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Article

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Review

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

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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



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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 JRGB, 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 word 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.

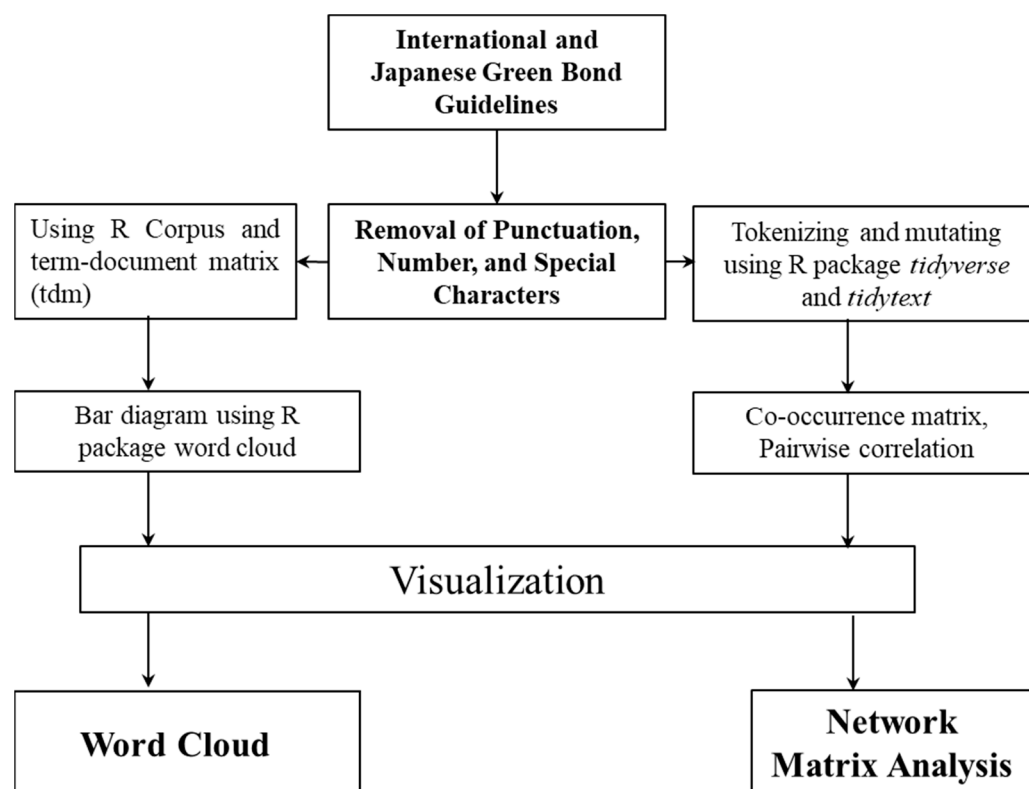


Figure 1. Flowchart of the working procedure.

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 X_1 and X_2 , 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:

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

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.

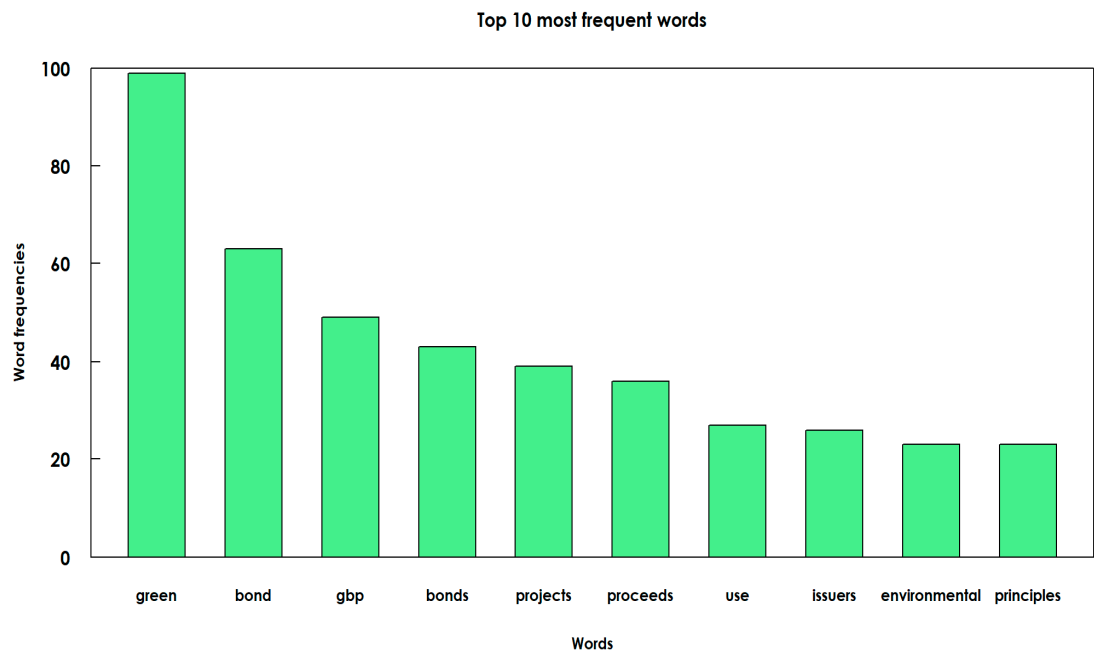
4. Results

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.

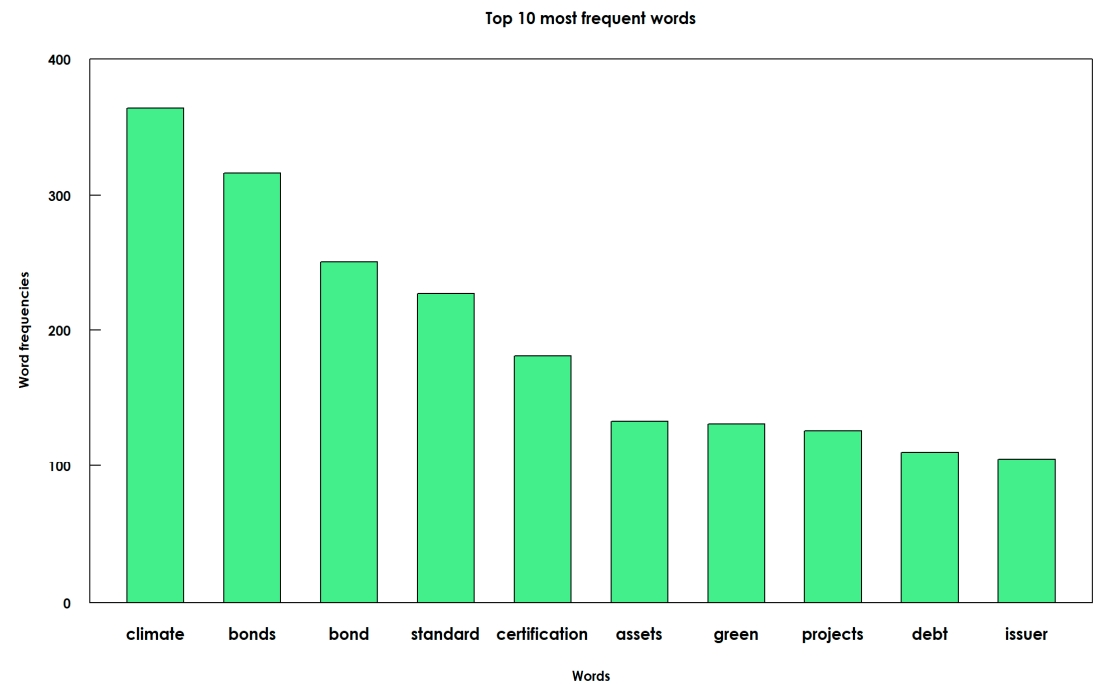
According to Figures 2 and 3, the word “green” recorded the highest frequency for the GBP, JPGB, and SMFG frameworks, and it was also the third most frequent word in the JBIC framework. On the other hand, the word “climate”, the most frequent word in the CBS, was not listed in the top 10 frequent words 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.

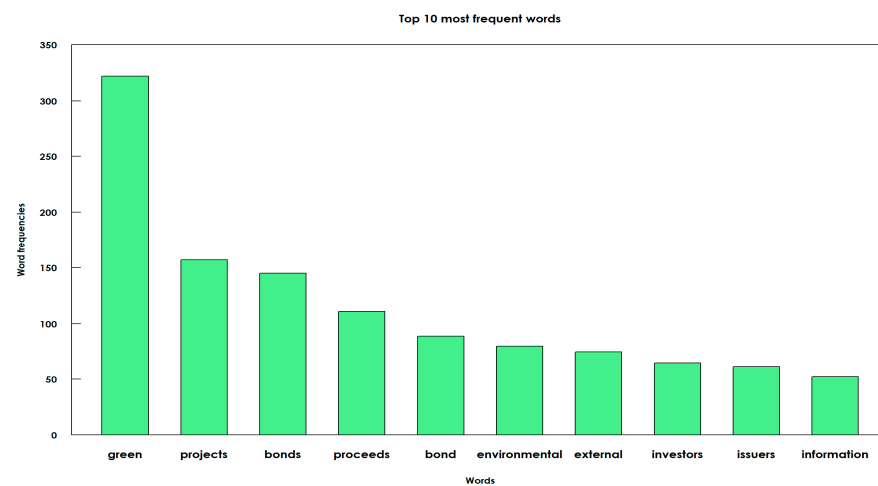


(a) GBP

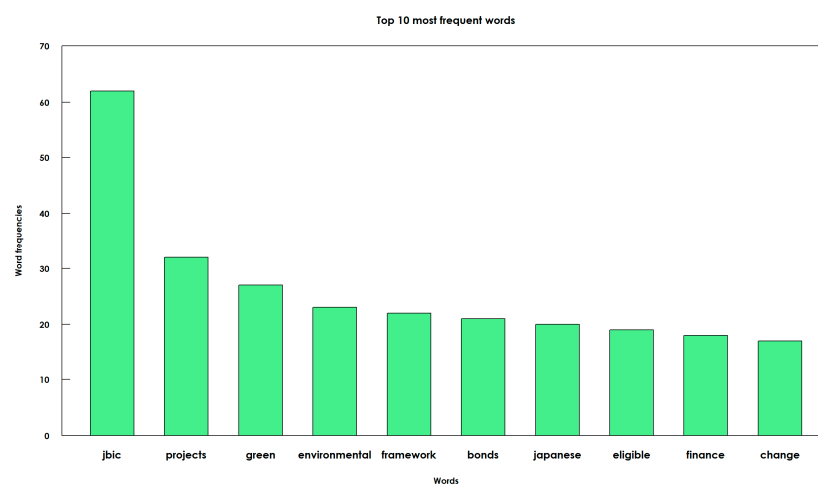


(b) CBS

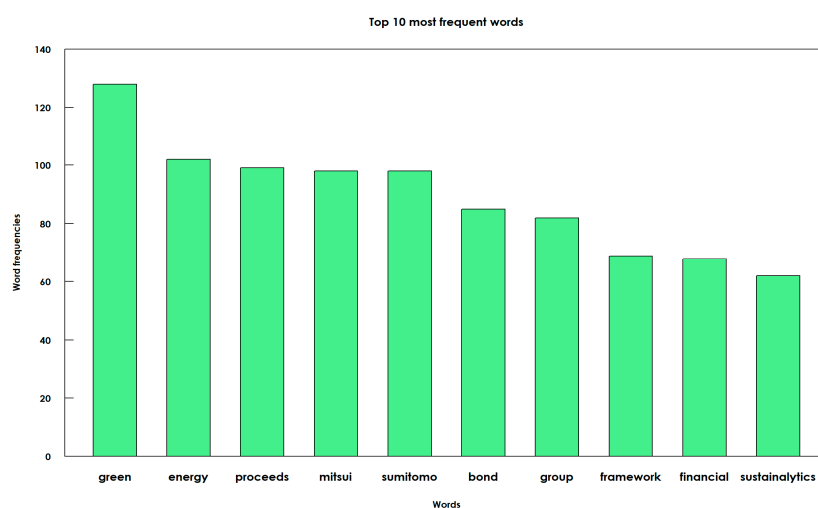
Figure 2. Most frequent words in the international GB guidelines.



(a) JPGF



(b) JBIC



(c) SMFG

Figure 3. Most frequent words in the Japanese guidelines and frameworks.

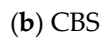
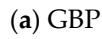
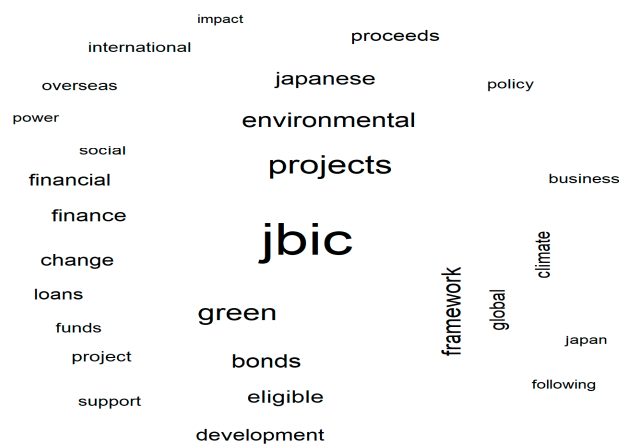


Figure 4. Word cloud result for the international GB guidelines.



(a) JPGB



(b) JBIC



(c) SMFG

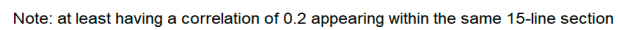
Figure 5. Word cloud results for the Japanese guidelines and frameworks.

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.

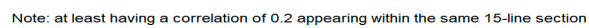
For the Japanese companies’ frameworks, a word correlation was found between “green” and “bond” or “bonds” in both the JBIC and SMFG documents, while the word “bond” or “bonds” did not show a connection with “climate.” This implies that the frameworks of the Japanese companies are also more aligned with 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 Climate Bonds Standard



Figure 6. Network matrix for the international GB guidelines.



Pairs of words in JBIC Greenbond Framework

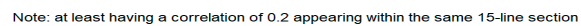


Figure 7. Cont.

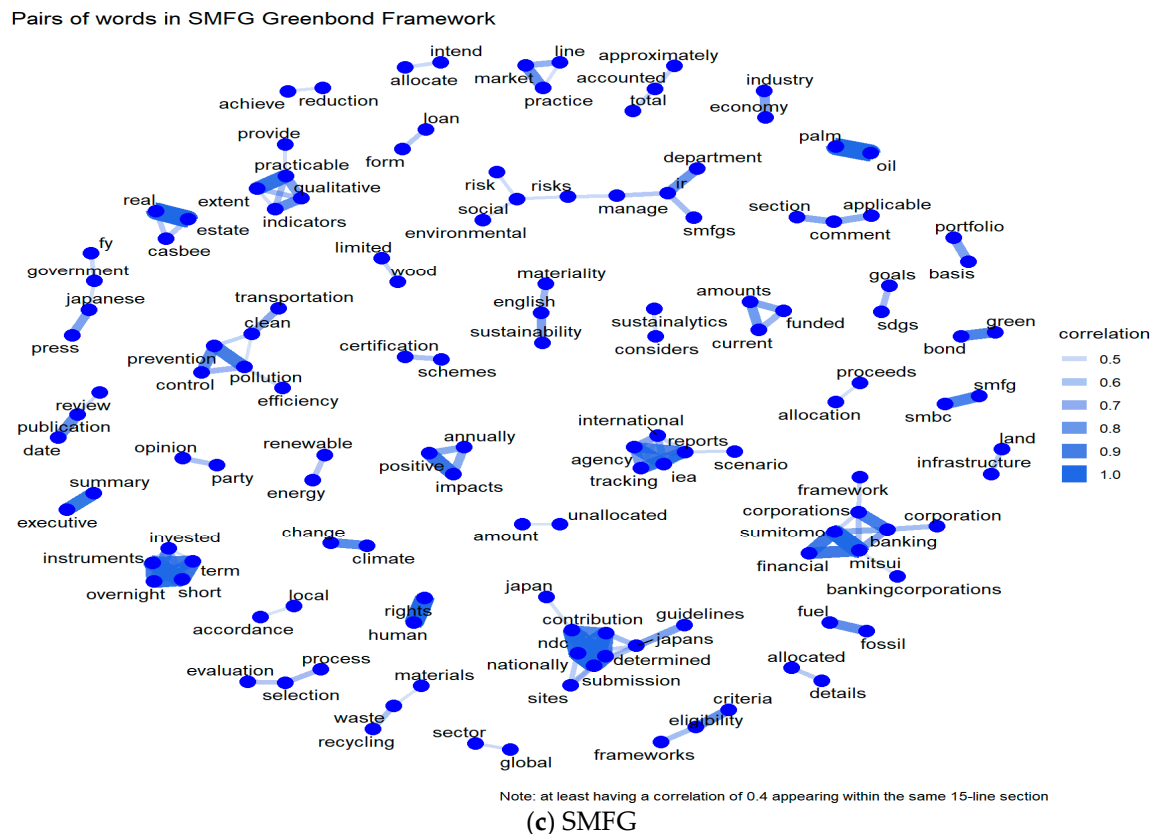


Figure 7. Network matrix for the Japanese guidelines and frameworks.

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.

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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	JPG 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	sustainability

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