

# REGULATORY AND SUPERVISORY TECHNOLOGY RESEARCH: A BIBLIOMETRIC ANALYSIS

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## Abstract

This bibliometric study examines articles on Supervisory Technology (SupTech) and Regulatory Technology (RegTech). The investigation's main focus was on author trends and keywords. The data was carefully examined from the sources indexed on Dimension.ai, where 'SupTech' and 'RegTech' were the search terms. A bibliometric map was derived using VOSviewer for bibliometric analysis and a descriptive statistical method. VOSviewer software was used to analyse the development trends of publications related to RegTech and Supertech. In recent years, there has been a sharp increase in the number of papers published on RegTech and SupTech. Various journals have tackled the subject, two of the best being "Fintech and RegTech: Impact on Regulators and Banks" by Ioannis Anagnostopoulos and "The Role of Big Data, Machine Learning, and AI in Assessing Risks: A Regulatory Perspective" by Scott W. Bauguess. The most frequently used terms include regulation, supervision, compliance, finance, and technology. Furthermore, over the past ten years, Douglas W. Arner and Simone Di Castri have authored the most articles of any authors. Challenge and Study are two of this theme's most commonly cited keywords. Digitalisation is critical today and presents a challenge for practitioners and researchers. Academics working in RegTech and SupTech can find relevant information in this study, which gives an overview of keyword trends and the most popular scholars on the subject.

**Keywords:** *Financial Technology, Regulatory Technology, Supervisory Technology, Bibliometric Analysis, VOSviewer*

## I. INTRODUCTION

Following the 2008 financial crisis, regulators have focused on creating new rules to prevent similar crises. However, this also led to a rise in FinTech, which challenges regulators. FinTech disrupts traditional finance, and regulation generally aims to prevent such disruption. Given this, the rapid evolution of FinTech demands a similar evolution of RegTech. RegTech, a contraction of the terms regulatory and technology, describes the use of technology,

particularly information technology (IT), in the context of regulatory monitoring, reporting, and compliance.<sup>1</sup>

FinTech increases the burden on legacy financial service providers by exposing the weaknesses of their existing business models. This also increases the burden on regulators to monitor their subjects effectively. RegTech offers an environment where technology providers respond to demand from financial institutions (and regulators) to achieve the goals of reducing the costs of regulatory and compliance requirements and improving market monitoring capabilities and, in doing so, also introducing opportunities for RegTech start-ups.<sup>2</sup>

Furthermore, Zetzsche et al.<sup>3</sup> show that Europe's financial services and data protection regulatory reforms have unintentionally driven the use of RegTech by intermediaries, supervisors and regulators, laying the foundation for the digital transformation of both EU financial services and regulation thereof. This includes the stringent GDPR (general data protection regulations), the open banking system established by PSD 2 (especially when paired with the GDPR's requirements for data portability), the pan-European digital identity framework established in accordance with eIDAS, and the digital regulatory reporting requirements of AIFMD and MiFID II.

According to DataHorizon Research<sup>4</sup>, the RegTech market was valued at USD 9.8 Billion in 2022 and is expected to grow at a CAGR of 17.3% and reach USD 47.7 Billion by 2032. The primary reasons leading to the rise in demand for RegTech are the efficiency, accuracy, and data management it provides in performing administrative tasks, along with the risk assessment tools to reduce the risk of fraud, especially in the financial sector. The primary reasons behind the growing demand for RegTech are increasing fraud, the filing of incorrect documents, and a rise in cyber-attacks and money laundering activities. These factors have necessitated a robust system that can quickly and easily detect ongoing or possible fraud to prevent data breaches and hacking or take appropriate, timely steps to address these risks. In the US in 2022, the Internal Revenue Service (IRS) collected \$23.8 billion due to late or incorrect tax returns. RegTech can help companies file returns on time and reduce penalties. Automation is also used to replace human resources and cut costs while minimising errors in performing routine tasks.

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<sup>1</sup> Douglas W. Arner, Janos Nathan Barberis, and Ross P. Buckley, *FinTech and RegTech in a Nutshell, and the Future in a Sandbox* (CFA Institute Research Foundation, 2017).

<sup>2</sup> Ioannis Anagnostopoulos, "Fintech and Regtech: Impact on Regulators and Banks," *Journal of Economics and Business* 100 (November 2018): 7–25.

<sup>3</sup> Dirk Andreas Zetzsche et al., "The Future of Data-Driven Finance and RegTech: Lessons from EU Big Bang II," *SSRN Electronic Journal*, 2019.

<sup>4</sup> "Regtech Market Size, Share & Industry Forecast 2032," (2023), <https://datahorizonresearch.com/regtech-market-2513>.

Furthermore, after the “Black Monday” market crash of 1987, regulators and supervisors began to digitise their operations to improve transparency and risk management in the financial markets. Through the 1990s and 2000s, the financial authorities’ data management workflows still heavily relied on manual data entry. Data collection relied on paper forms, then email portals and spreadsheet files. Data was stored in disjointed databases or disconnected folders. Validation occurred manually through spot checks, and the analysis primarily generated static management reports. In the second half of the 2000s, though, a wave of modernisation began when standard data reporting formats began being incorporated into supervisory processes and technologies.<sup>5</sup> Although the use of cutting-edge technologies for supervisory purposes increased during the 2010s, it wasn’t until 2017 that Ravi Menon, Managing Director at the Monetary Authority of Singapore (MAS), formally coined the term “SupTech” to refer to supervisory technologies. In his view, technological innovation was necessary for financial authorities to reduce inefficiencies and make supervision more effective.<sup>6</sup> Like the MAS, many other authorities began to adopt an institutional approach toward SupTech, which became an object of interest to global standard-setting bodies.

In 2017, the Basel Committee on Banking Supervision (BCBS) recommended that supervisors should consider exploring the potential of new technologies, including artificial intelligence and machine learning, distributed ledger technology, cloud computing, and application programming interfaces (APIs), to improve their methods and processes.<sup>7</sup> A new generation of SupTech applications went into production in this period, powered by API and natural language processing and under the leadership of EMDEs financial authorities. The RegTech for Regulators Accelerator (R<sup>2</sup>A) partnered with the Bangko Sentral ng Pilipinas (BSP) and the Mexican Comisión Nacional Bancaria y de Valores (CNBV) along with three technology firms to test and develop three SupTech prototypes, namely an API-based prudential reporting system, a chatbot application and consumer complaint management system, and an AML data infrastructure and advanced analytics solution.<sup>8</sup>

<sup>5</sup> Simone di Castri et al., “State of SupTech Report 2022,” *SSRN Electronic Journal*, 2023.

<sup>6</sup> Ravi Menon, “Ravi Menon: Financial Regulation - the Forward Agenda,” March 28, 2017, <https://www.bis.org/review/r170328a.htm>.

<sup>7</sup> “Sound Practices: Implications of Fintech Developments for Banks and Bank Supervisors,” (2018).

<sup>8</sup> Simone di Castri, Matt Grasser, and Arend Kulenkampff, “An API-Based Prudential Reporting System for the Bangko Sentral Ng Pilipinas (BSP): R<sup>2</sup>A Project Retrospective and Lessons Learned,” *SSRN Electronic Journal*, 2018; Simone di Castri, Matt Grasser, and Arend Kulenkampff, “An AML SupTech Solution for the Mexican National Banking and Securities Commission (CNBV) - R<sup>2</sup>A Project Retrospective and Lessons Learned,” *SSRN Electronic Journal*, 2018; Simone di Castri, Matt Grasser, and Arend Kulenkampff, “A Chatbot Application and Complaints Management System for the Bangko Sentral Ng Pilipinas (BSP). R<sup>2</sup>A Project Retrospective and Lessons Learned,” *SSRN Electronic Journal*, 2020.

Based on research results di Castri et al.,<sup>9</sup> 71% of the financial authorities surveyed indicated that they have already engaged in different SupTech efforts. Three-quarters of the respondents have one or more SupTech applications in operation (50%) and/or an application in development (27%). A further 23% of the authorities reported having a SupTech strategy or roadmap. For Example, the Indonesian Financial Services Authority (OJK) continues to develop supervisory technology for the financial services industry (IJK) by inaugurating OJK Suptech Integrated Data Analytics (OSIDA), namely the implementation of the development of SupTech to automate IJK report data analysis. Early warning signs and compliance checks, as well as possible fraud, data manipulation, and non-compliance with rules in bank business operations, are all detectable through the usage of OSIDA. As a preventative measure, OSIDA assists OJK supervisors in executing supervisory tasks and providing early intervention.<sup>10</sup>

Thus far, researchers from various countries are still exploring how RegTech and SupTech can be implemented and become a solution for effectiveness in various industries, including but not limited to the financial services industry. Based on the developments and brief history above, questions remain about how the research side has developed to continue updating the discussion on RegTech and SupTech. This study examines bibliometric mapping of paper articles on SupTech and RegTech, focusing on author trends and keywords. The analysis is based on Dimension.ai metadata for publications from 2015 to 2023.

## II. LITERATURE REVIEW

RegTech and FinTech differ in that RegTech focuses on the relationship between the intermediary and the supervisory and/or regulatory bodies, whereas FinTech primarily addresses business processes. RegTech offers a higher degree of compliance—or the same degree of compliance at a lower cost—and systems for designing better regulatory and supervisory systems and infrastructure. RegTech can be applied in any field of regulation, compliance, and system design, whether in the context of finance or not, while FinTech is limited by definition to the financial sector.<sup>11</sup>

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<sup>9</sup> di Castri et al., “State of SupTech Report 2022.”

<sup>10</sup> “Siaran Pers: Kembangkan Pengawasan Berbasis Digital OJK Luncurkan Suptech Integrated Data Analytics (OSIDA),” (2022), [https://ojk.go.id/id/berita-dan-kegiatan/siaran-pers/Pages/Kembangkan-Pengawasan-Berbasis-Digital-OJK-Luncurkan-Suptech-Integrated-Data-Analytics-\(OSIDA\).aspx](https://ojk.go.id/id/berita-dan-kegiatan/siaran-pers/Pages/Kembangkan-Pengawasan-Berbasis-Digital-OJK-Luncurkan-Suptech-Integrated-Data-Analytics-(OSIDA).aspx).

<sup>11</sup> Zetzsche et al., “The Future of Data-Driven Finance and RegTech: Lessons from EU Big Bang II.”

'RegTech' refers to using new technology to facilitate compliance with regulatory requirements. It consists of companies that use technology to help businesses comply with regulations efficiently and inexpensively.<sup>12</sup> RegTech has been described as covering three different market sectors and groups of participants, specifically financial institutions and the financial industry, regulators faced with the need to use technology, as well as policymakers and regulators who face the challenge of rapidly transforming financial systems.<sup>13</sup>

Based on Bauguess,<sup>14</sup> the Securities and Exchange Commission in the US (SEC), like many other market players and financial institutions, has recently and quickly advanced its big data or SupTech analytics initiatives. They spearhead advancements in numerous market risk assessment projects and push SEC surveillance programmes. SupTech is the analysis of big data using machine learning to monitor or prevent possible crimes by banks and financial institution customers or noncompliance with existing financial regulations. SupTech can also be used in sectors other than finance.

The term "bibliometrics" is derived from the words "biblio" (book, e.g., bibliography) followed by the word "metrics," which refers to measurement. Therefore, one way to understand "bibliometrics" is as a mathematical and statistical method of measuring or analysing books or other publications. However, most of the applications of bibliometrics so far have included measuring periodicals, such as scientific magazines or journals.<sup>15</sup>

A straightforward graphical depiction typically yields good results in tiny maps with, for example, 100 objects or less. For larger maps, on the other hand, which appear to be the trend, a straightforward graphical depiction is insufficient. Large bibliometric maps can be further enhanced graphically by using density metaphors, special labelling techniques, and zoom functions, among other things. Bibliometric researchers typically employ computer programmes that lack such capabilities. In this work, we present a novel computer program for bibliometric mapping. The programme gives particular consideration to the bibliometric map's graphical representation. The utilisation of VOS, namely for creating bibliometric maps, is covered in this section.

The purpose of VOS is to place items in a low dimension such that the distance between two items accurately reflects the uniformity or relatedness

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<sup>12</sup> Financial Conduct Authority, "Call for Input: Supporting the Development and Adoption of RegTech," 2016, <https://www.fca.org.uk/publication/call-for-input/RegTech-call-for-input.pdf>.

<sup>13</sup> Veerle Colaert, "Systematisation as a Response to Regulatory Expansion in the Financial Sector," *SSRN Electronic Journal*, 2015.

<sup>14</sup> Scott W. Bauguess, "The Role of Big Data, Machine Learning, and AI in Assessing Risks: A Regulatory Perspective," *SSRN Electronic Journal*, 2017.

<sup>15</sup> Himawanto Himawanto, "Bibliometric Study of the Oil and Gas Technology Field in Indonesia," *BBaca: Jurnal Dokumentasi dan Informasi* 36, no. 1 (March 3, 2016): 11.

of the items. For each pair of items  $i$  and  $j$ , VOS requires input similarity  $s_{ij}$  ( $s_{ij} \geq 0$ ). VOS treats the  $s_{ij}$  equation as a measurement on a ratio scale. The  $s_{ij}$  equation is usually calculated using the strength of association defined in Equation 1. VOS determines the location of items on the map by minimising

$$V(x_i, \dots, x_n) = \sum_{i < j} s_{ij} \|x_i - x_j\|^2 \quad (1)$$

To:

$$\frac{2}{n(n-1)} \sum_{i < j} \|x_i - x_j\| = 1 \quad (2)$$

Therefore, using VOS minimises the weighted sum of the squares and the distances between all pairs of items. The similarity between the items weighs the square of the distance between pairs of items. To avoid worthless solutions where all items have the exact location, a constraint is imposed that the average distance between two items must equal one.

This research uses scholarly publication data from various journals indexed by Dimension.ai with the keyword research theme Regulatory Technology and Supervisory Technology. Data were collected by searching papers published between 2015 and 2017 and January 23, 2023. From the search results, 419 and 88 published articles were obtained. Data on publication development trends with the theme Regulatory Technology and Supervisory Technology were analysed using VOSviewer software.

There are numerous ways that VOSviewer can display maps, each highlighting a distinct component of the map. Its zooming, scrolling, and searching features make examining a map in-depth easier. For maps with at least a considerable number of items (e.g., 100 items), the ability to display by VOSviewer is quite helpful.<sup>16</sup> Most computer programmes utilised for bibliometric mapping don't adequately display these maps.

VOSviewer uses the VOS mapping technique—VOS stands for similarity visualisation—to create the map for earlier research that employed VOS mapping methods. VOSviewer is capable of displaying maps created using the correct mapping methods. As a result, this program can be used to display maps created both with and without VOS mapping techniques, including

<sup>16</sup> Yaser Taufik Syamlan and Muhammad Syafii Antonio, "A Bibliometric Analysis of Islamic Regtech Research Indexed by Dimension.Ai," *Airlangga International Journal of Islamic Economics and Finance* 6, no. 01 (June 15, 2023): 22–32; Ulviya Tafitri et al., "Islamic Securities Crowdfunding Research: A Bibliometric Analysis," *Airlangga International Journal of Islamic Economics and Finance* 6, no. 02 (December 13, 2023): 130–43.

multidimensional scaling. VOSviewer may be launched straight from the Internet and is compatible with a wide range of hardware and operating systems.

### III. RESEARCH METHODS

Regulatory Technology- and Supervisory Technology-related academic journal publications provided the publication data used in this study. Precisely, data was gathered between 2015 and 2023—that is, over the last 10 and 8 years. For the entirety of the data, the search terms are “RegTech” and “SupTech” Consequently, as of January 23, 2024, there were 419 and 88 publications.

In addition, VOSviewer software was used to analyse the development trends of publications related to regulatory and supervisory technology. VOSviewer was the name of the computer program used. The bibliometric research community can create and view bibliometric maps with VOSviewer, freely accessible at [www.vosviewer.com](http://www.vosviewer.com).

VOSviewer can create author maps or journal maps based on co-authorship and keyword co-occurrence data, namely, building author and keyword maps based on co-occurrence data. The programme offers mapping that allows bibliometrics to be examined in detail. This research is descriptive research based on library data that is, in turn, based on bibliometric analysis. This research uses publication data related to Regulatory Technology and Supervisory Technology sourced from the Dimensions.ai database (<https://Dimensions.ai>). The alternative indexation dimension used is the criterion that all articles have a title and abstract.

VOSviewer builds maps using the visualisation of similarity (VOS) mapping technique.<sup>17</sup> For previous research using the VOS mapping technique, see Van Eck and Waltman (2007).<sup>18</sup> VOSviewer is capable of displaying maps created using any appropriate mapping method. Therefore, the application can display maps created with the VOS mapping technique and maps created with other approaches like multidimensional scaling. VOSviewer may be launched straight from the internet and is compatible with a wide range of hardware and operating systems.

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<sup>17</sup> Nees Jan van Eck and Ludo Waltman, “VOS: A New Method for Visualizing Similarities Between Objects,” *Studies in Classification, Data Analysis, and Knowledge Organization* (2007): 299–306.

<sup>18</sup> Nees Jan Van Eck and Ludo Waltman, “Bibliometric Mapping of The Computational Intelligence Field,” *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* 15, no. 05 (October 2007): 625–45.

## IV. FINDINGS AND ANALYSIS

### IV.A. Data

#### *IV.A.1. Yearly Publication*

This section discusses the number of papers published on the theme of regulatory technology and supervisory technology. As a result, 419 RegTech-related and 88 SupTech-related papers have been published in the 10-year observation period from 2015 to 2023. Table 1 presents the publication of documents per year, which varies over the last 10 years, ranging from one to 87 papers on the RegTech theme. Meanwhile, in the previous eight years on the SupTech theme, the number of publications per year has varied from zero to 29 papers.

**Table 1.**  
**Yearly Publication of RegTech and SupTech (2015-2023)**

<b>Year</b>	<b>RegTech</b>	<b>SupTech</b>
2015	1	0
2016	3	0
2017	13	1
2018	29	6
2019	86	5
2020	60	11
2021	87	23
2022	72	29
2023	64	13
<b>Total</b>	<b>415</b>	<b>88</b>

The highest number of papers published under the RegTech theme was published in 2021, with 87 papers, and the least was in 2015, when the term RegTech itself was unfamiliar and not widely used. Moreover, the highest number of papers on the SupTech theme was published in 2022, with 29 papers.

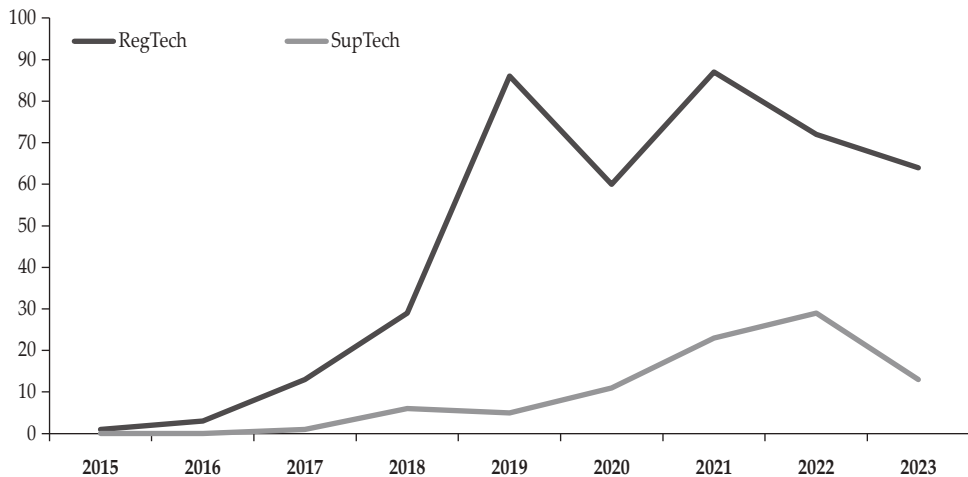
Based on Table 1 above and Diagram 1 below, there were fluctuations accompanied by an overall increasing trend in the number of papers published by various journals on Regulatory Technology and Supervisory Technology themes. Less than 30 papers with a RegTech theme were published between 2015 and 2018, suggesting that there was still minimal worldwide discussion of the RegTech theme during that time. Subsequently, in 2019, the annual count of articles featuring the RegTech theme surpassed 50 papers.

The dramatic rise in RegTech publications from 2019 to 2021 suggests heightened interest and development in response to evolving financial technologies and regulatory challenges. This peak in 2021 could be attributed to

increased regulatory scrutiny and innovation driven by the pandemic's impact on financial services. Another possibility is that this increase occurred because the development of FinTechs and data-driven financial services providers profoundly challenged the current regulatory paradigm. Financial regulators have been increasingly seeking to balance the traditional regulatory objectives of financial stability and consumer protection with promoting growth and innovation. The resulting regulatory innovations include technology (RegTech), regulatory sandboxes, and special charters.<sup>19</sup>

Meanwhile, the number of papers with the SupTech theme began to appear in 2017 and reached 29 publications in 2022. Unfortunately, this number decreased in 2023 and only reached 13 papers. In fact, according to Beerman et al.,<sup>20</sup> one of the challenges for financial institutions has been accelerating the development of new SupTech tools for qualitative monitoring and risk assessment. Furthermore, SupTech adoption was accelerated by the COVID-19 pandemic, which necessitated a shift towards off-site supervision and an increased focus on using SupTech applications to address increased consumer vulnerabilities better.<sup>21</sup>

**Diagram 1.**  
**Yearly Publication of RegTech and SupTech (2015-2023)**



<sup>19</sup> Dirk A. Zetzsche et al., "Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation," *SSRN Electronic Journal*, 2017.

<sup>20</sup> Kenton Beerman, Jermy Prenio, and Raihan Zamil, "Suptech Tools for Prudential Supervision and Their Use during the Pandemic." (Bank for International Settlements, December 2021).

<sup>21</sup> "A Roadmap to SupTech Solutions for Low Income (IDA) Countries," October 7, 2020.

*IV.A.2. Top Authors*

The four most prolific authors on regulatory technology during the previous ten years are displayed in Table 2. As mentioned, the four authors are law students from various universities and nations. “Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation” was the title of one of the articles they co-authored.<sup>22</sup>

**Table 2.**  
**Top RegTech Authors**

<b>RegTech Author</b>	<b>Number of Papers</b>
Douglas W Arner (University of Hong Kong, China)	18
Dirk Andreas Zetzsche (University of Luxembourg, Luxembourg)	17
Ross P Buckley (UNSW Sydney, Australia)	16
Janos Nathan Barberis (University of Hong Kong, China)	10

Table 3 shows the five most prolific authors on the theme of Supervisory Technology over the last eight years. As we can see, the three top authors, namely Simone di Castri, Matt Grasser, and Arend Kulenkampff, wrote a paper together in 2018 entitled “Financial Authorities in the Era of Data Abundance: Regtech for Regulators and SupTech Solutions”. Some of their research also discusses technically how SupTech can be used in the financial sector. Simone di Castri and Matt Grasser are from the Cambridge SupTech Lab Community. They are passionate about Addressing critical challenges of today’s economies and societies, using data to inform decision-making processes and to empower people, and creating financial sectors that are innovative and inclusive and that drive sustainability.<sup>23</sup>

Besides that, two other authors, Ibrahim Ethem Sancak and Stefan Zeranski, are from Germany. They wrote several papers, including “Digitalisation of Financial Supervision with Supervisory Technology (SupTech)” and “Prudential Supervisory Disclosure (PSD) with Supervisory Technology (SupTech): lessons from a FinTech Crisis”.<sup>24</sup>

<sup>22</sup> Zetzsche et al., “Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation.”

<sup>23</sup> “Cambridge SupTech Lab \textbar About Us,” September 29, 2023, [https://lab.ccaf.io/about\\_us](https://lab.ccaf.io/about_us).

<sup>24</sup> Stefan Zeranski and Ibrahim Ethem Sancak, “Digitalisation of Financial Supervision with Supervisory Technology (SupTech),” *JSRN Electronic Journal*, 2020; Stefan Zeranski and Ibrahim E. Sancak, “Prudential Supervisory Disclosure (PSD) with Supervisory Technology (SupTech): Lessons from a FinTech Crisis,” *International Journal of Disclosure and Governance* 18, no. 4 (February 24, 2021): 315–35.

**Table 3.**  
**Top SupTech Authors**

SupTech Author	Number of Papers
Simone Di Castri (University of Cambridge, United Kingdom)	6
Matt Grasser (University of Cambridge, United Kingdom)	5
Arend Kulenkampff (Independent)	5
Ibrahim Ethem Sancak (Ostfalia University of Applied Sciences, Germany)	5
Stefan Zeranski (Ostfalia University of Applied Sciences, Germany)	4

#### IV.A.3. Top Paper in Terms of Citations

The most referenced paper in Table 4 among the 419 papers published on the topic of regulatory technology over the past ten years is a lengthy study entitled “Fintech and RegTech: Impact on regulators and banks”, which provides a thorough analysis written by Ioannis Anagnostopoulos. This paper discusses the influence of FinTech innovations on the broader financial technology landscape. The 2008 financial crisis revealed serious shortcomings in oversight and regulation. This makes disruptive technological advances crucial for examining regulatory compliance, and changing times make financial market law and compliance a top priority of the current agenda.<sup>25</sup>

Several top RegTech papers by Citation have also been written by several top RegTech Authors, such as “Sustainability, FinTech and Financial Inclusion” by Douglas W. Arner, Ross P. Buckley, Dirk A. Zetsche, and Robin Veidt. Apart from that, the paper entitled “Decentralized Finance” by Dirk A. Zetsche, Douglas W Arner, and Ross P Buckley shows that decentralised finance (DeFi) potentially offers an opportunity for the development of an entirely new way to design regulation: the idea of ‘embedded regulation’. Regulatory approaches could be built into the design of DeFi, thus potentially decentralising both finance and its regulation, which is the ultimate expression of RegTech.<sup>26</sup>

Finally, a paper entitled “Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation” by Dirk A. Zetsche, Ross P. Buckley, Douglas W. Arner, and Janos Nathan Barberis discusses how financial regulators are increasingly seeking to balance traditional regulatory objectives of financial stability and consumer protection with promoting growth and innovation.

<sup>25</sup> Anagnostopoulos, “Fintech and Regtech: Impact on Regulators and Banks.”

<sup>26</sup> Dirk A. Zetsche, Douglas W. Arner, and Ross P. Buckley, “Decentralized Finance,” *Journal of Financial Regulation* 6, no. 2 (September 20, 2020): 172–203.

The resulting regulatory innovations include technology (RegTech), regulatory sandboxes, and special charters.<sup>27</sup>

**Table 4.**  
**Top RegTech Papers by Citations**

<b>Amount Citation</b>	<b>Title</b>	<b>Authors</b>
256	Fintech and RegTech: Impact on regulators and banks	Ioannis Anagnostopoulos (2018)
213	Sustainability, FinTech and Financial Inclusion	Douglas W. Arner, Ross P. Buckley, Dirk A. Zetsche, Robin Veidt (2020)
162	Decentralized Finance	Dirk A Zetsche, Douglas W Arner, Ross P Buckley (2020)
146	A Survey of Fintech Research and Policy Discussion	Franklin Allen, Xian Gu, Julapa Jagtiani (2021)
146	Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation	Dirk A. Zetsche, Ross P. Buckley, Douglas W. Arner, Janos Nathan Barberis (2017)

Furthermore, in Table 5, the top paper with the theme of Supervisory Technology, which has been cited 28 times by other papers, is entitled “The Role of Big Data, Machine Learning, and AI in Assessing Risks: A Regulatory Perspective” by Scott W. Bauguess. This paper provides an overview of how RegTech may simplify, expedite, and improve the efficiency of regulatory-related tasks and compliance. Furthermore, covered in this article is the role of technology in the preventive analysis of infractions and new regulatory changes through the use of Big Data and Machine Learning.<sup>28</sup>

Most SupTech-related papers have analysed and discussed the application of technology in each sector’s regulatory framework. The conclusion can be drawn from the literature that SupTech is a subset of RegTech, which is primarily targeted at supervisors and helps them analyse and use current data sources for compliance and regulatory requirements. Several studies, such as “The SupTech Generations” and “State of SupTech Report 2022”, both authored by Simone di Castri, are worth mentioning. They present survey data regarding SupTech utilisation and its significance in financial supervisory organisations across the globe.<sup>29</sup>

<sup>27</sup> Zetsche et al., “Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation.”

<sup>28</sup> Bauguess, “The Role of Big Data, Machine Learning, and AI in Assessing Risks: A Regulatory Perspective.”

<sup>29</sup> di Castri et al., “State of SupTech Report 2022.”

**Table 5.**  
**Top SupTech Paper by Citations**

Amount Citation	Title	Authors
28	The Role of Big Data, Machine Learning, and AI in Assessing Risks: A Regulatory Perspective	Scott W. Bauguess (2017)
19	Digitalisation of Financial Supervision with Supervisory Technology (SupTech)	Stefan Zeranski, Ibrahim Ethem Sancak (2020)
17	Fintech Development Trends in Russia: Expert Opinion of Finance University (translated from Russian)	М. А. Эскиндаров, et al. (2018)
13	The SupTech generations	Simone di Castri, Arend Kulenkampff, Stefan Hohl, Jermy Prenio (2019)
9	Risks and Opportunities of RegTech and SupTech Developments	Giorgio Gasparri (2019)

## IV.B. Bibliometric Mapping

### IV.B.1. Keyword

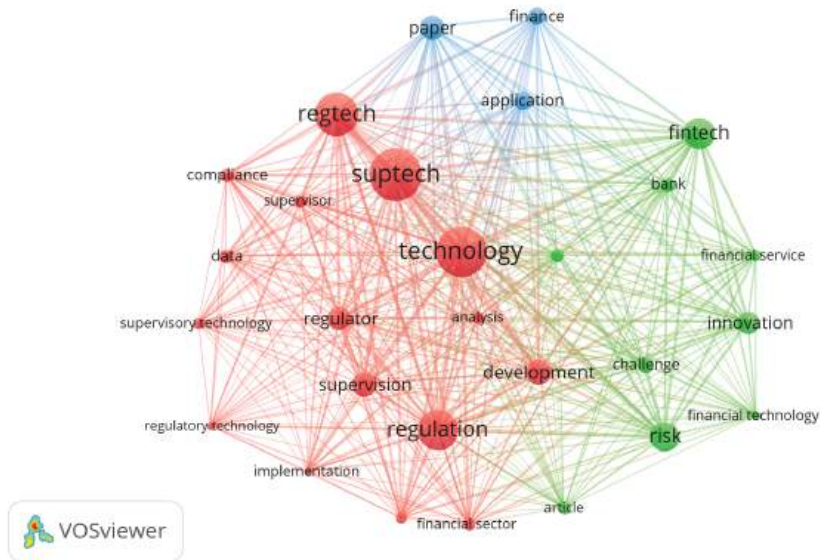
This section presents a graphical visual mapping of paper publications with the theme of Regulatory Technology (RegTech) and Supervisory Technology (SupTech). The results of the keyword mapping analysis form the basis for the co-occurrence mapping of important or unique terms contained in a particular article. Mapping is a process that facilitates the recognition of knowledge elements and their configurations, dynamics, interdependencies, and interactions. Related to bibliometrics, science mapping is a method of visualisation. This visualisation is done by creating a landscape map displaying science topics. The results of the visualisation of the co-word map network for paper publications with the theme Regulatory Technology and Supervisory Technology can be seen in Figures 1 and 2 below.

From 30 keywords in the Regulatory Technology theme papers taken below, the keywords frequently appearing in RegTech-themed papers and their relationship with other keywords in four clusters are shown. Cluster 1 in red includes keywords like bank, chapter, development, finance, financial service, financial technology, FinTech, future, impact, innovation, and role. Cluster 2 in green includes keywords such as application, article, artificial intelligence, blockchain, data, financial institution, financial sector, machine learning, risk, and technology. Cluster 3 in blue contains keywords such as challenge, compliance, RegTech, regulation, regulator, regulatory technology, and study. Finally, cluster 4 in yellow consists of two keywords, paper and SupTech.

Based on the results of keyword mapping with the theme of Regulatory Technology, each cluster is a reference to see how each keyword is related. Cluster 3 (blue) should show the keyword challenge and study, which are



**Figure 2.**  
**Bibliometric Mapping of SupTech Research Keywords**



#### *IV.B.2. Yearly Keyword Trend*

The colours in the circles that represent the clusters formed by the division of keywords are used to order them. Utilising this data, one can ascertain the keyword trend over the last ten years. The bibliometric analysis displays a few frequently used keywords in the document that are the subject of the investigation. A larger circle is displayed, and more keywords occur. Laila et al.<sup>30</sup> reported that their line relationship indicates the degree of relatedness between keywords.

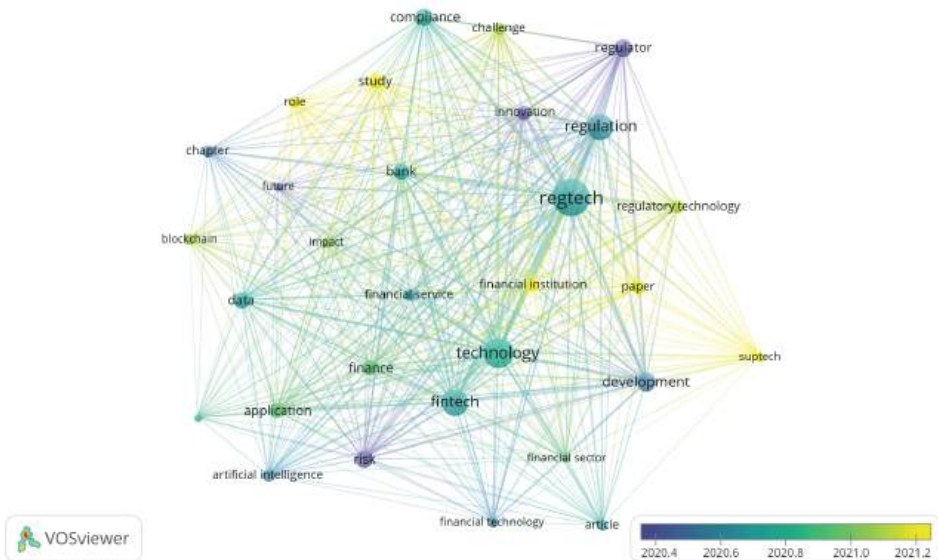
The keyword clusters are arranged as coloured circles within each set, indicating the cluster. If the keywords with the theme of Regulatory Technology and Supervisory Technology are classified by year of publication, the mapping results can be seen in Figures 3 and 4. The keyword colours of these charts are purple, green, and yellow intervals. The darker (purple) indicates older publication years, and the lighter (yellow) indicates more recent ones. This data can be useful in determining keyword trends over the past 10 years.

The results of the analysis of keyword trends in Figure 3 show that some of the keywords widely used since 2020 are innovation, regulator, risk, and future. In contrast, the most recent and widely used keywords since the beginning of 2021 are role, study, financial institution, paper, and SupTech. These new

<sup>30</sup> Nisful Laila, Aam Slamet Rusydiana, and Aisyah Assalafiyah, "The Impact of Covid-19 on The Halal Economy: A Bibliometric Approach," (2022).

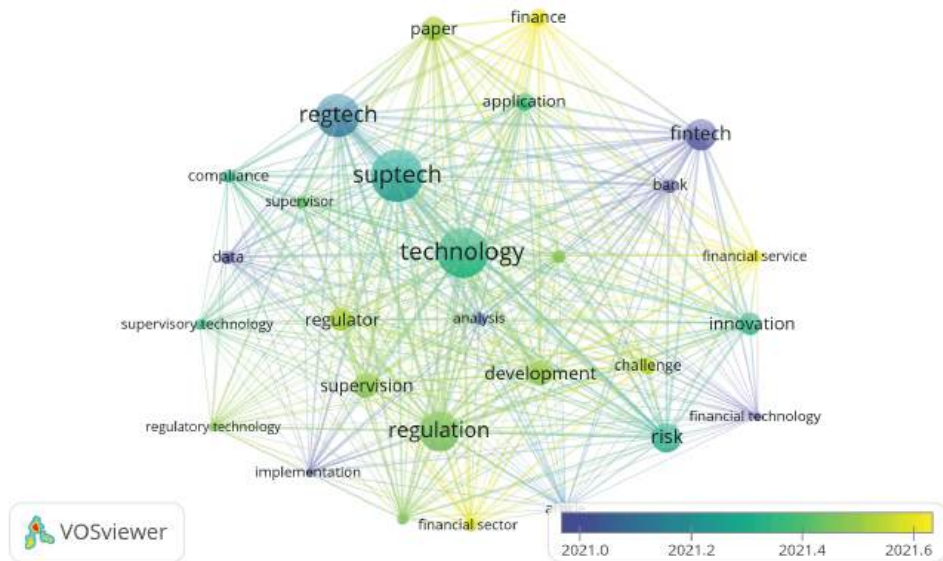
keywords can provide recommendations for further research. For example, the keyword financial institution shows that the discussion of RegTech in financial institutions is still relevant and ripe for discussion. In addition, the keyword study and paper prove that research on RegTech still needs to be done, considering the many different regulations in each country and how technology adapts to regulatory compliance needs. Finally, the keyword role and SupTech are the author's highlight papers with the RegTech theme; it can be seen that the discussion of RegTech in the future will focus on Supervisory Technology and the role of supervisors who use this technology for compliance needs. In summary, the research focus of the RegTech theme will be more on research, SupTech, and financial institutions.

**Figure 3.**  
**Bibliometric Mapping of RegTech Research Keywords by Year**



Furthermore, the results of the keyword trend analysis in Figure 4 show that some of the keywords that have been widely used since the beginning of 2021 are bank, data, FinTech, analysis, implementation, and RegTech. In contrast, the most recent and widely used keywords since the end of 2021 are finance, financial service, and financial sector. The new keywords in this paper under the SupTech theme can offer recommendations for further research. It can be seen if the focus or scope of the following SupTech paper will lead to the financial sector and how this surveillance technology can oversee finance and financial services.

**Figure 4.**  
**Bibliometric Mapping of SupTech Research Keywords by Year**

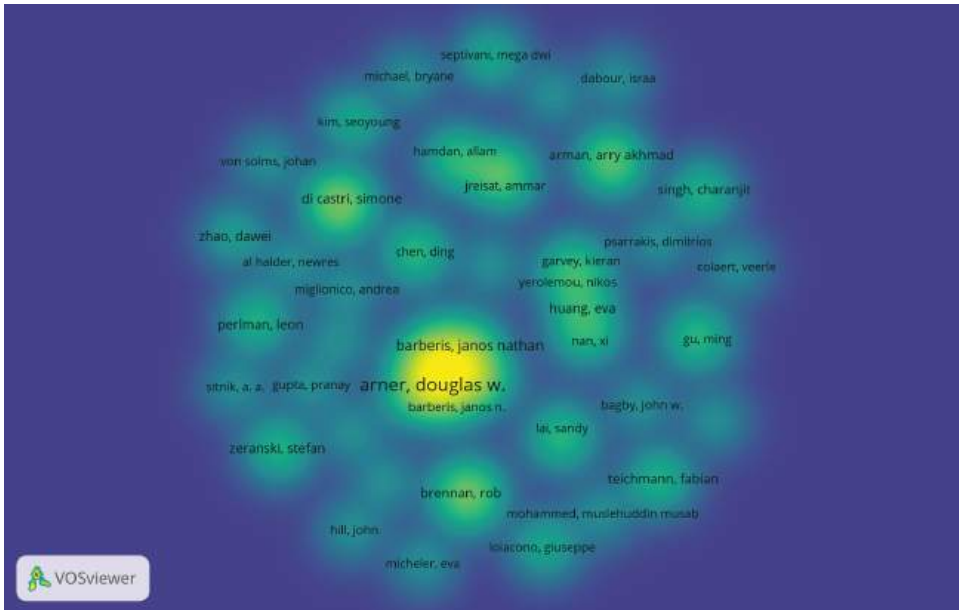


#### *IV.B.3. Authors*

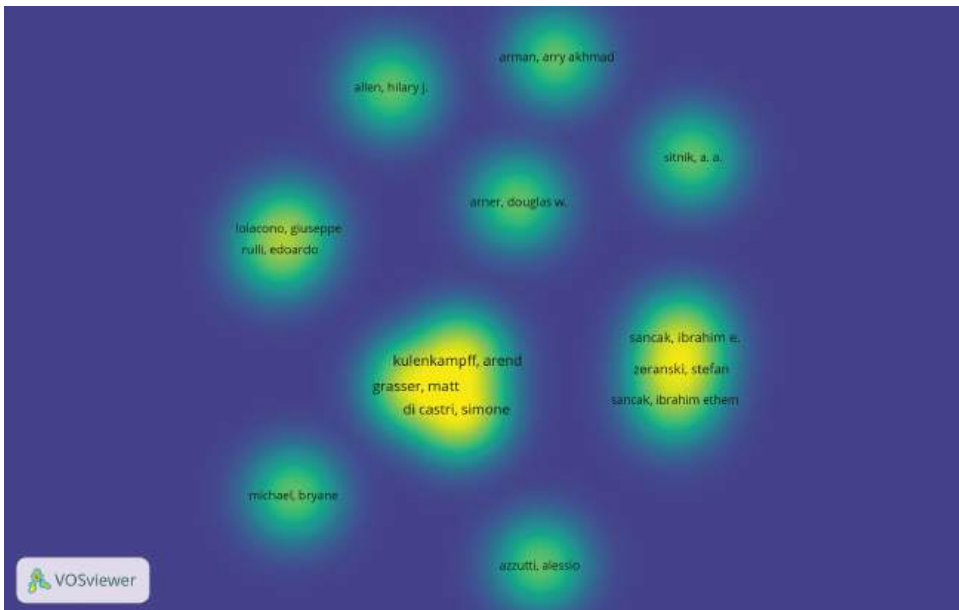
The meta-analysis of the top author was mentioned earlier. The top authors of Regulatory Technology- and Supervisory Technology-themed papers were further examined using the VOSviewer software - the bibliometric mapping of these authors can be seen in Figures 5 and 6. The larger and brighter the halos around the authors' names, the more papers they published in RegTech and SupTech-themed documents over the past 10 years. The cluster density view presents items (labels) marked as visible items. Each item point has a colour depending on the current item density. The colour of the map points depends on the number of items associated with the item (i.e., each author). This procedure is useful for obtaining an overview of the general structure of a bibliometric map. Through this worksheet, we can identify the authors who authored the most publications. There are many clusters when sorted by author.

The three most prolific RegTech authors based on bibliometric mapping are Douglas W Arner, Dirk Andreas Zetsche, and Ross P Buckley. This mapping not only displays the top-ranked authors from the meta-analysis. In addition, VOSviewer also considers the number of links between each author and places co-authors close to each other. It can be seen in Figure 5 that Douglas W Arner and his colleagues still dominate the authors of papers with the theme of RegTech.

**Figure 5.**  
**Bibliometric Mapping of RegTech Authors**



**Figure 6.**  
**Bibliometric Mapping of SupTech Authors**



Furthermore, Simone di Castri is the most prolific author on the SupTech theme based on bibliometric mapping. This mapping not only displays the top-ranked authors from the meta-analysis, but VOSviewer also considers the number of links between each author and places co-authors close to each other. It can be seen in Figure 6 that Simone di Castri and his colleagues still dominate the authors of papers with the SupTech theme.

## V. CONCLUDING REMARKS

Finance and technology have always interacted. The abacus first demonstrated the enduring bond between the two. However, the global financial crisis 2008 marked a turning point that distinguished earlier stages in the evolution of RegTech and FinTech to the present paradigm.<sup>31</sup> Moreover, SupTech has enabled the automation of existing processes and fresh use cases, opening new opportunities for supervisors.<sup>32</sup>

The results show that 415 articles on Regulatory Technology and 88 articles on Supervisory Technology published with journal titles and completed abstracts are significant. These could increase with the development of Financial Regulatory Innovation and Financial Technology (Fintech) platforms worldwide. The study results show that several popular topics and keywords, such as “challenge” and “study”, are used in these themes and have the potential to be developed further. In addition, some of the most prolific journals and authors can be used as reference considerations for researchers developing this theme.

This research only focuses on examining the trend of keyword development, authors and journals published with the theme of Regulatory Technology and Supervisory Technology, thematic evolution that describes keyword development, then word growth, and then the production of top authors over time, which shows author productivity. Of course, many more areas can be explored. It should also be noted that the articles studied were only obtained from Dimension.ai up to 23 January 2024, so it is still possible to continue to experience changes and developments in the future.

Suggestions for future research are to conduct a complete bibliometric analysis with more elements of the study or more diverse software to produce more comprehensive results. The results presented here are still dynamic and may change over time with new trends emerging or variables changing in this theme in the future. In addition, further authors can explore specific emerging trends or technologies such as wealth tech, insurtech, and blockchain. The

<sup>31</sup> Arner, Barberis, and Buckley, *FinTech and RegTech in a Nutshell, and the Future in a Sandbox*.

<sup>32</sup> di Castri et al., “State of SupTech Report 2022.”

author hopes that this paper can serve as a summary or a pathway for future researchers who want to focus on discussing RegTech and SupTech.

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