



Palm oil and its environmental impacts: A big data analytics study

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ABSTRACT

Expansion of oil palm plantations is under intense public scrutiny as it causes tropical deforestation and biodiversity loss in Southeast Asia. Despite the fact that extensive studies exploring topics related to palm oil land use, climate change, and deforestation, little is known regarding the international public's perceptions of palm oil's impacts on environmental issues. The objective of this study is to identify trends and patterns and categorize relevant themes of public opinions in this regard. With a large dataset of 4260 online posts gleaned from YouTube and Reddit, we apply the Institutional theory and social movements to analyze palm oil discussions in the social media context. Our major findings are: (1) the public has negative views on palm oil. Several drivers of environmental destruction are greed, corruption, profit, and capitalism; (2) social media campaigns against palm oil are highly successful. However, negative sentiments from consumers reveal ongoing institutional failures; (3) public opinion is polarized in terms of viewpoints on socioeconomics and the Roundtable on Sustainable Palm Oil; (4) global consumers' response to boycott palm oil products and seek for other solutions are driven by corporations' profit-driven malpractice and weak governmental legislation and governance. This study is the first attempt to apply big data of social media accounts to analyze consumers' perceptions of palm oil and its environmental impacts. It also proposes a predictive model for understanding factors and mechanisms of how social media applications can potentially stimulate and influence an international sustainability debate over palm oil.

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1. Introduction

The annual haze pollution has affected life in Southeast Asia despite the fact that national laws and corporations' practices restricting the use of fire in clearing lands. The recurring haze blankets Southeast countries in toxic fumes, which disrupted airline schedules, caused school closures, and has increased haze-related ill health (Padfield et al., 2016). Trans-boundary haze is commonly caused by the burning of rainforests and peatlands to make way for agriculture production. In the case of Southeast Asia, at the heart of this haze crisis is the oil palm plantation expansion. Plantation companies are under intense public scrutiny because the burning of lands occurs in agricultural estates where they manage (Gaveau et al., 2017). There are requests to closely monitor multinational companies' activities in order to prevent rainforests from deforestation and degradation. However, the growing demand from an ever-increasing world population has driven oil palm

industries to continue landscape clearance and transformation in such areas (Padfield et al., 2016).

Palm oil provides developing countries and oil palm industries with lucrative economic returns. Conversely, this plantation expansion has put acute and widespread pressure on our environments (Austin et al., 2017). The Indonesian government has announced a moratorium on new concessions in an attempt to improve the governance of national forest resources. As such, corporations are now committed to improving management practices to eliminate deforestation from their supply chain (Austin et al., 2017). The reality is always complex. The palm oil controversy still presents a considerable challenge to policymakers, i.e. how to increase palm oil production and maximize its benefits while simultaneously mitigating negative impacts on our ecosystem and landscape?

Langley and van den Broek (2010) apply the case study of Greenpeace's KitKat campaign in an empirical analysis. They investigate the effects of social media applications on participating in online sustainable initiatives. The results indicate social media campaigns can affect power balance and specifically change public

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Table 1
Author/year/methods/major findings of publications.

Author	Year	Methods	Major Findings
Orsato et al.	2013	Qualitative study, fieldwork	Business–environment relationships should be considered in configured power relations in the organizational field; The disputes between Greenpeace and RSPO showed that political actors try to secure their interests in the institutional field; While stressing institutional entrepreneurs, the constructed field remains a contested terrain; isomorphism emerges from conflict and negotiation over meaning and membership occurring in the organizational field.
Schouten and Glasbergen	2011	Case study	Legality, moral justifications, and consent and acceptance complement each other and deepens our insights into the source of legitimization of private governance; Creating legality must be regarded as the basis of the legitimization process; There are several tensions and trade-offs between the three elements of the legitimization process of the RSPO.
Hospes	2014	Case study	The comparative case study shows the limits of organizing and defining private sustainability standards at the global level for changing practices of largescale producers at the local level in the South; RSPO and RTRS differ from the global standards in terms of normative contents; Governments and producer associations in Indonesia and Brazil have not launched national standards to implement the RSPO or RTRS but to challenge these interventions from the North.
Schleifer	2016	Case study	RSPO is undermined by the rise of emerging markets and the accompanying shift in global economic power; existing private governance institutions are not well equipped to deal with large-scale deforestation and biodiversity loss.
Geibler	2013	Case study	Causal links between standard-setting and induced sustainability effects is an essential requirement for the successful establishment of sustainability in value chains; RSPO as a global sector-specific sustainability initiative is only partly effective; the analysis of the RSPO points out limited participation of some stakeholders from the perspective of legitimacy; initiatives for standard-setting and certification should not be seen as detached from other policies, especially environmental, energy-related, or development policy measures.

opinions, attitudes and behaviors toward targeted groups (Langley & van den Broek, 2010).

The objective of this study is to identify trends and patterns and categorize relevant themes of public opinions toward palm oil and its environmental impacts by using online data from social media accounts. We focus on palm oil and its environmental impacts because deforestation is a primary challenge for Southeast countries. We apply the Institutional Theory and social movement campaigns to investigate and evaluate the relationships of identified themes by proposing a predictive model. We predict that the model will illustrate a comprehensive picture of factors in driving deforestation and biodiversity loss. We then conclude the paper by providing implications for government and corporations to improve their management of sustainable palm oil productions.

The contributions of this study are as follows: first, our study is the first attempt to apply big data of social media accounts to analyze consumers' perceptions of palm oil and its environmental impacts. It extends our knowledge of the literature of the Institutional Theory, social movements and consumers' perceptions of palm oil to the specific context of social media. In addition, the proposed predictive model of this study provides a guide for researchers with a comprehensive illustration of important factors that impact consumers' perceptions of palm oil around environmental issues. Our research methods confirm that predictive modeling is suitable for analyzing the corpus of unstructured online datasets. In the following section, we describe our literature review on the Institutional Theory and social movements. We then apply text analytics to explore our online datasets. With an extensive qualitative study of public perceptions, we present our major findings and conclude the paper with theoretical and institutional implications and future studies in the domain of palm oil.

2. Literature review

2.1. Institutional theory

The Institutional Theory is traditionally concerned with what and how organizations act upon to secure their positions and legitimacy by conforming to the social norms, rules, and beliefs (DiMaggio and Powell, 1983; Scott, 2008). External political, economic and social pressures exerted by actors in the organizational field influence organizational decision-making (Glover et al., 2014; Jennings, 1995). Consequently, a firm acts upon a set of legitimate options determined by actors of the firm's organizational field to

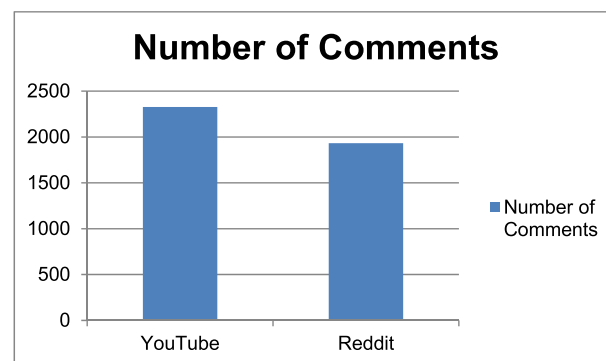


Fig. 1. Number of Comments of this Study.

legitimate the firm's practices (Hoffman, 1999; Scott, 1991). In other words, deviant actions lead to the condition of facing social sanctions or loss of legitimacy within the organizational field (Streeck and Thelen, 2005). Hoffman (1999) summarizes that the Institutional Theory explains how social choices are shaped and channeled by the institutional environment.

Looking back to the institutionalization process, institutions, historically, are modeled by contestation, conflicts, and compromises (Brammer et al., 2012). The process of institutionalization reflects power relationships at a particular point in time (Brammer et al., 2012). The scripts provided by the institutions may be broad on themes, or specific and binding (Brammer et al., 2012). Institutions create and form expectations that appear natural and abiding so that organizations can practice appropriate or legitimate actions (Scott, 2008; Zucker, 1987). This institutional perspective directs attention toward the importance of conformity, regulatory and social pressures in influencing organizational practices (Westphal et al., 1997). The Institutional Theory has been applied extensively in studies exploring environmental management in organizations (DiMaggio and Powell, 1983; Glover et al., 2014; Hoffman, 1999), social values changes (Ball and Craig, 2010), and technology advancements (Lounsbury, 1997) regarding sustainable activities. A number of research studies have been carried out to identify and examine factors that promote the survival and legitimacy of organizational practices. For example, social environment, regulation, tradition, and culture are found to influence organizational decision-making in the adoption of sustainable practices in the view of stakeholders (Bruton et al., 2010; DiMaggio and Powell,

Table 2
Excerpts of the text parsing results.

TERM	ROLESTRING	ATTRSTRING	STATUS	WEIGHT	OLDFREQ	FREQ	OLDNUMDOCS	NUMDOCS	RANK
+ be	Verb	Alpha	Drop	0	671	671	362	362	1
not	Adv	Alpha	Drop	0	347	347	230	230	2
+ oil	Noun	Alpha	Keep	0.243	329	329	208	208	3
+ do	Verb	Alpha	Drop	0	264	264	184	184	4
palm	Adj	Alpha	Keep	0.266	188	188	154	154	5
+ have	Verb	Alpha	Drop	0	178	178	130	130	6
s	Noun	Alpha	Drop	0	154	154	120	120	7
+ palm oil	Noun Group	Alpha	Keep	0.311	144	144	116	116	8
+ people	Noun	Alpha	Keep	0.324	137	137	110	110	9
+ world	Noun	Alpha	Keep	0.341	118	118	94	94	10
+ make	Verb	Alpha	Drop	0	100	100	78	78	11
no	Adv	Alpha	Drop	0	90	90	75	75	12
what	Adv	Alpha	Drop	0	73	73	67	67	13
+ use	Verb	Alpha	Drop	0	78	78	64	64	14
+ get	Verb	Alpha	Drop	0	74	74	63	63	15
+ land	Noun	Alpha	Keep	0.43	86	86	59	59	16
just	Adv	Alpha	Drop	0	71	71	57	57	17
so	Adv	Alpha	Drop	0	62	62	55	55	18
+ government	Noun	Alpha	Keep	0.421	63	63	53	53	19

Note: + depicts parent term.

1983; Glover et al., 2014).

The major critique of the Institutional Theory is that it does not well-explain how institutional entrepreneurs are willing and able to effect change during the power shift process (Levy and Egan, 2003). Levy and Egan (2003) point to the unclear condition whereby institutional entrepreneurs escape the norms and rules established by the institutions. Another problem of the Institutional Theory is its failure to adequately address changes (Hirsch and Lounsbury, 1997). Levy and Egan (2003) argue that the institutionalization is an ongoing process in which the institutions changed at one level cause changes in other components of the system. Hoffman (1999) develops the notion that sudden and unpredictable change prompts institutional players into a period of revolution. He suggests that institutional entrepreneurs can take advantage of this opportunity to seek a change by giving examples of the American chemicals industry in the period of 1960–1993. Drawing on past Institutional Theory and neo-institutional theory, Hoffman (1999) concludes that social conformity will not yield only a predictable structure. The inertia and resistance to change will be broken free during the institutionalization process. It is suggested that environmental issues should be solved through changes in organizational management practices (Hoffman, 1999).

Firms that perceive higher pressures from the market tend to adopt environmental management standards, such as ISO14001 (Delmas and Toffel, 2008). Study results indicate the role of institutional pressure in driving organizations to implement environmental management systems. It is also evidenced by better economic performance if organizations conform to institutional pressures (Schaefer, 2007). Increasingly, firms respond to external demands and address such demands to a greater extent (Hoffman, 1999; Wagner, 2015). However, Wagner (2015) finds that stakeholder demands do not have strong effects that can lead to changes in the actual performances of firms. He suggests that it is through the clear transmission of stakeholder demands and pressures to firms that the improvements in corporate sustainability can be ensured. In terms of methodology, Holtbrügge and Dögl (2012) conduct a literature review on international aspects of corporate environmental responsibility. Their findings show that 35% of reviewed papers apply the Institutional Theory as the major theory (Holtbrügge and Dögl, 2012). This study follows the Institutional Theory to examine the role of social media campaigns on organizational decision-making. Although the literature on Institutional

Theory illustrates the role of external pressures on organizational environment management, it has not addressed the impact of social media campaigns directly. More importantly, the Institutional Theory provides little insight into how a social media campaign moderates corporate environmental strategies. Thus, we supplement this study with insights from social media campaigns to enrich the understanding of institutional changes in the environmental sphere. The next section sets out the role of social media in instigating institutional changes.

2.2. Institutional theory and social media campaigns

In this section, we briefly discuss social movement, social movement tactics, and channels. We then introduce some key social media campaigns regarding corporate misdeeds around environmental issues. We argue the potential of social media in driving corporations and government agencies and private governance to implement sustainability strategies in the future.

A collectively expressed grievance to a perceived social problem can spur social movements in which 'oppositional identities' target existing systems of authority, such as the government and corporations (King and Soule, 2007; Tilly, 1978). Previous studies have predominantly focused on social movement targeting political authorities despite a variety of social problems that are addressed in society (McAdam et al., 2001; Van Dyke, Soule and Taylor, 2005). Recent studies direct attention to the impact of social movements on business organizations and non-governmental organizations (NGOs) (Davis et al., 2005; King and Soule, 2007). Social movements often fail to be recognized by the institutions in the process of creating changes in the world. By presenting themselves as democratic voices, social movements use protest demonstrations as their tactics. Protest brings social grievances to a public place in an attempt to appeal to a wider audience. That is, rather than expressing desired changes to authorities, protesters bypass direct communications with the institutions and vent openly to the public (King and Soule, 2007). Furthermore, the public finds fewer channels to gain access to the hierarchy of corporate decision-making processes. For example, corporate decision-makers may not detect the causes of boycotting their products unless consumer protest delivers their dissatisfaction with corporate environmental policies. Therefore, protest becomes an effective tactic used by social activists (King and Soule, 2007). If external pressures exerted by social movements are insufficient to

Table 3
Text cluster results.

Cluster ID	Cluster Description	Cluster Label	Frequency	Percent
20	+food +blame +good +phone +time better guns +work god +money planet	Capitalism	198	38%
8	+comment capitalism apes +palm +destroy +oil greedy guess 'palm oil' +forest +indonesian +right	Greed	89	17%
11	'vegetable oil' +sunflower crude vegetable wheat +jungle +produce produced +land +plant +soy +ban	Alternative vegetable oil	45	9%
19	europe +poor +watch different sad sounds video always eyes +want earth indonesia	Profit	47	9%
16	brought organizations global +money real +time destroying planet +protect man sad +world	Regulation	31	6%
18	lol 'palm oil products' +leave years products +euro god +war gold +buy +day demand	Boycott	32	6%
13	'palm trees' +run trees +corruption +plantation +burn +'palm oil plantation' plantations 'a lot of' +tree indonesia +forest	Corruption	21	4%
14	corn +product +boycott +bring +habitat environment +oil +palm +fuel +soy 'palm oil' +business	Alternative energy source	22	4%
21	+stop stopped buying countries +hand literally products +oil +palm 'palm oil' +corrupt +buy	Boycott	22	4%
23	+rich 'at all' +supply keeping poorer richer +american animals +evil +consume +deep +soy	Profit	13	3%

Note: + depicts parent term.

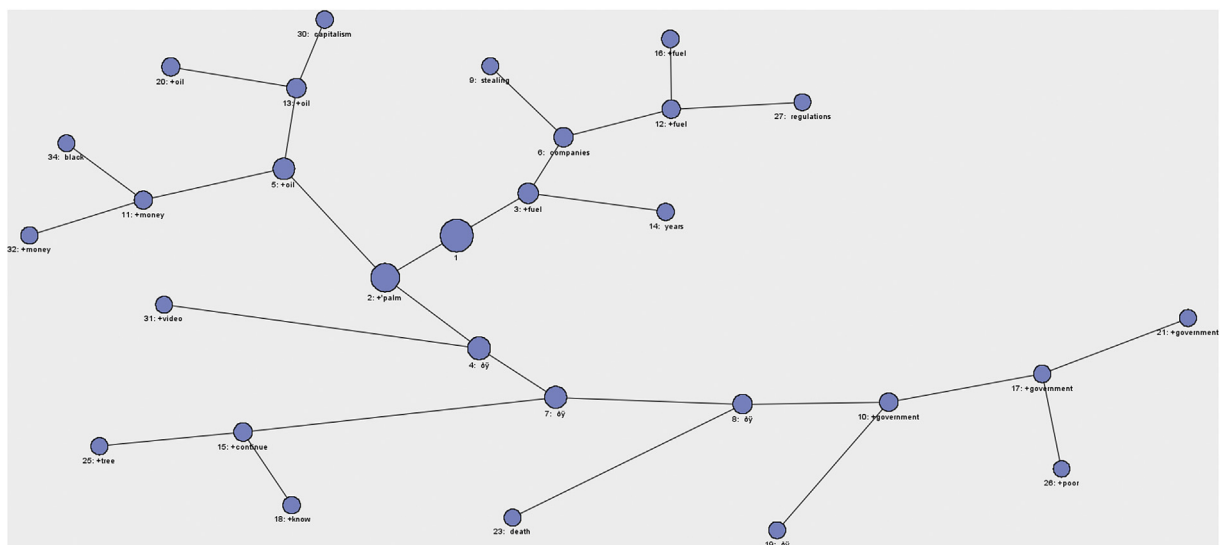


Fig. 2. Cluster hierarchy graph.

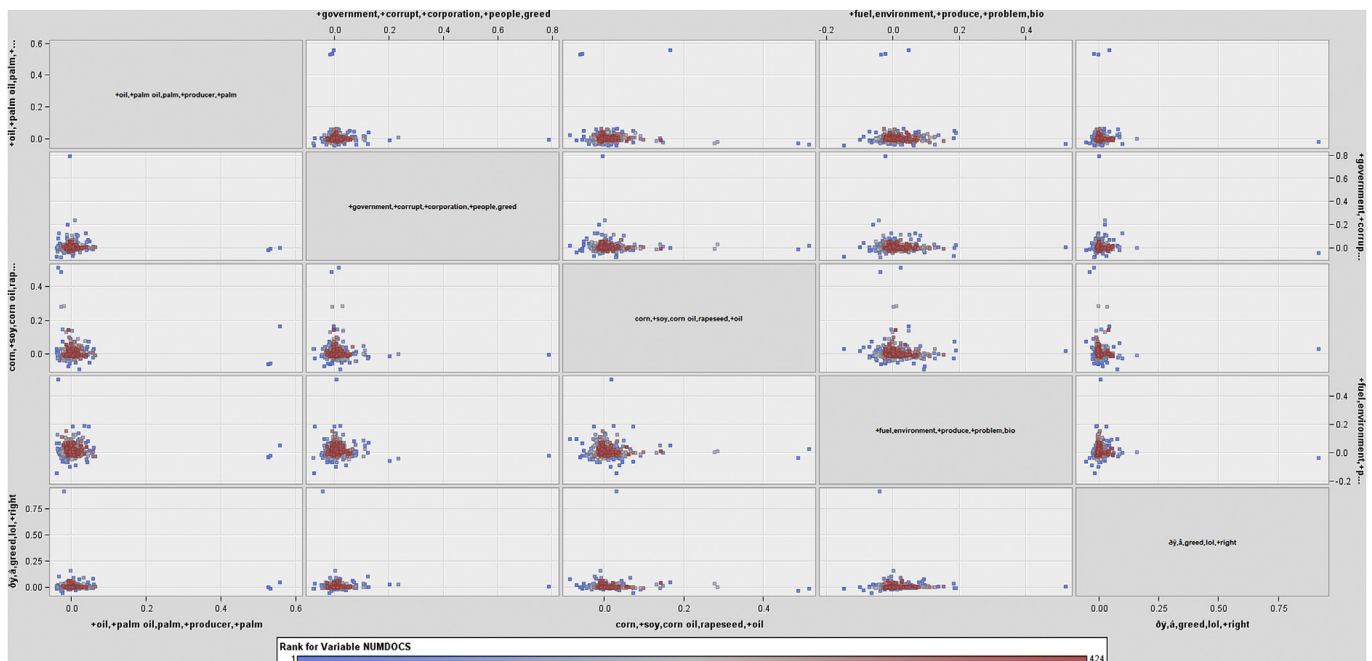
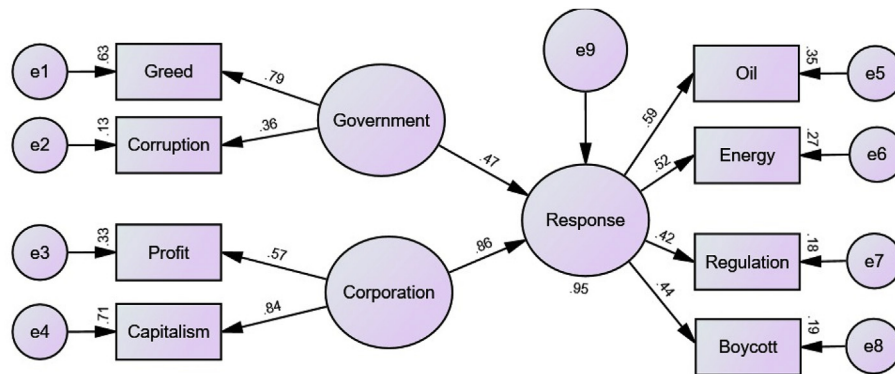


Fig. 3. Topic terms matrix graph.

Table 4
Constructs of the study model.

Cluster ID	Cluster Label	Construct	Cluster Description
8	Greed	Government	Economic returns disregarding environmental destruction
13	Corruption		Officers and politicians bribed by corporations
19&23	Profit	Corporation	Making profits from palm oil
20	Capitalism		Profit-driven malpractice
11	Alternative vegetable oil	Users' responses to palm oil and its environmental impacts	Replacing palm oil with sunflower, corn, canola and soy oils
14	Alternative energy source		Replacing vegetable oil energy source with the wind, solar and nuclear
16	Regulation	Legal restriction and regulation	Legal restriction and regulation
18&21	Boycott		Stop using palm oil products

**Fig. 4.** SEM Results.

Note: Oil denotes Alternative vegetable oil and Energy denotes Alternative energy source.

spur a change, vociferous activists may involve broader audiences via public opinions or the media to shape the way people perceive the targeted issues (King and Soule, 2007). A study points to the limited access to traditional media by actors in the institutionalization process (Deephhouse and Suchman, 2008). Compared to traditional media, social media involves two-way communication by allowing online users to comment on issues. More profoundly, social media offers easier accessible outlets for consumers to express opinions with full control of their content (Benkler, 2006). Ultimately, viral information can be spread rapidly in the social media context. These online opinions/comments as a form of electronic word-of-mouth (eWOM) have been extensively explored in terms of comments characteristics (Teng et al., 2014) and the impacts on consumer attitude and behavioral changes (Gao et al., 2015; Teng et al., 2014). Building on social movements and social movement channels, we explore the role of social media in influencing corporate environmental management. We choose palm oil in this study as much as it is a hot topic related to the environment in our society as well as in the social media context. We then turn to social media campaigns against palm oil in an attempt to learn how social media campaigns affect consumers' and corporations' perceptions, attitudes and behaviors.

In 2009, Greenpeace released a report accusing Nestlé's upstream supplier, Indonesian company Sinar Mas, of illegal deforestation of the rainforests in Indonesia. A video campaign was launched to target Nestlé as a threat to the extinction of orangutans. In the context of social media, this campaign was intensified by

Greenpeace by strategically calling on consumers to publicly express their anger toward Nestlé (Champoux et al., 2012). These mobilized critics exemplify an online protest initiated by non-government organizations. Under this significant pressure, Nestlé changed its sourcing decisions by committing to the procurement of sustainable palm oil and achieving 100% zero deforestation in its supply chain by 2020 (Shukla and Tiwari, 2017). There have been a number of downstream firms like Unilever, Nestlé, P&G, and others pledged to procure palm oil from producers that have not been involved in deforestation. Consequentially, this palm oil industry's major traders and processors such as Wilmar, Cargill and Musim Mas have pledged to source palm oil from growers who comply with the Roundtable on Sustainable Palm Oil (RSPO) standards (Nesadurai, 2017). This effective transnational social movement aims to ensure that downstream and upstream corporations and companies adhere to high environmental and social standards by applying sustainable production methods (McCarthy, 2012). For instance, to reduce CO₂ emissions, corporations can incorporate environmental waste management into the sustainability of the construction industry (Azevedo et al., 2020; Azevedo et al., 2019; Azevedo et al., 2018). Apparently, social media campaigns are proven to be an effective movement in influencing corporate decision-making regarding environmental issues (Dauvergne, 2017).

The growing relevance of palm oil social media campaigns on protecting environments is our motivation to conduct a systematic review of the literature. We can find several studies that

Table 5
Bayesian SEM results.

Construct Association	Standardized Regression Weights	Mean	S.E.	S.D.	C.S.	Skewness	Kurtosis	Min	Max
Response<–Government	0.47	0.524	0.005	0.247	1	1.266	4.714	0.009	2.886
Response<–Corporation	0.86	1.134	0.001	0.201	1	0.554	0.7	0.487	2.341

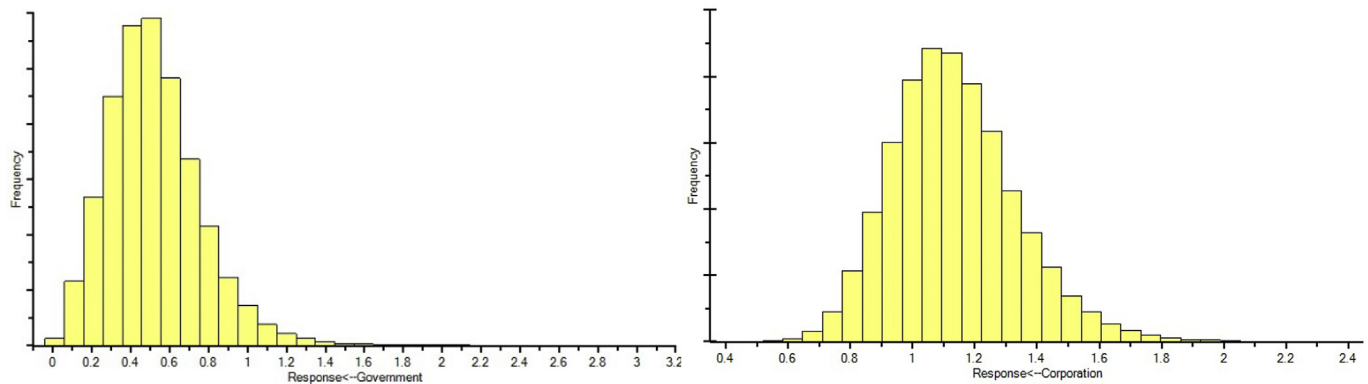


Fig. 5. Posterior distribution of the associations between the exogenous and endogenous constructs.

comprehensively deal with corporate environmental management toward palm oil within institutional changes. We searched for relevant articles in Google Scholar by applying the following keywords, 'palm oil', and 'institutional theory', and 'institutionalization' and combinations of these keywords. We identified 49 relevant articles. The inclusion criteria are the articles that examine the Institutional Theory in the case of palm oil. We discovered five articles fit to our goal. Table 1 shows the author, year, research methods and major findings of these articles. The majority of these studies have used a case study in the methodology section. The RSPO is predominantly used as a case in studying the institutionalization process of private governance. The research findings indicate that the RSPO is undermined in the legitimization process (Schleifer, 2016; Schouten and Glasbergen, 2011). Furthermore, we systematically reviewed studies that explore palm oil topics in the social media context. Ruggeri and Samoggia (2017) apply a qualitative approach to explore Twitter contents of key palm oil agri-food chain actors in the European context. They find that palm oil producers tend to shape public opinions with benefits of palm oil use, whereas food manufacturers and retailers choose not to react to consumers' questioning and doubt on the sustainability of palm oil production and use (Ruggeri and Samoggia, 2017). Von Rossum (2018) empirically investigates public opinions on Twitter regarding the wicked problem case of palm oil. She argues that NGOs such as Greenpeace, BBC Earth, and the RSPO play an above-average role in guiding and influencing public thinking. These social influencers turn Twitter into a public sphere (Von Rossum, 2018). Another content analysis study is carried out to examine the revolution of palm oil discussion in newspaper articles. The economic, environmental, health and social aspects of palm oil are discovered as different themes. The authors observe that specific linguistic strategies are applied by the media, such as promotion and prevention motivations, and analytical and narrative writing styles. It is suggested that moral legitimacy is winning over pragmatic legitimacy for palm oil-consuming countries (Corciolani et al., 2019). Despite the fact that an increasing number of studies deal with palm oil, little attention is directed toward identifying and categorizing social media campaign online reviews around palm oil. It is unknown what consumers' perceptions of palm oil regarding environmental issues are. Therefore, we try to gain a greater understanding of how the public views environmental impacts exerted by oil palm plantations. Our study focuses exclusively on the role of social media in driving corporate decision-making on environmental management and sustainability strategies.

2.3. Text analytics

Before conducting this research, we emphasize the benefits of

applying text analytics in investigating palm oil and its environmental impacts. Based on our second systematic review on palm oil in the social media context, we obtained that consumer-generated big data served as the global source of public opinions regarding palm oil.

This unprecedented growth of online posts boosts the interest of academicians across disciplines to harness this large scale unstructured data for descriptive and predictive modeling (Nassirtoussi et al., 2014). One big source of unstructured data comes in the shape of customer online review of their consumption experience. Online textual reviews are primarily unstructured but offer better and more detailed insight into customer consumption experience (Zhao et al., 2019). In this study, big data (i.e. online posts) related to palm oil is our research focus. In general, big data analytics uses predictive modeling to discover hidden patterns, market trends, and consumer preferences. Furthermore, using data mining and advanced analytical techniques to improve the decision-making process, it becomes a primary source of competitive advantage for firms such as Google, Facebook, and Amazon (Davenport, 2006; McAfee and Brynjolfsson, 2012). Extracting and clustering product features and sentiment analysis were employed to mine useful and valuable insights from text-based online reviews. Text mining allows researchers to process data from a large number of web pages. In recent years, this automated machine learning analysis has quickly and effectively interpreted large bodies of extracted online data, thus promising valuable insights across research areas (Bicquelet, 2017). Despite the popularity of big data, little is known about palm oil and its environmental impacts in the context of social media. This study thus examines the validity and utility of text mining while clustering public perceptions of palm oil. Term Frequency-Inverse Document Frequency (TF-IDF) weighted algorithm is applied to classify and manifest the weights of key terms from online posts. In the following sections, we conduct data collection and big data analytics. Results of data interpretation are included.

3. Methods

3.1. Data collection

We incorporated multiple methods, including exploratory content analysis and a text analytics analysis. We first conducted a preliminary content analysis by reading palm oil posts on Facebook, Twitter, YouTube and Reddit accounts. Posts on Facebook and Twitter were analyzed and initially considered. But this analysis has ruled out Facebook and Twitter as data collection sources because of the legal aspects of web scraping. We then performed a keyword search on YouTube and Reddit to collect the data that were

potentially related to palm oil arguments at an international level. These words included 'palm oil', 'environment', 'deforestation', 'wildlife' and a combination of these terms. The time frame of this collected data began in July and ended in September 2019. In the case of scraping YouTube video comments, we watched the videos from the first five consecutive result pages in order to select all of the relevant videos. We then progressed through the rest of the list until the searched videos became totally unrelated. Following in Meldrum et al. (2017) steps, videos pertaining to non-palm oil, videos in languages other than English and the videos targeting specific audiences and videos that had disabled the commenting feature were excluded. In total, eight videos remained after we independently screened and recorded the titles and links of the qualified videos. Replies to the existing comments and comments left by the video's creators were included as this content analysis focused on all of the community members' opinions on palm oil. Overall, 2458 comments and replies posted under the eight videos were scraped from YouTube (<http://ytcomments.klostermann.ca/>) and transferred to an Excel spreadsheet. We read through the dataset and removed data entries such as #NAME#, external links, and advertisements. This data cleansing process returned 2328 YouTube online posts data entries for the content analysis. Removing comments that did not address palm oil subjects, we collected 1932 data entries from Reddit posts. We excluded YouTube and Reddit account names, user IDs, likes, and upvotes as our focus is online comments. In total, we created a database of 4260 online comments for the data analysis. Fig. 1 illustrates datasets' information adapted from YouTube and Reddit platforms. Appendix 1 and 2 provide an overview of the sampled videos and threads from YouTube and Reddit platforms in this study. Similar to previous studies (Lewis et al., 2012; Meldrum et al., 2017), ethical approval was not needed for the study as the data used were from the public domain.

Notably, social media has become a vehicle for the collection of different viewpoints such as consumers and organizations. A large focus on the international level could give us better understandings of public opinions (Champoux et al., 2012). The large sample of online comments represents the various perceptions of palm oil around environmental issues.

3.2. SAS text analytics

We used a computer-assisted content analysis package called SAS Text Analytics to analyze the comments from selected YouTube videos and Reddit threads. This software combines textual and statistical analysis by focusing on the frequency of words in a corpus. The first step is text parsing, which identifies different parts of speech, removes punctuations, and defines a list of synonyms (Małaszczek, 2017). Table 2 shows excerpts of the text parsing results.

The text filter procedure was deployed after the text parsing procedure. This procedure filters out common and irrelevant terms for further analysis. In short, this procedure reduces the number of terms after text parsing. After retaining meaningful terms, the text cluster procedure was deployed using the Latent Semantic Analysis indexing method via the Singular Value Decomposition (SVD) algorithm. This procedure groups similar terms that will help in identifying the desired value of targeted themes. This clustering organizes terms and documents into a semantic space based on the frequencies of terms (Berry and Kogan, 2010) (Table 3). The constructs were labeled to manifest the cluster description in Table 3. The cluster hierarchy graph is a hierarchical graphical representation of the clusters (Fig. 2). The distance between the clusters depicts the relationships between these clusters. The further the clusters are from each other, the less likely the key themes between the clusters are associated. In short, the distance between clusters

manifests the association amongst the key themes. The endpoints are sets of clusters, where each cluster is distinct from each other cluster. The objects in each cluster are broadly similar to each other (SAS, 2017). For example, in this study, the *Capitalism* cluster relates to the terms *oil palm* and *money*. The *Greed* cluster is mainly related to *capitalism* and *palm oil*.

The text topic enables us to combine terms into topics. It automatically associates terms and documents based on uncovered topics that describe and characterize the main theme (Małaszczek, 2017). Contrary to text cluster, text topic assigns a score for the documents and one term can belong to more than one topic (Małaszczek, 2017). Topics in this study are the collection of terms that are generated via the text parsing procedure in the SAS Enterprise Miner. The main themes are characterized in this procedure. Fig. 3 the topic terms matrix graph shows the interaction of each pair of topics by examining terms that describe the topics. Two topic scores are given to the terms that are plotted in each scatterplot. The topic scores indicate how frequent the term is with the most frequently used term in the dataset. In this study, Topic '+government, +corrupt, +corporation, +people, greed' is closely associated with Topic '+oil, palm oil, +producer, +palm'. The matrix graph displays and highlights the associated observations of the topics. It also indicates that text topics SAS produced enable us to categorize major themes regarding palm oil.

4. Results

This section describes the results of applying text mining methods to the topic of palm oil and environmental issues in the social media context. There were ten clusters identified with regard to capitalism, greed, corruption, profit, boycotting palm oil, seeking alternative vegetable oil and energy sources, and government regulations. These clusters are reflected in the most frequent key terms used by the YouTube and Reddit commenters. These key terms were automatically selected on the basis of their occurrence and co-occurrence. We read through the key terms and sentences extracted from YouTube and Reddit posts in order to make sense of the clusters categorized by the software. We interpret each cluster with detailed explanations and excerpts of comments.

Capitalism Cluster
20: +food +blame +good +phone +time better +guns +work god +money planet

Aware of palm oil being among the ingredient of many kinds of food, consumers start reading nutrition labels on products. However, it is not clear what better alternatives can replace palm oil. People blame oil palm for deforestation. Others believe that corporations and governments are to blame for their profit-driven malpractice. Capitalism causes slavery and exploitation. Corporations push new phones every year and old phones became waste. Consumers need a certain standard of living regardless of waste. YouTube viewers discuss whether people should own guns if local people need to fight for their lands. Humans are destroying the planet to make money (The following italic sections are quotes from online comments).

So basically they steal the land, then force the locals to work on it for little money and collect profits. Late capitalism at its finest.

Capitalism. Companies like Nestlé® don't care about quality and the consequences of using the ingredientd they use ... they just care about money, profit over people is their motto.

Greed Cluster 8: +comment capitalism
apes +palm +destroy +oil greedy guess 'palm
oil' +forest +indonesian +right

Capitalists are greedy. They destroy forests for oil palm plantations. Indonesian government and politicians are corrupted. Local farmers burn trees to clear lands for palm oil. YouTube viewers have no idea of the pronunciation of orangutans. They argue whether humans come from apes. One believes in the theory of evolution. Humans share 95% of DNA with apes. The other denies the evolution theory and believes that God made humans. People push these guesses as facts.

The greedy people will destroy the Earth! What about the palm oil companies in India who pay 5dollars per murdered orangutan because the orangutans destroy the palms (how many palms would destroy if they are threatened from extinction?).

There is no proof what so ever other than fake bones and â€œexpert opinionsâ€ that evolution has taken place. If we have evolved from apes why havenâ€™t apes evolved. There are no transitional species from apes that prove adaptations have taken place. Donâ€™t take someone word for it and research yourself before believing in something.

Alternative vegetable oil	Cluster 11: 'vegetable oil' +sunflower crude vegetable wheat +jungle +produce produced +land +plant +soy +ban
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Food manufacturers proclaim they use 'vegetable oil'. If a product contains vegetable oil, it is most likely palm oil. Other vegetable oils include sunflower, corn, canola and soybean crop oils. Compared to these vegetable oils, palm oil is the most efficient vegetable oil and it has the highest yields with smaller land use. Banning palm oil would neither protect nor restore jungles. Replacing palm oil with other vegetable oil would lead to more deforestation and worsen problems.

1. Palm oil only accounts for 0.31% of total 5 billion hectares used for livestock and crops (YES!!! THAT'S 0.31%!!!) That;s equivalent to 15.5 million hectares only. Soy bean is far damaging to the amazon than the palm oil to south east asia. 2. Oil seeds that includes soy bean account for 5.25% of that 5 billion hectares. (yep, soy bean alone accounts for 120 million hectares - compare that to what palm oil land use is?) 3. Palm oil gives yield up to 3.6 tonnes per hectare, compared to only 0.43 tonne per hectare for soy bean (yes, palm oil has been saving us, the earth from more agricultural land.4. Malaysia's palm oil plantations are actually from other crops that have been converted to palm oil. Mostly rubber trees, cocoa and other crops. I cannot say much about Indonesia but again I would stress out that the deforestation is way less than what other crops have done to our forests ... sadly, these white colonialists, imperialists would say other wise!!!

Profit Cluster 19: europe +poor +watch different sad sounds video always eyes +want earth Indonesia

Europeans clear out their forests. They blame Indonesians for destroying rainforests. These gold diggers looted Indonesia in the old days and Indonesians are left behind in poverty. The Europeans are causing environmental destruction as their corporations make profits from palm oil. Meanwhile, the European Union uses deforestation to protect their vegetable oil and boycott palm oil. Human is the pandemic of the Earth. Greed is destroying our earth.

Corporations are destroying the world for a buck.

Excellent documentary - should be shown mainstream! Shows how corrupt the powerful Corporations are. Palm oil cultivation, and other mono-cultures, is destroying our NATURAL world!

Regulation Cluster 16: brought organizations global +money real +time
destroying planet +protect man sad +world

People do not generally trust global organizations. They believe that these organizations give out certificates (e.g. the RSPO) for money. They do not care about destroying the planet. The government illegally gave forests owned by locals to palm oil corporations.

Guess WWF just forgot (?) to mention that the RSPO is extremely corruptâ€! They have given certificates to several palm oil plantations and corporations declaring that their products are produced in a sustainable manner, when really they are no where near being such. If you want examples, just look at Wilmar and IOI Group! You can't trust the RSPO with anything!

I read that palm oil is the most efficient source of oil/biofuel. It would be best if there were strong regulations prohibiting products being grown on deforested rainforest in general. Banning palm oil won't stop the deforestation of rainforests.

Boycott Cluster 18: lol 'palm oil products' +leave years products +euro god +war gold +buy +day demand

Commentators urge people to leave trees and orangutans alone. Some believe that it is economic warfare whereby the west tries to destroy the wealth of other nations as well as introduce substitutes of other nations. Many people boycott palm oil products. However, some found it difficult to stop using palm oil. They try to phase out palm oil products. With the ever-rising world population, people believe that consumer demand for cheap vegetable oil will continue to increase.

Well if you never eat any sweets or bread or use cosmetics, then I guess it can be avoided. But I think the point was it is difficult because you have to look on every product if it has palm oil in it. And some people have to go eat something in their lunch break because they can't cook at their place of work. You can take food from home that is already prepared, but you will be called weird by your colleagues and if you also have kids, it will be difficult to get enough time to also cook for your lunch break, so it is not easy at all.

Literally no one seems to remember than just 20 years ago countries were urgently banding up to focus on palm oil production because it's a lot less destructive than many other oils that we use. International conferences were held to urgently phase out other oils in favour of palm oil. So yeah, sure, stop using palm oil for food - but also spend a while thinking what will replace it.

Corruption Cluster 13: 'palm trees' +run
trees +corruption +plantation +burn +'palm oil plantation'
plantations 'a lot of' +tree indonesia +forest

Local Indonesians slash and burn trees for palm oil plantations. Most commentators believe that the government officers and politicians are bribed by corporations and local businessmen to allow clearing forests for palm trees and killing wild animals. Many agree that corruption is out of hand in Indonesia.

There is. But the problem is that there is overlap regulation between central and local as the result of recent decentralisation. Additionally, some corrupt local leaders accept bribes for giant corporates. These corporates often slash and burn the forest illegally. Some of them have been charged, but most of them are still free. It is not all of us agree with these, some of the people also try to fight this.

Alternative energy source	Cluster 14: corn +product +boycott +bring +habitat environment +oil +palm +fuel +soy 'palm oil' +business
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People believe that oil palm plantation causes habitat loss and biodiversity destruction. They pledge to boycott palm oil products. However, they find it hard to get rid of these products as palm oil is included in absolutely everything. Some discuss alternative energy sources such as wind, solar, and nuclear in order to replace vegetable oil (e.g. soy, corn).

Palm oil may be the most land efficient biofuel, but that just shows that biofuel itself is a failed experiment IMO. Even the best case biofuel scenarios seem to do more harm than good. I think solar+wind+ nuclear with all electric transportation is the way forward.

Boycott Cluster 21: +stop stopped buying
countries +hand literally
products +oil +palm 'palm
oil' +corrupt +buy

Commentators urge everyone to stop buying palm oil products because they want to save rainforests and orangutans.

Boycott palm oil. We don't need it.

Save the Rainforest and these Amazing Animals and Go Vegan !

Profit Cluster 23: +rich 'at all' +supply keeping
poorer richer +american
animals +evil +consume +deep +soy

(:

People believe that greedy rich people exploiting low wage workers in countries where laws of environment protection are not enforced is what makes most of these people rich. Poor people buy products from rich people who benefit from it and become richer. Americans and Europeans are the biggest consumers of resources.

And their companies profit on palm oil. Some suggest that Americans should stop eating beef because beef is the worst deforesting culprit and responsible for deforestation in Latin American countries.

Sorry but it's not the consumer who wanted it ... it's the big companys which want to save money!

Trust me Climate change'ers are fake. It's all about money. No body cares!

Why blame palm oil.? You're a hypocrite Han Solo ... the corn and soy industries as well as the beef meat industry in the western countries needs more and more new land also leads to deforestation. Should do your research before making this video.

At this point, we are not implying any causal relationships between these clusters. However, it seems that some clusters are related to each other, which made it interesting to explore it using an appropriate method. From the clusters derived, we use a Cartesian coordinate system by displaying them in a scatter plot. The Cartesian coordinate measures the distance between clusters with X and Y coordinates representing space generated by the SVD algorithm. Clusters aligned together in the Cartesian system represent their similarities in semantic concepts. Using these coordinates, we develop a predictive model where the constructs Corporation and Government are associated with online users' Responses to palm oil environmental impacts. Table 4 shows the constructs of the research model. Structural Equation Modeling (SEM) is used to estimate the proficiency of the model. Results show that both Corporation and Government are positively associated with Response to palm oil environmental impacts. Fig. 4 indicates that 95% of the total variance of the endogenous construct Response can be explained by exogenous constructs Corporation and Government. Fig. 4 also depicts the relationships of constructs that are derived from cluster interpretations.

In order to test how robust the above model is, we apply Bayesian SEM via the Monte Carlo Markov Chain (MCMC) to train the model (Ong et al., 2018). The SEM results of construct relationships are shown in Table 5. With a burn in a sample of 500, the model reached convergence at 85,000 iterations with an acceptance rate of 0.326. According to Arbuckle (2009), model convergence between 0.2 and 0.5 is considered acceptable (Arbuckle, 2009). The posterior means of the associations between Response and Government and Response and Corporation are 0.52 and 1.13, respectively (Fig. 5). The posterior distribution indicates that these associations between exogenous and endogenous constructs will be positive. Both the SEM and Bayesian SEM show consistent results with the former confirming that the associations between Government and Response, and Corporation and Response are positive.

To this end, these results and proposed predictive model confirm our assumption about consumers' perceptions of palm oil and its impact on our environment. Next, we discuss the major findings and implications of our results.

5. Discussion

5.1. Major findings

First, the public has negative opinions on palm oil. Online commentators blame palm oil for rainforest deforestation and biodiversity loss. Our results categorize several drivers of this environmental destruction as greed, corruption, profit, and capitalism, which are based on textual impressions within online reviews. Specifically, palm oil product consumers shared experiences and opinions reflecting consumer behaviors. These consumers believe that their consumption of palm oil contributes to deforestation and global warming. They express their concerns and pledge

to boycott palm oil products. The contents of consumers' comments provide an indication and insight into the understanding of public sentiments regarding palm oil from qualitative data analysis (Wood et al., 2016; Von Rossum, 2018). With a dataset of 4260 online posts including 104,986 words, the majority of these texts contain overwhelmingly negative emotions, such as sad, horrific, disgusting, gut-wrenching, outraged, and disheartening and so forth. Although corporations may gauge changes in consumer desires and purchasing patterns on palm oil products using sentiment analysis of publicly available data, reacting to public complaints become a challenge for corporations.

Second, evidenced by the negative public opinions on palm oil, social media campaigns against palm oil are highly successful. However, negative sentiments from consumers reveal ongoing institutional failures. In other words, the campaigns reach quickly and cheaply to hundreds of millions of stakeholders through messaging and trending in the social media interface (Dauvergne, 2017; Langley & van den Broek, 2010). Activists effectively wield more influence on palm oil products consumers. The oil palm industry responds to the crisis with reforms on sourcing sustainability. Yet, even shifting sustainability practice would only modestly contribute to preventing tropical deforestation from mass environmental destruction (Dauvergne, 2017). Notably, social media campaigns can play an important role as external agents of change by offering solutions to collective problems (King and Soule, 2007). Dauvergne (2017) summarizes considerable challenges faced by the activists, such as diffuse and messy messages which cause confusion. This challenge limits the eventual effectiveness of social media campaigns against palm oil.

Third, based on the thematic analysis of public perceptions of palm oil, we acknowledge that the public holds comprehensive palm oil-related knowledge. Relatedly, we find these opinions are rather polarized in terms of viewpoints on socioeconomics and the RSPO. Consistent with Corciolani et al. (2019), we observe that people from palm oil-producing countries tend to focus on the economic returns (e.g. wage, making a living) of the oil palm industry. People from palm oil-consuming countries relate palm oil directly to deforestation and biodiversity loss (e.g. obliterating forest utterly). This competing paradigm still exists in the value system as the dominant value is attached to economic growth. Furthermore, we pay particular attention to the polarized opinion on private governance agents, i.e. the RSPO. On the one hand, some people are supportive of this transnational initiative on sustainable palm oil practice. On the other, others are skeptical about the effectiveness and trustworthiness of the RSPO. Richardson (2015) labels the RSPO practice as the commodification of certified palm oil. The RSPO is criticized for allowing buyers to claim sustainable palm oil by purchasing its certificate (Dauvergne, 2017; Padfield et al., 2016; Richardson, 2015). Modest capacity to monitor member behavior also limits the RSPO sustainable palm oil practice (Laurance et al., 2010).

The final major finding of this study is that a majority of palm oil product consumers choose to boycott palm oil and the public shares their solutions to halt environmental destruction, such as using other vegetable oils, seeking renewable energy sources, and implementing stringent regulations. Joined together with consumers' perceptions of drivers in deforestation and biodiversity loss, the results of SEM predictive modeling suggest that our study can provide a comprehensive picture of factors related to palm oil environmental issues. Specifically, we confirm that the public associates capitalism, greed, profit and corruption with the main drivers of tropical deforestation and animal extinction. We find a strong positive relationship between the roles of corporation and government and consumers' response to their roles in the palm oil-related environmental issues. In other words, consumers'

responses to boycott palm oil products and seeking other solutions are driven by corporations' profit-driven malpractice and weak governmental legislation and governance. This finding signifies the important roles of corporations and the government in tackling environmental issues for the benefits of humankind (Padfield et al., 2016). In addition, consumers' seeking solutions to mitigate palm oil deforestation suggests that the palm oil issue is a solvable problem. Taken together with these factors underpinned in this empirical analysis, we deduce that the results of this study capture the public perceptions of palm oil and its environmental impacts on society.

5.2. Implications

Our empirical work has several theoretical implications. To the best of our knowledge, this is the first attempt to apply the Institutional Theory and social media campaigns to study palm oil and its environmental impacts. This study contributes to extend our knowledge of the literature of the Institutional Theory, social movements and consumers' perceptions of palm oil to the specific context of social media. In particular, we categorize factors related to palm oil environmental issues and public opinions toward palm oil in the process of institutional changes. Furthermore, by performing SEM predictive modeling, we confirm that these factors of causes of deforestation can lead to international opprobrium against palm oil. Another important implication is the use of big data allows researchers and data scientists to develop predictive analytics to uncover sentiments and patterns of public opinion across various data sources (Wood et al., 2016). It opens avenues for researchers to address the volume, variety, and velocity of social media content. In addition, the proposed predictive model of this study provides a guide for researchers with a comprehensive illustration of important factors that impacted consumers' perceptions of palm oil around environmental issues. This research model enriches past studies and establishes the framework and concepts of online opinions regarding palm oil. Below, we provide institutional implications for related parties in the oil palm industry.

There are significant implications for corporations and social movement organizations to develop sustainability strategies. Indicated by the Institutional Theory and social movements in this study, social media has changed the power balance in our society. Based on our findings, social media applications enable social movements to organize a large mass of consumers to bring about a change to support a good cause. To ameliorate the egregious environmental impact caused by deforestation, the public joining the concerted effort initiated by social movements is the sine qua non to save the planet. Hence, social media campaigns can increasingly act as online agents to help active activists to achieve online sustainability initiatives (Langley & van den Broek, 2010). On the other hand, negative public opinion exerts negative publicity of the oil palm industry and makes corporations vulnerable to this external criticism. Therefore, it is vital that palm oil companies downstream and upstream are aware of the ongoing criticism in the mass media. Proactively, these firms should identify their vulnerable aspects and prepare their alternative sustainability strategies. For instance, palm oil companies can stress the role of palm oil as an effective substitute lubricant on improving sustainable machining performance (Sen et al., 2020). Moreover, adopting social media applications in marketing and communication activities, especially an appropriate response conforming to social network norms (Xia, 2013), can assuage the public outcry on deforestation and endangered orangutans. As implied in the study findings, there is a pressing need for incumbent firms to monitor the sustainability commitments and definitive attribution of

responsibility for deforestation in the supply chain activities. For example, an effective tracking system allows tracing palm oil through the chain. Aligned with our findings, we believe that the potential yield of palm oil in existing oil palm plantations could be the most responsible way for corporations to produce sufficient palm oil to meet the growing demand for existing and emerging markets (Woittieza et al., 2017). Woittieza et al. (2017) investigate the factors related to potential yields, such as available radiation, CO₂ concentration, temperature, planting materials, planting density and so on. They advise smallholders who produce 40% of world palm oil to understand these factors and identify effective ways to improve their sustainability and yield in oil palm plantations.

Evidenced by our findings, social media applications can decrease government authority. Concerned consumers seem to have more authority over public opinions than the responsible ministry (Langley & van den Broek, 2010). Consistent with previous studies (Austin et al., 2017; McCarthy and Zen, 2010), our findings indicate the failure to provide effective oversights and consistently implement sound environmental friendly policies are caused by lack of governance transparency, lack of accountability and administrative capacity, and vested interests coupled with the presence of corruption. Much of the oil palm conflict in Indonesia is about the land because there is a lack of clear written agreements outlining land titles, and enduring land ownership disagreements (Gillespie, 2012). The application of national law can assist plantations and rural communities with crafted solutions. We argue that policymakers should take action to implement environmental regulations, although intractable problems exist in the bureaucratic regulations. In particular, the legal instruments should be sharpened to ensure corporations comply with sustainability standards (McCarthy and Zen, 2010). Moreover, it is imperative for the state to listen to public voices and enforce strong governance on environment protection and biodiversity conservation in the pursuit of collective interest in the environment.

Next, we provide recommendations for third-party private governance, i.e. the RSPO. Our findings imply that the public is dubious about the idea of certifying sustainability practices by the RSPO. We believe it is important to have independent outside experts in the RSPO to monitor the organization. This may greatly increase the credibility of the RSPO and its members to the public (Laurance et al., 2010). Furthermore, the RSPO is advised to include more environmental organizations and experts and allow them more weight in decision-making processes. This solution can perhaps reduce the pro-industry bias in the RSPO and its members (Laurance et al., 2010). In addition, we agree with Laurance and colleagues' potential solution, that the RSPO should take a stronger stand to combat unsustainable practices by complicit corporate members to mitigate detrimental impacts caused by tropical deforestation. Recognized as the barriers to the inclusion of independent smallholders, Brandi et al. (2015) argue that these barriers can undermine the effectiveness of sustainable standards. Therefore, the RSPO should improve access to certification information for independent smallholders. To overcome the hurdle of requisite financial resources, initial costs can be covered by national subsidy schemes or be sponsored by oil palm industry-funded projects (Brandi et al., 2015). Regarding energy, economic and environmental aspects of crop sustainable productions (Nabavi-Pelesaraei, Rafiee, Mohtasebi, Hosseinzadeh-Bandbafha and Chau, 2019a), Nabavi-Pelesaraei et al. (2019a) investigate energy flow, environmental impacts, and profits and costs in the life cycle of converting paddy to white rice. They argue that the adaptive neuro-fuzzy inference system can be an efficient tool to learn and forecast energy management and life cycle assessment during the development of sustainable productions (Nabavi-Pelesaraei, Rafiee, Mohtasebi, Hosseinzadeh-Bandbafha and Chau, 2019b). Hence, in

the near future, we advise the RSPO to undertake and implement an appropriate environmental impact assessment in the life cycle assessment of palm oil production, such as anaerobic treatments of palm oil mill effluent (Yap et al., 2020).

5.3. Limitations and future studies

There are limitations to our study. We believe that to better understand the overall picture of public opinions on palm oil, it is crucial to include social media online posts regarding the health aspects of palm oil products. Future studies could shed some light on the health frame. For example, researchers can explore specific aspects of health issues, such as cardiovascular diseases possibly related to palm oil products consumption, and controversial issues between red palm oil and refined palm oil. The future analysis of scientific studies on health issues could enlighten the public with a more accurate understanding of palm oil.

Schmidt (2010) compares the life cycle assessment of rapeseed oil and palm oil and concludes that palm oil is environmentally preferable to rapeseed oil within ozone depletion, acidification, land use and so forth. It is not clear the impacts of these two kinds of oil crops on global warming and biodiversity (Schmidt, 2010). Our findings show that the public concerns on palm oil are dominated by its environmental impacts. Conversely, palm oil-based biofuel has been accepted as an alternative renewable energy source to replace fossil fuel because fossil fuel releases a great number of greenhouse gases (Hosseini-Fashami et al., 2019; Kaab et al., 2019). Future studies are advised to explore the reasons for palm oil being targeted by social movement campaigns isolated on deforestation. It would be interesting to elucidate and gauge how emotions expressed by social media accounts can effectively influence public opinions.

6. Conclusion

This paper represents the first attempt to apply the Institutional Theory and social movements to understand a new aspect of palm oil and investigate public sentiments in this domain of palm oil and its environmental impacts. This exploratory analysis allows us to look closely at the mechanisms of social media campaigns toward targeted groups. Based on applying text analytics methods, we identify and categorize relevant themes with regard to consumers' perceptions of palm oil in driving tropical deforestation and biodiversity loss, and their solutions to combat environmental destruction. With a large dataset of 4260 online posts, we obtain critical insights on how the public debates over palm oil, such as capitalism, poverty, law and order, consumerism and sustainable supply chain. We propose a predictive model and run SEM predictive modeling in order to examine significant relationships among identified concepts related to consumers' perceptions of palm oil. We believe this study serves as a starting point for future studies on palm oil-related topics. This study offers insights on social media applications bringing an institutional change to policymaking. Corporations and public and private governance agents will need to devise their strategies and policies to proactively respond to compounded external public pressures by using social media. We hope our empirical analysis can inspire researchers to critically explore factors and mechanisms that influence public opinion toward palm oil and sustainable palm oil products.

CRediT authorship contribution statement

Shasha Teng: Data curation, Formal analysis, Writing - original draft. **Kok Wei Khong:** Data curation, Formal analysis, Writing - original draft.

Declaration of competing interest

None.

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Appendix 1. An Overview of the Sampled YouTube Videos

Titles	Links	Number of comments
The Devastating Effects Of The World's Palm Oil Addiction	https://www.youtube.com/watch?v=qO9EqOc6Zg	786
The Problem With Palm Oil!	https://www.youtube.com/watch?v=LSumTLrJzdU	452
How can palm oil be more sustainable? The Roundtable on Sustainable Palm Oil and WWF's role in it	https://www.youtube.com/watch?v=0Lev1mnonUM	45
Harrison Ford Learns How Palm Oil Is Linked to Deforestation	https://www.youtube.com/watch?v=54dmDQsSqrU	74
GREEN a film by Patrick Rouxel	https://www.youtube.com/watch?v=WNgoqBGw4Y	275
Deforestation: Indonesia's Palm Oil Crisis and Orangutans	https://www.youtube.com/watch?v=KkLh5SAG_fE	142
Deforestation in Borneo by BBC's Orangutan Diary	https://www.youtube.com/watch?v=qmRaN5OcQZs	43
A Rare Look at the Secret Life of Orangutans Short Film Showcase	https://www.youtube.com/watch?v=0fts6xEE_E	641

Appendix 2. An Overview of the Reddit Threads

Titles	Links	Number of comments
Norway bans biofuel from palm oil to fight deforestation - The entire European Union has agreed to ban palm oil's use in motor fuels from 2021. If the other countries follow suit, we may have a chance of seeing a greener earth.	https://www.reddit.com/r/Futurology/comments/bvk1rj/norway_bans_biofuel_from_palm_oil_to_fight/	899
One Casualty of the Palm Oil Industry: An Orangutan Mother, Shot 74 Times	https://www.reddit.com/r/news/comments/c7qit8/one_casualty_of_the_palm_oil_industry_an/	357
An area twice the size of the UK has been destroyed for products such as palm oil and soy over the last decade,	https://www.reddit.com/r/worldnews/comments/bz9y0p/an_area_twice_the_size_of_the_uk_has_been/	465

(continued)

Titles	Links	Number of comments
according to analysis by Greenpeace International.		
Viewer outcry as distressed Orangutan attempts to physically fight off bulldozer destroying its habitat for Palm Oil in David Attenboroughs Documentary 'Climate Change: The Facts'	https://www.reddit.com/r/worldnews/comments/bexedq/viewer_outcry_as_distressed_orangutan_attempts_to/	2300
The European Commission has concluded that palm oil cultivation results in excessive deforestation and its use in transport fuel should be phased out.	https://www.reddit.com/r/worldnews/comments/b11w85/the_european_commission_has_concluded_that_palm/	357

References

- Arbuckle, J.L., 2009. Amos 18 User's Guide. Amos Development Corporation, Chicago.
- Austin, K.G., Mosnier, A., Pirker, J., McCallum, I., Fritz, S., Kasibhatla, P.S., 2017. Shifting patterns of oil palm driven deforestation in Indonesia and implications for zero-deforestation commitments. *Land Use Pol.* 69 (1), 41–48.
- Azevedo, A., Alexandre, J., Marvila, M., Castro Xavier, G., Monteiro, S., Pedroti, L., 2020. Technological and environmental comparative of the processing of primary sludge waste from paper industry for mortar. *J. Clean. Prod.* 249 (1), 119336.
- Azevedo, A., Alexandre, J., Pessanha, L., Manhães, R., Brito, J., Marvila, M., 2019. Characterizing the paper industry sludge for environmentally-safe disposal. *Waste Manag.* 95 (1), 43–52.
- Azevedo, A., Alexandre, J., Xavier, G., Pedroti, L., 2018. Recycling paper industry effluent sludge for use in mortars: a sustainability perspective. *J. Clean. Prod.* 192 (1), 335–346.
- Ball, A., Craig, R., 2010. Using neo-institutionalism to advance social and environmental accounting. *Crit. Perspect. Account.* 21 (4), 283–293.
- Benkler, Y., 2006. *The Wealth of Networks*. Yale University Press, London.
- Berry, M.W., Kogan, J., 2010. *Text Mining: Applications and Theory*. John Wiley & Sons, Ltd, Chichester.
- Bicquelet, A., 2017. Using online mining techniques to inform formative evaluations: an analysis of YouTube video comments about chronic pain. *Evaluation* 23 (3), 323–338. <https://doi.org/10.1177/1356389017715719>.
- Brammer, S., Jackson, G., Matten, D., 2012. Corporate social responsibility and institutional theory: new perspectives on private governance. *Soc. Econ. Rev.* 10 (1), 3–28.
- Brandi, C., Cabani, T., Hosang, C., Schirmbeck, S., Westermann, L., Wiese, H., 2015. Sustainability standards for palm oil: challenges for smallholder certification under the RSPO. *J. Environ. Dev.* 24 (3), 292–314.
- Bruton, G.D., Ahlstrom, D., Li, H.-L., 2010. Institutional theory and entrepreneurship: where are we now and where do we need to move in the future? *Enterpren. Theor. Pract.* 34 (1), 421–440.
- Champoux, V., Durgee, J., McGlynn, L., 2012. Corporate Facebook pages: when “fans” attack. *J. Bus. Strat.* 33 (2), 22–30.
- Cercioli, M., Gistri, G., Pace, S., 2019. Legitimacy struggles in palm oil controversies: an institutional perspective. *J. Clean. Prod.* 212 (1), 1117–1131.
- Dauvergne, P., 2017. Is the power of brand-focused activism rising? The case of tropical deforestation. *J. Environ. Dev.* 26 (2), 135–155.
- Davenport, T.H., 2006. Competing on analytics. *Harv. Bus. Rev.* 84 (1), 98–107.
- Davis, G.F., McAdam, D., Scott, W.R., Zald, M.N., 2005. *Social Movements and Organization Theory*. Cambridge University Press, Cambridge.
- Deephouse, D.L., Suchman, M., 2008. Legitimacy in organizational institutionalism. In: Greenwood, R., Oliver, C., Suddaby, R., Sahlin-Andersson, K. (Eds.), *The SAGE Handbook of Organizational Institutionalism*. Sage, Thousand Oaks, pp. 49–77.
- Delmas, M.A., Toffel, M.W., 2008. Organizational responses to environmental demands: opening the black box. *Strat. Manag. J.* 29 (10), 1027–1055.
- DiMaggio, P.J., Powell, W.W., 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *Am. Socio. Rev.* 48 (2), 147–160.
- Gao, Q., Tian, Y., Tu, M., 2015. Exploring factors influencing Chinese user's perceived credibility of health and safety information on weibo. *Comput. Hum. Behav.* 45 (1), 21–31.
- Gaveau, D.L., Pirard, R., Salim, M.A., Tonoto, P., Yaen, H., Parks, S.A., Carmenta, R., 2017. Overlapping land claims limit the use of satellites to monitor No-deforestation commitments and No-burning compliance. *Conserv. Lett.* 10 (2), 257–264.
- Gillespie, P., 2012. The challenges of corporate governance in Indonesian oil palm: opportunities to move beyond legalism? *Asian Stud. Rev.* 36 (2), 247–269.

- Glover, J.L., Champion, D., Daniels, K., Dainty, A., 2014. An Institutional Theory perspective on sustainable practices across the dairy supply chain. *Int. J. Prod. Econ.* 152 (1), 102–111.
- Hirsch, P.M., Lounsbury, M., 1997. Putting the organization back into organization theory: action, change, and the "new" institutionalism. *J. Manag. Inq.* 6 (1), 79–88.
- Hoffman, A.J., 1999. Institutional evolution and change: environmentalism and the U.S. Chemical industry. *Acad. Manag. J.* 42 (4), 351–371.
- Holtbrügge, D., Dögl, C., 2012. How international is corporate environmental responsibility? A literature review. *J. Int. Manag.* 18 (2), 180–195.
- Hospes, O., 2014. Marking the success or end of global multi-stakeholder governance? The rise of national sustainability standards in Indonesia and Brazil for palm oil and soy. *Agric. Hum. Val.* 31 (1), 425–437.
- Hosseini-Fashami, F., Motevali, A., Nabavi-Pelesaraei, A., Hashemi, S., Chau, K.-w., 2019. Energy-Life cycle assessment on applying solar technologies for greenhouse strawberry production. *Renew. Sustain. Energy Rev.* 116 (1), 109411.
- Jennings, P.D., 1995. Ecologically sustainable organizations: an institutional approach. *Acad. Manag. Rev.* 20 (4), 1015–1052.
- Kaib, A., Sharifi, M., Mobli, H., Nabavi-Pelesaraei, A., Chau, K.-w., 2019. Use of optimization techniques for energy use efficiency and environmental life cycle assessment modification in sugarcane production. *Energy* 181 (1), 1298–1320.
- King, B.G., Soule, S.A., 2007. Social movements as extra-institutional entrepreneurs: the effect of protests on stock price returns. *Adm. Sci. Q.* 52 (3), 413–442.
- Langley, D., van den Broek, T., 2010. Exploring social media as a driver of sustainable behaviour: case analysis and policy implications. In: *Internet Politics and Policy Conference 2010*, pp. 1–28 (Oxford).
- Laurance, W.F., Koh, L., Butler, R.A., Sodhi, N., Bradshaw, C.J., Neidel, D., et al., 2010. Improving the performance of the roundtable on sustainable palm oil for nature conservation. *Conserv. Biol.* 24 (2), 377–381.
- Levy, D.L., Egan, D., 2003. A neo-gramscian approach to corporate political strategy: conflict and accommodation in the climate change negotiations. *J. Manag. Stud.* 40 (4), 803–829.
- Lewis, S.P., Heath, N.L., Sornberger, M.J., Arbuthnott, A.E., 2012. Helpful or harmful? An examination of viewers' responses to nonsuicidal self-injury videos on YouTube. *J. Adolesc. Health* 51 (4), 380–385. <https://doi.org/10.1016/j.jadohealth.2012.01.013>.
- Lounsbury, M., 1997. Exploring the institutional tool kit: the rise of recycling in the U.S. Solid waste field. *Am. Behav. Sci.* 40 (4), 465–477.
- Malaszk, P., 2017. Using Text Analysis to Improve the Quality of Scoring Models with SAS® Enterprise Miner™. SAS Institute Inc, Cary.
- McAdam, D., Tarrow, S., Tilly, C., 2001. *Dynamics of Contention*. Cambridge University Press, Cambridge.
- McAfee, A., Brynjolfsson, E., 2012. Big data: the management revolution. *Harv. Bus. Rev.* 90 (10), 60–68.
- McCarthy, J.F., 2012. Certifying in Contested Spaces: private regulation in Indonesian forestry and palm oil. *Third World Q.* 33 (10), 1871–1888.
- McCarthy, J.F., Zen, Z., 2010. Regulating the oil palm boom: assessing the effectiveness of environmental governance approaches to agro-industrial pollution in Indonesia. *Law Pol.* 32 (1), 153–179.
- Meldrum, S., Savarimuthu, B., Licorish, S., Tahir, A., Bosu, M., Jayakaran, P., 2017. Is knee pain information on YouTube videos perceived to be helpful? An analysis of user comments and implications for dissemination on social media. *Digital Health* 3 (1), 1–18. <https://doi.org/10.1177/2055207617698908>.
- Nabavi-Pelesaraei, A., Rafiee, S., Mohtasebi, S., Hosseinzadeh-Bandbafha, H., Chau, K.-w., 2019a. Assessment of optimized pattern in milling factories of rice production based on energy, environmental and economic objectives. *Energy* 169 (1), 1259–1273.
- Nabavi-Pelesaraei, A., Rafiee, S., Mohtasebi, S., Hosseinzadeh-Bandbafha, H., Chau, K.-w., 2019b. Comprehensive model of energy, environmental impacts and economic in rice milling factories by coupling adaptive neuro-fuzzy inference system and life cycle assessment. *J. Clean. Prod.* 217 (1), 742–756.
- Nassirtoussi, A., Aghabozorgi, S., Teh, Y., Ngo, D., 2014. Text mining for market prediction: a systematic review. *Expert Syst. Appl.* 41 (16), 7653–7670.
- Nesadurai, H.E., 2017. New constellations of social power: states transnational private governance of palm oil sustainability in Southeast Asia. *J. Contemp. Asia* 48 (2), 1–26.
- Ong, F., Khong, K., Yeoh, K., Syuhaily, O., Othman, M., 2018. A comparison between structural equation modelling (SEM) and bayesian SEM approaches on in-store behaviour. *Ind. Manag. Data Syst.* 118 (1), 41–64.
- Orsato, R.J., Clegg, S.R., Falcão, H., 2013. The political ecology of palm oil production. *J. Change Manag.* 13 (4), 444–459.
- Padfield, R., Drew, S., Syayuti, K., Page, S., Evers, S., Campos-Arceiz, A., et al., 2016. Landscapes in transition: an analysis of sustainable policy initiatives and emerging corporate commitments in the palm oil industry. *Landsc. Res.* 41 (7), 744–756.
- Richardson, B., 2015. Making a market for sustainability: the commodification of certified palm oil. *New Polit. Econ.* 20 (4), 545–568.
- Ruggeri, A., Samoggia, A., 2017. Twitter communication of agri-food chain actors on palm oil environmental, socio-economic, and health sustainability. *J. Consum. Behav.* 17 (1), 75–93.
- SAS, 2017. SAS® text miner 14.3. September 15), *Reference Help*. Retrieved from <https://documentation.sas.com/?docsetId=tmref&docsetTarget=n1d7r58qug6sefn162cu6cqx0nq4.htm&docsetVersion=14.3&locale=en>.
- Schaefer, A., 2007. Contrasting institutional and performance accounts of environmental management systems: three case studies in the UK water & sewerage industry. *J. Manag. Stud.* 44 (4), 506–535.
- Schleifer, P., 2016. Private governance undermined: India and the roundtable on sustainable palm oil. *Global Environ. Polit.* 16 (1), 38–58.
- Schmidt, J.H., 2010. Comparative life cycle assessment of rapeseed oil and palm oil. *Int. J. Life Cycle Assess.* 15 (2), 183–197.
- Schouten, G., Glasbergen, P., 2011. Creating legitimacy in global private governance: the case of the Roundtable on Sustainable Palm Oil. *Ecol. Econ.* 70 (11), 1891–1899.
- Scott, W.R., 1991. Unpacking institutional arguments. In: DiMaggio, P., Powell, W.W. (Eds.), *The New Institutionalism in Organizational Analysis*. University of Chicago Press, Chicago, pp. 164–182.
- Scott, W.R., 2008. *Institutions and Organizations: Ideas and Interests*, third ed. Sage Publications, Los Angeles, CA.
- Sen, B., Mia, M., Mandal, U., Mondal, S., 2020. Synergistic effect of silica and pure palm oil on the machining performances of Inconel 690: a study for promoting minimum quantity nano doped-green lubricants. *J. Clean. Prod.* 258 (1), 120755.
- Shukla, M., Tiwari, M., 2017. Big-data analytics framework for incorporating smallholders in sustainable palm oil production. *Prod. Plann. Contr.* 28 (16), 1365–1377.
- Streeck, W., Thelen, K., 2005. *Beyond Continuity: Institutional Change in Advanced Political Economies*. Oxford University Press, Oxford.
- Teng, S., Khong, K., Goh, W., Chong, A., 2014. Examining the antecedents of persuasive eWOM messages in social media. *Online Inf. Rev.* 38 (6), 746–768. <https://doi.org/10.1108/OIR-04-2014-0089>.
- Tilly, C., 1978. *From Mobilization to Revolution*. Addison-Wesley, Reading.
- Van Dyke, N., Soule, S.A., Taylor, V., 2005. The targets of social movements: beyond a focus on the state. *Res. Soc. Mov., Conflicts Change* 25 (1), 27–51.
- Von Geibler, J., 2013. Market-based governance for sustainability in value chains: conditions for successful standard setting in the palm oil sector. *J. Clean. Prod.* 56 (1), 39–53.
- Von Rossum, S., 2018. *Public Opinion on Twitter: A Case Study on Palm Oil*. Delft University of Technology, Delft.
- Wagner, M., 2015. The link of environmental and economic performance: drivers and limitations of sustainability integration. *J. Bus. Res.* 68 (6), 1306–1317.
- Westphal, J.D., Gulati, R., Shortell, S.M., 1997. Customization or conformity? An institutional and network perspective on the content and consequences of TQM adoption. *Adm. Sci. Q.* 42 (2), 366–394.
- Woittieza, L.S., van Wijk, M.T., Slingerland, M., van Noordwijk, M., 2017. Yield gaps in oil palm: a quantitative review of contributing factors. *Eur. J. Agron.* 83 (1), 57–77.
- Wood, L.C., Reiniers, T., Srivastava, H.S., 2016. Think exogenous to excel: alternative supply chain data to improve transparency and decisions. *Int. J. Log. Res. Appl.* 20 (5), 426–443.
- Xia, L., 2013. Effects of companies' responses to consumer criticism in social media. *Int. J. Electron. Commer.* 17 (4), 73–99.
- Yap, C., Chan, Y., Loh, S., Vimala, S., Soh, A., Chong, M., et al., 2020. Comparison of different industrial scale palm oil mill effluent anaerobic systems in degradation of organic contaminants and kinetic performance. *J. Clean. Prod.* 262 (1), 121361.
- Zhao, Y., Xu, X., Wang, M., 2019. Predicting overall customer satisfaction: big data evidence from hotel online textual reviews. *Int. J. Hospit. Manag.* 76 (A), 111–121.
- Zucker, L.G., 1987. Institutional theories of organization. *Annu. Rev. Sociol.* 13 (1), 443–464.