Review

Developing Novel Technique for Investigating Guidelines and Frameworks: A Text Mining Comparison between International and Japanese Green Bonds

Kentaka Aruga [1,*], Md. Monirul Islam [2,3], Yoshihiro Zenno [1] and Arifa Jannat [3,4]

1 Graduate School of Humanities and Social Sciences, Saitama University, 255 Shimo-Okubo, Sakura-ku, Saitama 338-8570, Japan
2 Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
3 Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba 305-8572, Japan
4 Institute of Agribusiness and Development Studies, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
* Correspondence: aruga@mail.saitama-u.ac.jp

Abstract: In most cases, the official documents related to guidelines and frameworks are complicated, long, and hard to understand for general readers, regardless of whether the government and financial companies follow international standards or not. In this context, the current study examines how the green bond (GB) guidelines created by the Japanese government are aligned with the Green Bond Principles (GBP) and Climate Bonds Standard (CBS) through a text mining technique. It also investigates whether the GB frameworks for the Japanese public and private companies follow the GB guidelines of the Japanese government. While the CBS is the guideline that focuses on climate bonds, the GBP specializes in GB whose scope is broader. The word frequency and word cloud analyses identify that the documents created by the Japanese government and companies have more similarities with the GBP, indicating that the Japanese GB guidelines and frameworks are more aligned with the GBP than the CBS. A pairwise word network matrix analysis also reveals that the Japanese GB guidelines and frameworks are more focused on broader environmental issues and sustainability than the CBS, which had more similarities with the GBP than the CBS.

Keywords: text mining; word cloud; network matrix; green bond; Japan

1. Introduction

Climate change is wreaking havoc around the world, and recently, more attention has been drawn to the role of financial institutions in contributing to reducing greenhouse gas (GHG) emissions. Following this trend, the European Investment Bank (EIB) issued the world's first green bond (GB) in 2007, followed by the World Bank (WB) in 2008 (IFC 2016). GB is a type of bond issued to raise money to specifically support projects that will contribute to environmental objectives, such as climate change mitigation, natural resource conservation, pollution prevention, and so on (ICMA 2021). As of 2021, the GB market has exceeded half a trillion dollars (USD 517.4 bn) (CBI 2022a).

The Paris Agreement set a long-term target of keeping the rise in the average global temperature well below 2 °C. To address the substantial "reduction of greenhouse gas (GHGs) emissions" and "2 °C objectives" in Japan, significant private investment in green initiatives must be mobilized. In addition, the Sustainable Development Goals (SDGs) have raised expectations for the contribution of private investments to initiatives aimed at preserving natural capital and serving other environmental goals. To achieve the target, GBs are becoming an effective tool to raise funds for green projects and have been particularly notable since the establishment of the GB Principles (GBP) in January 2014 by a consortium of investment banks, hosted by the International Capital Market Association (ICMA). As the

GB market grew globally, GB guidelines were also created in Japan to encourage the issue of GBs and investments by the Ministry of the Environment, Japan (MOEJ), on 28 March 2017. A research group on GB has been formed by MOEJ and is made up of academics and industry professionals in order to discuss the guidelines' substance. The deliberations of the study group served as the basis for MOEJ's development of the Guidelines (MOEJ 2017).

The issuance of GB in Japan has recently been growing dramatically. Although the total issuance of GB in Japan was USD 319 million in 2014 (MOE 2021) when its first GB was issued by the Development Bank of Japan (DBJ), the level of GB issuance in Japan increased to USD 1.1 trillion in 2022 (CBI 2021). In addition, Japan ranks 9th in cumulative global country rankings (USD 26.15bn) and 7th in 2020 rankings (USD 10.6bn) (CBI 2022b).

In 2014, voluntary best practice guidelines called the GBP was created by a consortium of investment banks from the US, Europe, China, and Japan to ensure that money raised through GB will be used to mitigate environmental pressure. The GBP is currently managed and hosted by the International Capital Market Association (ICMA). Although guidelines for issuing GBs exist, the environment for issuing green bonds has been underdeveloped in some developing countries or regions (Deschryver and de Mariz 2020; Nguyen et al. 2022), while in the case of Japan, the guidelines are well developed but need a systematic procedure to be accepted. In the case of Japan, issuers are required to publish a green bond framework pre-issuance, which is then validated or certified by an independent third-party expert (ICMA 2021).

Since the guidelines of the GBP are voluntary processes and initiatives, the principles are not associated with strict penalties, and whether the bonds that are issued are strictly in compliance with the guidelines depends on the issuers. Thus, GB pertains to the risk of greenwashing, where companies might channel proceeds from GB toward non-environmental projects that could have adverse impacts on the environment.

Another well-known framework for issuing GB is the Climate Bonds Standard (CBS). This framework is established by an investor-focused not-for-profit organization, the Climate Bonds Initiative (CBI) (CBI 2019). The Climate Bond Certification Mark allows issuers to certify to investors that their GBs meet the CBS criteria, though this process requires the bond to be verified by a third-party verifier known as a certification agency. The CBS provides a Climate Bonds Taxonomy, which restricts projects that can deliver a low carbon economy and covers projects that are more directly related to climate change mitigation and adaptation.

To obtain investor confidence in the GBs issued by governments and companies, the issuers are recommended to provide credibility that their GBs comply with the GBP or CBS. As the GB guidelines issued by the Ministry of Environment (MOE 2020), Japan, claim that the Japanese GB guidelines (JPGB) are aligned with the GBP, it is expected that the JPGB is strongly connected to the international GBP. Understanding the connections between the GBP, CBS, and GB guidelines published by the Japanese government are essential for creating and updating guidelines for issuing GB in Japan. Moreover, the GBP (ICMA 2021) and CBS guidelines framework (CBI 2022a) are the most important resources for ensuring and comparing the local GB with the international green bond standards.

However, there are not yet any studies that investigate how such guidelines are prepared by the government or related authorities, and frameworks prepared by companies have similarities with the GBP and CBS. To shed light on this issue, this study examines the similarities between the keywords used in the main documents for the GBP and CBS and the JPGB through a text mining analysis. The study also tests how much the GB guidelines announced by the Japanese government are permeated in the frameworks created by public and private financial institutions issuing GBs in Japan.

If similarities among the GB documents can be identified through a text mining approach in the case of Japan, this type of analysis could be applied to understand how much GB documents provided at the national level are consistent with the GBP and CBS. Thus, we believe that the study provides a new method to verify how guidelines created by different institutions are aligned with each other.

In the following section, studies related to this current research will be discussed. In the third section, the details of the text mining analysis are explained. The fourth section presents the results of the analyses and the implications that could be drawn from the results. Finally, the study concludes with practical implications.

2. Related Studies

Most of the studies on GB investigate whether a greenium (green bond premium) exists in the GB market (Zerbib 2019; Nanayakkara and Colombage 2019; Larcker and Watts 2020; Partridge and Medda 2020) since GB are often purchased by investors at a lower yield. Meanwhile, there are only a few studies that examine the consistency in the definitions of green bonds and factors influencing the green bond market expansion (Anh et al. 2020). Zhang (2020) is one of the few that examines whether the Chinese GB regulations are coherent with international GB standards. Shimizu et al. (2021) also conducted a review on the impact reporting for the JPGB by comparing the JPGB and GB frameworks with the international standards to make recommendations for the future development of the Japanese GB market. Findings from the previous studies highlighted that research on green bond guidelines is less studied in the domain of the related literature review. To the best of our knowledge, none of the studies used text mining techniques to investigate various domestic and corporate green bond frameworks concerning international GBP and CBS schemes.

Moreover, the text mining approach is a widely used scientific technique for evaluating different newspapers (Hossain et al. 2021), text shortening and visualization (Text Mining 2020), understanding, predictions, and decision-making for the information extraction (Al-Hasan et al. 2018) and estimation of cross-lingual news similarities (Wang et al. 2018). Text mining is also used for opinion mining, feature extraction, sentiment analysis, predictive modeling, and trend analysis in areas such as search engines, customer relationship management systems, filtered emails, and social media analytics (He 2013). Text mining aims to identify implicit, hidden meanings and structures in texts by using unstructured textual information (Rao 2003; Karanikas et al. 2000). Hale (2005) explored that using text mining will speed up decision-making by at least ten times more than traditional methods.

Although the text mining approach for analyzing bibliometric data is still relatively new in business research, it has recently begun obtaining popularity in the field (Donthu et al. 2021; Gupta et al. 2020). However, the text mining method is mostly limited to analyzing citation structure and the publication trends of certain journals (Baker et al. 2021; Kumar et al. 2020), and until now, no study has investigated green bond guidelines with a visual representation of the highlighting words and the key motivations of each document. Cortellini and Panetta (2021) conducted a review on GBs; however, the scope of their study was not to identify the similarities among international and regional green bond guidelines and frameworks but was to perform an overall systematic review of the literature related to GBs. Hence, this is the first modest attempt to evaluate the performance of text mining techniques for the evaluation of specific guidelines-related documents.

3. Materials and Methods

3.1. Selection of Models

The amount of data being generated today is increasing exponentially. It is more common for organizations, institutions, and business sectors to store data electronically. In addition, large amounts of text are being transmitted via the internet from numerous digital libraries, repositories, and other formatted texts, such as emails, blogs, and social media accounts (Kumar et al. 2021). Due to this large volume of data, it is difficult to extract valuable knowledge from these patterns and trends (Padhy et al. 2012). The use of text mining is a great solution for analyzing textual data sources to extract significant patterns and explore their meanings (Fan et al. 2006). Therefore, these techniques are used frequently in academia, web applications, the internet, industry, and so on (Liao et al. 2012).

Recently, researchers have proposed various text mining methods and applications. These text mining methods can be classified into four types: context-based, semantic-based, sentiment analysis-based, and content-based text mining methods. The context-based text mining method aims to extract valuable information that depends on contextual information. Takeuchi et al. (2008) proposed an analytical approach based on contextual information and developed a method to extract insight from long documents.

Our text mining approach focuses on extracting "green bond guidelines and frameworks for international and Japanese government and companies" attributes from web pages, which are plain text documents. Hence, we applied a context-based text mining model. However, among context-based text mining approaches, this study employs two widely used and contemporary text mining techniques, word clouds and network matrix analyses. In recent times, different correlation matrix data have been analyzed through network analysis (Kojaku and Masuda 2019), and the application of network matrix has been widely accepted across a variety of fields (Zanin et al. 2012; Onnela et al. 2004). To generate a network from a correlation matrix, a threshold can be set on the value of the pairwise correlation (Kojaku and Masuda 2019). In this study, the word correlations under GB guidelines and frameworks were also assessed through network matrix analysis.

3.2. Data Preparation

In-text analytics and clustering can be accomplished using two popular terms: term-document matrix (TDM) or document-term matrix (DTM). The distance and similarity between terms or documents are typically calculated. This paper applied the word cloud, and network matrix approaches to extract information from different international and Japanese green bond guidelines and frameworks. For this purpose, we picked the three GB guidelines and the two GB frameworks. The first two documents are the GBP and CBS, which are known as the two major international guidelines for GBs. The third guideline is the JPGB, issued by the Ministry of Environment, Japan. In addition to these documents, we also examined the frameworks of public and private banks. For the public bank frameworks, we chose the documents published by the Japan Bank for International Cooperation (JBIC). Although the DBJ was the first public institution to issue GB, the framework of the DBJ was more focused on sustainable bonds than the GBs, and the DBJ did not provide a specific framework for GB. Meanwhile, the JBIC published a framework, particularly focusing on its rules for issuing GBs (JBIC 2021). Finally, for documents regarding the private bank we used those for the Sumitomo Mitsui Financial Group (SMFG), since the SMFG was the first private company to issue GB in 2018 in Japan. The SMFG also has the largest amount of GB issuance among the three mega-banks in Japan (Green Finance Portal 2022). The document for the SMFG is provided by a second-party certificate verifier Morningstar Sustainalytics (Sustainalytics 2021), which is recognized by the CBI as the largest certifier of climate bonds (Morningstar Sustainalytics 2021).

Before applying the text mining techniques to the above-mentioned five documents, we first removed the punctuations and other special characters, such as roman numerals, that are irrelevant for comparing the texts among the documents. Second, we explored the highest frequency keywords through the world cloud approach (Holtz 2021). Finally, tokenization under the unrest token package was used to examine the co-occurrence matrix and pairwise correlation among keywords in the documents. All the analyses were conducted in R version 4.0.5. The entire procedure of the analysis and methods is illustrated in Figure 1.
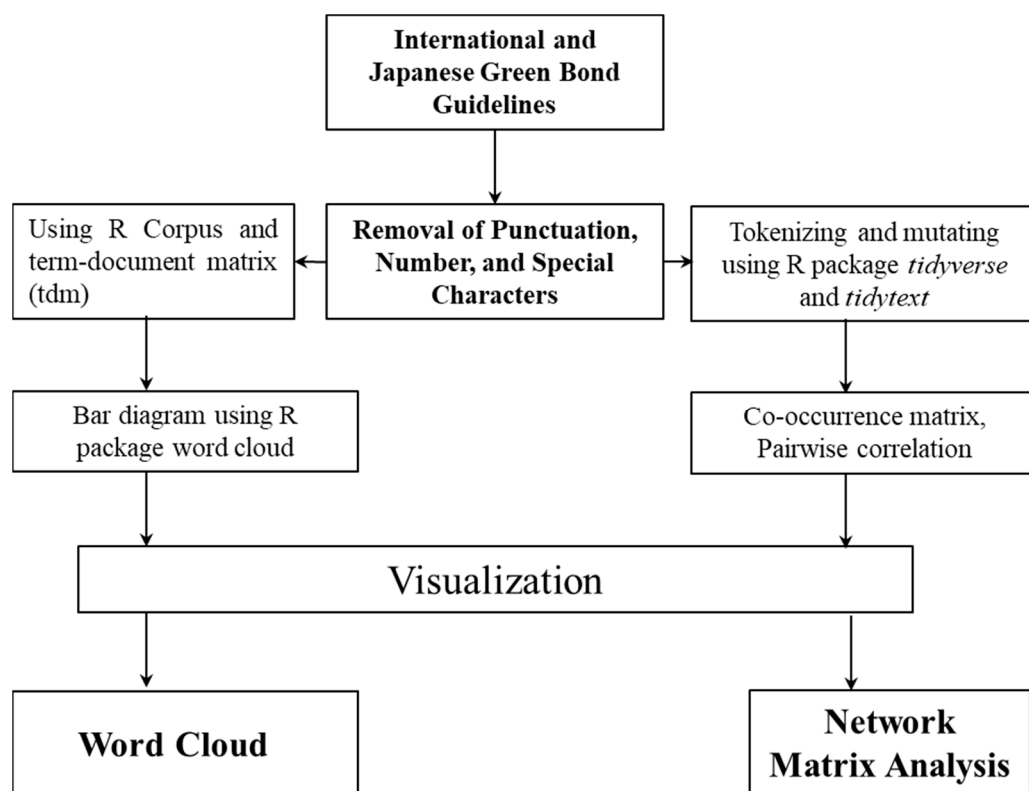
Figure 1. Flowchart of the working procedure.

3.3. Word Cloud

Word clouds or tag clouds are a type of text data visualization technique that conveys a concept about a subject through the visual representation of words and is an effective technique for analysis, survey, and the collection of written opinions, among other things. The word cloud is one of the most useful and straightforward methods for visualizing text data in a graphical format. Not only does it represent a word, but it also represents something other than the word (Anandarajan et al. 2019; Chowdhury et al. 2018). Generally, the term "cloud" has been used to refer to the initial stage of a text document's analysis. Therefore, the frequency of words is the primary consideration when categorizing or visualizing a word cloud.

Nonetheless, the method has certain drawbacks as well. One of the major drawbacks is that it does not consider the linguistic knowledge of the words and their respective links to the given subject while providing a purely statistical summary of the segregated words. As a result, in most systems, word clouds are often employed statistically for summarizing text, providing very little or no means for correlating the data. It is perceived that this could be one of the most influencing paradigms of visualization for most of the analysis conditions. Thus, in this paper, we have employed the use of the most frequently (the highest number of words that appear in our document) used words. Word clouds of five different guidelines show a random display of all the words in each source of text, where the size of each word is proportional to the number of times it has been counted in the text. So, the higher the number of frequently used words in each document, the greater their appearance in the word cloud. In our research, we considered the thirty most frequently used words in the word cloud for all the guidelines and frameworks.

3.4. Network Matrix

Text analyses are often interested in the relationships between words and examine which words tend to follow others immediately or co-occur within the same documents. In this case, network analysis is used to explore the mathematical, statistical, and structural

properties of a set of items (nodes) and the connections between them (edges) (Newman 2003). Hence, the pairwise network matrix produces significant results, and the outcomes indicate how often the pairwise words appear together relative to how often they appear separately. In this regard, the phi (φ) coefficient is a common measure for identifying binary correlation among words that appear in documents. The phi coefficient is similar to the Pearson correlation coefficient in its interpretation. Thus, it indicates a weak correlation when the coefficient is between 0.3 and 0.7, and the two words tend to have a strong correlation when the coefficient is above 0.7.

The frequencies of the two words to appear in a line can be categorized into four types. For example, if we want to find out the correlations between the two words X1 and X2, the frequencies of these words within a line can be presented in Table 1. In the table, A through D are the frequencies in the four cells.

Table 1. Frequencies of the two words within each line.

	Contains X_2	**Does Not Contain X_2**
Contains word X_1	*A*	*B*
Does not contain word X_1	*C*	*D*

Then, the phi coefficient, which denotes the correlation between the two words within a document, can be estimated as:

$$\varphi = \frac{AD - BC}{\sqrt{(A+B)(C+D)(A+C)(B+D)}} \tag{1}$$

To conduct the network matrix analysis, the five documents are all split into 15 lines. Then, using Equation (1), the correlation coefficient between the pairs of words is estimated. Finally, those pairs with a correlation greater than 0.2 are plotted into a figure.
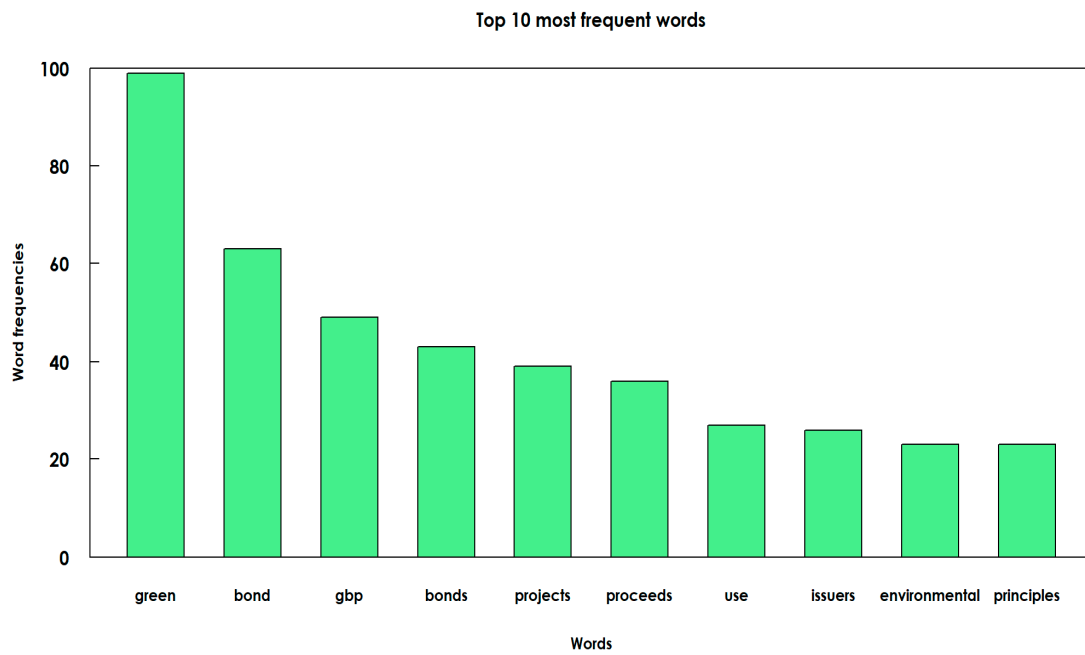
4. Results

Apart from the visual representation of the word cloud, the top 10 words that appeared more frequently are presented in a bar diagram. The details of the top 10 frequent words in the five documents are summarized in Table A1 of the Appendix A. In Figures 2 and 3, it is seen that "green", "bond", "bonds", "projects", "proceeds", "issuers", and "environmental" are the top 10 words for the GBP and JPGB. The results of the word cloud analysis in Figures 4 and 5 also reveal similarities in the words that appear more frequently within the GBP and JPGB, as these words tend to appear in bold and large sizes.

According to Figures 2 and 3, the word "green" recorded the highest frequency for the GBP, JPGB, and SMFG frameworks, and it was also the third most frequent word in the JBIC framework. On the other hand, the word "climate", the most frequent word in the CBS, was not listed in the top 10 frequent words in all Japanese guidelines and frameworks. The word cloud analysis in Figures 4 and 5 also reveals that the word "green" is presented larger than "climate" in the Japanese GB guidelines and frameworks, whereas the word "climate" stood out in the center of the CBS guidelines document. These results indicate that the JPGB and company frameworks are more aligned with the GBP than the CBS.

The word cloud analysis reveals that there are differences in the top keywords between GBP and CBS. It is noticeable from Figure 4 that the certification aspect is more important for the CBS since the CBS and the certification scheme is a labeling scheme for bonds, loans, and other debt instruments (CBI 2022c). Prospective issuers must appoint an approved verifier before receiving a certification mark, who verifies that the bond meets the international green bond standard. The CBS board finalizes all climate bond certifications. A set of definitions of green, compiled by scientists and industry experts, can be found in the ICMA (CBI 2022d). The term "certification" is one of the most frequently used words at CBS, since sector-specific standards are used for certification. As a result of the CBS, bonds can be certified in advance of their issuance, which allows the issuer to use the certification mark

in bond marketing efforts and investor road shows. A CBS board report is required for the post-issuance assurance that follows bond issuance and the allocation of bond proceeds.
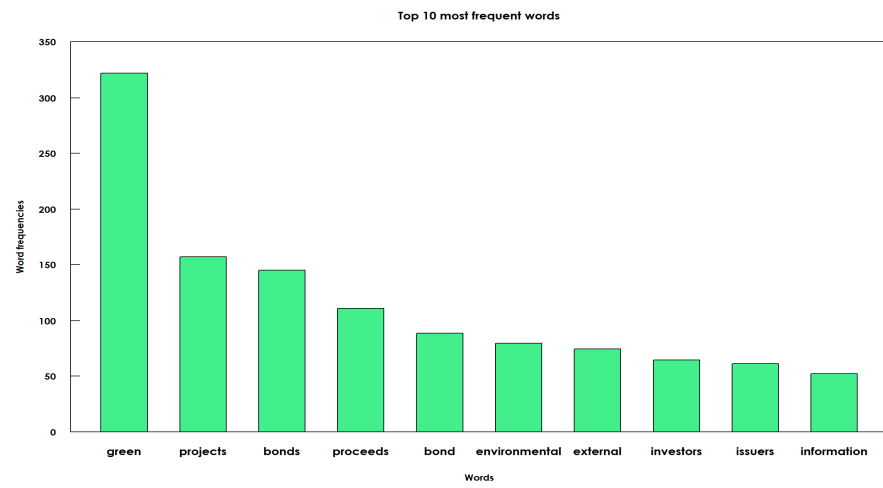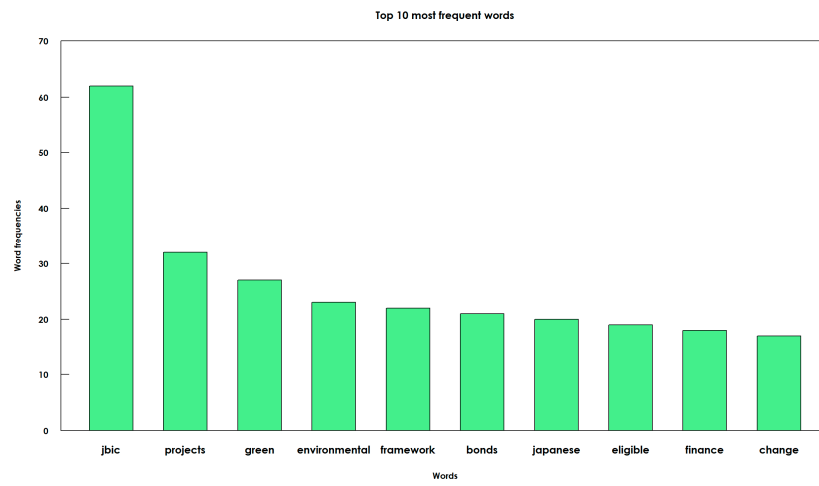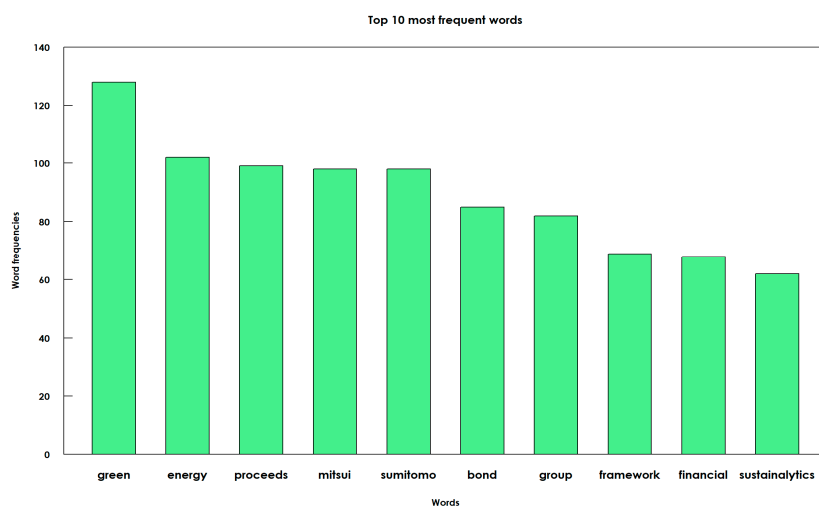

(**a**) GBP
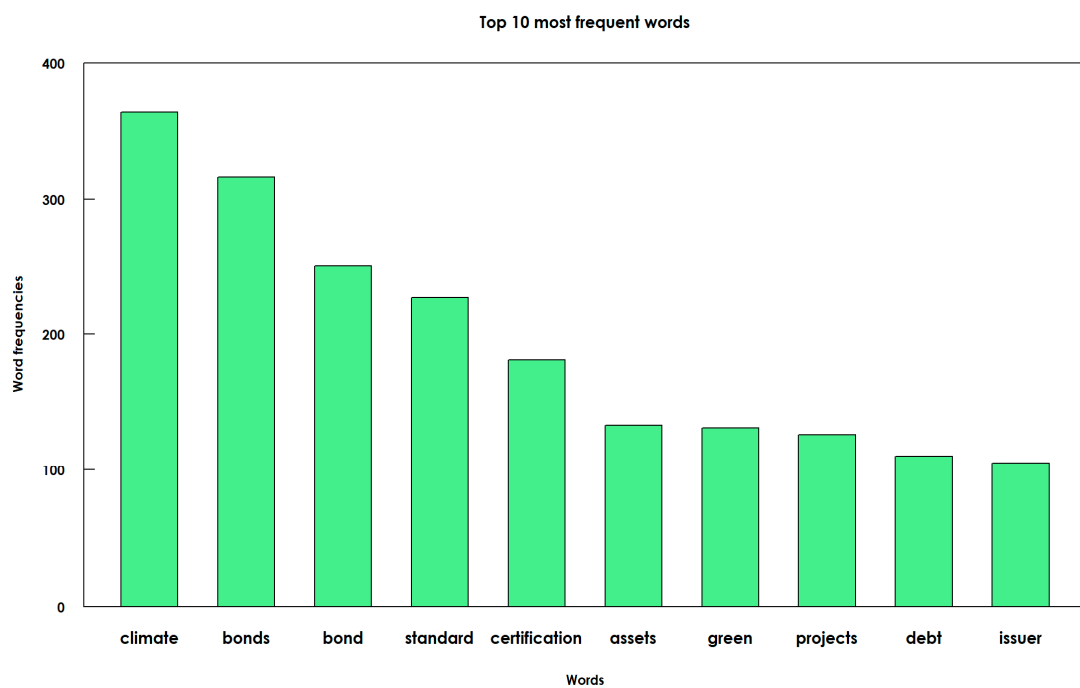
(**b**) CBS

Figure 2. Most frequent words in the international GB guidelines.
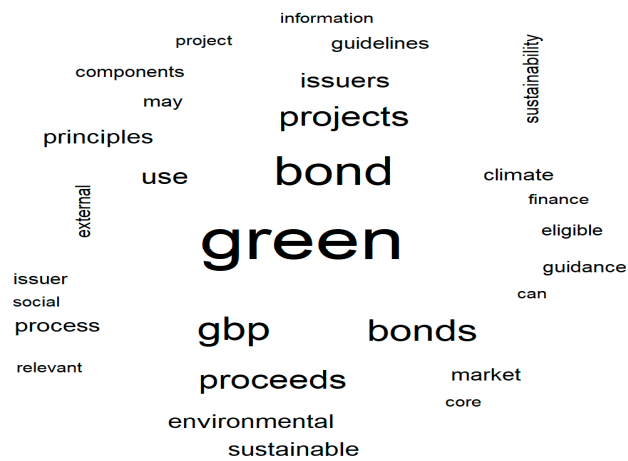
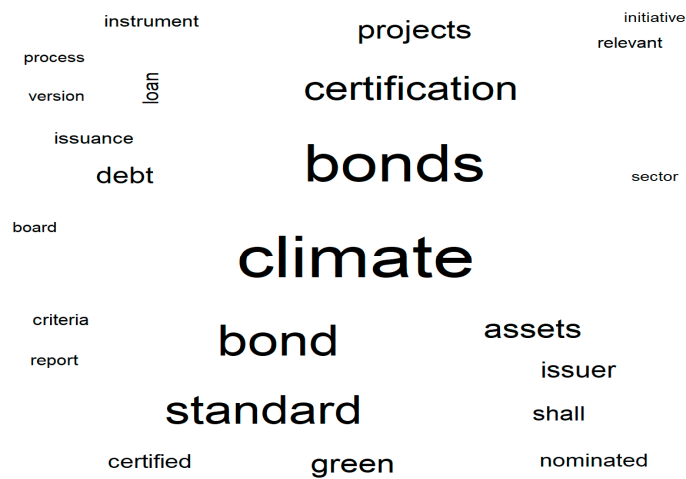(**a**) JPGB

(**b**) JBIC

(**c**) SMFG

Figure 3. Most frequent words in the Japanese guidelines and frameworks.
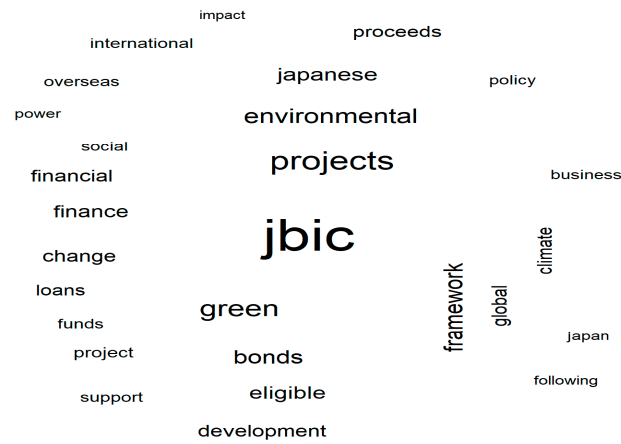
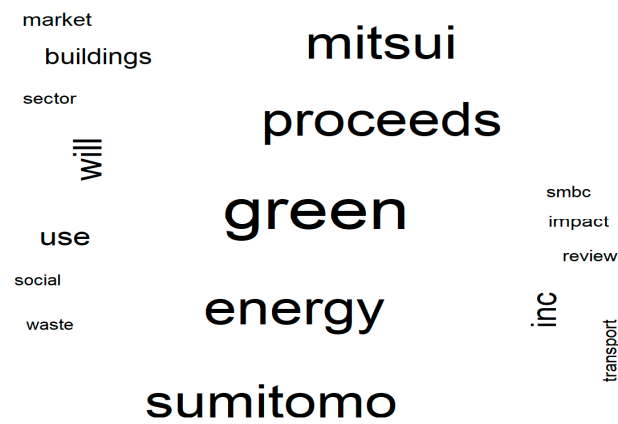(**a**) GBP

(**b**) CBS

Figure 4. Word cloud result for the international GB guidelines.

(**a**) JPGB

(**b**) JBIC

(**c**) SMFG

Figure 5. Word cloud results for the Japanese guidelines and frameworks.
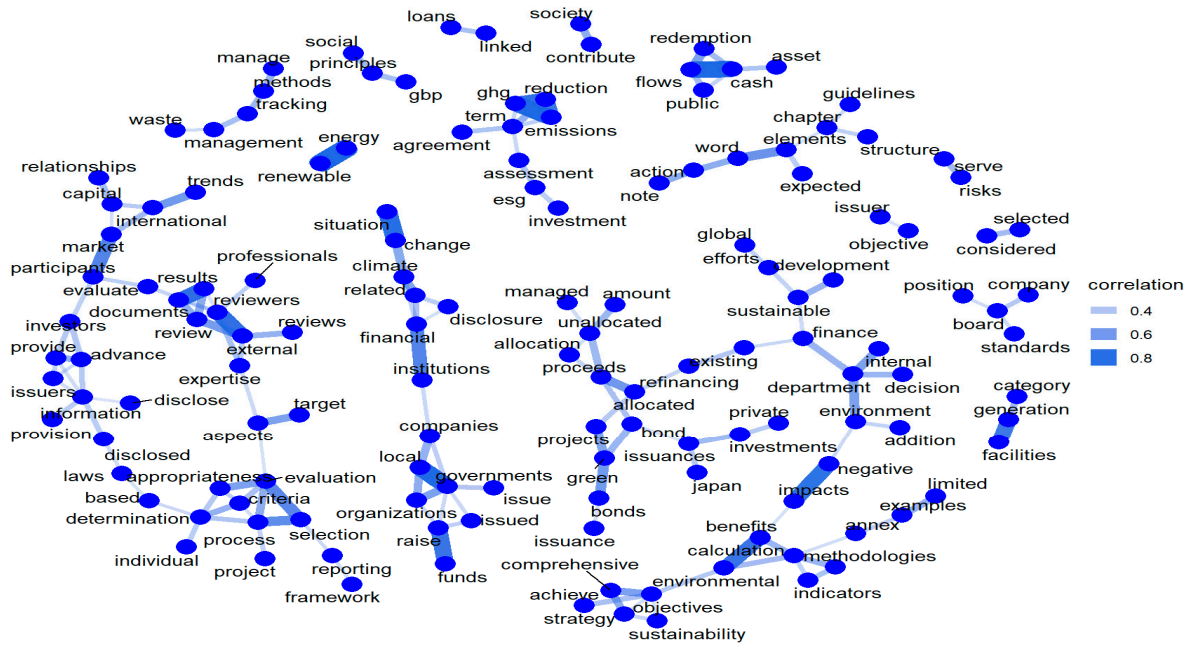
On the other hand, the GBP does not provide details on "green." The green definitions are left to the issuer to determine (CBI 2022d). A green building is defined by GBP guidelines as having met regional, national, or international environmental performance standards. The GBP guidelines highlight the eligibility or applicability of green standards or certifications referenced in project selection. Moreover, issuers are also encouraged to disclose any taxonomies, green standards, or certifications referenced in project selection under the recommendation of the green bond framework (Corporation's Green Bond Framework 2021). So, the GBP guidelines focus much more on green bonds and core components than certification schemes.

The correlations and co-occurrences show the two words are more often used together in the same context. The higher the correlation, the greater the chances of using two words in the same context. We focused only on those topmost words and their associations to emphasize our most frequently used words. For the GBP document, a high correlation (0.60) was observed between "green" and "bond." Furthermore, words such as "core-components", "handbook-transition", "guidelines-issuing", and "selection-evaluation" were highly correlated (0.80). For the CBS guidelines, a very high correlation (0.80) was observed for "climate-bonds" and "climate-standard." There was also a high correlation (0.80) between the words "remains-outstanding", "low-carbon", "pairs-goals", "goals-achieving", "assets-nominated", "nominated-projects", "indicator-metrics", and "capital-markets." Another intriguing difference seen in Figure 6 between the GBP and CBS is that while the word "sustainability" appeared in the GBP this word was not present in the CBS.

The network matrix for the JPGB shows that a high correlation (0.60) exists between "projects-green" and "green-bonds." This suggests that the words that are correlated in the JPGB are related to the word "green", implying that the JPGB has a similarity with the GBP. Furthermore, similarly to the GBP, the word "sustainability" came out in the JPGB.

For the Japanese companies' frameworks, a word correlation was found between "green" and "bond" or "bonds" in both the JBIC and SMFG documents, while the word "bond" or "bonds" did not show a connection with "climate." This implies that the frameworks of the Japanese companies are also more aligned with the GBP than the CBS. In addition, the results of the network matrix in Figure 7 also depict a correlation specific to the companies. For example, the connection between "developing" and "countries" for JBIC is likely related to the main business of JBIC providing funding for projects in developing countries. Similarly, the link between "palm" and "oil" for the SMFG became apparent since the SMFG limits its waste-derived materials for its biomass power generation project to be palm oil suppliers certified by the Roundtable on Sustainable Palm Oil (RSPO) (Sustainalytics 2021).

Pairs of words in the Green Bond Principles

Note: at least having a correlation of 0.2 appearing within the same 15-line section

(**a**) GBP

Pairs of words in Climate Bonds Standard

Note: at least having a correlation of 0.2 appearing within the same 15-line section

(**b**) CBS

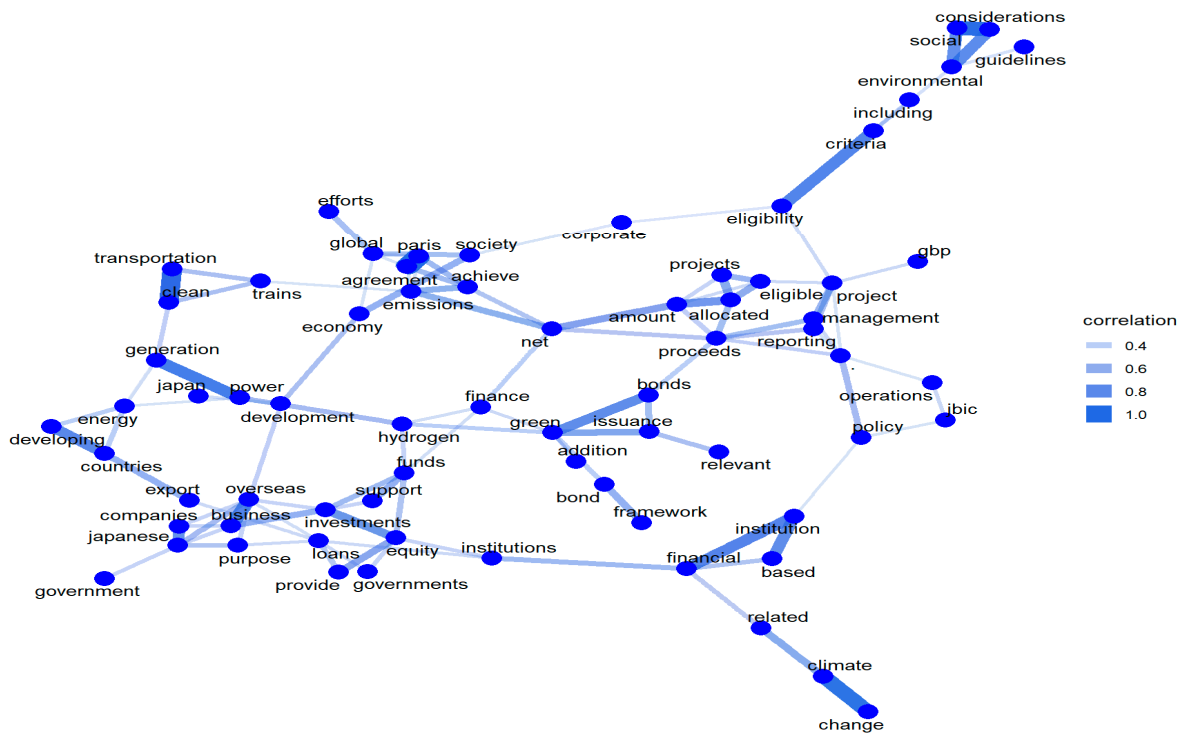**Figure 6.** Network matrix for the international GB guidelines.

Pairs of words in Japanese green bond guidelines

Note: at least having a correlation of 0.2 appearing within the same 15-line section

(**a**) JPGB

Pairs of words in JBIC Greenbond Framework

Note: at least having a correlation of 0.2 appearing within the same 15-line section

(**b**) JBIC

Figure 7. *Cont.*

Pairs of words in SMFG Greenbond Framework

Note: at least having a correlation of 0.4 appearing within the same 15-line section
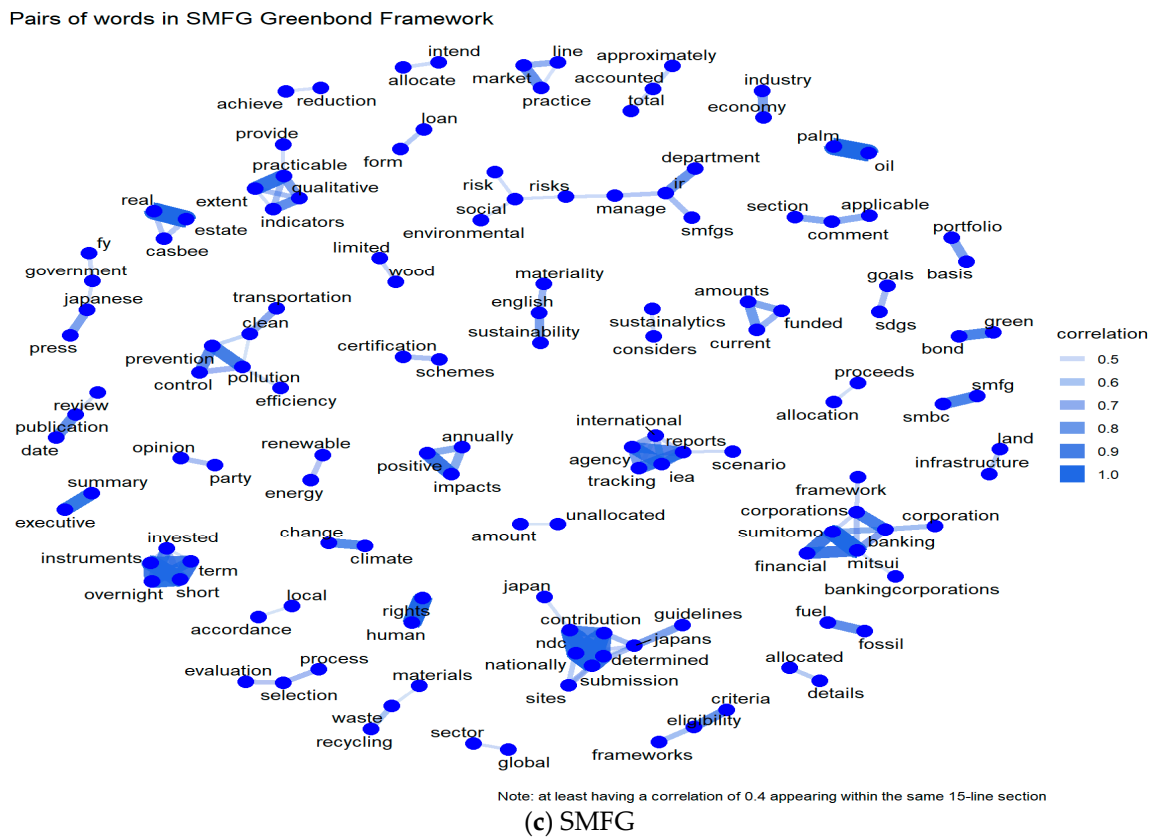
(**c**) SMFG

Figure 7. Network matrix for the Japanese guidelines and frameworks.

5. Discussion and Conclusions

While there is a study performing a systematic review for identifying the overall trends in GB research (Cortellini and Panetta 2021), no studies have applied a text mining approach to identify similarities and connections among the international and regional GB guidelines and frameworks. To fill this gap, the current article explored how the GB guidelines created by the Japanese government and frameworks created by Japanese companies are linked with the major international GB guidelines (GBP and CBS) through a text mining technique. The word cloud and word network matrix analyses identify that both the government and company GB guidelines in Japan are more closely aligned with the GBP than the CBS. The main difference between the GBP and CBS is that the GBP is labeled as "green" while the CBS is labeled as "climate" and the GBP covers a broader environmental and sustainability issue, while the CBS focuses more on the climate-related issue.

Thus, our results likely reflect that the Japanese GB intends to cover a broader environmental problem where the contents covered as "green" are not strictly defined and are left to the issuer to decide their scope. As previously mentioned, by Ehlers and Packer (2017) the GBP are very general while the CBS establishes sector-specific eligibility criteria for the issuance of GB. Thus, it could be that the Japanese government and companies followed the GBP, considering that the barrier to issuing GBs will be lower than issuing climate bonds. A further study is required to find out why the JPGB and frameworks are more linked with the GBP.

We believe the text mining method applied in this study revealed the effectiveness of understanding how the GB guidelines and the GB frameworks created locally are relevant to the two major international GB guidelines. Thus, the study result implies the usefulness of applying a text mining approach to identify the similarity in the keywords used in official documents and guidelines. Therefore, our study contributes to further studies that seek to compare official documents and guidelines by analyzing their links and similarities through text mining methods.

Data Availability Statement: The data source is all explained in Section 3.2.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. The most frequently used top 10 words.

International		National	Local Companies	
GBP File	**CBS File**	**JPGB File**	**JBIC File**	**SMFG File**
green	climate	green	Jbic	green
bond	bonds	projects	projects	energy
gbp	bond	bonds	Green	proceeds
bonds	standard	proceeds	environmental	mitsui
projects	certification	bond	framework	sumitomo
proceeds	assets	environmental	Bonds	bond
use	green	external	Japanese	group
issuers	projects	investors	eligible	framework
environmental	debt	issuers	finance	financial
principles	issuer	information	change	sustainalytics

References

Al-Hasan, Abrar, Dobin Yim, and Henry C. Lucas. 2018. A Tale of Two Movements: Egypt during the Arab Spring and Occupy Wall Street. *IEEE Transactions on Engineering Management* 66: 84–97. [CrossRef]

Anandarajan, Murugan, Chelsey Hill, and Thomas Nolan. 2019. Text Preprocessing. In *Practical Text Analytics: Maximizing the Value of Text Data*. Edited by Murugan Anandarajan, Chelsey Hill and Thomas Nolan. Advances in Analytics and Data Science. Cham: Springer International Publishing, pp. 45–59. [CrossRef]

Anh, Tu Chuc, Tapan Sarker, and Ehsan Rasoulinezhad. 2020. Factors Influencing the Green Bond Market Expansion: Evidence from a Multi-Dimensional Analysis. *Journal of Risk and Financial Management* 13: 126. [CrossRef]

Baker, Kent H., Satish Kumar, and Debidutta Pattnaik. 2021. Twenty-five years of the Journal of Corporate Finance: A scientometric analysis. *Journal of Corporate Finance* 66: 101572. [CrossRef]

Climate Bonds Initiative. 2019. Climate Bonds Standard Version 3.0. Available online: https://www.climatebonds.net/files/files/climate-bonds-standard-v3-20191210.pdf (accessed on 15 May 2022).

Climate Bonds Initiative. 2021. Record $269. 5bn green issuance for 2020: Late Surge Sees Pandemic Year Pip 2019 Total by $3bn. Available online: https://www.climatebonds.net/2021/01/record-2695bn-green-issuance-2020-late-surge-sees-pandemic-year-pip-2019-total-3bn? (accessed on 15 June 2022).

Climate Bond Initiative. 2022a. Certification under the Climate Bonds Standard. Available online: https://www.climatebonds.net/certification (accessed on 15 June 2022).

Climate Bond Initiative. 2022b. Japan GB Market Review 2020: Latest Collaboration with Green Bond Promotion Platform. Available online: https://www.climatebonds.net/2021/03/japan-gb-market-review-2020-latest-collaboration-green-bond-promotion-platform (accessed on 3 August 2022).

Climate Bond Initiative. 2022c. Green Bond Principles & Climate Bonds Standard. Available online: https://www.climatebonds.net/market/best-practice-guidelines (accessed on 15 June 2022).

Climate Bonds Initiative. 2022d. $500bn Green Issuance 2021: Social and Sustainable Acceleration: Annual Green $1tn in Sight: Market Expansion Forecasts for 2022 and 2025. Available online: https://www.climatebonds.net/2022/01/500bn-green-issuance-2021-social-and-sustainable-acceleration-annual-green-1tn-sight-market (accessed on 15 June 2022).

Chowdhury, S. M. Mazharul Hoque, Priyanka Ghosh, Sheikh Abujar, Most. Arina Afrin, and Syed Akhter Hossain. 2018. Sentiment Analysis of Tweet Data: The Study of Sentimental State of Human from Tweet Text. In *Emerging Technologies in Data Mining and Information Security*. Edited by A. Abraham, P. Dutta, J. Mandal, A. Bhattacharya and S. Dutta. Advances in Intelligent Systems and Computing. Singapore: Springer, p. 813. [CrossRef]

Corporation's Green Bond Framework. 2021. Available online: https://www.smfg.co.jp/english/sustainability/materiality/environment/procurement/pdf/GREEN_BOND.pdf (accessed on 5 July 2022).

Cortellini, Giuseppe, and Ida Claudia Panetta. 2021. Green Bond: A Systematic Literature Review for Future Research Agendas. *Journal of Risk and Financial Management* 14: 589. [CrossRef]

Deschryver, Pauline, and Frederic de Mariz. 2020. What Future for the Green Bond Market? How Can Policymakers, Companies, and Investors Unlock the Potential of the Green Bond Market? *Journal of Risk and Financial Management* 13: 61. [CrossRef]

Donthu, Naveen, Satish Kumar, Debmalya Mukherjee, Nitesh Pandey, and Weng Marc Lim. 2021. How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research* 133: 285–96. [CrossRef]

Ehlers, Torsten, and Frank Packer. 2017. Green Bond Finance and Certification. BIS Quarterly Review September 2017. Available online: https://www.bis.org/publ/qtrpdf/r_qt1709h.htm (accessed on 3 August 2022).

Fan, Weiguo, Linda Wallace, Stephanie Rich, and Zhongju Zhang. 2006. Tapping the power of text mining. *Communications of the ACM* 49: 76–82. [CrossRef]

Green Finance Portal. 2022. Major Green Bond Issuance Cases in Japan. Available online: http://greenfinanceportal.env.go.jp/en/bond/issuance_data/issuance_list.html (accessed on 15 June 2022).

Gupta, Aaryan, Vinya Dengre, Hamza Abubakar Kheruwala, and Shah Manan. 2020. Comprehensive review of text-mining applications in finance. *Financial Innovation* 6: 39. [CrossRef]

Hale, Roger. 2005. Text mining: Getting more value from literature resources. *Drug Discovery Today* 10: 377–379. [CrossRef]

He, Wu. 2013. Examining students' online interaction in a live video streaming environment using data mining and text mining. *Computers in Human Behavior* 29: 90–102. [CrossRef]

Holtz, Yan. 2021. The Wordcloud2 Library. Available online: https://www.r-graph-gallery.com/196-the-wordcloud2-library.html (accessed on 6 June 2022).

Hossain, Arafat, Md. Karimuzzaman, Md. Moyazzem Hossain, and Azizur Rahman. 2021. Text Mining and Sentiment Analysis of Newspaper Headlines. *Information* 12: 414. [CrossRef]

International Capital Market Association (ICMA). 2021. The Green Bond Principles (GBP). Available online: https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/ (accessed on 15 June 2022).

International Finance Corporation (IFC). 2016. Mobilizing Private Climate Finance–Green Bonds and Beyond. Available online: https://openknowledge.worldbank.org/bitstream/handle/10986/30351/110881-BRI-EMCompass-Note-25-Green-Bonds-FINAL-12-5-PUBLIC.pdf (accessed on 8 May 2022).

Japan Bank for International Cooperation (JBIC). 2021. Japan Bank for International Cooperation (JBIC) Green Bond Framework. Available online: https://www.jbic.go.jp/ja/ir/contents/JBIC_greenbond_framework_en.pdf (accessed on 22 August 2022).

Karanikas, Haralampos, Christos Tjortjis, and Babis Theodoulidis. 2000. An approach to text mining using information extraction. Paper presentend at Workshop of Knowledge Management: Theory and Applications, Lyon, France, September 13–16.

Kojaku, Sadamori, and Naoki Masuda. 2019. Constructing networks by filtering correlation matrices: A null model approach. *Procedings of the Royal Society A* 475. [CrossRef]

Kumar, Satish, Vinodh Madhaven, and Riya Sureka. 2020. The Journal of Emerging Market Finance: A Bibliometric Overview (2002–2019). *Journal of Emerging Market Finance* 19: 326–352. [CrossRef]

Kumar, Sunil, Kar Arpan Kumar, and P. Vigneswara Ilavarasan. 2021. Applications of text mining in services management: A systematic literature review. *International Journal of Information Management Data Insights* 1: 100008. [CrossRef]

Larcker, David F., and Edward M. Watts. 2020. Where's the greenium. *Journal of Accounting and Economics* 69: 101312. [CrossRef]

Liao, Shu-Hsien, Pei-Hui Chu, and Pei-Yuan Hsiao. 2012. Data mining techniques and applications—A decade review from 2000 to 2011. *Expert Systems with Applications* 39: 11303–11311. [CrossRef]

Ministry of the Environment Government of Japan (MOE). 2020. Green Bond Guidelines 2020. Available online: https://www.env.go.jp/policy/guidelines_set_version_with%20cover.pdf. (accessed on 15 June 2022).

Ministry of the Environment Government of Japan (MOE). 2021. Green Bond ni Kansuru Kankyoushyo no Torikumi ni Tuite (Initiatives Taken by the MOE on Green Bond). Available online: https://www.fsa.go.jp/singi/social_bond/siryou/20210310/03.pdf (accessed on 15 June 2022). (In Japanese)

Ministry of the Environment, Japan (MOEJ). 2017. Green Bond Guidelines, 2017. Available online: https://www.env.go.jp/en/policy/economy/gb/guidelines.html (accessed on 3 August 2022).

Morningstar Sustainalytics. 2021. Morningstar Sustainalytics Recognized as the Largest Verifier for Certified Climate Bonds by Climate Bonds Initiative for a Fifth Consecutive Year. Available online: https://www.sustainalytics.com/esg-news/news-details/2022/06/06/morningstar-sustainalytics-recognized-as-the-largest-verifier-for-certified-climate-bonds-by-climate-bonds-initiative-for-a-fifth-consecutive-year? (accessed on 15 June 2022).

Nanayakkara, Madurika, and Sisira Colombage. 2019. Do investors in Green Bond market pay a premium? Global evidence. *Applied Economics* 51: 4425–4437. [CrossRef]

Newman, Mark E. J. 2003. The structure and function of complex networks. *SIAM Reveiw* 45: 167–256. [CrossRef]

Nguyen, Anh Huu, Thinh Gia Hoang, Duy Thanh Nguyen, Loan Quynh Thi Nguyen, and Duong Thuy Doan. 2022. The Development of Green Bond in Developing Countries: Insights from Southeast Asia Market Participants. *The European Journal of Development Research* 21: 1–23. [CrossRef]

Onnela, Jukka-Pekka, Kimmo Kaski, and Janos Kertész. 2004. Clustering and information in correlation based financial networks. *European Physical Journal B* 38: 353–362. [CrossRef]

Padhy, Neelamadhab, Dr. Pragnyaban Mishra, and Rasmita Panigrahi. 2012. The survey of data mining applications and feature scope. *International Journal of Computer Science, Engineering and Information Technology* 2: 43–58. [CrossRef]

Partridge, Candace, and Francesca Romana Medda. 2020. The evolution of pricing performance of green municipal bonds. *Journal of Sustainable Finance & Investment* 10: 44–64. [CrossRef]

Rao, Ramana. 2003. From unstructured data to actionable intelligence. *IT Professional* 5: 29–35. [CrossRef]

Shimizu, Noriko, Maiko Morishita, Naoki Mori, and Abdessalem Rabhi. 2021. Current Status, Issues and Recommendations on Impact Reporting: A Case Study of Green Bonds for Renewable Energy Sector in Japan. Institute for Global Environmental Strategies, 2021. Available online: https://www.iges.or.jp/en/pub/gbimpactreporting/en (accessed on 22 June 2022).

Sustainalytics. 2021. Second-Party Opinion Download. Sumitomo Mitsui Financial Group, Inc./Sumitomo Mitsui Banking. Available online: https://www.sustainalytics.com/corporate-solutions/sustainable-finance-and-lending/published-projects/project/sumitomo-mitsui-financial-group-inc-sumitomo-mitsui-banking-corporation/sumitomo-mitsui-financial-group-inc-sumitomo-mitsui-banking-corporation-(2021)/sumitomo-mitsui-financial-group-inc-sumitomo-mitsui-banking-corporation-(2021) (accessed on 22 June 2022).

Takeuchi, Hironori, Shiho Ogino, Hideo Watanabe, and Shirata Yoshiko. 2008. Context-based Text Mining for Insights in Long Documents. In *International Conference on Practical Aspects of Knowledge Management (PAKM2008)*. Berlin and Heidelberg: Springer, pp. 123–34.

Text Mining. 2020. Available online: https://en.wikipedia.org/wiki/Text_mining (accessed on 6 June 2022).

Wang, Zhouhao, Enda Liu, Hiroki Sakaji, Tomoki Ito, Kiyoshi Izumi, Kota Tsubouchi, and Tatsuo Yamashita. 2018. Estimation of Cross-Lingual News Similarities Using Text-Mining Methods. *Journal of Risk and Financial Management* 11: 8. [CrossRef]

Zanin, Massimiliano, Pedro Sousa, David Papo, Bajo Ricardo, García-Prieto Juan, Francisco del Pozo, Ernestina Menasalvas, and Boccaletti Stefano. 2012. Optimizing Functional Network Representation of Multivariate Time Series. *Scientific Reports* 2: 630. [CrossRef]

Zerbib, Olivier David. 2019. The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking & Finance* 98: 39–60. [CrossRef]

Zhang, Hao. 2020. Regulating green bond in China: Definition divergence and implications for policy making. *Journal of Sustainable Finance & Investment* 10: 141–56. [CrossRef]