Foundations and trends in the darknet-related criminals in the last 10 years: a systematic literature review and bibliometric analysis

Author

Luong, Hai Thanh

Published

2023

Journal Title

Security Journal

Version

Version of Record (VoR)

DOI

10.1057/s41284-023-00383-4

Security Journal
https://doi.org/10.1057/s41284-023-00383-4

ORIGINAL ARTICLE

Foundations and trends in the darknet-related criminals in the last 10 years: a systematic literature review and bibliometric analysis

Hai Thanh Luong[1]

Accepted: 15 May 2023

Abstract

After the *Silk Road* closure, many studies started focusing on the trend and patterns of darknet-related crimes in the 2010s. This first study combined a systematic literature review and bibliometric analysis in the field. This study clarifies 49 articles in criminology and penology among 1150 publications relating to the darknet on the Web of Science database to review and analyze the research evolutions of this topic in the last decade. The main findings point out (1) almost all leading authors with their most influential papers came from the Global South with predominant contributions; (2) unbalancing publications between regional scholars and their institutions and countries although the darknet-related criminals occurred and operated without border; and (3) some specialized themes have identified to call further extensive research such as policing interventions in the darknet and flows of the cryptocurrency in cryptomarkets, among others.

Keywords Darknet · Criminology · Policing · Cryptocurrency · Network · Silk road

Introduction

People use the darknet,[1] the most popular being The Onion Router, known as *Tor* (Demant et al. 2018a, b; Lacson and Jones 2016; Martin 2014a, 2014b). According to the latest report (2021), the *Tor* network is the largest darknet and contains most

[1] For the terminology, to distinguish with the surface (clean) net/web (which only cover around 5% in the world wide web), there are different usages to describe the deep net/web (95%), including small dark net/web channel. With this article's aim, for short name: Darknet will be preferred to use frequently. It does not mean to different with the rest of the meaning with others (see more detail 14 keywords in "Database and Keyword-Based Search" section).

✉ Hai Thanh Luong
h.luong@uq.edu.au

[1] School of Social Science, The University of Queensland, Brisbane, QLD 4072, Australia

Published online: 28 May 2023

channels for those lovers, with at least 200,000 onion services worldwide in mid-2020 (servers inside the *Tor* darknet). Although it is possible to provide a specific estimate of the number of darknet users in a country, it is not feasible to precisely identify their reasons for using darknets (Laferriere and Decary-Hetu 2022; Munksgaard and Tzanetakis 2022; Tor 2021). In theory and practice, salient motivating factors appear to be the protection of privacy and circumventing online censorship in addition to those who commit cybercrimes (Moeller et al. 2021; Munksgaard et al. 2021). It led to the reality that cybercriminal use of darknets varies. For some, it is a place to access illicit goods and services where products available include firearms and ammunition, hacking tools and services, child sexual exploitation material, and a wide variety of trade of payment card information and counterfeit documents (Leclerc et al. 2021; Roddy and Holt 2022; Wilson 2020; Wronka 2022). For others, it is a springboard to launch cyberattacks, while for others, it is a place to exchange and trade cryptocurrencies and anonymous communication applications or to provide legitimate privacy (Johnson et al. 2020; Kamphausen and Werse 2019). Particularly for illicit drug markets (including cocaine, heroin, and opioids), the UNODC World Drug Report 2022 estimates that people who purchased drugs over the Darkweb continued a marked increase from January 2014 to January 2021, followed by a decline until January 2022. Accordingly, the costs were estimated at just $315 million per year based on calculations from drug-related transactions on 19 major darknet markets monitored from 2011 to 2020 (UNODC 2022b, p. 57). Their geographical markets are no longer limited to Western countries when they expand to Eastern Europe, Latin America, Asia, and Africa (UNODC 2022a, b). Although darknet markets accounted for a small share of drug transactions, their smoldering activities have been maintained over the past years (Décary-Hétu and Giommoni 2017; Demant et al. 2018a, b; Lacson and Jones 2016; Martin 2014a, 2014b). Data collection on 38 major global darknet markets, 2011–2021, reflected that user interfaces increasingly allow vendors as friendly options as possible. For instance, they can bulk order and combine orders of different products into one and/or multiple shipments daily (UNODC 2022a). As a result, it makes it more difficult for law enforcement to find and triage priority threats. While there is an overall lack of consistent, quantitative, and qualitative data from law enforcement agencies, there is also lacking a bibliometric analysis and/or systematic literature review (SLR) to provide the trends and patterns of these concerns.

As one of the burgeoning fields in cybercrime, the volume of content on darknets and the number of people using them (especially *Tor*) is growing continuously. Although not all darknet activities are illicit (Mirea et al. 2019), organized criminals working within the darknet constantly develop their capabilities, security mechanisms and business practices (Gupta et al. 2021; Rojas-Sanchez et al. 2022). As darknets strengthen their levels of security, gaining access and having a meaningful impact have become more complicated and costly, making it increasingly difficult to achieve progress at an individual research level (Demant et al. 2018a, b; Martin 2014a; Martin and Christin 2016). Instead, conducting a SLR based on the previous darknet-criminal studies is necessary to call for specific focuses with evidence-based research in future (Roemer and Borchardt 2015).

There are a few systematic reviews about the evolution of the darknet. Two of those came from Australian institutions. One of three researchers of the School of

Information Technology, Deakin University and their colleague in the College of Computer and Information Sciences, King Saud University, Riyadh, Saudi Arabia (Nazah et al. 2020) to review the evolution of the dark web threat analysis and detection. The other is a review of the dark web by three researchers from the School of Computing and Information Systems University of Melbourne (Gupta et al. 2021) to review the dark web phenomenon. Others have contributed to assessing the impact of the dark web on online anonymity and privacy (Beshiri and Susuri 2019) and evaluating the secure end-user experience on the darknet (Tazi et al. 2022). The author also quickly searched *Security Journal* with the term 'dark web' or 'dark net.' As of July 2022, except for one article (mentioned about dar web/net by Mirea et al. (2019), there were no more studies to assess the darknet-related criminalities among 25 (dark web) or 19 (dark net) results. Furthermore, in the total of 35 volumes in 35 years of *Security Journal*'s publication, there are no studies to systematically review darknet-related criminals since the *Silk Road* and its dismantled in the 2010s. This article will conduct SLR and visualize bibliometric analyses in criminology and penology to categorize the existing research on darknet-related criminals. As the most contributions of the paper, the combination of SLR and bibliometric methods allows for finding the main topics, authors, sources, most cited articles and countries (Linnenluecke et al. 2020; Rojas-Sanchez et al. 2022). It helps the readers know the darknet-related criminals' conceptual, intellectual and social structure (Beshiri and Susuri 2019; Gupta et al. 2021; Nazah et al. 2020; Tazi et al. 2022). To obtain these objectives, there are six research questions (RQs) following:

- RQ1: What are the trends concerning demographics, data sources, and temporal trends in the darknet? ("Overview of the identified publications" section)
- RQ2: Which is the main journal with its related citations on the darknet's topic? ("Main publication's sources with its related citations" section)
- RQ3: Where are the leading author's countries in darknet research? If so, how does their local and global citation record? ("Author's contributions and their affiliations and countries" section)
- RQ4: What are the most influential papers, and who are the leading authors in darknet-related criminals? ("Leading publication with its related influences" section)
- RQ5: How did the identified themes concerning darknet-related criminals evolve during the past ten years? ("Thematic evolution in the darknet-criminal concerns" section)
- RQ6: What and how do the authors share and collaborate to research darknet-related criminals? ("Scale of co-authors' collaboration in the darknet-related criminals" section)

To some extent, it is the first study that applies bibliographic mapping approaches to visualize bibliometric information and findings from an SLR via applying the Biblioshiny software to review and illustrate the trend and pattern of darknet-related criminals in the last decade. Below, the article first describes some key concepts and discusses the methods and tools used in this study. Later, the author interprets

the results of the SLR and bibliometric analyses before discussing past, present, and likely future research.

Methods

Systematic literature review

Literature reviews play a significant role in every field of study as they provide a summary of the evidence needed to inform new research projects (Pickering and Byrne 2014; Pickering et al. 2015; Tranfield et al. 2003). Particularly, with the new areas in cybercrime/cybersecurity, reviewing the literature system provides policymakers, academics, practitioners, and law enforcement agencies with the whole picture of the darknet from its previous studies (Beshiri and Susuri 2019; Gupta et al. 2021; Nazah et al. 2020; Tazi et al. 2022). Yet, it also contributes to the call for further research to fix any potential gaps through the process of the SLR in criminology and penology (Suzuki et al. 2018). In comparison, the narrative literature reviews provide a synthesis or description of the existing literature without using any quantitative measures; an SLR offers a replicable, transparent and comprehensive means of identifying relevant material (Pickering and Byrne 2014; Pickering et al. 2015).

Several data acquisition and clean-up strategies have been used to address the above six RQs. They include keyword identification, database identification and keyword search, and expert advice on relevant literature (Tranfield et al. 2003). Both quantitative and qualitative methods have been utilized to systematize and interpret the data. "Database and keyword-based search" and "Inclusion and exclusion criteria" Sections describe the selected quantitative methods and the research tools in "Bibliometric research tools" section. Some bibliometric methods include a citation, co-citation (Small 1973), co-authorship and network analyses (Peters and van Raan 1991). From the obtained data, prominent research themes have been identified and described (Gupta et al. 2021; Nazah et al. 2020). Moreover, to better understand the fields and bodies of literature, the current article quantitatively analyzes the geographies of case studies and theoretical and conceptual frameworks utilized in the publications relating to the darknet and its related criminals. A key benefit of using this method is that it highlights the existing literature's diversity, spread and gaps.

Database and keyword-based search

Several darknet publications can be found in databases such as Scopus, Clarivate Analytics' Web of Science, Association for Computing Machinery (ACM) Digital Library, IEEE Xplore, Criminal Justice Abstracts (EBSCO), PubMed, and Cochrane. However, three main reasons led to focusing on only the Web of Science database (WoS). First, the author is holding a Research Fellow in Cybercriminology to set up a new course relating to the darknet and its impacts on criminal activities in the digital age. To some extent, this first SLR article will review previous publications in cybercriminology rather than others. Second, this article combines

SLR and bibliometric analysis to review and visualize the trend and pattern of darknet-related criminals. Currently, it is a burgeoning field in cybercriminology's sub-field and cybersecurity degrees at the University of Queensland. This SLR is the first kick-off approach without co-authors who are similar interests. Thus, with one new researcher, I prefer to focus on one main resource, WoS, rather than covering all those resources, which should be called for further collaborations with more than two above scholars in subsequent studies (Pickering and Byrne 2014; Pickering et al. 2015; Suzuki et al. 2018). Some leading authors in bibliometric analysis (Aria and Cuccurullo 2017; Cuccurullo et al. 2016) also recommended that scholars should be kept in mind to select one source rather than a mix of multiple sources to avoid conflicts in calculating. Lastly, compared to WoS and Scopus, the classification of criminology and penology publications has only been indexed in the WoS database, not by Scopus. Thus, it is satisfied with the specific aims of this SLR's articles to downsize into small inches.

The author searched through five digital scholarly databases on the WoS (Clarivate), namely Emerging Sources Citation Index (ESCI), Conference Proceedings Citation Index – Social Science & Humanities (CPCI-SSH), Social Sciences Citation Index (SSCI), Science Citation Index Expanded (SCI-EXPANDED), Arts & Humanities Citation Index (A&HCI). Based on the basic steps of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), the result of searching and scanning is illustrated in Fig. 1. The selection process was based on iterative evaluation. I started by defining appropriate keywords for darknet-based research, which is quite similar to some previous studies (Beshiri and Susuri 2019; Gupta et al. 2021; Nazah et al. 2020; Tazi et al. 2022). The search terms were identical throughout the five WoS digital libraries. They included the following 14 terms: "Deep Web" OR "Dark Web" OR "Dark Net" OR "Deep Net" OR "Deepnet" OR "Deepweb" OR "Darkweb" OR "Darknet" OR "Hidden Web" OR "Hidden Net" OR "Tor" OR "Invisible Web" OR "Invisible Net" OR "Cryptomarket." In this paper, the terms 'dark net' (or 'darknet') and 'dark web' (or 'darkweb') are sometimes used interchangeably, referring to an invisible and/or hidden online system on the Internet. For the first step, there were 1,150 results from those five databases as of this writing (July 2020).

Inclusion and exclusion criteria

Our selection standards for the corpus required that all papers be: (1) research papers or articles published in peer-reviewed journals or conferences to ensure academic integrity best; (2) published in English only; and (3) made available by 30 June 2022. These selection criteria were chosen to ensure all papers were held to a high academic standing in the WoS system and could be accessed and analyzed. Moreover, papers were excluded if: (1) the content analysis showed that the research was not directly related to the darknet or darkweb; (2) they were presented as a work in progress, posters, extended abstracts of book series or any other form apart from a complete paper; (3) the full text was not available despite having privileged administrative access; and (4) the collected articles were part of book chapters. At the end of this step, we had 899 papers (Fig. 1).

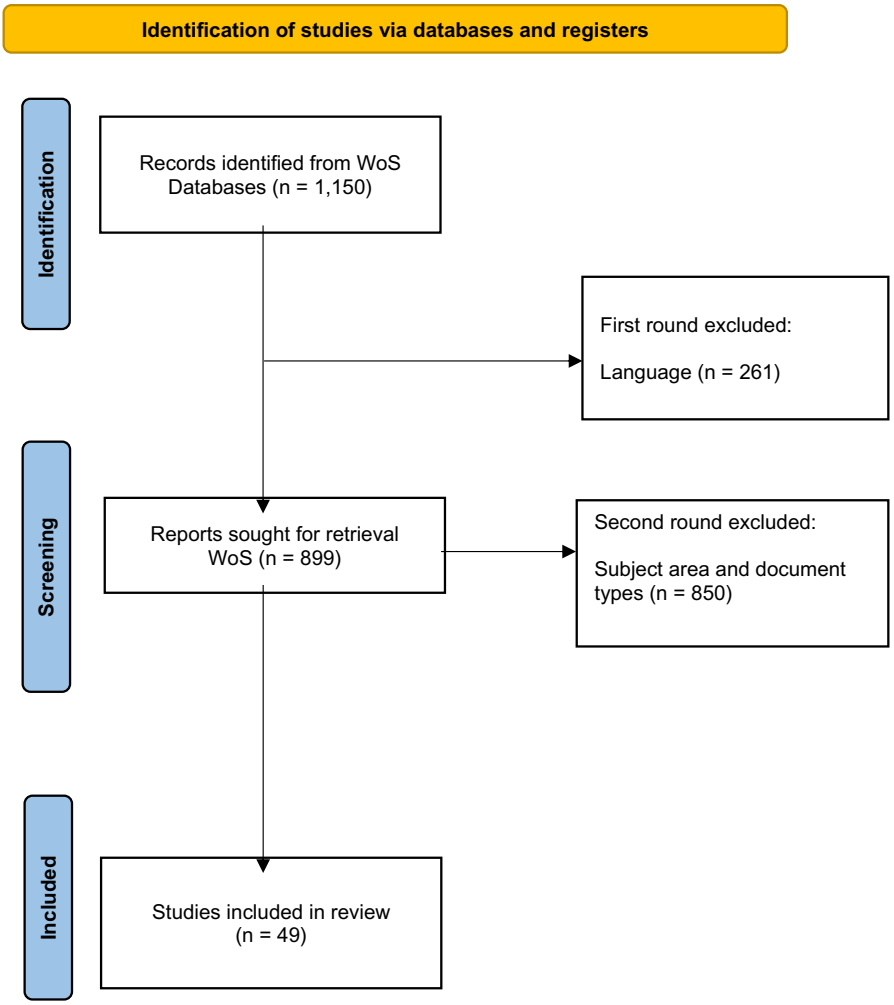


Fig. 1 PRIMAS for the darknet-related criminals

The author conducted a manual title and abstract-based screening to remove irrelevant papers. Targeting only criminology and penology, and thus, 850 papers were excluded at this stage. Instead, only 49 articles were satisfied to enter the final step (Fig. 1). Regarding the darknet-related criminals in this field, these selected articles were classified into psychology social, sociology, law, psychology clinical, social sciences interdisciplinary, and linguistics. For the last one, the linguistic article (Chiang et al. 2020) was not accessible to collect via the University of Queensland's library system; the author reached out to the authors via email to access the full text.

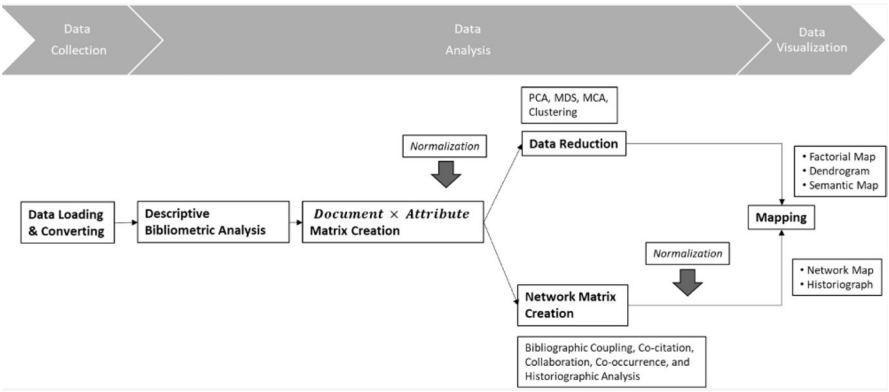


Fig. 2 Flows of the Biblioshiny tool

Bibliometric research tools

One of the common methods of bibliometrics, citation analysis, has been performed for the SLR (Linnenluecke et al. 2020). In the case of SLR, bibliometric studies give an overview of what publications affected the subsequent articles and others (Cuccurullo et al. 2016). Moreover, citation analysis permits the identification of leading journals, research affiliations, and other data types for bibliometric analysis (Aria and Cuccurullo 2017).

Main functions of the bibliometric analysis

Bibliometric is an open-source tool for executing a comprehensive science mapping analysis of scientific literature. It was designed in R language to be flexible and easy to integrate with other statistical and graphical packages. To some extent, thus, it is a tool used worldwide (85 countries) with over one thousand publications (as of April 2022) in the last four years (2018–2022), with an increased rate on average of 91.94% (Bibliometrix 2022). In technical, bibliometrics provides diverse pathways for importing bibliographic data from Scopus, WoS, PubMed, and Cochrane databases (Aria and Cuccurullo 2017). However, merging WoS and Scopus collections with others, which are very different approaches to codifying the bibliographic metadata, is a complex task without open-access software (Aria and Cuccurullo 2017). Thus, the current study uses the Biblioshiny app, a web-based app included in the bibliometric package to support plain text files for WoS, to analyze and build data matrices for co-citation, coupling, scientific collaboration, and others (Fig. 2). With Biblioshiny, bibliometrics has become very user-friendly, even for those with no coding skills and knowledge, including myself (Aria and Cuccurullo 2017).

After collecting the final listing ($n = 49$ articles), it is saved as plaintext to work smoothly in the Biblioshiny environment. The compiled file was imported into the Biblioshiny, which allows for creating and analyzing citation networks, clusters of

publications and core publications (Aria and Cuccurullo 2017; Cuccurullo et al. 2016). As part of the technical defaults in the Biblioshiny software, only the top twenty most cited publications should be prioritized to visualize in the network to ensure the quality of the image. Furthermore, this volume's size (20) is the default parameter by the Biblioshiny software users to show the most important citation connected within the collection (Aria and Cuccurullo 2017; Cuccurullo et al. 2016; Linnenluecke et al. 2020). Biblioshiny retrieved the reference lists from the SLR database to analyze citation networks for quantitative analysis. The Biblioshiny created graphs that depict network layout, degree centrality, and clustering. The size of nodes represents the degree of centrality: the larger the node, the more times it was mentioned within the SLR database for quantitative analysis. In addition, the thickness of the edges represents the number of times the two connected nodes were mentioned together, indicating their relevance to each other. The networks were default distributed from the largest to the smallest on the graph.

Interpretations from biblioshiny software

The article utilized R software to analyze bibliometrics via conducting the Biblioshiny app. It provides an overview of data collection and analyzes three level metrics (source, author, and document) and three knowledge structures (conceptual, intellectual, and social). This tool analyzed two sets of data—keyword co-occurrence and co-authors co-occurrence—in two stages. One is to show the full network, and the other is to narrow it down for further analysis. In the case of the author's keywords, the study filtered out those combinations that occur only once in the network. The network analysis illustrated and calculated all these figures with their vertices (also called nodes or points) and edges (also called links or lines) to create science mapping in the Biblioshiny tool. The bigger the node's size, the more frequently the keyword is used. The thickness of the links between the nodes represents the number of times pairs of the author's keywords occur (the thicker the line, the more often the pair of words is used).

The Biblioshiny allowed analysis of four main areas for the author's contributions. One is to focus on the author's production over time, their most relevant publications and cited time. Two is to look for the author's most relevant affiliations at the time of publishing. Three is to compare the author's countries based on three main criteria (corresponding author's country, country scientific production, and most cited countries). It also allowed for analysis of the scale of the collaboration network between authors, affiliations, and countries. Last, using Finally, utilizing the co-citation network (the intellectual structure) and the collaboration network (the social structure) identifies the scale of the author's collaborations in research.

This tool used three main functions to identify the leading paper and its impacts on the field. One is to examine each article's two most important figures, local citation score (LCS) and global citation score (GCS). The former refers to the author's citations by one of the 49 articles. The latter receives citations from any bibliographic database (WoS, Scopus, etc.) and/or different fields (rather than only criminology and penology). Two is to compare the cited references in each article to understand the scope of the theoretical and applicable resources in writing. Three is

to visualize the top-ranking keywords and their trend topics in darknet-related criminals among 49 articles by conducting the WordCloud's function in the Biblioshiny. The font size of the words represents the frequency of occurrence of the keyword. Besides that, the three-field plot in the Biblioshiny software, a Sankey Plot, summarizes the relationship among different fields. They include authors, affiliations, countries, keywords, references, titles, abstracts, sources, and cited sources. It helps identify the top keywords in darknet-related research and leading authors to some extent. The current paper compares the top keywords, authors, journals, and references they used based on these.

Finally, to determine the thematic map and evolution in the timespan among articles, applying a clustering algorithm on the keywords in the Biblioshiny has two main meanings. One is to reflect the importance of the theme/topic in the entire research field (centrality), and the other is to measure the theme's development (density) (Aria et al. 2020). Each bubble represents a network cluster to provide the centrality and density of each theme/topic (Aria et al. 2022). The bubble name is the word belonging to the cluster with the higher occurrence value. The bubble size is proportional to the cluster word occurrences, while the bubble position is set according to the cluster Callon centrality and density (Aria and Cuccurullo 2017). Accordingly, the R language will be classified these thematic maps into four main groups, namely (1) motor themes, (2) basic and transversal themes, (3) emerging or declining themes or (1) highly developed and isolated themes (very specialized/niche) (Aria et al. 2022; Cobo et al. 2011).

Findings and interpreting analysis

Overview of the identified publications

All the analyses indicated in the following were carried out with the open-source R package bibliometrics via the Biblioshiny software. Table 1 shows the timeline, sources, annual scientific production, average citations per year, and references. It reflects the main information about data, including (1) document types, (2) document context, and (3) authors' collaborations.

Accordingly, the main information about this study's collection shows that research on the darknet and its related criminal activities was published in 2014. The timespan in the current systematic literature review was recorded between 2014 and 2022. There are 49 articles to be written by 113 authors, including single-authored ($n = 7$) and multi-authored documents ($n = 106$). The average year from publication is 2.77; however, there was no publication in 2015 in the timeline. If only one publication was released in 2014, 11 articles were in 2021, which boosted the annual growth rate by 16.99% (Fig. 3). The average number of citations per document is 9.959%, while the article published in 2014 collects the highest number of average total citations per year (14.6%).

To identify the top keywords in the darknet-related research and leading authors, I used the bibliometric's three-field plot to compare the top keywords, authors, journals and references. Focusing on the top keywords, Fig. 4 shows that

Table 1 The main information about the darknet-related publications

Description	Results
Main information about data	
Timespan	2014:2022
Sources (Journals, Books, etc.)	24
Documents	49
Average years from publication	2.77
Average citations per document	9.959
Average citations per year per doc	2.43
References	1946
Document types	
Article	43
Article; early access	6
Document contents	
Keywords plus (ID)	109
Author's keywords (DE)	135
Authors	
Authors	113
Author appearances	136
Authors of single-authored documents	7
Authors of multi-authored documents	106
Authors collaboration	
Single-authored documents	7
Documents per author	0.434
Authors per document	2.31
Co-Authors per documents	2.78
Collaboration index	2.52

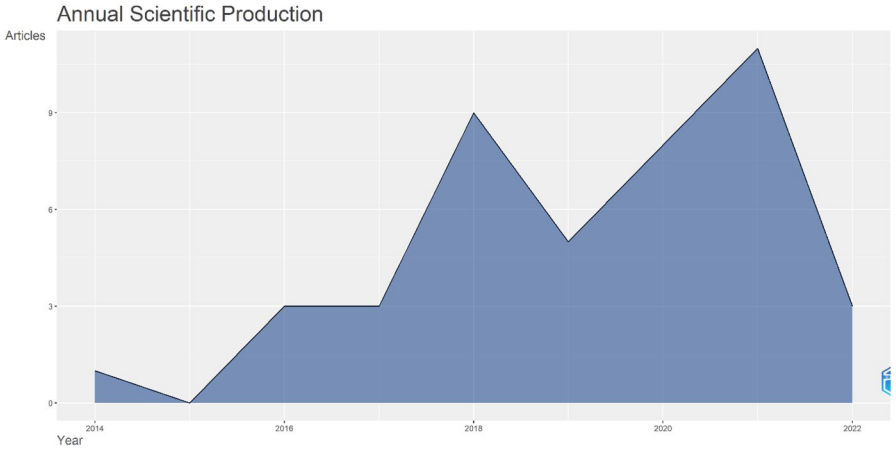


Fig. 3 The annual scientific production

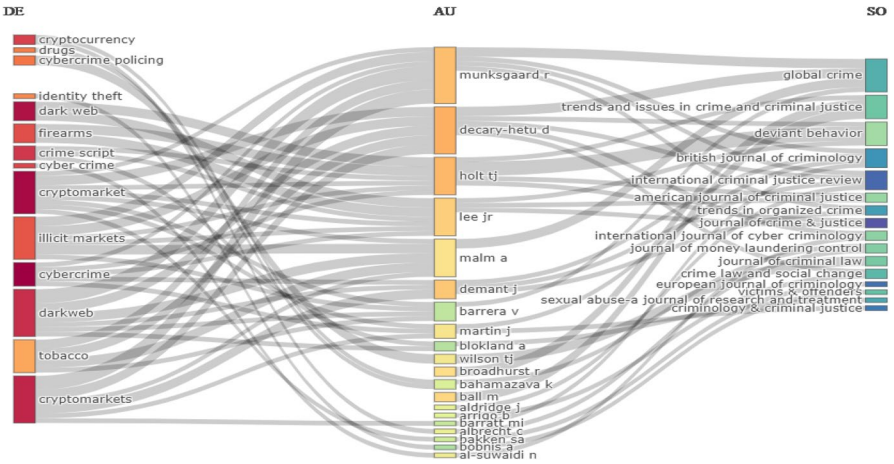


Fig. 4 Top keywords, authors, and references

all the top twenty authors focused on three main areas. They include (1) the dark-web with its related illicit markets (drugs, tobacco, firearms, and identity theft), (2) the form of exchange on the dark net (cryptocurrency) and (3) policing in cybercrime/cryptomarkets. As relevant approaches, for instance, the top authors (Rasmus Munksgaard, David Décary-Hétu, Thomas Holt, Jin Lee, Alli Malm, and Jakob Demant) with their specific articles also concentrated on these keywords as part of their empirical studies between 2014 and 2022. Most of these articles were also published in the top criminology and penology journals' rankings, including the *Global Crime, Trends and Issues in Crime and Criminal Justice,* the *Deviant Behavior,* the *British Journal of Criminology and* the *International Criminal Justice Review*, with three or four times.

Using WordCloud's function in the Biblioshiny software, Fig. 5 points out that ' silk road' is the most frequent word with nine times. Three words are equal usage with seven times ('cryptomarkets,' Internet' and 'trafficking').

Document (or citing document) refers to a scientific document (Article, review, conference proceedings, etc.) included in a bibliographic collection. Reference (or cited reference) refers to a scientific document included in at least one of the document's reference lists (bibliography). In our collection, we have 1946 references cited in the 49 articles in which the reference publication year spectroscopy is a quantitative method for identifying the historical origins of the research field and topic to identify the temporal roots of a discipline. Figure 6 indicates that while the earliest article was cited in 1928, the highest point of authors to use references in their articles was recorded in 2016, with 269 different publications' references. However, we must identify each document keyword and its related references (Aria and Cuccurullo 2017).

Conducting the three-field relationship among top authors, references they cite and keywords they use, we can identify the top authors among 113 authors in 49

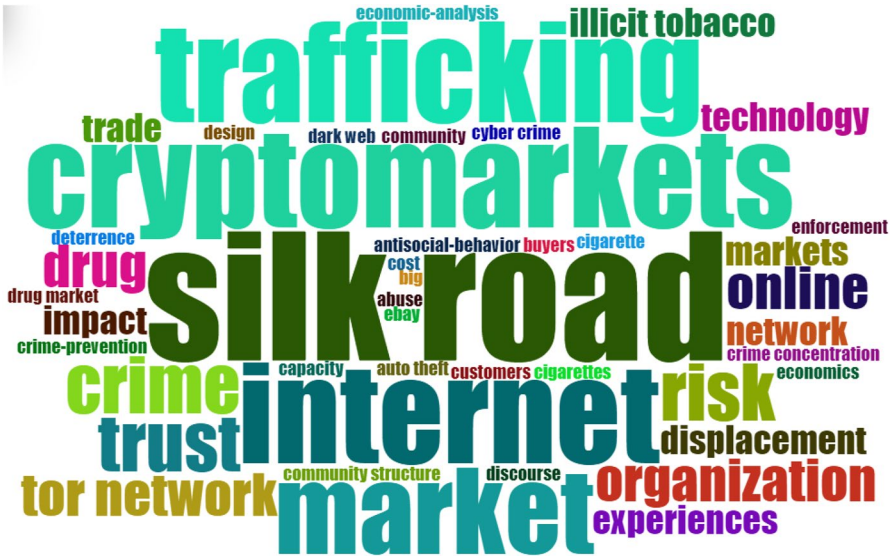


Fig. 5 The CloudWord of the darknet-related criminals

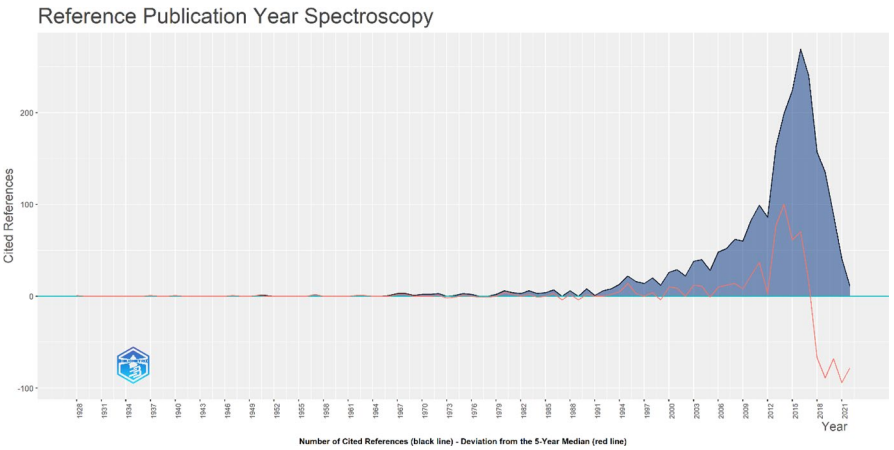


Fig. 6 The Reference publication year spectroscopy

articles. Figure 7 points out that the article of James Martin in 2014 is the leading author with 42 times re-cited in the top authors' references.

Main publication's sources with its related citations

A source is a journal article published in one or more documents in our bibliographic collection. In the current study, in our collection, we have 24 different journals. According to Fig. 8, the highest rates include six times for *Deviant Behavior*

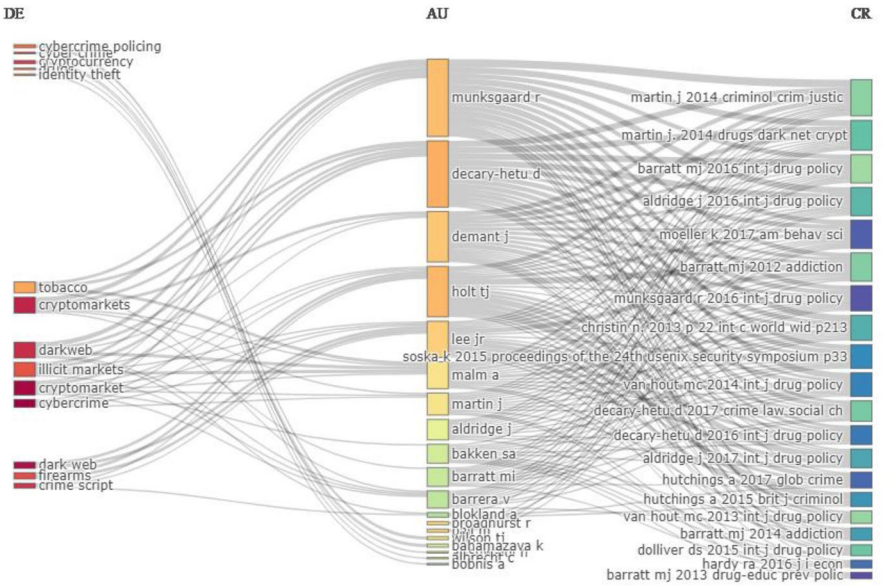


Fig. 7 The three-field relationship among top authors, references, and citation

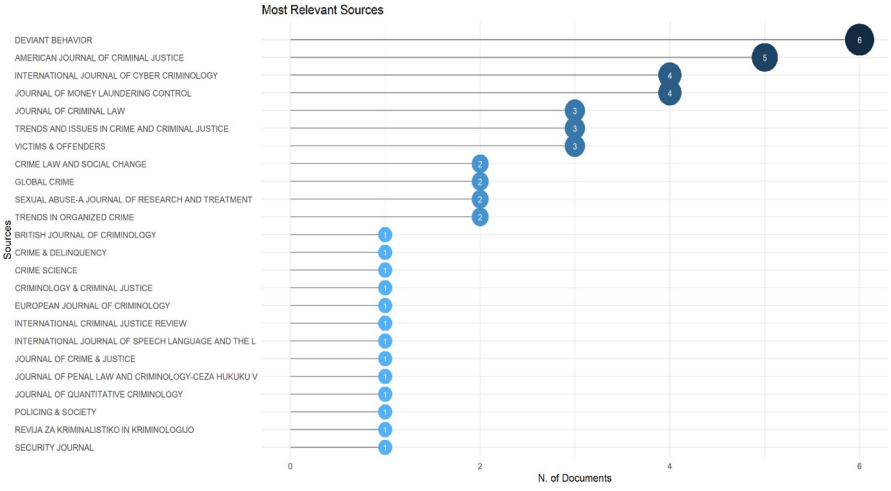


Fig. 8 The most relevant sources

and five times for the *American Journal of Criminal Justice*. Both the *International Journal of Cyber Criminology and* the *Journal of Money Laundering Control* were equal, with four articles each. Similarly, there were three times per each in the *Journal of Criminal Law*, the *Trends and Issues in Crime and Criminal Justice,* and *the Victims and Offenders*. While there are four journals to be selected to publish two

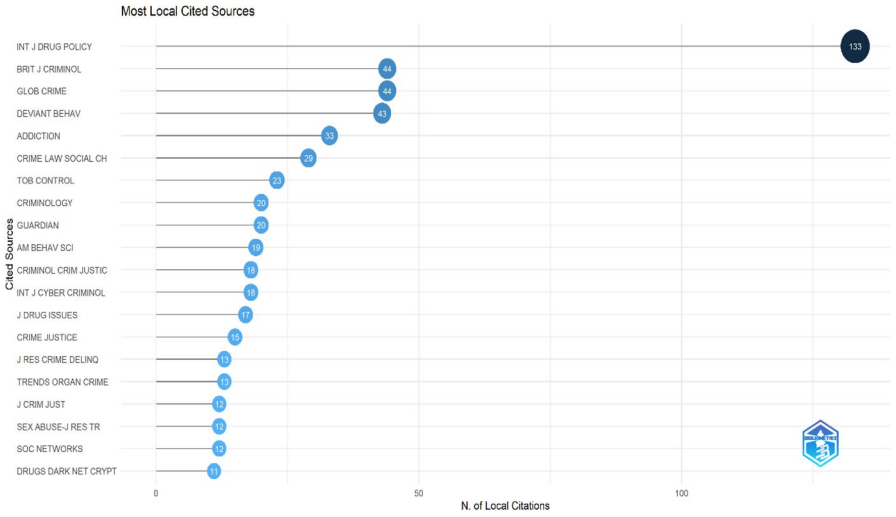


Fig. 9 The most local cited sources

articles per each, the rest of the journals have only one time occurred from 2014 to 2022.

A cited source is a journal included in at least one of the document's reference lists (bibliography). Regarding the most locally cited source (from the reference list), our current collection has recorded 1,946 references being used in 49 articles. Figure 9 illustrates that the *International Journal of Drug Policy* is the highest in our collection, with 133 times. It is around threefold with the second and third one, 44 for the *British Journal of Criminology* and the *Global Crime* and 43 for the *Deviant Behavior*. Although *Criminology* is often ranked as the top-ranking journal in criminology and penology, it has been cited in the eighth selection ($n = 20$) in our current collection. However, it does not mean these journals will cover the most important darknet-related articles.

This study used Bradford's law to determine a 'core' journal in a discipline and eventually focus the analysis on the core zone document. In theory, Bradford's law is a first-described pattern that estimates the exponentially diminishing returns of searching for references in science journals. One formulation is that if the number of articles or journals in a field is into three groups, each with about one-third of all articles, then the number of journals in each group will be ratioed to 1:n:n2 (Bradford 1934). Within the scope of Bradford's law, if the journals are arranged in descending order of the number of articles they carried on the field, then successive zones of periodicals containing similar productions of articles on the subject form. In particular, it is called the first zone, the nucleus of journals devoted to the subject, while the other journals will be divided into 'zones' of decreasing relevance to the field (Peritz 1990). In our collection, Zone 1 will cover four to six articles; Zone 2 is between two and three, and Zone 3 is only one.

According to Fig. 10, among 24 publications, the core (Zone 1) is composed of just four journals out of 49. They include *Devian Behavior* (six papers), the

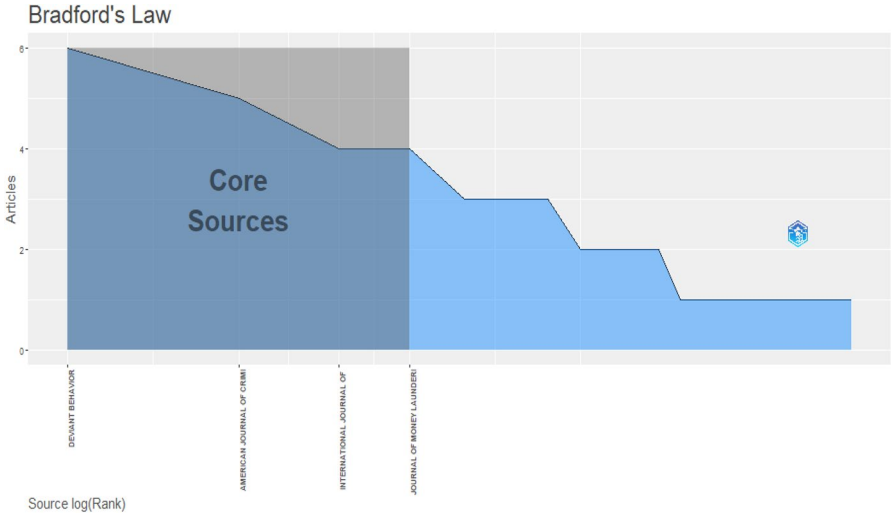


Fig. 10 The Bradford's law classification

American Journal of Criminal Justice (five), the *International Journal of Cyber Criminology* and the *Journal of Money Laundering Control* (four per each). Six journals are gathered at Zone 2, the Journal of Criminal Law, the *Trends and Issues in Crime and Criminal Justice*, the *Victims and Offenders*, the *Crime, Law, and Social Change*, the *Global Crime*, and the *Sexual Abuse—A Journal of Research and Treatment*. The rest of the journals belong to Zone 3. Surprisingly, the highest journal's locally cited source (the *International Journal of Drug Policy*) was excluded from these three Zones (see reasons in "Implications" section).

Biblioshiny also allows calculating the source local impact of publication via scoring the Hirsch index (H-index), an author's (or journal's) number of published articles (h), each of which has been cited in other papers at least h time. Figure 11 indicates that the highest H-index of the journal is three, and the lowest is one. Among the top 20 journals are two leading journals (*Deviant Behavior* and *Victims and Offender*), while six journals rank second with the 2's H-index. The rest of the productions ($n = 11$) get the 1's H-index.

Author's contributions and their affiliations and countries

In our collection, one hundred and thirteen authors have written forty-nine articles. The rate of documents per author is 0.434, and the number of authors per document is 2.31. Among the top twenty most relevant authors, Fig. 12 indicates that two authors with six documents ranked at the top, David Décary-Hétu and Thomas Holt, accounted for 12.2%. While Rasmus Munksgaard ranks second with five articles (10.2%), both Jin Lee and Jakob Demant are next ranked with three documents per each (6.1%). While five authors published two articles (4.1%), the rest of those authors released one document at a time.

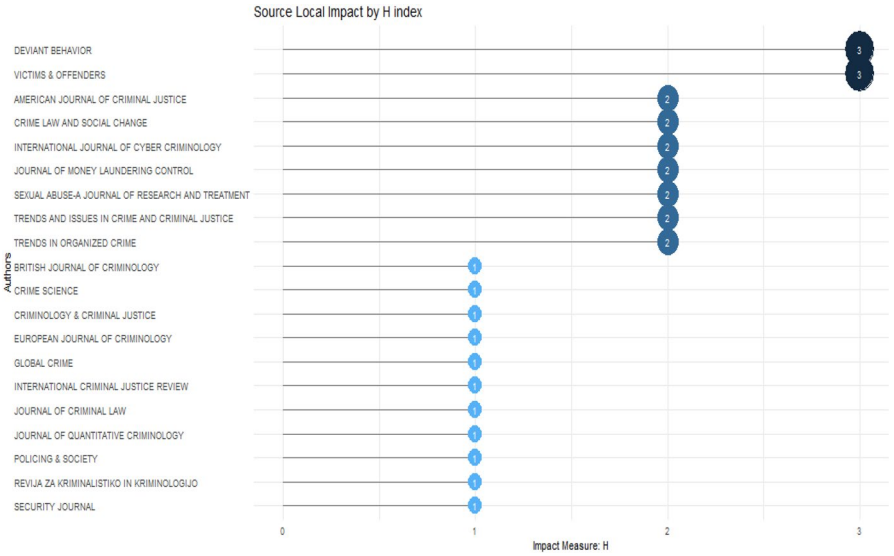


Fig. 11 The source local impact by H-index

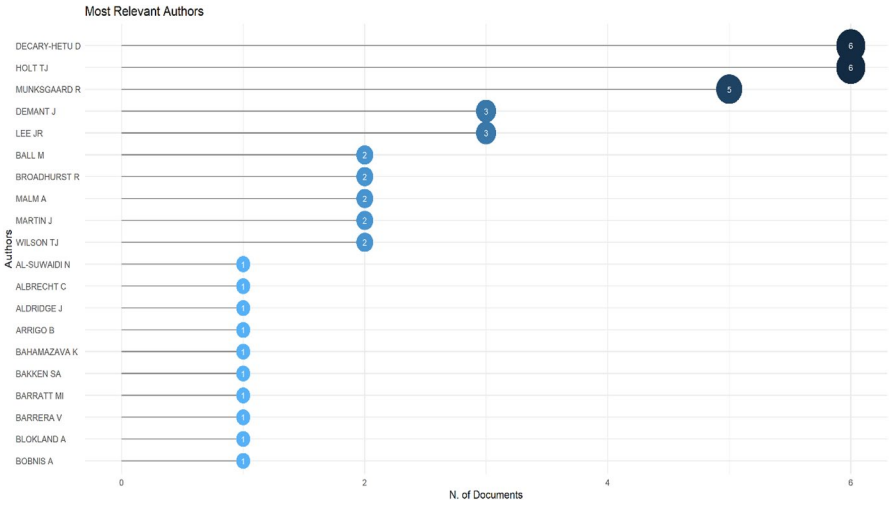


Fig. 12 The most relevant authors

Regarding the most locally cited authors among 113 authors, Fig. 13 shows that in comparison to 20 top-ranking authors, all articles of David Décary-Hétu have counted as number one with at least 16 citations per year from other authors. James Martin's publications are ranked second with 15 times, while Luca Giommoni is third with ten times. Noticeably, not all 49 articles of 113 authors have been cited by their colleagues (in our current collection) after publishing. Instead, nearly

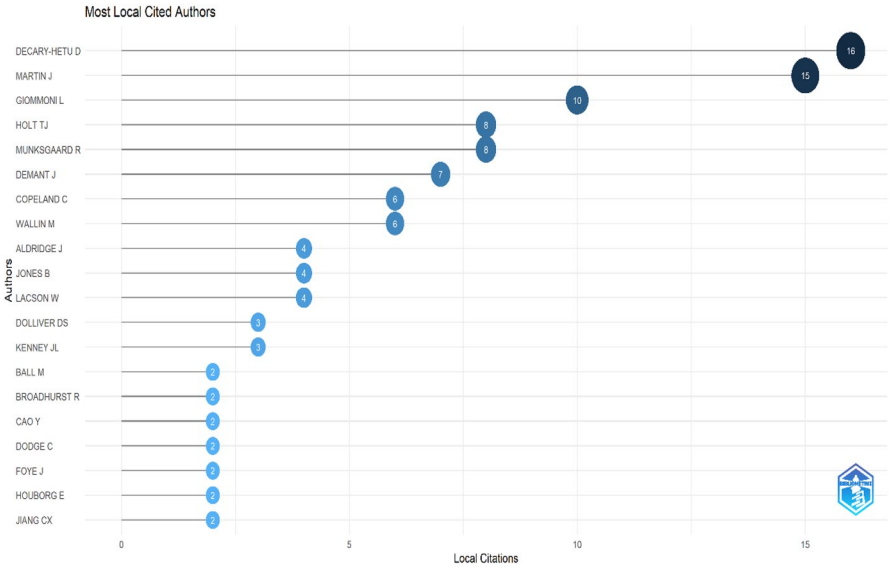


Fig. 13 The most local cited authors

one-quarter of those authors ($n=26$) only received citations one to three times between 2017 and 2022. Even as of this writing, more than 65% of authors have not recorded any citations.

For the author's production over time, around 6% of these documents ($n=7$) were written by a single author. The rest of the publications have been collaborated by over two authors ($n=106$, around 94%). On average, 49 articles/113 authors per document is 2.31 in the timeline from 2014 to 2022. In particular, to calculate the author's productivity, the Biblioshiny software allows using Lotka's law which describes the frequency of publication by authors in any given field. In theory, Lotka's law is an approximate inverse-square law where the number of authors publishing a certain number of articles is a fixed ratio to the number of authors publishing a single article (Bookstein 2008). In our current data (2014–2022), almost all authors ($n=103$) published only one document, while only two authors published six articles as the highest productions (Table 2). To some extent, thus, Lotka's law states that as the number of articles published increases, authors producing many publications become less frequent (Bookstein 2008).

Regarding author affiliation, 67 addresses are recorded in our timeline's collection (Fig. 14). While there are nine affiliations to claim their author production with twice the time, the rest of the 50 is only one. For ranking, among the top twenty listings, the University of Montreal, the Michigan State University and the Australian National University hit the top ranks, with eight, six, and five times, respectively. Alongside Georgia State University and the University of South Florida, three non-American universities (Northumbria University, University of Copenhagen, and Adu Dhabi University) are equal contributions, with three articles each.

Table 2 The rate of publication per author

Documents written	N. of authors	Proportion of authors
1	103	0.912
2	5	0.044
3	2	0.018
5	1	0.009
6	2	0.018

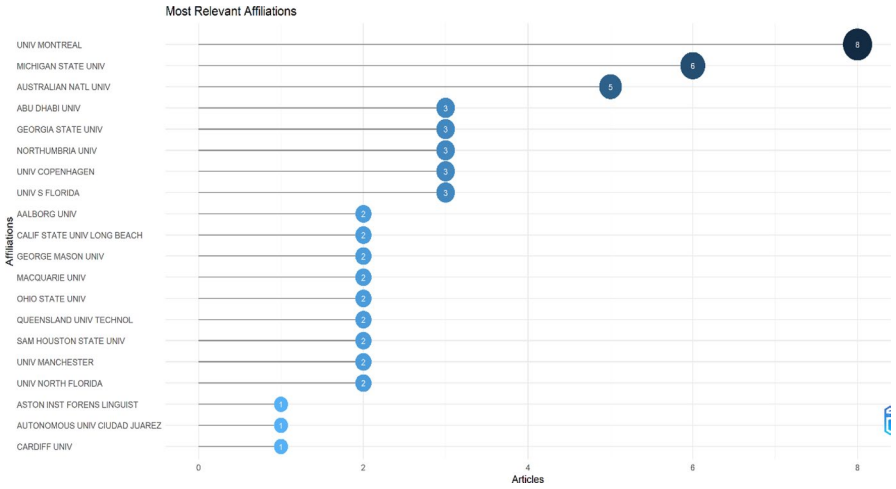


Fig. 14 The most relevant affiliations

Although 96% of co-authors ($n = 106$ authors) are in 49 articles, their country's corresponding address is only 11 countries when publishing. In particular, the US is the highest, with 21 articles, while the UK and Australia are next, with seven and six, respectively. The fourth one is Canada, with three productions. The rest of the European countries (Germany, Denmark, the Netherlands, Norway, and Slovenia) and the Asian representative (the United Arab Emirates) are the next, with one article per each. However, the most cited countries among these 11 nations differ from their author's corresponding countries. As illustrated in Fig. 15, except for the predominant position of the American productions with 160 times, while Australia ($n = 149$) shifted the second ranking of the UK (now is the only fifth position with 16 times), representatives from Canada, Denmark, and Norway follow up (70, 54, and 22, respectively). Only Italia has not yet received any citation in this indicator.

In terms of country scientific production from the author(s), the map indicates that South Korea ($n = 1$) with Jeyong Jung's (from the Korean National Police, Seoul) collaborations with Mirea et al. (2019) replaced the United Arab Emirates to become the unique Asian country in the ranking (Fig. 16). As a similar

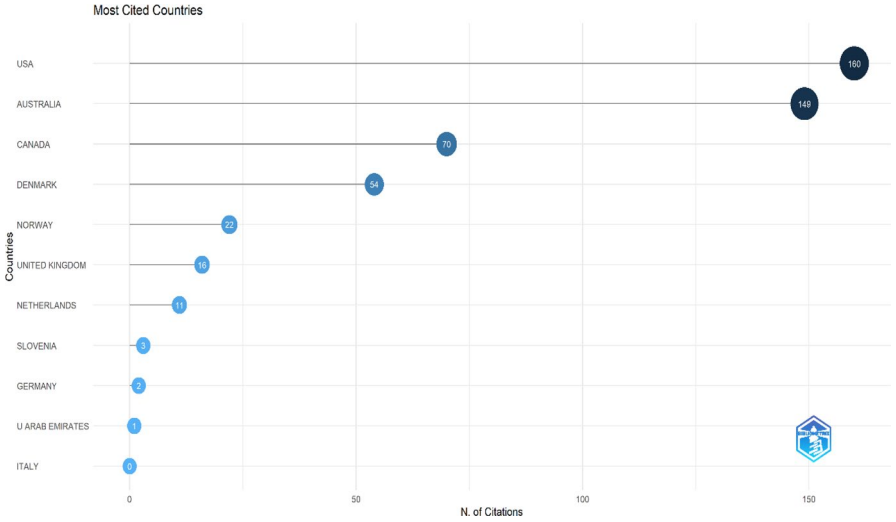
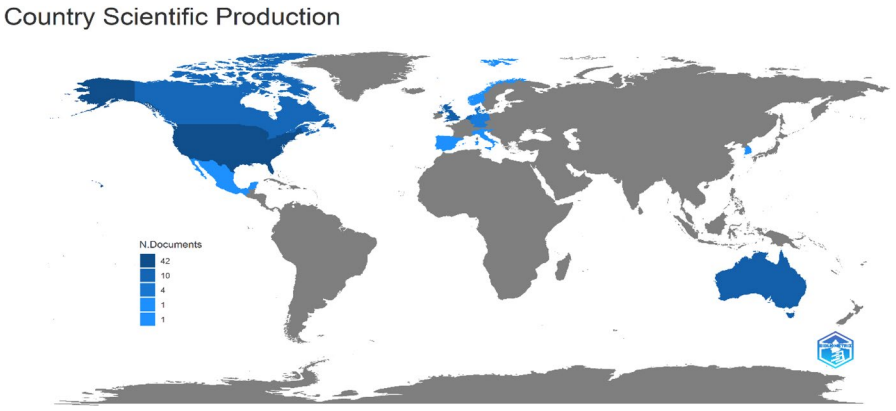


Fig. 15 The most cited countries



(The colour intensity is proportional to the number of publications)

Fig. 16 The country scientific publication (The color intensity is proportional to the number of publications)

number of the article by those South Korean authors, five European countries (Italy, Norway, Portugal, Slovenia, and Spain) and one Norther American (Mexico) published only one paper. Again, the US continues to hold the first ranking ($n = 42$), while Australia and the UK are similar productions ($n = 15$).

Leading publication with its related influences

As mentioned above ("Bibliometric research tools" section), the Biblioshiny software determines each production's scale of LCS and GCS. It is calculated by bibliometric analysis of the whole reference set, known as the most influential papers. These indexes are the two most cited document levels to reflect on the leading article of the author. Thus, it determines the most influential darknet-related research published in the last decade since the Silk Road cryptomarket was established in 2011. By doing this, the figure will allow academics, policymakers, and practitioners better understand the state of the art and discover the linkage among authors in this field.

This article used a historiographic map of the paper in the Biblioshiny software to define and measure the influence or impact of a research article. I mapped the top 20 articles concerning darknet-related issues. Nodes name specific articles in our collection and sort the main bibliography in ascending order by timeline. A dash-line arrow pointing from one node to the next, usually to older papers, informs the citation nexus between articles. The circles represent the full document title, while their size (LCS and GCS) indicates the detailed scores. It is only displayed in the Biblioshiny for bibliometrics (with support from R language) unless you hold the mouse at each point you want to check. Alternatively, I extracted this historiographic index into an Excel table to show the specific scale of each article.

Figure 17 and Table 3 show the historiography map of the most influential papers in darknet-related concerns based on the 20 most highly cited papers in LCS and GCS. Based on this intellectual structure's metric, with 14 LCS and 117 GCS, the paper – *Lost on the Silk Road: Online Drug Distribution and the 'Cryptomarket'* (Martin 2014b) has recorded the highest score in the historical direct citation network. Historically, it is the earliest publication among our 49 collections in criminology and penology, focusing on darknet-related issues. However, the same topic (Silk Road) written by Lacson and Jones (2016) – *The 21st Century DarkNet Market: Lessons from the Fall of Silk Road*, only ranked eighth position among GCS ($n = 19$). Next year later, the empirical study of Décary-Hétu and Giommoni (2017)—*Do Police Crackdowns Disrupt Drug Cryptomarkets? A Longitudinal Analysis of the Effects of Operation Onymous* examines the policing interventions to combat illicit drugs trading on the darknet. It ranks as the second most influential paper, with ten LCS and 67 GCS. Using the DATACRYPTO software to crawl 15 cryptomarkets between 2013 and 2016, Demant et al. (2018a, b) first introduced the specific tool to map and identify, and visualize the trajectory of drug trading in the darknet. Their publication –*Going Local on a Global Platform: A Critical Analysis of the Transformative Potential of Cryptomarkets for Organized Illicit Drug Crime*, was recorded as the third most impacted paper (GCS = 31). At the same time, he and his colleagues (Demant et al. 2018a, b) continued using a custom web crawler supplied with a dataset collected by independent researcher Gwern Branwen (from February 2014 to April 2015). The study investigated the drug markets and drug trafficking via two new platforms—*Personal Use, Social Supply or Redistribution: Cryptomarket Demand on Silk Road 2.0 and Agora*. Again, this important finding has been considered among the top five GCS in our collection ($n = 23$). The other in the top

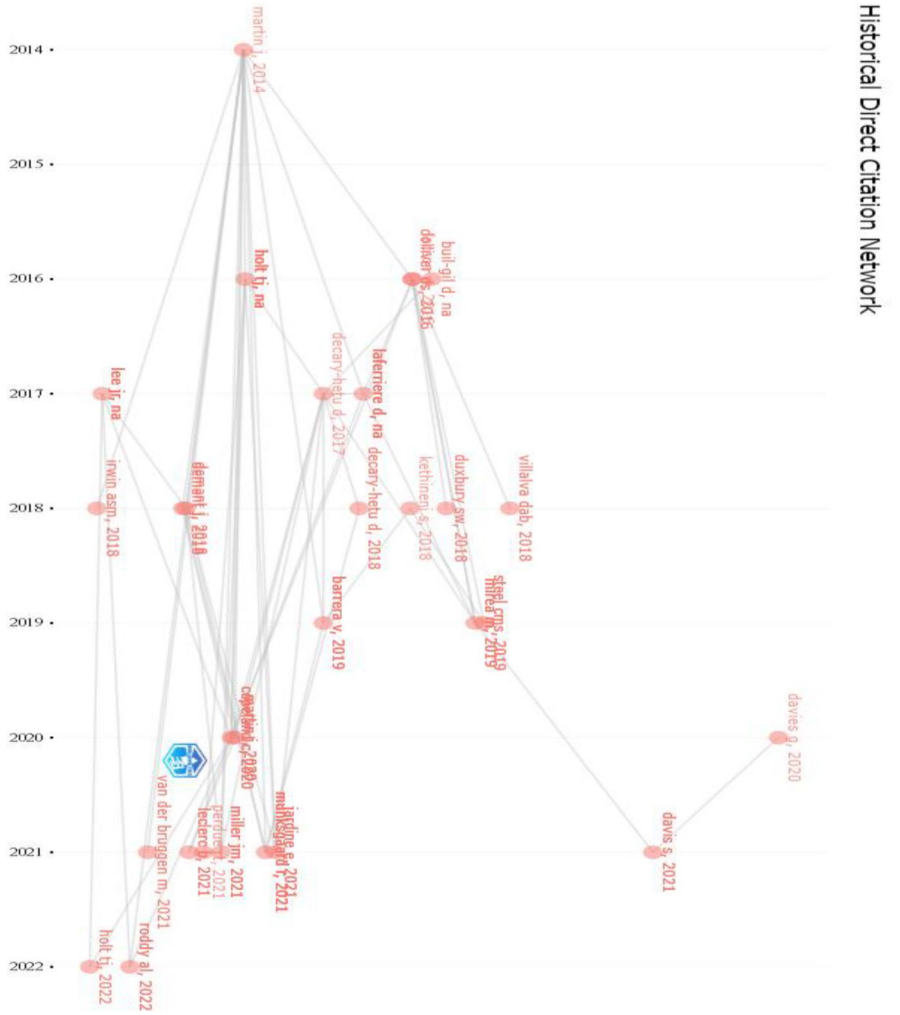


Fig. 17 The historiography map of the most influential papers in darknet-related concerns

five influential papers belong to analyze of Kethineni et al. (2018)—*Use a Bitcoin in Darknet Markets: Examining Facilitative Factors on Bitcoin-Related Crimes*, with the fourth GCS ($n=24$). Although the most impacted articles have mentioned the occurrence of Bitcoin about the existence and operation of the Silk Road (Martin 2014b), the five-year later's article by those three authors (Kethineni et al. 2018) just reviewed Bitcoin's security and anonymity of transactions with its related activities in 12 Bitcoin-related criminal cases systematically. Bitcoin-related crimes have continued to receive many approaches from the rest of the top twenty papers to look for (1) the process of money laundering of cryptocurrency crimes (Albrecht et al. 2019), (2) differentiated pathways, risks, and rewards via selling drugs on darkweb

Table 3 The listing 49 selected articles with its LCS and GCS

No	Author, Year, Journal	Title	Year	LCS	GCS
1	Martin J, 2014	Lost on the silk road: online drug distribution and the 'cryptomarket'	2014	14	117
2	Decary-Hetu D, 2017	Do police crackdowns disrupt drug cryptomarkets? a longitudinal analysis of the effects of operation onymous	2017	10	67
3	Demant J, 2018	Going local on a global platform: a critical analysis of the transformative potential of cryptomarkets for organized illicit drug crime	2018	4	31
4	Kethineni S, 2018	Use of bitcoin in darknet markets: examining facilitative factors on bitcoin-related crimes	2018	2	24
5	Demant J, 2018	Personal use, social supply or redistribution? cryptomarket demand on silk road 2 and agora	2018	2	23
6	Bakken SA, 2018	Coordination problems in cryptomarkets: changes in cooperation, competition and valuation	2018	0	22
7	Duxbury SW, 2018	The network structure of opioid distribution on a darknet cryptomarket	2018	0	22
8	Lacson W, 2016	The twenty-first century darknet market: lessons from the fall of silk road	2016	4	19
9	Albrecht C, 2019	The use of cryptocurrencies in the money laundering process	2019	0	17
10	Dolliver DS, 2016	Characteristics of drug vendors on the tor network: a cryptomarket comparison	2016	3	14
11	Braaten CN, 2021	Convenience theory of cryptocurrency crime: a content analysis of us federal court decisions	2021	0	14
12	Copeland C, 2020	Assessing the practices and products of darkweb firearm vendors	2020	6	12
13	Martin J, 2020	Selling drugs on darkweb cryptomarkets: differentiated pathways, risks and rewards	2020	1	12
14	Mirea M, 2019	The not so dark side of the darknet: a qualitative study	2019	2	11
15	Irwin ASM, 2018	Illicit bitcoin transactions: challenges in getting to the who, what, when and where	2018	0	10
16	Finn MA, 2016	How targeted enforcement shapes marketing decisions of pimps: evidence of displacement and innovation	2016	0	9
17	Barrera V, 2019	Size and scope of the tobacco trade on the darkweb	2019	1	6
18	Leukfeldt ER, 2019	Criminal networks in a digitized world: on the nexus of borderless opportunities and local embeddedness	2019	0	6
19	Westlake B, 2017	Assessing the validity of automated web crawlers as data collection tools to investigate online child sexual exploitation	2017	0	5
20	Van Der Bruggen M, 2021	A crime script analysis of child sexual exploitation material fora on the darkweb	2021	0	5
21	Broadhurst R, 2020	Fentanyl availability on darknet markets	2020	0	4
22	Broadhurst R, 2021	Illicit firearms and other weapons on darknet markets	2021	2	4
23	Holt TJ, 2022	A crime script analysis of counterfeit identity document procurement online	2022	1	4

Table 3 (continued)

No	Author, Year, Journal	Title	Year	LCS	GCS
24	Tomazic T, 2017	Ongoing criminal activities in cyberspace: from the protection of minors to the deep web	2017	0	3
25	Davies G, 2020	Shining a light on policing of the dark web: an analysis of uk investigatory powers	2020	1	3
26	Davis S, 2021	The dark web and anonymizing technologies: legal pitfalls, ethical prospects, and policy directions from radical criminology	2021	0	3
27	Piquero NL, 2021	Preventing identity theft: perspectives on technological solutions from industry insiders	2021	0	3
28	Decary-Hetu D, 2018	The shift to online tobacco trafficking	2018	1	2
29	Villalva Dab, 2018	under and over the surface: a comparison of the use of leaked account credentials in the dark and surface web	2018	0	2
30	Daly A, 2021	3D printing, policing, and crime	2021	0	2
31	Jardine E, 2021	Policing the cybercrime script of darknet drug markets: methods of effective law enforcement intervention	2021	1	2
32	Wronka C, 2022	Money laundering through cryptocurrencies-analysis of the phenomenon and appropriate prevention measures	2022	0	2
33	Holt TJ, 2022	A crime script model of dark web firearms purchasing	2022	0	2
34	Al-Suwaidi N, 2018	Estimating causes of cybercrime: evidence from panel data FGLS estimator	2018	0	1
35	Steel CMS, 2019	Stolen identity valuation and market evolution on the dark web	2019	0	1
36	Miller JM, 2021	Beating the house: ethnographic insights into a web-based marijuana gray market	2021	1	1
37	Munksgaard R, 2021	Distributing tobacco in the dark: assessing the regional structure and shipping patterns of illicit tobacco in cryptomarkets	2021	0	1
38	Perdue RT, 2021	Who needs the dark web? exploring the trade in critically endangered plants on eBay	2021	1	1
39	Roddy AL, 2022, Deviant Behav	An assessment of hitmen and contracted violence providers operating online	2022	1	1
40	Chiang E, 2020	Linguistic analysis of suspected child sexual offenders' interactions in a dark web image exchange chatroom	2020	0	0
41	Johnson D, 2020	Police functional adaptation to the digital or post-digital age: discussions with cybercrime experts	2020	0	0
42	Wilson TJ, 2020	Collaborative justice and harm reduction in cyberspace: policing indecent child images	2020	0	0
43	Worner L, 2020	The new German darknet-criminal law draft—darkening by restricting individual rights-	2020	0	0

Table 3 (continued)

No	Author, Year, Journal	Title	Year	LCS	GCS
44	Leclerc B, 2021	Child sexual abuse material on the darknet: a script analysis of how offenders operate	2021	0	0
45	Bahamazava K, 2022	The comparative analysis of regulations in the Italian republic and the Russian federation against crypto-laundering techniques	2022	0	0
46	Buil-Gil D, 2022	Offending concentration on the Internet: an exploratory analysis of bitcoin-related cybercrime	2022	0	0
47	Howell CJ, 2022	Risk avoidance behavior on darknet marketplaces	2022	0	0
48	Laferriere D, 2022	Examining the uncharted dark web: trust signaling on single vendor shops	2022	0	0
49	Lee JR, 2022	An assessment of the state of firearm sales on the dark web	2022	0	0

(Braaten and Vaughn 2021; Dolliver 2016; Duxbury and Haynie 2018; Martin et al. 2020) and firearm vendors (Copeland et al. 2020), and (3) challenges of law enforcement agencies to combat darknet-related concerns (Finn and Stalans 2016; Irwin and Turner 2018).

Since some darknet markets were dismantled, vendors had also recognized authorities' potential takedowns of marketplaces, which they counter by operating in multiple markets simultaneously. The variety of illicit goods and services' marketplaces on the virtual platform have been prioritized to assess and publish by the different authors and co-authors. It includes drugs (Broadhurst et al. 2020; Dolliver 2016; Miller and Miller 2021), online tobacco (Décary-Hétu et al. 2018; Munksgaard et al. 2021), identity documents (Holt and Lee 2022a), weapon activities (Broadhurst et al. 2021; Holt and Lee 2022b; Lee et al. 2022), account credentials (Villalva et al. 2018), child sexual exploitation material (Chiang et al. 2020; Leclerc et al. 2021; van de Ven and Blokland 2021; Westlake et al. 2017; Wilson 2020), and contracted violence (Roddy and Holt 2022).

Thematic evolution in the darknet-criminal concerns

This section provides the outcomes of the network approach via conducting three conceptual structures, namely (1) co-occurrence network, (2) thematic map, and (3) thematic evolution. This structure reflects on the topics a research field covers to define the most important and recent issues. Each network approach has four fields (keywords plus author's keywords, title, and abstracts). However, calculating 'author's keywords' will identify the keyword used in the article by all authors. By doing this, we can indicate what science talks about the main themes and trends, and represent relations among concepts or words in a set of publications.

In one article, words related to a network always appear together, known as the co-words or co-occurrence network (Aria and Cuccurullo 2017). Figure 18 shows that authors focused on 11 keywords in their 49 articles, separating them into three clusters. Red is for the first cluster ('cybercrime,' 'cryptomarket,' and 'silk road'), blue is for the second group ('dark web,' 'darknet,' 'crime script,' and 'firearms'), while the third one is green ('cryptomarkets,' 'darkweb,' 'illicit markets,' and 'tobacco'). The co-occurrence network is also structured and connected by its related betweenness and closeness among clusters. The bubble size reflects the number of betweenness, while the size of the arrow states their closeness. Running the network maps to identify the scale of the co-occurrence network, the Biblioshiny indicated that cluster 1 (red) with the 'cybercrime' is the highest betweenness (33.5%) with its cluster and closeness (0.076%) with others. Accordingly, except for 'cryptomarket' and 'silk road'—at the central pillars, 'cybercrime' is also connected with five themes in the blue and green groups. The second (blue) and third (green) clusters scored less on the scale. Betweennesses and closeness of the former are 16% and 0.058%, while the latter is 9.5% and 0.055%, respectively. In particular, the narrowing down of topics relating to the darknet/darkweb has been conducted from these two clusters. The first is to refer to criminology's theory and application. It includes utilizing crime scrip analysis in cryptomarkets (Holt and Lee 2022a, 2022b; Leclerc et al. 2021;

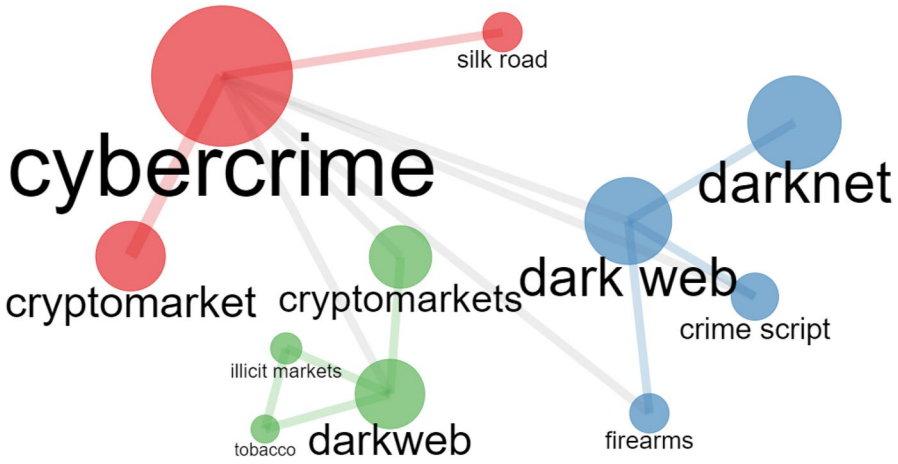


Fig. 18 The authors' keywords

van de Ven and Blokland 2021). The second focuses on testing and assessing illicit goods and services in the darknet/darkweb. It covers illegal drugs (Broadhurst et al. 2020; Dolliver 2016; Miller and Miller 2021), tobacco (Décary-Hétu et al. 2018; Munksgaard et al. 2021), and firearms trafficking (Broadhurst et al. 2021; Holt and Lee 2022b; Lee et al. 2022).

Secondly, the thematic map illustrates topics in darknet-related issues using bibliometrics. Figure 19 shows a thematic map with the quadrant of the author's keywords in which they are placed: (1) upper-right quadrant: motor themes; (2) lower-right quadrant: basic themes; (3) lower-left quadrant: emerging or disappearing themes; and (4) upper-left quadrant: very specialized/niche themes. Accordingly, there are 20 keywords to gather to analyze the cluster composition under the thematic map. They are divided into ten cluster groups and classified based on their occurrence in our collection. Excluding the emerging or declining themes ('cybercrime' and 'cryptomarket'), between motor and basic themes, almost of authors focused on (1) the specific types of illicit goods and services in the darkweb ('firearms,' 'identify theft' and 'drugs'), (2) the exchange transaction in the cryptomarket ('cryptocurrency'), and (3) the predominant form of darknet ('anonymity') with challenges with authorities ('law enforcement'). As part of the motor-theme keywords, 'policing' and 'cybercrime policing' became the specialized/niche themes in most publications in our current collection. The empirical study of Décary-Hétu and Giommoni (2017)—*Do Police Crackdowns Disrupt Drug Cryptomarkets? A Longitudinal Analysis of the Effects of Operation Onymous* is one of the first publications to review the impact of the police crackdown on the darknet and question the role of policing in cybercrime. They pointed out that the successful crackdown on Operation Onymous affected the other darknet markets 'but only for a short time,' and even policing activities 'are not effective measures to lower the volume of sales on online illicit drug markets' (Décary-Hétu and Giommoni 2017, p. 72). At the time, further research was needed to

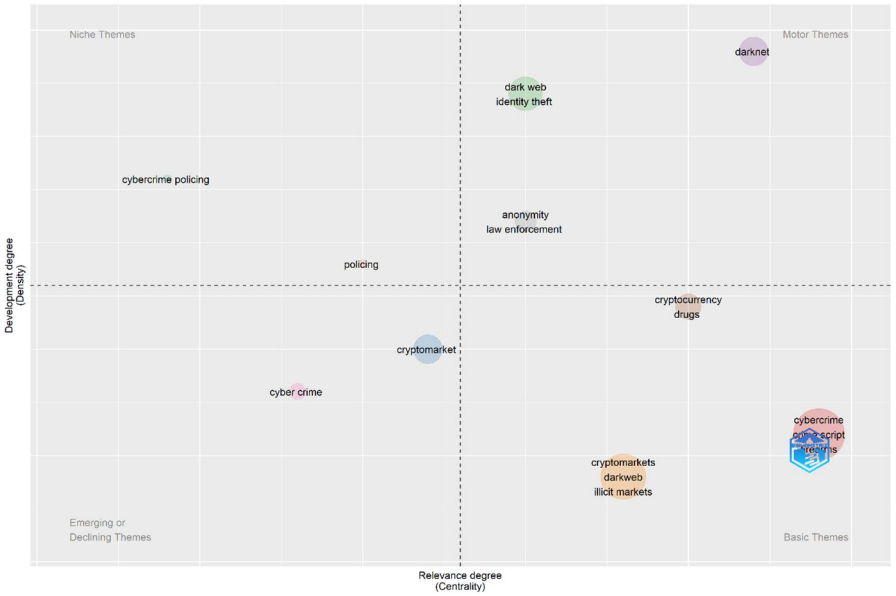


Fig. 19 Thematic map with the quadrant of the author's keywords

examine the specific techniques of law enforcement on the activities of crypto- and illicit online markets. As Décary-Hétu and Giommoni (2017, p. 73, added) highlighted that exploring 'the structure of cryptomarkets and the operations of their participants [*will*] provide new insights on how drug markets are organized.'

Dividing the timespan into two main stages, we can find the changes in the thematic evolution in the Biblioshiny tool (Fig. 20). Firstly, for the time slice 1: 2014–2018, most authors used the 'silk road' as one of the basic and motor themes to reflect the trends and patterns of 'cryptomarket' and 'cybercrime,' with the leading articles of Martin (2014b)—*Lost on the Silk Road: Online Drug Distribution and the 'Cryptomarket'*, and Lacson and Jones (2016)—*The 21st Century DarkNetw Market: Lessons from the Fall of Silk Road*. However, no specific niche themes have been recorded at the first timeslice.

However, in time slice 2: 2019–2022, many authors specialized their research to concentrate on the detailed types of darknet (Fig. 21), in which 'identity theft' has shifted from basic themes ('cybercrime' and 'cryptomarkets') to merging themes. Significantly, investigating the flows of the currency's transactions between vendors and buyers through exchanging Bitcoin and others that have become an urgent and niche topic with scholars. There are two specific papers: One is *the Use of Bitcoin in Darknet Markets: Examining Facilitative Factors on Bitcoin-Related Crimes* by Kethineni et al. (2018), and the other is *the Use of Cryptocurrencies in the Money Laundering Process* by Albrecht et al. (2019). Besides that, assessing experimental tools and tactical applications of law enforcement agencies ('cybercrime policing') to anticipate and dismantle cryptomarkets was more attractive and interesting to the authors. Among them, at the timescale, there are two specific articles to

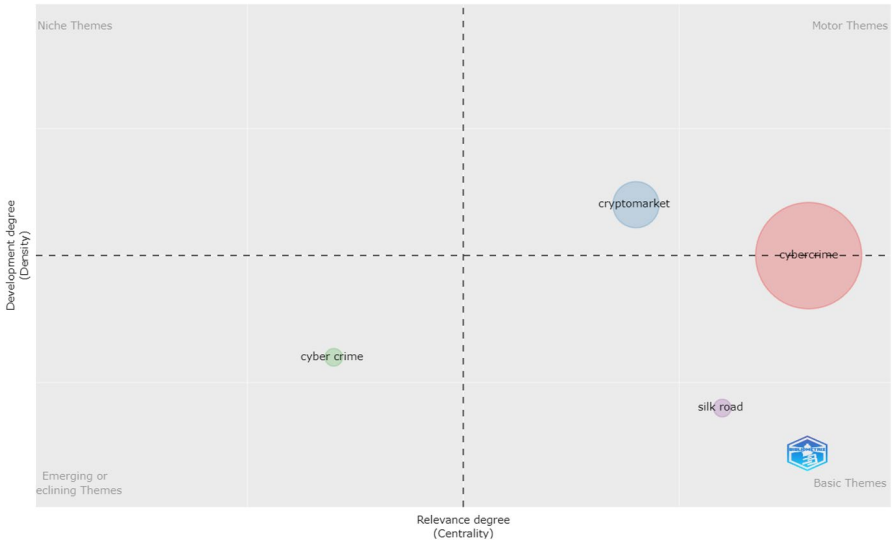


Fig. 20 The thematic evolution in the 2014–2018

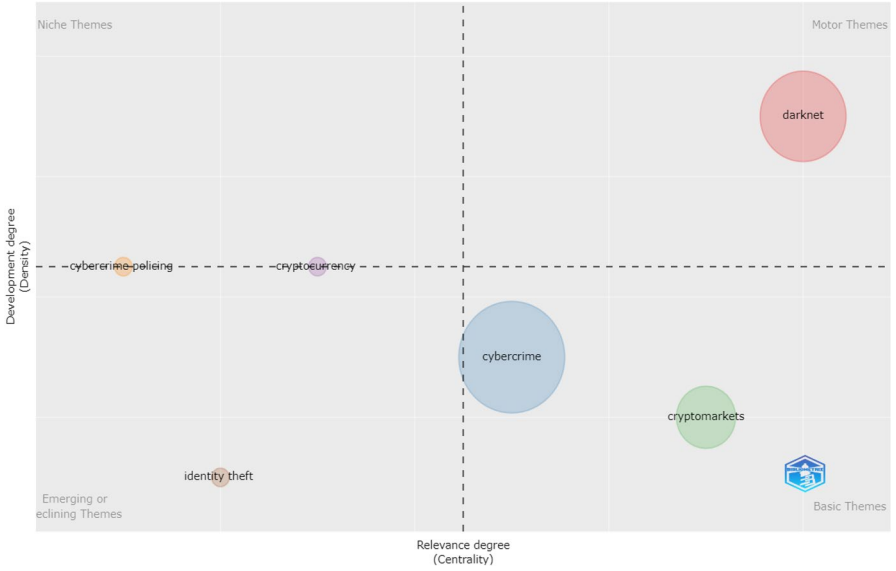


Fig. 21 The thematic evolution in the 2019–2022

consider further the practical applications and functional adaptation of police to investigate illicit goods and services in the darknet, as Décary-Hétu and Giommoni (2017)'s recommendations in the first timeslice. One belongs to Derek Johnson et al. (2020)—*Police Functional Adaptation to the Digital or Post Digital Age: Discussions with Cybercrime Experts*. It analyzed the results of a workshop held with

cybercrime investigators in England and Wales concerning the importance of four key organizational and cultural issues (management, leadership, and institutional ethos within the police; the risks of over-complication and exaggerated distinctions between cyber and real-world policing; ethics; and knowledge, training, and development). Those authors also emphasized developing and acquiring new technical capabilities to prevent and combat darknet-related criminals. Their conclusions also confirmed that 'knowledge and training is a fundamental pillar to success in the digital world, but that work needs to influence thinking across the complete policing hierarchy rapidly' (Johnson et al. 2020, p. 449). The other is the paper of Eric Jardine (2021)—*Policing the Cybercrime Script of Darknet Drug Markets: Methods of Effective Law Enforcement Intervention*. It reviewed the four generic steps, (1) Informational Accumulation, (2) Account Formation, (3) Market Exchange, and (4) Delivery/Receipt, of a novel cybercrime script for darknet drug markets. It also presents vignette examples of known law enforcement interventions that have effectively targeted each stage of the script to reduce the usage of these marketplaces.

Scale of co-authors' collaboration in the darknet-related criminals

This section gives a deeper understanding of the intellectual and social structure, not only of authors but also of the affiliations and countries in which they locate. Overall, not many institutions and nations collaborate worldwide regarding darknet-related criminals. For the former, there are only three institutions from three countries to cooperate and conduct their topics, including the University of Montreal (Canada), the California State University Long Beach (the US), and the University of Copenhagen (Denmark). The top side of Fig. 22 shows that the first authors have readily co-authored with the last two universities. For the latter, the bottom side of the Figure indicates that most publications on darknet-related criminals have been co-authored by one of the five leading countries. They include Australia, Canada, Denmark, the US, and the UK Interestingly, co-authors came from Canada and the UK at least three times to collaborate in this group. Although some authors are the most global impact in the field, Australia (e.g., James Martin and Monica Barratt) and the US (e.g., Thomas Holt and Sesha Kethineni) have not yet established their co-authors' collaboration networks (see reasons in "Implications" section).

Regarding the collaboration in publication, while the single country publication (SCP) only covers author(s) from one country, the multiple countries publication (MCP) indicates the number of documents in which there is at least one co-author from a different country. Figure 23 shows that both Germany [the Deloitte GmbHWirtschaftsprüfungsgesellschaft, Frankfurt, of Christoph Wronka (2022) and the Konstanz, Baden-Württemberg of Worner and Preetz (2020)] and the United Arab Emirates (from the Abu Dhabi University, Abu Dhabi of Al-Suwaidi et al. (2018)) have not yet collaborated other authors from different countries. Almost papers have collaborated with at least one co-author from different countries. Once again, the US still keeps the highest co-author collaborations with other countries, with four articles. On average, the rate of co-authors per document is 2.77, while the collaboration index is 2.61.

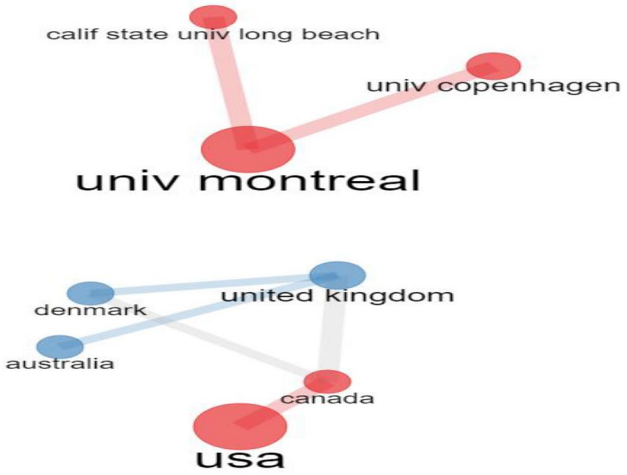


Fig. 22 The scale of co-authors' collaborations

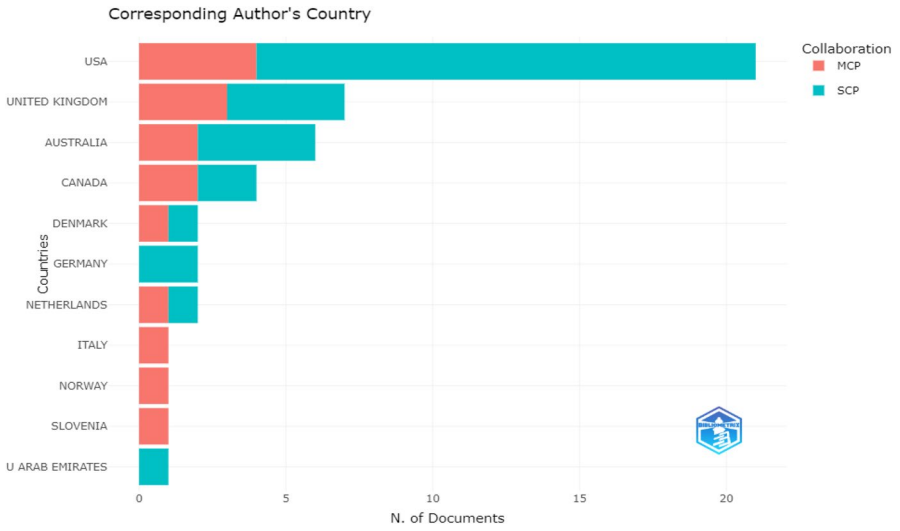


Fig. 23 The corresponding author's country

However, the rate of joint research among those authors and countries is the same. The collaboration world map shows that the authors from the top three countries have dominated the trend of co-author to research and publish. Among the 11 above countries, while the US and the UK institutions have the authors to collaborate with the five countries per each, there are three collaborations from Australia (Fig. 24).

Another common bibliometric analysis is co-author analysis which measures the author and their affiliations and countries to study the intellectual and social

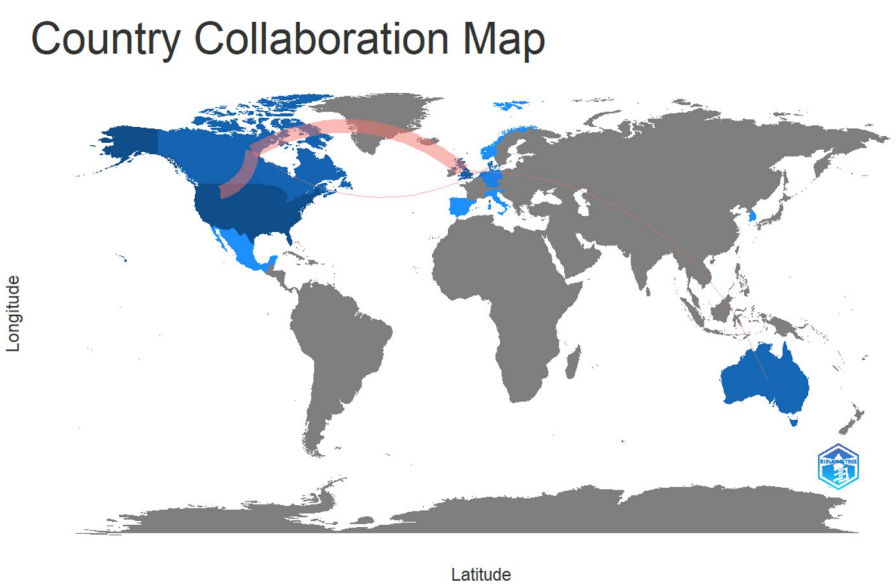


Fig. 24 The country collaboration map

structure. At the same time, the co-citation network shows citation counts of papers, authors, and sources, and the collaboration networks firm the scale of authors, affiliations, and countries' cooperation in publishing. Firstly, Fig. 25 shows 48 co-cited authors with their relevant articles in our current collections. It divides into two main groups. The red groups include 21 authors, while the rest belong to the blue groups ($n=27$). The top five authors (red) are the highest betweenness and closeness (e.g., Thomas Holt, James Martin, Alex Hutching, Carlo Morselli, and Anna Lavorgna). Their top five counterpart representatives (blue) include David Décary-Hétu, Monica Barratt, Judith Aldridge, Marie Clarie van Hout, and David Dolliver). Importantly, to the nature of characteristics to conduct and research on the darknet, several authors and their collaborators used 'anonymous' or 'fake names' when releasing their publications. It does not mean their anonymities are insignificant; instead, the size of the red bubble of 'anonymous' authors, both vertices and edges, is also ranked at the highest connections in the system co-citation network.

Secondly, the co-author collaboration network is illustrated in Fig. 26. The three main co-authors' groups rank as the leading collaborators in the field. There are two groups as similar in size as the number of co-authors in their collaboration's publications, at least two different articles. One is the blue group of Thomas Holt and Jee Lee in the American Journal of Criminal Justice and the Deviant Behavior (Holt and Lee 2022a, 2022b), and the other is the green one of Roderic Broadhurst and Matthew Ball in the Trends and Issues in Crime and Criminal Justice (Broadhurst et al. 2020, 2021). The red is the crowdest group with four authors, David Decary-Hetu, Jakob Demant, Aili Malm, and Rasmus Munksgaard. Particularly, the last author (Demant et al. 2018a, b; Demant et al. 2018a, b; Martin et al. 2020; Munksgaard et al. 2021) frequently co-authored one another rather than the first three authors

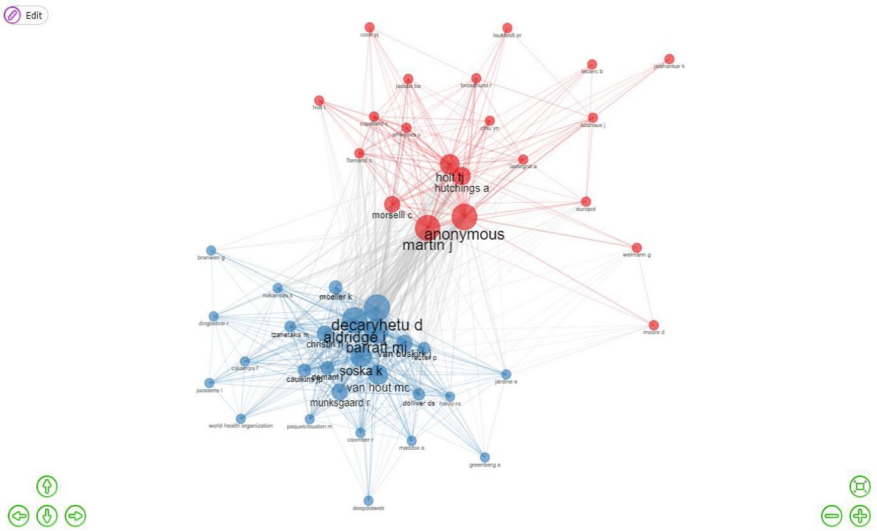


Fig. 25 The network of co-citation authors

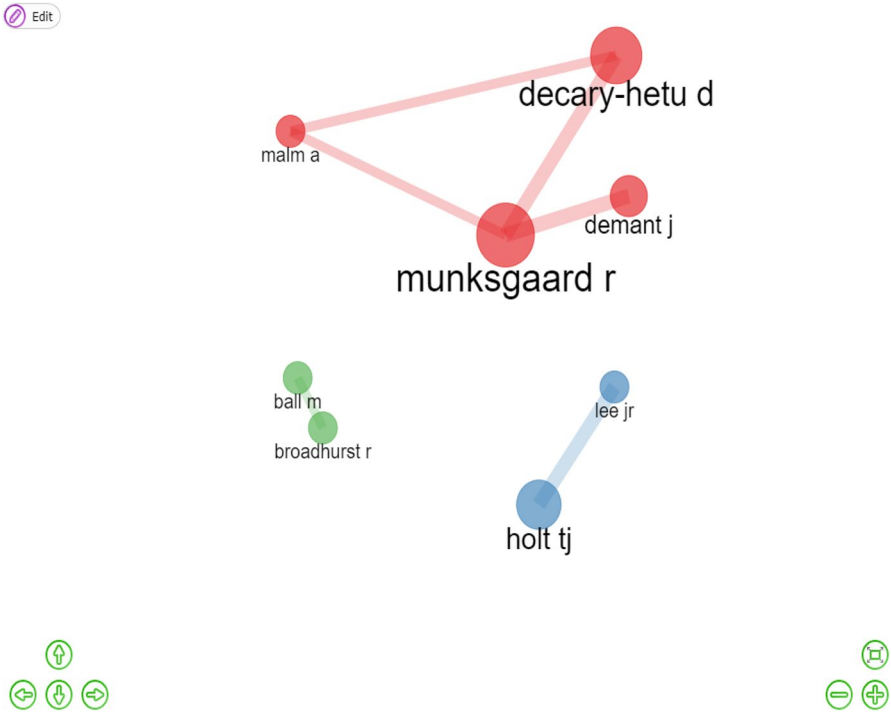


Fig. 26 The co-authors' collaborations

in the Trends in Organized Crime, the International Criminal Justice Review, the

British Journal of Criminology, and the Global Crime.

Implications

The current study conducted detailed literature of 49 articles focused on darknet-related criminals with a combination between the SLR and bibliometric analysis. The author recognize and acknowledges the significant contributions and important findings of the valuable research toward improving the understanding of the darknet's illicit goods and services since the *Silk Road* occurred in 2011. We can learn several issues from previous global, regional, and national studies to conduct the cryptomarket's research and the role of policing interventions in these virtual platforms. However, it is important to note that some identified research gaps through this SLR can be further expanded to enrich this subject. To some extent, we must conduct more studies to fully comprehend the trend, patterns, and related impacts of the darknet marketplaces faced by all darknet users (vendors and buyers) and law enforcement agencies. This section shares some specific recommendations for future directions based on the above six RQs with the relevant findings of this paper.

Firstly, for demographic figures, almost all articles have been conducted from Angle-Saxon and English-speaking authors/affiliations. It is likely to reflect darknet-related criminals' detailed trends and patterns but not yet provide a wider approach (Lacson and Jones 2016; Martin and Christin 2016; Mirea et al. 2019). The anonymous and freedom features are inevitable points to exchange and trade via the cryptomarket's platform. It also supports those interested in surfing on hidden distributions, either vendor or buyer or both, in reality (Demant et al. 2018a, b; Jardine 2021; Johnson et al. 2020). The latest report of the UNODC (2022a) warned that the geographical markets are not only operated in Western countries; several Asia darknet users took advantage to trade illicit goods and services. For example, Southeast Asia, with its booming Internet users, including darknet accounts and platforms, has yet to focus on research with empirical studies. However, all most authorities and law enforcement agencies admitted the complicated impacts of darknet-related criminal activities in the last five years (UNODC 2020, 2022a).

Secondly, the current papers only downsized criminology and penology for the journal and its related scope of field-based searching—this WoS classification is still a controversial source. For example, the *International Journal of Drug Policy* has published several articles and authors on criminology's background and context in recent five years (Aldridge and Askew 2017; Bergeron et al. 2020, 2022; Cunliffe et al. 2019, 2017; Grimani et al. 2020; Jardine and Lindner 2020; Kamphausen and Werse 2019; Kowalski et al. 2019; Ladegaard 2019; Masson and Bancroft 2018; Moeller et al. 2021; Munksgaard and Tzanetakis 2022; Negri et al. 2021; Norbutas 2018; Norbutas et al. 2020; Paquet-Clouston et al. 2018; Quintana et al. 2017; Sawicka et al. 2022; Tzanetakis 2018; van Hout and Hearne 2017) but still not yet gathered into criminology and penology. It led to missing data if we only tick the 'criminology and penology' box. The paper of James

Martin and Nicholas Christin – *Ethics in Cryptomarket Research* is one of the specific examples to cause several confuses. It includes the misinformative confirmation about the co-author collaborations/citations/countries/affiliations/networks between those two authors (see more detail in Fig. 17 and Table 3). It led to 'wrong' reflections about the lack of collaborations among Australian and US authors/institutions/countries because this journal does not belong to criminology and penology. It requires 'new' researchers in the field to search carefully to select the scope.

Thirdly, regarding the research database, *Tor* and its related darknets are quite a friendly environment with some research aims with journalists, activists, and researchers. However, conducting darknet-related criminal activities in the cryptomarket's platform required technical knowledge and ethical approvals for scholars. Thus, looking for an open-access database could be easier, more economical, flexible, and adaptable, particularly with naïve participants. From this SLR with bibliometric analysis, I would like to call for further considerations to access the Dark Net Market (DNM), which has readily been obtained from a vast archive compiled by Gwern Branwen (2013). Except for ethics exemptions, there are at least two different benefits. One is for cost; this archive provides more than 30 different Dark Web forums, mostly in the HTML format, without charges for research (Munksgaard et al. 2016; Rhumorbarbe et al. 2016). Two is for subject-based research; this platform covers different types/forms of illicit goods and services in the darknet platform rather than only tobacco, child sexual exploitation material, weapons, and drugs as previous research conducted. In this SLR's findings, there were few papers ($n = 5$ out of the 49) in the current collection to utilize the DNM as their primary and/or secondary sources (Décary-Hétu and Giommoni 2017; Demant et al. 2018a, b; Demant et al. 2018a, b; Laferriere and Decary-Hetu 2022; Lee et al. 2022; Martin and Christin 2016). Thus, future studies and researchers should use these archived contains data of Gwern Branwen to implement their extended scopes (not only criminology) such as psychology, sociology, business, marketing, and so on.

Fourthly, in terms of documents, in this paper, the author conducted an SLR combined with bibliometric analysis to evaluate and visualize the research articles and peer-reviewed papers published relating to darknet-based criminalizing in the last decade. With only myself as a burgeoning scholar in the field, the scope of the data collection is to look for the WoS system rather than integrate others due to human resource capacity. Assumingly, it is one of the limitations of this article. I only collected papers from five different digital repositories (ESCI, CPCI-SSH, SSCI, SCI-EXPANDED, and A&HCI) and limited my search to papers published in English. Therefore, the author should have included some papers outside these digital databases, particularly for publications on technical approaches. However, my extensive literature review provides a detailed overview of the current research on darknet-related criminals. It maps a specific picture of authors, affiliations, countries, citations, and their collaboration networks in the field.

Fifthly, the current paper only uses basic approaches in SLR combined with bibliometric analysis. Thus, in future extension of this work, we plan to conduct a systematic quantitative literature review (SQLR) by calling further students and colleagues interested in co-author to research the darknet-centered approach.

Conducting SQLR is not only to provide 'evidence-based' practices by using a specific size with sophisticated statistical techniques but also to identify the knowledge about 'what we know' and 'what we don't know' (Pickering et al. 2015, p. 1761). It should be conducted with team groups to (1) implement the full 15-step process of SQLR, (2) assist students to 'map their discipline' while studying cybercriminology, (3) collect various data resources such as Scopus, ACM Digital Library, Google Scholar, SSRN, IEEE Xplore, and Sagepub (rather than using only WoS's articles at this study), and (4) delve into the more 'transdisciplinary research' with different mains, methods, data collected and analyzed (rather than focusing on criminology and penology) in the darknet's topics (Pickering and Byrne 2014; Pickering et al. 2015). The author plans to contribute to the field by putting two main criminological theories into practice. One is to focus on the social network theory to visualize the organizational structure of darknet-based gangs. and the other is to utilize the crime script theory to analyze step-by-step modus operandi from the other illicit goods and services that have not yet been focused on in the current literature, such as ransomware and Distributed Denial-of-Service (DDoS) attacks.

Finally, concerning research contributions, cybercrimes, including darknet-related criminals, are covered by both cyber-focused and cyber-enabled crimes. While the former category of crimes is more technical and targets cyberspace's infrastructure and data, the latter amplifies traditional crimes through cyberspace in general and darknet platforms in particular (Ho et al. 2022). Both types of crimes, amateur or astute darknet accounts, have their set of challenges and use of whatever tools are at their disposal, including targeting the cryptomarket's forms. Establishing informative approaches to cryptomarket-related crimes requires bringing together teams from multiple disciplines and practices, including criminology, criminal justice, crime science, psychology, sociology, computer science, cybersecurity, and law enforcement (Ho et al. 2022; Ho and Luong 2022). Yet, the literature review in this paper showed few articles that look at darknet-related criminals from a multidisciplinary approach (Chiang et al. 2020; Martin 2014b; Mirea et al. 2019; Wronka 2022) rather than focusing on only criminology. Furthermore, the police-based research to look for structure and modus operandi of the darknet's platforms should be extended to seek evidence-based policing with law enforcement interventions in future, which there are still few studies in our current collection (Décary-Hétu and Giommoni 2017; Jardine 2021; Johnson et al. 2020).

Conclusions

The darknet is an overlay network within the Internet that can only be accessed with specific software, configurations, or authorization through anonymization tools such as *Tor*. Although the darknet is an essential tool for many people looking for anonymity, such as journalists and politicians, to contribute their voices of freedom, it is often associated with illegal and criminal activities (Martin 2014a, 2014b; Munksgaard et al. 2016). Darknet-based criminalizing is a burgeoning study in criminology and penology to compare with a bunch of critical analyses from technical detections (Gupta et al. 2021; Nazah et al. 2020). To understand this further, I conducted

a detailed SLR with bibliometric analysis supplements after collecting 1150 papers from five digital repositories on the WoS, including ESCI, CPCI-SSH, SSCI, SCI-EXPANDED, and A&HCI. After that, the author thematically analyzed 49 relevant articles on the topic. In these papers, except for some limitations explained above, I have primarily examined the darknet-related criminal studies by prior literature with specific findings to address six RQs. Alongside the scientific contributions of these 49 articles, this paper should be considered one of the specific papers to SLR with a visualization of bibliometric analysis that focuses on analyzing prior work on cryptomarket-related crimes. Based on the current analysis, the author provides six actionable recommendations that pave the future direction for darknet-related criminals.

Acknowledgements Not yet.

Authors contributions Not applicable.

Funding Open Access funding enabled and organized by CAUL and its Member Institutions. Not applicable.

Data availability All 49 selected articles in this study are displayed on the Table 3.

Declarations

Conflict of interest Not applicable.

References

Albrecht, C., K. Duffin, S. Hawkins, and V. Rocha. 2019. The Use of Cryptocurrencies in the Money Laundering Process. *Journal of Money Laundering Control* 22 (2): 210–216. https://doi.org/10.1108/JMLC-12-2017-0074.

Aldridge, J., and R. Askew. 2017. Delivery Dilemmas: How Drug Cryptomarket Users Identify and Seek to Reduce Their Risk of Detection by Law Enforcement. *International Journal of Drug Policy* 41: 101–109. https://doi.org/10.1016/j.drugpo.2016.10.010.

Al-Suwaidi, N., H. Nobanee, and F. Jabeen. 2018. Estimating Causes of Cyber Crime: Evidence from Panel Data FGLS estimator. *International Journal of Cyber Criminology* 12 (2): 392–407. https://doi.org/10.5281/zenodo.3365895.

Aria, M., and C. Cuccurullo. 2017. Bibliometrics: An R-tool for Comprehensive Science Mapping Analysis. *Journal of Informetrics* 11 (4): 959–975. https://doi.org/10.1016/j.joi.2017.08.007.

Aria, M., C. Cuccurullo, L. D'Aniello, M. Misuraca, and M. Spano. 2022. Thematic Analysis as a New Culturomic Tool: The Social Media Coverage on COVID-19 Pandemic in Italy. *Sustainability* 14 (3643): 1–12. https://doi.org/10.3390/su14063643.

Aria, M., M. Misuraca, and M. Spano. 2020. Mapping the Evolution of Social Research and Data Science on 30 Years of *Social Indicators Research*. *Social Indicators Research* 149: 803–831. https://doi.org/10.1007/s11205-020-02281-3.

Bergeron, A., D. Décary-Hétu, and L. Giommoni. 2020. Preliminary Findings of the Impact of COVID-19 on Drugs Crypto Markets. *International Journal of Drug Policy* 83 (102870): 1–4. https://doi.org/10.1016/j.drugpo.2020.102870.

Bergeron, A., D. Décary-Hétu, L. Giommoni, and M.-P. Villeneuve-Dubuc. 2022. The Success Rate of Online Illicit Drug Transactions During a Global Pandemic. *International Journal of Drug Policy* 99 (103452): 1–7. https://doi.org/10.1016/j.drugpo.2021.103452.

Beshiri, A., and A. Susuri. 2019. Dark Web and Its Impact on Online Anonymity and Privacy: A Critical Analysis and Review. *Journal of Computer and Communications* 7: 30–43. https://doi.org/10.4236/jcc.2019.73004.

Bibliometrix. 2022. *Bibliometrix Around the World*. Retrieved 1 July from https://www.bibliometrix.org/home/index.php/about-us-2/bibliometrix-around-the-world

Bookstein, A. 2008. Explanations of the Bibliometric Laws. *Collection Management* 3 (2–3): 151–162. https://doi.org/10.1300/J105v03n02_04.

Braaten, C., and M. Vaughn. 2021. Convenience Theory of Cryptocurrency Crime: A Content Analysis of U.S. Federal Court Decisions. *Deviant Behavior* 42 (8): 958–978. https://doi.org/10.1080/01639625.2019.1706706.

Bradford, S. (1934). Sources of Information on Specific Subjects. *Engineering, 137*.

Broadhurst, R., M. Ball, and H. Trivedi. 2020. Fentanyl Availability on Darknet Markets. *Trends and Issues in Crime and Criminal Justice* 590, 1–14. https://doi.org/10.52922/ti04244

Broadhurst, R., J. Foye, C. Jiang, and M. Ball. 2021. Illicit Firearms and Other Weapons on Darknet Markets. *Trends and Issues in Crime and Criminal Justice* 622, 1–19. https://doi.org/10.52922/ti78009

Chiang, E., D. Nguyen, A. Towler, M. Haas, and J. Grieve. 2020. Linguistic Analysis of Suspected Child Sexual Offenders' Interactions in a Dark Web Image Exchange Chatroom. *International Journal of Speech Language and the Law* 27 (2): 129–161. https://doi.org/10.1558/ijsll.41446.

Cobo, M.J., A.G. Lopez-Herrera, E. Herrera-Viedma, and F. Herrera. 2011. An Approach for Detecting, Quantifying, and Visualizing the Evolution of a Research Field: A Practical Application to the Fuzzy Sets Theory Field. *Journal of Informetrics* 5 (1): 146–166. https://doi.org/10.1016/j.joi.2010.10.002.

Copeland, C., Wallin, M., and Holt, T. (2020, AUG 2). Assessing the Practices and Products of Darkweb Firearm Vendors. *Deviant Behavior, 41*(8), 949–968. https://doi.org/10.1080/01639625.2019.1596465

Cuccurullo, C., M. Aria, and F. Sarto. 2016. Foundations and Trends in Performance Management: A Twenty-Five Years Bibliometric Analysis in Business and Public Administration Domains. *Scientometrics* 108: 595–611. https://doi.org/10.1007/s11192-016-1948-8.

Cunliffe, J., Décary-Hêtu, D., and Pollak, T. (2019). Nonmedical Prescription Psychiatric Drug Use and the Darknet: A Cryptomarket Analysis. *International Journal of Drug Policy, 73*, 263–272. https://doi.org/10.1016/j.drugpo.2019.01.016

Cunliffe, J., J. Martin, D. Décary-Hétu, and J. Aldridge. 2017. An Island Apart? Risks and Prices in the Australian Cryptomarket Drug Trade. *International Journal of Drug Policy* 50: 64–73. https://doi.org/10.1016/j.drugpo.2017.09.005.

Décary-Hétu, D., and L. Giommoni. 2017. Do Police Crackdowns Disrupt Drug Cryptomarkets? A Longitudinal Analysis of the Effects of Operation Onymous. *Crime, Law and Social Change* 67 (1): 55–75. https://doi.org/10.1007/s10611-016-9644-4.

Décary-Hétu, D., V. Mousseau, and I. Rguioui. 2018. The Shift Online Tobacco Trafficking. *International Journal of Cyber Criminology* 12 (1): 47–67. https://doi.org/10.5281/zenodo.1467842.

Demant, J., R. Munksgaard, and D. Décary-Hétu. 2018a. Going Local on a Global Platform: A Critical Analysis of the Transformative Potential of Cryptomarkets for Organized Illicit Drug Crime. *International Criminal Justice Review* 28 (3): 255–274. https://doi.org/10.1177/1057567718769719.

Demant, J., R. Munksgaard, and E. Houborg. 2018b. Personal Use, Social Supply or Redistribution? Cryptomarket Demand on Silk Road 2 and Agora. *Trends in Organized Crime* 21 (1): 42–61. https://doi.org/10.1007/s12117-016-9281-4.

Dolliver, D. 2016. Characteristics of Drug Vendors on the Tor Network: A Cryptomarket Comparison. *Victims & Offenders* 11 (4): 600–620. https://doi.org/10.1080/15564886.2016.1173158.

Duxbury, S.W., and D.L. Haynie. 2018. The Network Structure of Opioid Distribution on a Darknet Cryptomarket. *Journal of Quantitative Criminology* 34 (4): 921–941. https://doi.org/10.1007/s10940-017-9359-4.

Finn, M., and L. Stalans. 2016. How Targeted Enforcement Shapes Marketing Decisions of Pimps: Evidence of Displacement and Innovation. *Victims & Offenders* 11 (4): 578–599. https://doi.org/10.1080/15564886.2016.1187694.

Grimani, A., A. Gavine, and W. Moncur. 2020. An Evidence Synthesis of Strategies, Enablers and Barriers for Keeping Secrets Online Regarding the Procurement and Supply of Illicit Drugs. *International Journal of Drug Policy, 75*(102621), 1–11. https://doi.org/10.1016/j.drugpo.2019.102621

Gupta, A., S. Maynard, and A. Ahmad. 2021. *The Dark Web Phenomenon: A Review and Research Agenda.* Australasian Conference on Information Systems, Perth.

Gwern, B. 2013. *Darknet Market Archives (2013–2015)*. Retrieved 1 July from https://www.gwern.net/DNM-archives

Ho, H., R. Ko, and L. Mazerolle. 2022. Situational Crime Prevention (SCP) Techniques to Prevent and Control Cybercrimes: A Focused Systematic Review. *Computers & Security* 115 (102611): 1–24.

Ho, T.N.H., and T.H. Luong. 2022. Research Trends in Cybercrime Victimization During 2010–2020: A Bibliometric Analysis. *SN Social Science* 2 (1): 1–32.

Holt, T., and J. Lee. 2022a. A Crime Script Analysis of Counterfeit Identity Document Procurement Online. *Deviant Behavior* 43 (3): 285–302.

Holt, T., and J. Lee. 2022b. A Crime Script Model of Dark Web Firearms Purchasing. *American Journal of Criminal Justice*. https://doi.org/10.1007/s12103-022-09675-8.

Irwin, A., and A. Turner. 2018. Illicit Bitcoin transactions: Challenges in getting to the who, what, when and where. *Journal of Money Laundering* 21 (3): 297–313. https://doi.org/10.1108/JMLC-07-2017-0031.

Jardine, E. 2021. Policing the Cybercrime Script of Darknet Drug Markets: Methods of Effective Law Enforcement Intervention. *American Journal of Criminal Justice* 46 (6): 980–1005. https://doi.org/10.1007/s12103-021-09656-3.

Jardine, E., and A. Lindner. 2020. The Dark Web and Cannabis Use in the United States: Evidence from a Big Data Research Design. *International Journal of Drug Policy* 76 (102627): 1–11. https://doi.org/10.1016/j.drugpo.2019.102627.

Johnson, D., E. Faulkner, G. Meredith, and T.J. Wilson. 2020. Police Functional Adaptation to the Digital or Post Digital Age: Discussions with Cybercrime Experts. *Journal of Criminal Law* 84 (5): 427–450. https://doi.org/10.1177/0022018320952559.

Kamphausen, G., and B. Werse. 2019. Digital Figurations in the Online Trade of Illicit Drugs: A Qualitative Content Analysis of Darknet Forums. *International Journal of Drug Policy* 73: 281–287. https://doi.org/10.1016/j.drugpo.2019.04.011.

Kethineni, S., Y. Cao, and C. Dodge. 2018. Use of Bitcoin in Darknet Markets: Examining Facilitative Factors on Bitcoin-Related Crimes. *American Journal of Criminal Justice* 43 (2): 141–157. https://doi.org/10.1007/s12103-017-9394-6.

Kowalski, M., C. Hooker, and M. Barratt. 2019. Should We Smoke It for You As Well? An Ethnographic Analysis of a Drug Cryptomarket Environment. *International Journal of Drug Policy* 73: 245–254. https://doi.org/10.1016/j.drugpo.2019.03.011.

Lacson, W., and B. Jones. 2016. The 21st Century DarkNet Market: Lessons from the Fall of Silk Road. *International Journal of Cyber Criminology* 10 (1): 40–61.

Ladegaard, I. 2019. Crime Displacement in Digital Drug Markets. *International Journal of Drug Policy* 63: 113–121. https://doi.org/10.1016/j.drugpo.2018.09.013.

Laferriere, D., and D. Decary-Hetu. 2022. Examining the Uncharted Dark Web: Trust Signalling on Single Vendor Shops. *Deviant Behavior*. https://doi.org/10.1080/01639625.2021.2011479.

Leclerc, B., J. Drew, T. Holt, J. Cale, and S. Singh. 2021. Child Sexual Abuse Material on the Darknet: A Script Analysis of How Offenders Operate. *Trends and Issues in Crime and Criminal Justice* 627: 1–13.

Lee, J., T. Holt, and O. Smirnova. 2022. An Assessment of the State of Firearm Sales on the Dark Web. *Journal of Crime and Justice*. https://doi.org/10.1080/0735648X.2022.2058062.

Linnenluecke, M., M. Marrone, and A. Singh. 2020. Conducting Systematic Literature Reviews and Bibliometric Analyses. *Australian Journal of Management* 45 (2): 175–194. https://doi.org/10.1177/0312896219877678.

Martin, J. (2014a). *Drugs on the Dark Net: How Crypotmarkets Are Transforming the Global Trade in Illicit Drugs*. Palgrave Macmillan.

Martin, J. 2014b. Lost on the Silk Road: Online Drug Distribution and the 'Cryptomarket.' *Criminology & Criminal Justice* 14 (3): 351–367. https://doi.org/10.1177/1748895813505234.

Martin, J., and N. Christin. 2016. Ethics in Cryptomarket Research. *International Journal of Drug Policy* 35: 84–91. https://doi.org/10.1016/j.drugpo.2016.05.006.

Martin, J., R. Munksgaard, R. Coomber, J. Demant, and M. Barrat. 2020. Selling Drugs on Darkweb Cryptomarkets: Differentiated Pathways, Risks and Rewards. *The British Journal of Criminology* 60 (3): 559–578. https://doi.org/10.1093/bjc/azz075.

Masson, K., and A. Bancroft. 2018. 'Nice People Doing Shady Things': Drugs and the Morality of Exchange in the Darknet Cryptomarkets. *International Journal of Drug Policy* 58: 78–84. https://doi.org/10.1016/j.drugpo.2018.05.008.

Miller, J.M., and H.V. Miller. 2021. Beating the House: Ethnographic Insights into a Web-Based Marijuana Grey Market. *AMERICAN JOURNAL OF CRIMINAL JUSTICE* 46 (6): 1018–1033. https://doi.org/10.1007/s12103-021-09661-6.

Mirea, M., V. Wang, and J. Jung. 2019. The Not So Dark Side of the Darknet: A Qualitative Study. *Security Journal* 32 (2): 102–118. https://doi.org/10.1057/s41284-018-0150-5.

Moeller, K., R. Munksgaard, and J. Demant. 2021. Illicit Drug Prices and Auantity Discounts: A Comparison Between a Cryptomarket, Social Media, and Police Data. *International Journal of Drug Policy* 91 (102969): 1–7. https://doi.org/10.1016/j.drugpo.2020.102969.

Munksgaard, R., D. Décary-Hétu, A. Malm, and A. Nouvian. 2021. Distributing Tobacco in the Dark: Assessing the Regional Structure and Shipping Patterns of Illicit Tobacco in Cryptomarkets. *Global Crime* 22 (1): 1–21. https://doi.org/10.1080/17440572.2020.1799787.

Munksgaard, R., J. Demant, and G. Branwen. 2016. A Replication and Methodological Critique of the study "Evaluating Drug Trafficking on the Tor Network." *International Journal of Drug Policy* 35: 92–96. https://doi.org/10.1016/j.drugpo.2016.02.027.

Munksgaard, R., and M. Tzanetakis. 2022. Uncertainty and Risk: A Framework for Understanding Pricing in Online Drug Markets. *International Journal of Drug Policy* 101: 103535. https://doi.org/10.1016/j.drugpo.2021.103535.

Nazah, S., S. Huda, J. Abawajy, and M. Hassan. 2020. Evolution of Dark Web Threat Analysis and Detection: A Systematic Approach. *IEEE Access* 8: 171796–171819. https://doi.org/10.1109/ACCESS.2020.3024198.

Negri, A., H. Townshend, T. McSweeney, O. Angelopoulou, H. Banayoti, M. Prilutskaya, O. Bowden-Jones, and O. Corazza. 2021. Carfentanil on the Darknet: Potential Scam or Alarming Public Health Threat? *International Journal of Drug Policy* 91 (103118): 1–6. https://doi.org/10.1016/j.drugpo.2021.103118.

Norbutas, L. 2018. Offline Constraints in Online Drug Marketplaces: An Exploratory Analysis of a Cryptomarket Trade Network. *International Journal of Drug Policy* 56: 92–100. https://doi.org/10.1016/j.drugpo.2018.03.016.

Norbutas, L., S. Ruiter, and R. Corten. 2020. Reputation Transferability Across Contexts: Maintaining Cooperation Among Anonymous Cryptomarket Actors When Moving Between Markets. *International Journal of Drug Policy* 76 (102635): 1–11. https://doi.org/10.1016/j.drugpo.2019.102635.

Paquet-Clouston, M., D. Décary-Hétu, and C. Morselli. 2018. Assessing Market Competition and Vendors' Size and Scope on AlphaBay. *International Journal of Drug Policy* 54: 87–98. https://doi.org/10.1016/j.drugpo.2018.01.003.

Peritz, B. 1990. A Bradford Distribution for Bibliometrics. *Scientometrics* 18: 323–329. https://doi.org/10.1007/BF02020148.

Peters, H., and A. van Raan. 1991. Structuring Scientific Activities by Co-Author Analysis: An Exercise on a University Faculty Level. *Scientometrics* 20 (1): 235–255.

Pickering, C., and J. Byrne. 2014. The Benefits of Publishing Systematic Quantitative Literature Reviews for PhD Candidates and Other Early-Career Researchers. *Higher Education Research & Development* 33 (3): 534–548.

Pickering, C., J. Grigon, R. Steven, D. Guitart, and J. Byrne. 2015. Publishing Not Perishing: How Research Student Transition From Novice to Knowledgeable Using Systematic Quantitative Literature Reviews. *Studies in Higher Education* 40 (10): 1756–1769.

Quintana, P., M. Ventura, M. Grifell, A. Palma, L. Galindo, I. Fornís, C. Gil, X. Carbón, F. Caudevilla, M. Farré, and M. Torrens. 2017. The Hidden Web and the Fentanyl Problem: Detection of Ocfentanil As An Adulterant in Heroin. *International Journal of Drug Policy* 40: 78–83. https://doi.org/10.1016/j.drugpo.2016.10.006.

Rhumorbarbe, D., L. Staehli, J. Broséus, Q. Rossy, and P. Esseiva. 2016. Buying drugs on a Darknet market: A better deal? Studying the online illicit drug market through the analysis of digital, physical

and chemical data. *Forensic Science International* 267: 173–182. https://doi.org/10.1016/j.forsciint.2016.08.032.

Roddy, A., and T. Holt. 2022. An Assessment of Hitmen and Contracted Violence Providers Operating Online. *Deviant Behavior* 43 (2): 139–151. https://doi.org/10.1080/01639625.2020.1787763.

Roemer, R., and R. Borchardt. 2015. *Meaningful Metrics: A 21st Century Libraian's Guide to Bibliometrics, Altmetrics, and Research Impact*. American Library Association (ALA).

Rojas-Sanchez, M., P. Palos-Sanchez, and J. Folgado-Fernandez. 2022. Systematic Literature Review and Bibliometric Analysis on Virtual Reality and Education. *Education and Information Technologies*. https://doi.org/10.1007/s10639-022-11167-5.

Sawicka, M., I. Rafanell, and A. Bancroft. 2022. Digital Localisation in an Illicit Market Space: Interactional Creation of a Psychedelic Assemblage in a Darknet Community of Exchange. *International Journal of Drug Policy* 100: 103514. https://doi.org/10.1016/j.drugpo.2021.103514.

Small, H. 1973. Co-Citation in the Scientific Literature: A New Measure of the Relationship between Two Documents. *Journal of the Association for Information Science and Technology* 24 (4): 265–269.

Suzuki, M., C.-F. Pai, and M.J. Islam. 2018. Systematic Quantitative Literature Review on Criminological Theories in Asia. *Asian Journal of Criminology* 13: 129–151. https://doi.org/10.1007/s11417-017-9262-9.

Tazi, F., S. Shrestha, J. Cruz, and S. Das. 2022. SoK: An Evaluation of the Secure End User Experience on the Dark Net through Systematic Literature Review. *Journal of Cybersecurity and Privacy* 2 (2): 329–357. https://doi.org/10.3390/jcp2020018.

Tor. 2021. *Annual Report: The Tor Project* (Report, Issue. The Tor Project. https://www.torproject.org/static/findoc/2020-2021-TorProject-Annual-Report.pdf?h=3fdc0ff6

Tranfield, D., D. Denyer, and P. Smart. 2003. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management* 14 (3): 207–222.

Tzanetakis, M. 2018. Comparing Cryptomarkets for drugs. A Characterisation of Sellers and Buyers Over Time. *International Journal of Drug Policy* 56: 176–186. https://doi.org/10.1016/j.drugpo.2018.01.022.

UNODC. 2020. *Darknet Cybercrime Threats to Southeast Asia* UNODC. https://www.unodc.org/roseap/uploads/documents/Publications/2021/Darknet_Cybercrime_Threats_to_Southeast_Asia_report.pdf

UNODC. 2022a. *Executive Summary: Policy Implications* (World Drug Report 2022a, Issue. UNODC. https://www.unodc.org/res/wdr2022a/MS/WDR22_Booklet_1.pdf

UNODC. 2022b. *Global Overview: Drug Demand Drug Supply* (World Drug Report 2022b, Issue. UNODC. https://www.unodc.org/res/wdr2022b/MS/WDR22_Booklet_2.pdf

van de Ven, B., and A. Blokland. 2021. A Crime Script Analysis of Child Sexual Exploitation Material Fora on the Darkweb. *Sexual Abuse* 33 (8): 950–974. https://doi.org/10.1177/1079063220981063.

van Hout, M., and E. Hearne. 2017. New Psychoactive Substances (NPS) on Cryptomarket Fora: An Exploratory Study of Characteristics of Forum Activity between NPS Buyers and Vendors. *International Journal of Drug Policy* 40: 102–110. https://doi.org/10.1016/j.drugpo.2016.11.007.

Villalva, D., J. Onaolapo, G. Stringhini, and M. Musolesi. 2018. Under and Over the Surface: A Comparison of the Use of Leaked Account Credentials in the Dark and Surface Web. *Crime Science* 7 (17): 1–11. https://doi.org/10.1186/s40163-018-0092-6.

Westlake, B., M. Bouchard, and R. Frank. 2017. Assessing the Validity of Automated Webcrawlers as Data Collection Tools to Investigate Online Child Sexual Exploitation. *Sexual Abuse* 29 (7): 685–708. https://doi.org/10.1177/1079063215616818.

Wilson, T. 2020. Collaborative Justice and Harm Reduction in Cyberspace: Policing Indecent Child Images. *The Journal of Criminal Law* 84 (5): 474–496. https://doi.org/10.1177/0022018320952560.

Worner, L., and Preetz, N. 2020. The new German Darknet-criminal law-draft—darkening by restricting individual rights. *Journal of Penal Law and Criminology 8*(1), 33–58. https://doi.org/10.26650/JPLC2020-0008

Wronka, C. 2022. Money Laundering Through Cryptocurrencies-Analysis of the Phenomenon and Appropriate Prevention Measures. *Journal of Money Laundering Control* 25 (1): 79–94. https://doi.org/10.1108/JMLC-02-2021-0017.