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BIBLIOMETRIC ANALYSIS OF CRYPTOJACKING CRIME BASED ON SCOPUS INDEX: 2018 - 2021

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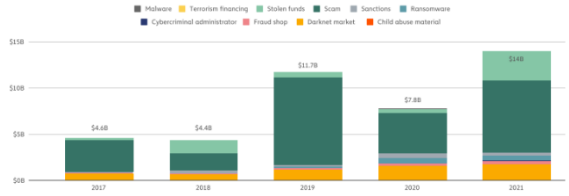
Abstract

Spain's Computer Security Incident Response Team in 2021 stated that there is experiencing growth in cryptocurrency usage. This is in line with the growth of cryptojacking crimes that use cryptocurrencies. Cryptocurrency mining requires large amount of resources. There are people carrying out mining activities using illegal resources, defined as a cryptojacking crime. Based on the Scopus indexing system, research related to cryptojacking began in 2018. Until 2021, there are 94 articles related to cryptojacking. Active countries in cryptojacking crime research are China, India, and the United States. Research of crypto-jacking crimes, requiring basic knowledge about computer systems and network security, malicious software (malware), and electronic currencies such as bitcoin, ethereum, litecoin, etc. Using bibliometric analysis, it is possible to conduct further studies using certain keywords or trends from a research topic. In addition, it also makes it easier for researchers to map advanced topics.

Keywords*: cryptojacking, crypto currency, cybercrime, scopus, bibilometry*

1. INTRODUCTION

Since the recognition of Bitcoin as a cryptocurrency that uses a peer-to-peer scheme in 2008, cryptocurrencies have experienced quite rapid growth, including Ethereum, Litecoin, and Ripple.(Centro Criptológico Nacional-Computer Emergency Response Team, 2021). The increasing use of crypto money has an impact on the use of crypto money in cybercrime. The trend in the development of cybercrimes that use cryptocurrencies in the last five years has reached 42.5 billion dollars, as shown in Figure 1. Cybercrimes that use cryptocurrencies include: malware, terrorism, theft, scams, ransomware, illegal markets, and crimes in children(Chainalysis, 2022).



Picture1Trends in the Development of Cybercrimes

Cybercrime that utilizes cryptocurrencies by mining, was first published in 2018 with indications of manipulation of HTML scripts on the Open Proxy service. In addition, there are several Man-in-the-Middle (MitM) attacks on network infrastructure that insert trojans or malware.(Mani et al., 2018). In its development, cryptocurrency mining activities use several communication models between miners and mining pools, including: connecting directly, connecting using proxies, and connecting using encrypted proxies. Therefore, steps are needed to illegally detect cryptocurrency mining activities on the infrastructure. MineHunter is a practical proposal in detecting traffic of cryptocurrency mining activity(Zhang et al., 2021).

Based on these two scientific publications, it is necessary to conduct studies related to cyber crimes that utilize cryptocurrencies in the 2018 - 2021 period. In line with reports and monitoring of anomalous traffic by the National Cyber and Crypto Agency, it is known that mining pool activity is an anomalous traffic with the order number three in Indonesia(National Cybersecurity Operations Center for National Cyber and Crypto Agency, 2021). So in this paper it is proposed to study illegal cryptocurrency mining activities based on research indexed on Scopus using bibliometric analysis to determine research gaps.

2. RESEARCH METHODS

2.A. Data source

To determine research topics can analyze research gaps using bibliometrics. In previous studies, bibliometric analysis was used to find out digital forensic researchers in Indonesia using Digital Reference Garba (GARUDA) data sources. However, at GARUDA, research topics do not accommodate more than one research search keyword (Kusuma et al., 2021). Subsequent studies use data sources from the Scopus indexing system. From this research, the results of studies related to research such as topics based on keywords were obtained which could be used as further references. Bibliometric analysis can also be used to determine

tertiary institutions for further studies or research collaborations (Kusumaningrum et al., 2022).

In this study, it is proposed to study crimes that utilize cryptocurrencies using bibliometrics using data sources from the Scopus indexing system. Cryptocurrency was created as a medium of exchange in electronic transaction delivery systems, not to support cyber crime (Nakamoto, 2008). However, there are cybercrimes for financial transactions that use cryptocurrencies. So it is necessary to carry out further studies regarding the activity of using cryptocurrencies in cybercrime or what is commonly called cryptojacking. Cryptojacking which involves cryptomining activities in principle mining resources that are converted to crypto currency. However, in practice cryptomining activities make use of resources illegally (Widiyasono et al., 2021).

Data sources are collected based on cryptojacking keywords in the Scopus indexing system. The number of articles collected in the 2018 – 2021 period is 94 articles. Filtering criteria such as country of origin and type of publication were not carried out for a number of these articles. Of the 94 articles, there are 302 authors and 227 keywords related to cryptojacking. The collected data source file format is in the form of CSV resulting from the processing of the Scopus indexing system.

2.B. Data Processing

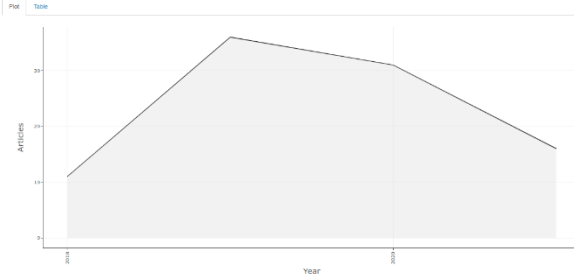
Files in the form of CSV from the Scopus indexing system with a total of 94 articles were processed using the bibliometric application. The bibliometric application was built using the R application to comprehensively map and analyze a research topic(Aria & Cuccurullo, 2017). The scope of bibliometric analysis in this study includes publication trends, researcher analysis, research topic analysis, and network analysis.

3. RESULTS AND DISCUSSION

3.A. Publication Trends

The process of exploring this research uses the cryptomining keyword in the Scopus indexing system as a data source for bibliometric analysis. The search query used in the Scopus indexing system is TITLE-ABS-KEY cryptomining. The search does not pay attention to the time. This aims to find out the beginning of research on cryptomining.

Based on the search results on the Scopus indexing system, 94 articles were found spanning from 2018. To make searching easier, the timeframe is limited to 2021, because 2022 is still running. The search results are in the form of a list of Scopus indexed articles which can be downloaded in CSV file format. By using the bibliometric application, CSV files from the Scopus indexing system make it easy to analyze publication trends from year to year(Tong & Liang, 2020). Compared to 2018, there will be more research related to cryptomining in 2021, namely 16 articles. In the 2018-2021 timeframe, the highest score was achieved in 2019, with a total of 36 published articles, as shown in Figure 2.



Picture2 Cryptomining Research Trends

3.B. Researcher Analysis

Of the 94 articles indexed by Scopus with the keyword cryptojacking from 2018-2021, 302 authors were identified. There are not many article authors or researchers identified with the keyword cryptojacking. There are only 6 authors who actively write more than 2 articles, as shown in Table 1.

Table1Cryptojacking Researcher

Writer	Article
Jonah Burgess	3
Domhnall Carlin	3
Aviad Cohen	3
Yuval Elovici	3
Nir Nissim	3
Sakir Sezer	3

Meanwhile, the analysis based on the author's institution of origin is quite diverse. There were no writing institutions that published more than 10 articles. Table 2 shows only 8 institutions that publish scientific articles related to cryptojacking with more than 4 articles.

Table2Cryptojacking Research Institute

Institution	Article
Ben-Gurion University of The Negev	9
Tsinghua University	9
Amrita School of Engineering	6
University of Missouri	6
Fudan University	5
Sichuan University	5
The University of Texas At Dallas	5
University of Texas At San Antonio	5

Not much different from the origin of the institution, articles about cryptojacking are dominated by China, India and the United States. This is based on the country of origin of the corresponding author with an article limit of more

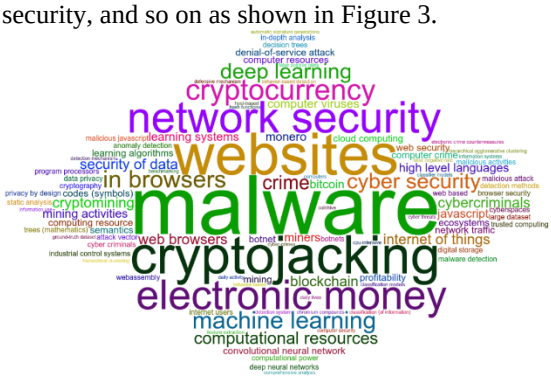
than 2 articles. Table 3 shows the three countries equipped with Single Country Publication and Multiple Country Publication values. Single Country Publication (SCP) is a publication assessment based on the origin of the authors from the same country as a form of domestic research collaboration. Meanwhile, Multiple Country Publication (MCP) is a publication assessment based on the origin of the authors from various countries as a form of research collaboration between countries(Sweileh et al., 2017).

Table3Cryptojacking Research Country

Country	Article	SCP	MCP
China	4	2	2
India	4	4	0
United States of America	4	3	1

3.C. Research Topic Analysis

Scopus has a feature of extracting publication content into keywords which makes it easier for researchers to be able to choose research topics in a more directed manner by combining keywords from the researchers themselves. This feature is called Keyword Plus(Kusumaningrum et al., 2022). Through Keyword Plus, a researcher gets references related to the scope of the object under study. In articles with cryptojacking keywords, keywords for further searches are obtained, namely the keywords malware, websites, electronic money, network security, and so on as shown in Figure 3.



Picture3Advanced Keywords

In line with Keyword Plus, the keywords obtained from the abstracts of Scopus indexed articles show that the crime in the form of cryptojacking has an effect on the level of security of computer networks. The advanced keywords of cryptojacking crimes extracted from the abstract of the article are IoT Devices, Cryptocurrency Mining, Network Traffic, and so on. The keyword visualization in the form of Word Cloud in Figure 4 uses bigram processing, which is processing a text by separating two words in a paragraph, in this case the article abstract.(Ramadan et al., 2021).

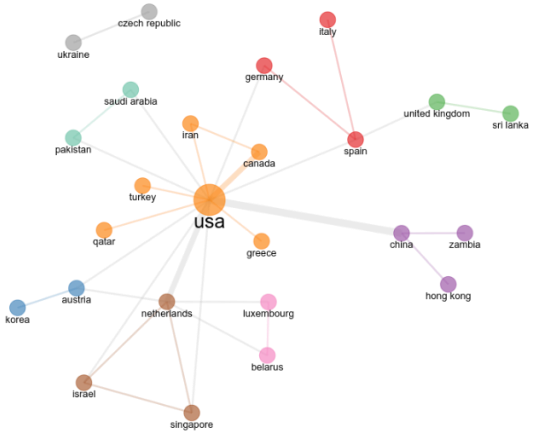
Picture4Keywords Extraction Result

3.D. Network Analysis

In network analysis, cryptojacking research is dominated by the United States as the network center. There are only 2 countries that are not connected to researchers from the United States, namely the Czech Republic and Ukraine, which are in the gray cluster, as shown in Figure 5. There are 3 types of networks, namely direct networks, indirect networks.), and a combination of direct and indirect (hybrid). The description of the cryptojacking research network with the United States network center is shown in Table 4.

Table4Description of the Cryptojacking Research Network

Country	Cluster Color	Direct	Indirects	Liaison
Pakistan	Tosca	V		
Saudi Arabia	Tosca	V		
Iran	Orange	V		
Turkey	Orange	V		
Qatar	Orange	V		
Canada	Orange	V		
Greece	Orange	V		
China	Purple	V		
Zambia	Purple		V	China
Hong Kong	Purple		V	China
German	Red	V	V	Spanish
Spanish	Red	V		
Italy	Red		V	Spanish
great Britain	Green		V	Spanish
Sri Lanka	Green		V	Spain, Great Britain
Austria	Blue	V	V	Dutch
Korea	Blue		V	Austria
Dutch	Chocolate	V	V	Austria
Israel	Chocolate	V	V	Dutch
Singapore	Chocolate	V	V	Dutch
Luxembourg	Pink		V	Dutch
Belarus	Pink		V	Dutch



Picture5Research Network Analysis

4. CONCLUSIONS AND RECOMMENDATIONS

In principle, cryptocurrency mining or cryptomining activities are neutral, even legal if using personal resources. However, there is a cryptocurrency mining process that utilizes illegal resources such as using servers obtained by illegal access, using office resources such as computers, the internet, and office electricity. The crypto currency mining process requires no small amount of resources. So this kind of illegal mining activity can be categorized as resource piracy or cryptojacking. Based on the Scopus indexing system, research related to cryptojacking began in 2018. There are 94 articles about cryptojacking recorded up to 2021. Bibliometric analysis makes it easier for researchers to determine further studies by taking into account the findings of supporting keywords such as malware, websites, electronic money, and network security. As for indicators to facilitate further research by analyzing trends from several researchers and countries, analyzing the emergence of related keywords through word cloud visualization, and the potential for further studies in countries or universities that have research roadmaps on cryptojacking.

Countries that dominate in cryptojacking research include China, India, and the United States. For research networks, it is still dominated by the United States as the network center. There are only two countries that are not affiliated with the United States, namely the Czech Republic and Ukraine. Based on the findings in this bibliometric analysis, it is necessary to further explore using supporting keywords in order to produce a comprehensive research.

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