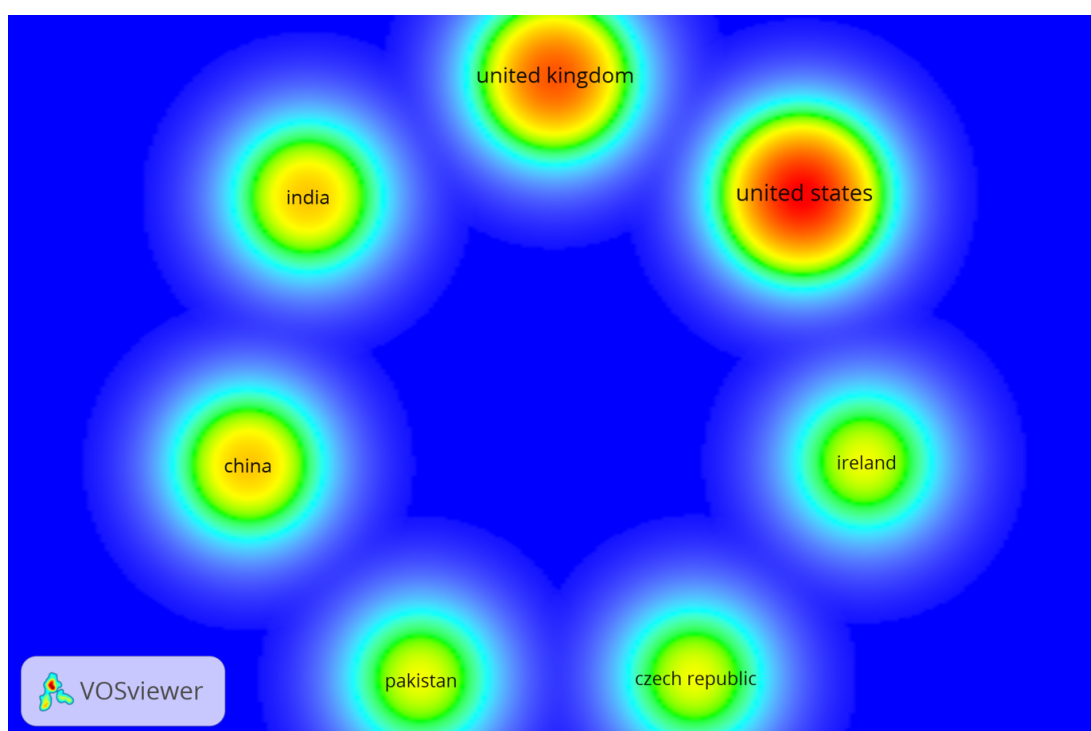


Fig. 5. Network visualization map of hardware wallet research co-authors by country

Citation analysis metrics. Based on Table 9 shows the citation metrics based on academic papers from the Scopus Database. The total number of articles, total citations, years covered, and various

citation-related ratios are all included in Table 9's list of citation metrics for hardware wallet research. According to the table, 37 works in total with 210 citations between 2017 and 2023 were examined. Each paper obtained an average of 8.40 citations overall and 5.68 citations annually. The average number of citations per author when the total number of writers is taken into account is 1.69, suggesting that each author has been cited 1.69 times on average. The author's productivity and effect are gauged by the h-index, which is 8. This indicates that there are 8 papers with a minimum of 8 citations apiece. Another measure that illustrates the distribution of citations is the g-index, which is 13. It implies that there are 13 papers, each of which has at least 13 citations. These citation metrics show the quantity of citations received, the effect of particular papers, and the productivity of writers in the area. They offer insights into the overall impact and productivity of hardware wallet research.

Table 9
Citations metrics

Metrics	Data
Total Papers	37
Total Citations	210
Years	2017-2023
Citations per year	5.68
Citations per paper	8.40
Cites per author	1.69
h-index	8
g-index	13

Next, the top 20 articles in hardware wallet research, as shown in Table 10, are listed. The authors, titles of the articles, number of citations, average number of citations per year, and journal or conference where they were published are all listed in the table. The work by Dai W., Deng J., Wang Q., Cui C., Zou D., and Jin H. with the title "*SBLWT: A Secure Blockchain Lightweight Wallet Based on Trustzone*" has received the most citations. It has 36 citations and a citation rate of 6 per year on average. IEEE Access published the article. Other notable highly cited articles include "*New Secure Approach to Backup Cryptocurrency Wallets*" by Rezaeighaleh H. and Zou C.C. with 15 citations, "*Usability and Security Analysis of the KeepKey Wallet*" by Almutairi E. and Al-Megren S. with 7 citations, and "*Memory FORESHADOW: Memory FOREnSics of HARdware CryptOcurrence wallets - A Tool and Visualisation Framework*" by Thomas T., Piscitelli M., Shavrov I., and Baggili I. with 5 citations. The number of citations for the remaining articles on the list ranges from 3 to 0. These articles discuss a range of subjects, including integrating hardware wallets based on cellphones, trustzone-based blockchain chip wallets, clipboard manipulation attacks, and off-chain transactions. Overall, these highly referenced works advance knowledge of hardware wallet research by addressing issues of security, usability, and cutting-edge methods.

Table 10
Top 20 Highly cited articles

No.	Authors	Title	Cites	Cites per Year	Journal
1	Dai W.; Deng J.; Wang Q.; Cui C.; Zou D.; Jin H. (2018)	SBLWT: A Secure Blockchain Lightweight Wallet Based on Trustzone	36	6	IEEE Access

Table 10 (Continued)

2	Rezaeighaleh H.; Zou C.C. (2019)	New Secure Approach to Backup Cryptocurrency Wallets	15	3	2019 IEEE Global Communications Conference,
3	Almutairi E.; Al-Megren S. (2019)	Usability and Security Analysis of the KeepKey Wallet	7	1.4	ICBC 2019 - IEEE International Conference on Blockchain and Cryptocurrency
4	Thomas T.; Piscitelli M.; Shavrov I.; Baggili I. (2020)	Memory FORESHADOW: Memory Forensics of Hardware Cryptocurrency wallets – A Tool and Visualization Framework	5	1.25	Forensic Science International: Digital Investigation
5	Ivanov N.; Yan Q. (2021)	EthClipper: A Clipboard Meddling Attack on Hardware Wallets with Address Verification Evasion	3	1	2021 IEEE Conference on Communications and Network Security, CNS 2021
6	Rezaeighaleh H.; Zou C.C. (2020)	Efficient off-chain transaction to avoid inaccessible coins in cryptocurrencies	2	0.5	Proceedings - 2020 IEEE 19th International Conference on Trust, Security and Privacy in Computing and Communications, TrustCom 2020
7	Dabrowski A.; Pfeffer K.; Reichel M.; Mai A.; Weippl E.R.; Franz M. (2021)	Better Keep Cash in Your Boots - Hardware Wallets are the New Single Point of Failure	2	0.66666667	DeFi 2021 - Proceedings of the 2021 ACM CCS Workshop on Decentralized Finance and Security, co-located with CCS 2021
8	Zhang Q.; Chen H.; Shi W.; Zhang W. (2021)	Design and Implementation of Trustzone-Based Blockchain Chip Wallet	2	0.66666667	2021 6th International Conference on Signal and Image Processing, ICSIP 2021
9	Yeh L.-Y.; Hsu W.-H.; Huang J.-L.; Shen C.-Y.; Wu-Lee C. (2020)	Integrating Cellphone-based Hardware Wallet with Visional Certificate Verification System	0	0	2020 IEEE Global Communications Conference, GLOBECOM 2020 - Proceedings
10	Chiu W.-Y.; Meng W.; Li W. (2023)	TPMWallet: Towards Blockchain Hardware Wallet using Trusted Platform Module in IoT	0	0	2023 International Conference on Computing, Networking and Communications, ICNC 2023

6. Discussion

This study been motivated by the three research questions which is

- How has hardware wallet evolved and spread?
- What are the patterns and trends in Hardware wallet research?
- Who are the highly cited researchers and institutions in the field of Hardware wallet?

A bibliometric analysis of hardware wallet research is important since it offers a thorough and accurate evaluation of the studies done on the subject. Researchers can use it to determine the most significant articles and study subjects, as well as the most significant authors, organisations, and nations involved in hardware wallet research. Bibliometrics can help pinpoint knowledge gaps and promising research fields by evaluating publication patterns and trends. Hardware wallets are also a complicated and varied phenomenon that may be analysed from a number of perspectives, including social, psychological, and cultural ones. As a result, bibliometrics can help in determining the different aspects of hardware wallet research and the depth to which each aspect has been explored. Researchers looking for a thorough understanding of the subject as well as policymakers and practitioners looking for evidence-based solutions to the problem will find this information helpful. In summary, bibliometric analysis might be a useful technique for mapping the terrain of hardware wallet research and pinpointing potential areas for additional study and cooperation.

Research question 1 shows that the hardware wallet research gained attention from the researchers around the world to know and understand the important of this technology for data security [2,4,5]. From this we can conclude that hardware wallet will gain significant attention after the pandemic covid19 happened especially for financial sectors [1].

Our results then demonstrate trends and patterns based on keyword analysis that were applied in hardware wallet study, which is based on the second research questions. The words "hardware wallet," "blockchain," "cryptocurrency," "hardware security," "electronic money," "network security," and "side channel attack" are frequently used in research on hardware wallets. Researchers can learn more about the trends and significant contributions to hardware wallet research, as well as get a better picture of the present state of knowledge, by doing a bibliometric analysis. This kind of analysis can also help in highlighting areas that need more research and identifying gaps in the literature. An overview of the research landscape provided by a bibliometric study can be helpful for academics, decision-makers, and healthcare specialists who are interested in knowing more about hardware wallet and its consequences.

Then, based on the third research question shows that countries that focus on research related to hardware wallet mostly come from Indonesia then followed by United States, Taiwan, China, Australia, Iran, Nigerias and Poland. The top research institution in this study is from Jadara University, Bina Nusantara University and Universitas Padjajaran Indonesia.

7. Conflict of Interest

The author declare no conflict of interest

8. Conclusion

According to the findings of the bibliometric research, it was found that a number of characteristics, such as social isolation, loneliness, depression, culture, and the COVID-19 pandemic, are connected to the study of hardware wallets. These findings highlight the need of understanding

the intricate and multifaceted nature of hardware wallets as well as the demand for interdisciplinary study in this field.

Additionally, this study contributed two important contributions to subsequent research, namely:

- To begin with, this is the first study to use the Scopus database to perform a bibliometric analysis of the body of knowledge already available on hardware wallets. For individuals who want to research trends and patterns in this area, this analysis is a great resource.
- Second, by indicating topics that need more consideration and inquiry, the study guides academics who are interested in performing additional research.

But it's important to understand that this study has some restrictions. The scope of this study did not include additional databases like Web of Science (WoS), PubMed, EbscoHost, or CSSCI (Chinese Social Science Citation Index). Despite the fact that WoS is a different literature database than Scopus and is not as widely utilised in business, management, and medical research publications, WoS is the largest database currently in existence. In order to improve comprehension and allow new researchers to go deeper into the subject, it is also essential to understand the technical features of the highly cited articles discovered in this study.

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