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Speaking of Sustainability... The Triple Bottom Line in Firm- and User-Generated Content

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Abstract Sustainability has become a critical concern of many societies worldwide. The need for a more sustainable mode of producing and consuming goods and services while balancing related environmental, social, and economic consequences (i.e., the triple bottom line) is evident. Although research offers insights into many aspects of this necessary transformation, little is known about the extent to which firms and consumers stress environmental, social, and economic sustainability in their communication. This research addresses these questions by conceptualizing the interplay between sustainability-related firm-generated and user-generated content as a signaling phenomenon. In addition, the authors develop a custom dictionary that enables researchers and practitioners to identify and analyze sustainability-related textual data. An illustrative application based on major data sources (corporate websites, Amazon, and YouTube) indicates significant divergence in how firms and consumers communicate about sustainability. Building on this first conceptual and empirical foray into sustainability-related firm-generated and user-generated content, this research outlines open research questions and potential use cases for the provided analytical tool.

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1 Introduction

Sustainability—defined as the production and consumption of “goods and services that meet basic needs and quality of life without jeopardizing the needs of future generations” (OECD 2002, p. 16)—has become a critical concern of many societies worldwide. Severe environmental, social, and economic ramifications of the current *modus operandi* of the global economy are evident. Mass production and consumption significantly contribute to global carbon emissions, accelerating climate change (Ivanova et al. 2016); eroding trust in institutions, such as governmental bodies, challenges efforts to uphold public support of important social causes (OECD 2017); and digitalization and the emergence of the gig economy are transforming many industries, threatening both firms’ long-term viability and citizens’ economic participation (World Economic Forum 2023).

Many governments, firms, and consumers have recognized the signs of the times and have put sustainability on their agendas, business plans, and shopping lists (UNFCCC 2015; European Commission 2021; Nielsen 2024). The propagation of the United Nations’ Sustainable Development Goals, the European Union’s Corporate Sustainability Reporting Directive, and the increased scrutiny from financial analysts underscores the intensified collective efforts to transform current business practices (European Union 2022; Morgan Stanley 2024; PwC 2021; United Nations 2025). As a result, firms have stronger incentives than ever to adopt sustainable business practices that balance the environmental, social, and economic consequences of their operations (Lloret 2016), a notion encapsulated by the term “triple bottom line” (Elkington 1999).

The transformation toward sustainability has become increasingly visible in the marketplace, with a growing number of brands promoting their sustainability efforts and positioning their products as desirable and sustainable choices. A prominent example is Unilever, which has made substantial strategic adjustments to integrate sustainability into its core business operations. Its ‘Sustainable Living Plan’ aims to reduce its environmental impact while generating social benefits (Unilever 2021). Similarly, Patagonia has long been recognized as a leader in sustainability, advocating responsible supply chains, circular economy principles, and environmental activism (McKinsey and Company 2023).

To promote their sustainability efforts, firms rely on *firm-generated content* (FGC), i.e., firm-initiated marketing communication disseminated through official communication channels (Kumar et al. 2016; Lacka et al. 2022). However, consumers also form their attitudes toward brands and products based on information and opinions shared by other consumers online, i.e., through *user-generated content* (UGC) (Tirunillai and Tellis 2012; Tang et al. 2014).

Despite the central role of communication in informing consumers and influencing their purchase behavior (Hoyer and MacInnis 2007), insights into how firms and consumers discuss sustainability are scarce. Current literature primarily focuses

on investor-facing channels, such as corporate reports (e.g., Bingle et al. 2022, Maibaum et al. 2024, Vaupel et al. 2023). Studies focusing on UGC remain scarce and fragmented. For example, Dunn and Harness (2019) examine how consumers perceive sustainability-related UGC; Han et al. (2018) and Leung (2009) investigate what consumer attributes drive content creation and dissemination; and Elgaied-Gambier and Mandler (2021) explore sustainability-related memes as expressions of eco-anxiety and a related coping mechanism.

We contribute to the nascent literature at the intersection of sustainability and FGC/UGC in two major ways. First, we propose a conceptual model of the interplay between sustainability-related FGC and UGC. Adopting a signaling theory perspective (Erdem and Swait 1998, 2004), we describe how firms and consumers engage in a continuous exchange of signals and emphasize the interactive nature of sustainability-related FGC and UGC. Building on this conceptualization, we outline a set of open research questions. Second, we develop a custom dictionary that enables researchers and practitioners to identify and analyze corporate communication and consumer narratives about environmental, social, and economic sustainability.¹ We demonstrate the dictionary's usefulness through an illustrative application based on data from corporate websites, a leading online marketplace (Amazon), and a major social media platform (YouTube). The results reveal a major divergence in how firms and consumers communicate about sustainability.

The remainder of the paper is structured as follows. The next section discusses our conceptual model, followed by related research questions. Then, we present the development and application of the custom dictionary, including first insights. We conclude by discussing the implications of this work, including an overview of potential use cases.

2 Sustainability-Related FGC and UGC as a Signaling Phenomenon

The conceptual framework that guides our investigation is grounded in signaling theory (Erdem and Swait 1998, 2004). Signaling theory, rooted in information economics, posits that markets are characterized by imperfect and asymmetric information (Spence 1974). Consequently, consumers look for signals that convey indirect information about specific market offerings (Erdem and Swait 2004). For example, high prices, strong advertising, wide geographical reach, and generous warranties may signal superior quality (Boulding and Kirmani 1993; Kihlstrom and Riordan 1984; Mandler et al. 2021; Spence 1974). The process of identifying and interpreting these signals is a key part of the customer journey, as consumers engage with different sources of information at different decision-making stages, particularly as they progress from initial awareness to deeper evaluation (Tueanrat et al. 2021).

In this context, FGC and UGC serve as important signals that inform potential customers about the sustainability attributes of a brand and its products. On the one hand, firms might actively signal their stance on sustainability in their consumer-

¹ We provide our dictionary, collected FGC and UGC data, and the R code for its deployment in a public GitHub repository: <https://github.com/nyegoryan/replication-speaking-of-sustainability>.

facing communication (e.g., on their official websites) to strengthen corresponding brand associations and/or highlight specific sustainable features when presenting their products to consumers (e.g., on online marketplaces like Amazon). On the other hand, firms may act opportunistically by portraying themselves as sustainable without actually operating sustainably. Signaling theory provides a useful lens for understanding both phenomena (Connelly et al. 2011). It helps explain how companies communicate their sustainability efforts, particularly in light of the inherent risk of misleading signals (e.g., “greenwashing”). As Connelly et al. (2011) point out, signals can be either authentic—i.e., accurately reflecting a firm’s genuine actions—or opportunistic—i.e., intended to mislead consumers for competitive advantage. In the context of sustainability, this distinction is crucial: Authentic signals represent real efforts toward sustainable practices (e.g., third-party certifications, transparent reporting); whereas opportunistic signals involve false sustainability claims for marketing purposes (e.g., vague or unverifiable environmental claims, selective disclosure of positive impacts while concealing harmful practices).

In terms of UGC, consumers also rely on signals from other consumers, such as product reviews from peers (e.g., Amazon customers) or experts (e.g., influencers on YouTube) (Goldsmith and Horowitz 2006). Consumers tend to perceive such user-provided information as more credible than corporate signals (Cheong and Morrison 2008; Dunn and Harness 2019), despite the prevalence of fake reviews (He et al. 2022). It is also well established that online reviews have a significant impact on measures of firm performance (e.g., Chevalier and Mayzlin 2006; Vana and Lambrecht 2021). This aligns with findings from customer journey research, which emphasize that evaluating claims is not a one-time event but a process requiring multiple interactions across different touchpoints (Tueanrat et al. 2021). Consumers may initially rely on FGC for broad sustainability positioning but often seek verification through UGC before making purchase decisions.

In summary, the cost of signaling plays a key role in determining authenticity for both, firms and consumers. When the cost of sending a signal is low (e.g., vague sustainability claims that are difficult to verify for consumers), the risk of misleading signals increases. Thus, firms often adopt labels, certificates, and detailed product descriptions to reinforce the credibility of their sustainability messaging. However, even these signals vary in terms of credence—some aspects can be validated by consumers (e.g., ingredient lists), while others remain unverifiable, requiring consumers to trust the firm or external certifiers. Consequently, from the consumer’s perspective, evaluating signals comes at a cost, particularly in terms of time and effort. Assessing the credibility of a claim requires research, comparison, and a deeper understanding of sustainability standards. Just like firms use costly signals to enhance their reputation, consumers engage in effortful evaluations as a way of signaling their own informed decision-making. In both cases, the cost associated with signaling serves to enhance the sender’s perceived authenticity—whether it is the firm demonstrating its commitment to sustainability or the consumer demonstrating conscious consumption.

Figure 1 depicts our conceptual model, showing the interactive signaling process between firms and consumers in the context of sustainability-related FGC and UGC. It emphasizes the dynamic feedback loop between firms and consumers, showing

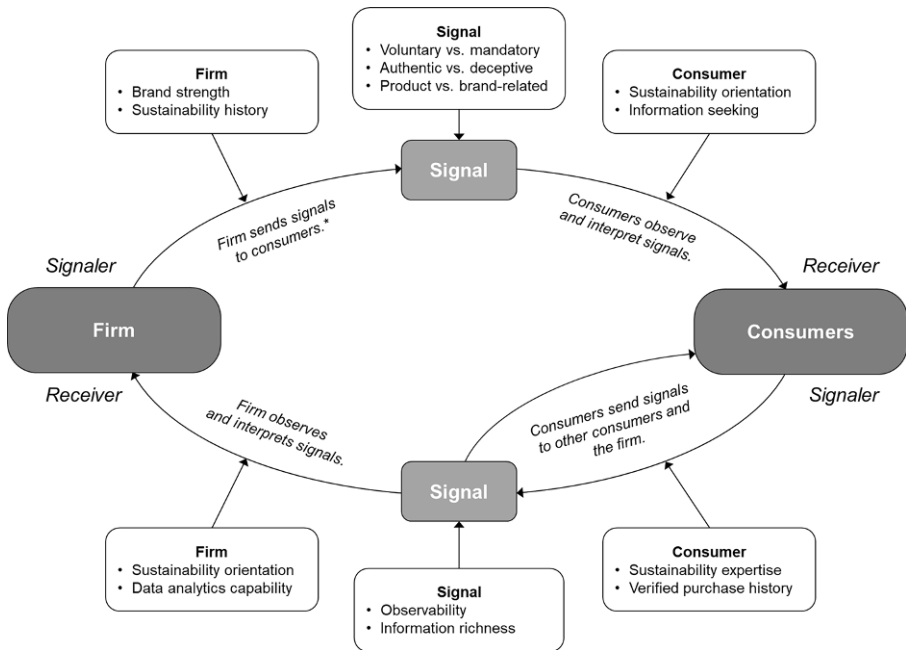


Fig. 1 Sustainability-related FGC and UGC as a signaling phenomenon.

Note: * Signals can also be targeted toward other stakeholders, such as investors and regulators

how both parties alternately act as signalers and receivers, thereby creating a continuous flow of information that influences perceptions and decisions. This perspective guides our following investigation of sustainability-related FGC and UGC. At the heart of the model lies the concept of the signal—the primary mechanism through which sustainability-related information is communicated. Signals are encoded and sent by firms and consumers and then received and decoded by their respective audiences. The effectiveness of this process depends not only on the nature of the signal itself but also on certain characteristics of the firm and consumer involved. By considering both firm-generated and user-generated signals, our framework highlights the dynamic exchange of sustainability-related information between firms and consumers, emphasizing the importance of credibility, observability, and interpretation in the signaling process.

2.1 Firm-Generated Content as a Signal

2.1.1 Firms Send Signals to Consumers

The sustainability-related signals firms send to consumers can take different forms based on their characteristics, shaping how they are perceived and interpreted by consumers. First, signals may be mandatory or voluntary, depending on whether they are driven by regulatory requirements or by a firm's commitment to sustainability beyond legal obligations (Rao and Ursu 2025). Mandatory signals arise from

governmental regulations or industry standards that require a firm to disclose certain environmental or social impact metrics (Balasubramanian and Cole 2002; Christensen et al. 2021). Examples include legally required carbon emissions reporting, compliance with labor laws, and adherence to minimum sustainability certifications (Christensen et al. 2021). In contrast, voluntary signals—such as publishing detailed sustainability reports following agreed standards (Friske et al. 2022), introducing carbon-neutral product lines (Stokes and Turri 2013), or participating in independent certification programs (Darnall et al. 2018; Christensen et al. 2021; Rao and Ursu 2025)—are often seen as indicators of a firm’s genuine dedication to sustainability (Brown et al. 2009; Friske et al. 2022). Second, firm-generated signals can be authentic or deceptive, influencing consumer trust and brand reputation. Authentic signals align with a firm’s actual sustainability practices, backed by verifiable data and transparent communication (Berrone et al. 2017; Christensen et al. 2021). Companies that genuinely integrate sustainability into their core business strategies—such as using responsibly sourced materials, reducing waste across supply chains, or actively engaging in social responsibility initiatives—are more likely to be perceived as credible (Bhattacharya and Sen 2004). Conversely, deceptive signals involve exaggerating, misrepresenting, or selectively disclosing sustainability-related information (Delmas and Burbano 2011; Berrone et al. 2017). When consumers detect deception, it can severely damage trust (e.g., Chen and Chang 2013), leading to skepticism toward not only the specific claim but also the firm’s brand image as a whole (e.g., Parguel et al. 2011).

Third, firm signals vary in focus, being either product- or brand-related (Boulding and Kirmani 1993). Product-related signals provide sustainability information at the level of individual products or services, such as the use of organic ingredients, carbon footprint labels, biodegradable packaging, and fair-trade certifications (Parguel et al. 2011; Atkinson and Rosenthal 2014). These signals help consumers make informed choices by offering tangible, product-specific sustainability attributes (Atkinson and Rosenthal 2014). In contrast, brand-related signals communicate a firm’s general commitment to sustainability (Bhattacharya and Sen 2004). These can include public pledges to achieve net-zero emissions, investments in renewable energy, or company-wide policies on ethical labor practices.

Together, these signal characteristics define how firms communicate their sustainability efforts, how consumers interpret them, and ultimately, how firms shape their credibility in the sustainability landscape.

Consumers Observe and Interpret These Signals Apart from the characteristics of the signal itself, firm-specific factors can also influence the efficacy of the signaling process. First, brand strength may affect how consumers interpret signals. Established brands with a strong market presence are more likely to have their sustainability messages taken seriously, as their reputation serves as an implicit endorsement of credibility (Erdem and Swait 1998, 2004). Second, a firm’s sustainability history affects how its signals are received. Signals from firms with a long-standing commitment to sustainability are more likely to be perceived as genuine, whereas those from firms with a weaker track record may face consumer skepticism.

Finally, the observability and interpretation of signals likely depend on two consumer-specific characteristics. First, consumers with a strong sustainability orientation are more likely to actively seek and prioritize sustainability-related information (White et al. 2019). Second, consumers' information-seeking behavior plays a role in how they validate and compare signals before making purchasing decisions (Bartschat et al. 2022; Tueanrat et al. 2021). Because expertise is positively related to information processing diligence (Alba and Hutchinson 1987), we expect those who engage deeply with the topic of sustainability to be more capable of differentiating between credible and non-credible firm-generated signals.

2.2 User-Generated Content as a Signal

Consumers Send Signals to Other Consumers and Firms Consumers also act as signalers. They send sustainability-related signals, such as product reviews, to other consumers as well as to firms (Goldsmith and Horowitz 2006; Siering et al. 2018). These consumer-generated signals vary in observability and information richness, two critical characteristics influencing their effectiveness (Connelly et al. 2011). Observability refers to the extent to which other consumers and firms can detect and assess a given signal. Highly observable signals, such as publicly shared product reviews, can reach a broader audience and generate a stronger impact, compared to signals that are less publicly visible (Connelly et al. 2011).

Information richness determines how much detail, context, and substantiating evidence a consumer-generated signal contains. Richer signals, such as in-depth product reviews that analyze and compare specific sustainability claims, provide valuable insights that help other consumers and firms make informed decisions (Filieri 2014; Siering et al. 2018). Conversely, vague or ambiguous signals, such as one-line reviews that simply state “eco-friendly” without supporting details, offer limited interpretability and may be less persuasive (Siering et al. 2018).

Consequently, high observability and information richness make consumer-generated signals particularly impactful. When UGC is widely visible and well-substantiated, it becomes more difficult for firms to ignore, as other consumers may rely on it in their decision-making. Hence, firms must carefully monitor and respond to these signals.

Other Consumers and Firms Observe and Interpret These Signals The quality and credibility of consumer-generated signals depend on two factors. First, consumers with a deeper understanding of sustainability practices can generate high-quality signals that inform others about genuine and misleading claims. Their contributions shape how other consumers and firms interpret sustainability-related information (Jiménez and Mendoza 2013; Thomas et al. 2019). Second, a verified purchase history strengthens the credibility of consumer-generated signals. Reviews and feedback from verified buyers tend to be trusted more by fellow consumers and firms seeking authentic insights (He et al. 2020).

Both firms and other consumers observe and interpret these consumer-generated signals. Especially firms rely on their internal capabilities to detect, process, and respond to such signals. Two firm-specific factors effectively influence their ability

to engage with UGC. First, firms with a strong sustainability orientation are more likely to pay attention to relevant consumer-generated signals and integrate this information into their strategies (Eccles et al. 2014). Second, firms with advanced data analytics capabilities can monitor and analyze UGC more effectively, helping them improve sustainability-related strategies and tactics (Kunz et al. 2016). For example, if a firm detects a growing number of consumers questioning the authenticity of its sustainability claims, it can adjust its messaging, increase transparency, or align the underlying sustainability practices with consumer expectations.

2.3 Next Steps in Sustainability-Related UGC and FGC Research

Our conceptual model underscores the theoretical relevance of sustainability-related communication between firms and consumers. While certain aspects, such as participating in independent certification programs (Darnall et al. 2018), are well understood in terms of their effects, many questions remain empirically underexplored. Table 1 provides an overview of open research questions that build upon the prior conceptualization. The topics address the main effects of sustainability-related FGC and UGC on a range of outcomes of interest, as well as the attributes that may moderate their impact. Additionally, measuring and comparing the two are important fields for empirical research.

For example, future research could explore the impact of different triple bottom line dimensions of FGC on the relevance of sustainability in UGC and how firms can convey their messages more effectively. To this end, studies could compare online communication patterns of products marketed as sustainable versus those that do not determine what communication content and style help managers to influence consumer perceptions and behaviors. We also lack an understanding of the extent to which the detected sustainability-related communication in UGC reflects consumers' sincere interest in sustainability. Do they really care about sustainability? And does their online chatter translate into actual (sustainable) purchase behavior? Establishing the (non-)existence of a connection between UGC, personal relevance, and actual consumption would be an important and insightful extension of this research. Finally, the proliferation of generative artificial intelligence (AI) is transforming how people search for information, including brand- and product-related information. It would be valuable to investigate whether AI-generated summaries of reviews accurately reflect sustainability-related information and to what extent consumers rely on this new feature.

Addressing these open empirical research questions will enhance our understanding of the dynamics between FGC and UGC and their roles in shaping corporate communication and consumer behavior regarding sustainability. However, such research requires adequate tools to identify sustainability-related content.

Various methods for the analysis of UGC exist (see Baier et al. 2025 in this issue for a review) and some have been applied to the context of sustainability, such as topic modeling for the detection and categorization of sustainability-related communication (Székely and vom Brocke 2017; Maibaum et al. 2024), transformer-based models for the analysis of sustainability discourse in corporate contexts (e.g., ClimateBERT; Bingler et al. 2022), and Large Language Models (LLMs) for per-

Table 1 Open empirical research questions about sustainability-related FGC/UGC

Topic	Research Questions
<i>Firm-generated content as a signal</i>	
FGC to consumer	What impact does FGC have on sustainability-related UGC?
	How important are the different triple-bottom line dimensions in FGC?
	Are all triple-bottom line dimensions of similar importance for consumers?
	What roles do consumers' sustainability orientation and information-seeking behavior play?
FGC attributes	How do brand strength and a firm's sustainability history influence signaling efficacy?
	How do signal attributes (mandatory vs. voluntary nature, authentic vs. deceptive natures) influence signaling efficacy?
	How does sustainable brand- vs. product-level FGC differ in its impact?
<i>User-generated content as a signal</i>	
UGC to consumer	How does user-generated content influence consumer awareness and behavior toward sustainable products and practices?
	Which social media platforms are most effective for disseminating UGC related to sustainability?
	How does UGC about sustainable vs. non-sustainable products/brands differ?
	How does consumer sustainability expertise impact the creation of sustainability-related UGC?
	Do visible/verified purchase disclaimers matter to other consumers?
UGC to firm	How do observability and information richness of UGC about sustainability influence consumer responses (e.g., sustainability perceptions, willingness to purchase)?
	How can firms leverage UGC to enhance their sustainability initiatives?
	What role do data analytics capabilities play in this context?
	Why do consumers create UGC about the sustainability aspects of products/services?
	Are there differences in UGC about the different dimensions of the triple bottom line?
UGC as a measurement	How do firms react to sustainability-related UGC, and what role does their sustainability orientation play?
	How can sustainability and the triple-bottom line dimensions be measured in FGC and UGC?
	How much does UGC reflect the true importance of and interest in sustainability for the consumers?
	How accurate are AI-generated summaries of reviews and sustainability-related discussions, and to what extent do consumers rely on this new feature of major platforms like Amazon?
<i>Difference in firm-generated and user-generated content</i>	
FGC and UGC comparison	How do FGC and UGC differ in terms of communicating the different dimensions of the triple bottom line?
	What are the underlying causes of differences in FGC and UGC?
	What are the key differences in the impact of FGC and UGC on consumers' sustainability-related perceptions and attitudes?
	How do FGC and UGC complement each other in promoting sustainable practices?
	What are the potential synergies and conflicts between FGC and UGC in sustainability communication?

forming zero-shot classifications without predefined keyword lists (Maibaum et al. 2024).

Particularly dictionary-based techniques have been widely used in sustainability research (e.g., Vaupel et al. 2023; Pencle and Malaescu 2016; Baier et al. 2020). Compared to more recent approaches that involve a black-box problem, dictionary-based text analyses are based on a clearly defined set of keywords that reflect the conceptual domain of the target construct. However, existing dictionaries are (1) limited to corporate contexts, such that the included keywords reflect corporate reporting terminology rather than language consumers would use, and (2) rarely account for all three dimensions of the triple bottom line. Therefore, this research offers a new, specialized dictionary that enables researchers and practitioners to measure environmental, social, and economic sustainability in both FGC and UGC.

3 Dictionary Development and Application

In the following section, we report the development of a specialized dictionary tailored to the concept of sustainability. It intended to be broadly applicable across diverse contexts and product categories. To demonstrate its versatility, we present an illustrative application to unstructured text data from four distinct product categories, collected from multiple FGC sources (corporate websites, Amazon product descriptions) and UGC sources (YouTube videos, Amazon customer reviews).

3.1 Identification of Keywords

In line with the triple bottom line, we consider three dimensions of sustainability: environmental sustainability—the responsible use of resources in products and services by minimizing material and energy consumption, reducing waste and emissions, and prioritizing recyclability and eco-friendly practices—, social sustainability—the alignment of products and services with ethical consumption principles that promote a fair and inclusive society, such as respecting human rights, promoting well-being, and enhancing product accessibility and safety—, and economic sustainability—the long-term economic value that products and services offer through their durability, efficiency, ease of maintenance, repairability, and affordability (Goodland 1995; Elkington 1999; Dyllick and Hockerts 2002). For each dimension, we draw on the sub-themes and factors identified by Menigstu et al. (2024) to generate an initial corpus of keywords. Table 2 provides an overview of these dimensions, and serves as the basis for keyword development. We also include a “global” category for sustainability-related terms (e.g., “sustainable,” “sustainability”) that refer to overarching sustainability claims that are not specific to any one dimension. This approach ensures that general sustainability statements are not lost or misclassified under more narrowly defined categories. This initial corpus of keywords underwent multiple rounds of discussion and refinement, resulting in a list of 105 keywords.

Next, we enriched the pool of keywords with additional synonyms and related terms by providing the LLMs Gemini 1.5 and ChatGPT 3.5 with the definition of the triple bottom line and detailed descriptions of the factors within each sustainability

Table 2 Sustainability framework (adapted from Menigstu et al. 2024)

Dimension	Sub-theme	Factors
Environmental	End-of-life management	Recyclability, reusability, disassemblability, disposability
	Resources	Material consumption, energy consumption/efficiency, packaging material use, recycled material use
	Waste and emissions	Waste, greenhouse gas emissions
	General	Eco-friendliness, green marketing
Social	Functionality and usability	Ergonomics, accessibility
	Social well-being	Product safety, health and well-being, ethical responsibility
Economic	Costs	Material costs, operating costs, energy costs, maintenance costs
	Financial gain	Product price
	Manufacturability	Modularity, upgradeability
	Quality and reliability	Durability/lifespan, product quality, maintainability, reliability, repairability
Global	–	Sustainable, sustainability

dimension (see Web Appendix A). After removing duplicates, terms already present in the initial corpus, and terms deemed unrelated to sustainability, we included 32 additional keywords. Next, we aggregated keywords with identical word stems but varying endings through manual truncation (e.g., “environmental” and “environmentally” were consolidated under “environmental”). This resulted in a corpus of 110 keywords.

As we want to capture both positive and negative discussions of sustainability, most of our keywords can appear in a range of contexts. For example, including “*toxic*” captures any token containing the substring “toxic,” thus encompassing both “nontoxic” and “toxic.” Where such coverage was not feasible, we explicitly included paired positive and negative terms (e.g., “high-quality” vs. “low-quality”) to ensure balanced representation.

3.2 Validation of Keywords

The dictionary was then refined and validated in two steps. First, we surveyed a sample of 250 U.S. consumers via Prolific (mean age=38.9; age range=19–82; 57.2% female) to assess the clarity of all keywords, as ambiguous keywords could generate hits that are unrelated to the construct of interest, thereby increasing Type I errors. Each respondent rated a random subset of 10 keywords in terms of clarity of meaning. Based on these ratings, we excluded 9 out of 110 keywords that were perceived as highly ambiguous (i.e., falling within the top 10th percentile).²

² Two keywords related to economic sustainability (“futureproof”, “transparent price”), two related to social sustainability (“barrier free”, “fairtrade”), and five related to environmental sustainability (“carbon neutral”, “energy star”, “green marketing”, “greenwash”, “low carbon”) were excluded.

Second, we recruited two domain experts who independently rated each keyword's domain relevance on a 7-point scale (1 = "Not linked at all" to 7 = "Very closely linked"). The ratings' correlation of 0.72 indicated high levels of agreement but also revealed 17 keywords that both experts flagged as unrelated (below scale midpoint).³ Consequently, we removed these keywords, resulting in a corpus of 84 validated keywords.

Finally, we considered the possibility of alternative spellings by also including joint and hyphenated variants (e.g., "bio-degradable," "biodegradable," and "bio degradable"), which led to the addition of 100 keywords. Table A1 in Appendix A presents the final dictionary.

3.3 Illustrative Application

Next, we applied our dictionary to FGC and UGC for four distinct product categories—fragrances, scented candles, wireless headphones, and multi-purpose cleaners—chosen to ensure heterogeneity in consumption motives (hedonic vs. utilitarian), visibility of consumption (private vs. public), durability, consumer involvement, and price. For each category, we selected the best-selling products on Amazon (excluding "Featured Products" to reduce bias from paid promotions). While this application illustrates how text analytics can be used for both FGC and UGC, the generalizability of the findings is limited to the sampled products.

For each product, we obtained FGC and UGC from three sources: corporate websites, the leading online marketplace Amazon, and the leading video platform YouTube. For FGC, we focused on content aimed at consumers—mission and sustainability statements, if available, from the brands' corporate websites (see Web Appendix B for an example). We focused solely on on-site textual information, excluding external materials like annual ESG reports, which primarily target other stakeholders, such as investors. Additionally, we collected each product's Amazon description, including text from the "Product Name," product attribute fields, and sections such as "About this item," "From the manufacturer," "From the brand," "Product information," "Product description," "Sustainability features," and "Important information," as well as any tabular comparisons (see Web Appendix B for an example). We also manually transcribed text from images to ensure completeness.

For UGC, we collected customer reviews on Amazon and influencer reviews on YouTube. Using Outscraper, we scraped 100 "Top Reviews" (Amazon's default sort) per product. After excluding non-English reviews, we retained 2029 reviews across the selected products. We then searched for the most-watched English-language YouTube product reviews (by exact product name) and identified 67 videos, for which we obtained the transcripts using Video Summarizer GPT. We used otter.ai to transcribe two review videos for which transcripts were not directly accessible.

³ Of these, 15 related to economic sustainability ("budget friendly", "cost of energy", "costs of energy", "cost to maintain", "costs to maintain", "cost of material", "costs of material", "material cost", "materials cost", "cost of operating", "costs of operating", "operating cost", "overpriced", "pricey", "sturdy"), and two to social sustainability ("childproof", "secure").

An overview of the selected product categories, products, and the related data we collected from different sources is provided in Web Appendix C.

We performed several pre-processing steps for the text analysis. First, we used ChatGPT 3.5 to spell-check⁴ all UGC from Amazon and YouTube, minimizing the impact of misspellings on our results. Next, we removed case sensitivity, numbers, punctuation, symbols, separators (except for hyphens), and common English stop words, retaining only meaningful content (Gentzkow et al. 2019). We then tokenized the text, compounded tokens to preserve multi-token keywords from our dictionary, and applied a simple bag-of-words approach to measure keyword frequency using the R package Quanteda (Benoit et al. 2018). All collected data, the dictionary, and the R code are available in a public GitHub repository (<https://github.com/nyegoryan/replication-speaking-of-sustainability>).

We observe clear differences in the prominence of sustainability-related signals across FGC and UGC channels. Table 3 summarizes these differences by reporting the absolute keyword frequencies and the ratios of each sustainability dimension relative to both the total number of tokens in the text and the total number of sustainability-related keywords. Overall, we find only a small fraction of sustainability signals in both FGC and UGC, but they appear more often in FGC (4.31% on corporate websites and 0.94% in Amazon product descriptions) than in UGC (0.14% on YouTube and 0.33% in Amazon reviews). This pattern also holds within individual product categories (see Appendix B, Fig. B1). We also find a wider range of sustainability-related terms in FGC, especially on corporate websites, which mention 47 unique keywords (e.g., “sustainab*,” “recycle*,” “environmental*,” “emission*,” “health*,” “recyclab*”). In contrast, Amazon product descriptions include only 19 distinct sustainability-related keywords, most frequently “long-lasting,” “health*,” “sustainab*,” and “high-quality” (see Appendix B, Fig. B2).

On corporate websites, environmental sustainability dominates, accounting for 59.28% of all sustainability-related keywords, which may reflect firms’ attempts to appeal to a broad range of stakeholders, including investors. This trend holds across product categories except for multi-purpose cleaners, where social sustainability nearly equals environmental sustainability (see Appendix B, Fig. B1). Economic sustainability is least mentioned (3.84%). However, the emphasis shifts in Amazon product descriptions—FGC aimed directly at consumers—where social and economic sustainability each account for 33.33% of all sustainability-related keywords. Still, the prominence of specific dimensions varies by product category: Social sustainability leads in multi-purpose cleaners (with environmental sustainability close behind), whereas economic sustainability is most prominent in scented candles and wireless headphones (see Appendix B, Fig. B2). Firms may view environmental sustainability as a desirable brand association (which is established in corporate communication afar from the point-of-sale) but not a key product attribute that can

⁴ We implemented this through OpenAI’s API with temperature 0 for more deterministic responses. To ensure that the text is not altered, we prompted ChatGPT to only check for and correct misspellings using the following prompt “You are a professional copy editor. Please only correct spelling mistakes in the following text: [sentence]”.

Table 3 Absolute and relative frequency of sustainability-related keywords across sources

	FGC: Website			FGC: Amazon			UGC: Youtube			UGC: Amazon		
	Abs. freq	Rel. freq. wrt all tokens	Rel. freq. within keywords	Abs. freq	Rel. freq. wrt all tokens	Rel. freq. within keywords	Abs. freq	Rel. freq. wrt all tokens	Rel. freq. within keywords	Abs. freq	Rel. freq. wrt all tokens	Rel. freq. within keywords
Environmental	278	2.56%	59.28%	19	0.20%	21.11%	7	0.02%	15.91%	20	0.03%	8.55%
Social	69	0.63%	14.71%	30	0.31%	33.33%	17	0.05%	38.64%	31	0.04%	13.25%
Economic	18	0.17%	3.84%	30	0.31%	33.33%	20	0.06%	45.45%	181	0.25%	77.35%
Global	104	0.96%	22.17%	11	0.12%	12.22%	0	0.00%	0.00%	2	0.00%	0.85%
Total no. of sustainability keywords	469	4.31%	100.00%	90	0.94%	100.00%	44	0.14%	100.0%	234	0.33%	100.00%
Total no. of tokens	10,869	100.00%		9,537	100.00%		31,814	100.00%		71,239	100.00%	

convince consumers to purchase (relative to economic aspects, such as durability, product quality, and repairability).

In UGC, economic sustainability dominates: It accounts for 77.35% of sustainability-related keywords in Amazon reviews and 45.45% in YouTube reviews. Environmental sustainability is least discussed (8.55% in Amazon reviews and 15.91% in YouTube reviews), indicating a clear contrast with firm-generated content. Social sustainability ranks second (13.25% in Amazon reviews and 38.64% in YouTube reviews). However, this result should be interpreted with caution, as the limited focus of end consumers' communication on environmental sustainability does not necessarily imply a lack of concern. Amazon reviews also contain more frequent and varied sustainability-related terms (234 total mentions at 0.33% of content) compared to YouTube (44 mentions at 0.14% of content; see Table 3). Overall, 30 distinct sustainability-related terms appear in Amazon reviews (e.g., “long-lasting”, “durab*”, “reliab*”, “toxic”) versus 17 in YouTube reviews (e.g., “long-lasting”, “toxic”, “safety”).

Notably, product category differences persist. While economic sustainability generally dominates in Amazon reviews, multi-purpose cleaners prompt a more balanced discussion across economic, social, and environmental dimensions. In YouTube reviews for these products, environmental and social sustainability dominate, likely reflecting the marketing of multi-purpose cleaners as eco-friendly and safe for consumers—factors that heighten the perceived importance of these dimensions (see Appendix B, Fig. B1).

As a robustness check, we also applied GPT models—particularly GPT-4—for zero-shot classification, exploiting their capability to classify text without labeled training data. While labeled datasets exist for corporate reports, they remain scarce for UGC (e.g., customer reviews and social media posts). Although the zero-shot classifier identified more sustainability signals overall, the patterns matched our dictionary-based results (see Appendix B, Table B1).

3.4 Discussion and Limitations

This illustrative application showcases how text analysis can be employed to examine sustainability discourse in both FGC and UGC. Using data from corporate websites, Amazon product descriptions, influencer YouTube reviews, and consumer reviews on Amazon, we shed initial light on how environmental, social, and economic sustainability—the triple bottom line dimensions—are communicated across these channels.

All dimensions of the triple bottom line are present across channels, underscoring the risk of overlooking key sustainability facets by focusing on a narrower view of sustainability, e.g., exclusively on the environmental aspect. We also observe inconsistencies in FGC: Firms may not adopt a fully integrated sustainability approach and instead adjust their emphasis across different channels. Finally, both firms and consumers appear to prioritize concrete economic and communal (social) benefits over more abstract environmental considerations in purchase-related contexts, as reflected in product descriptions and reviews.

Several limitations warrant caution. First, we analyzed a small set of product categories and products, which limits generalizability. Second, like any dictionary-based approach, our method faces the challenge of ensuring complete coverage of relevant keywords. Because we aimed for versatility, we kept our dictionary at a broad level of abstraction. Future research might extend it with context-specific keywords (e.g., ingredients tied to sustainability). Third, dictionary-based methods also involve the risk of not fully accounting for novel or evolving terminology. Thus, our findings are likely conservative.

Finally, GPT models for zero-shot classification show promise; however, they still function as “black boxes,” limiting transparency. Without prelabeled data from consumer-facing channels, it is not possible to fully validate this approach. Moreover, zero-shot performance depends on the underlying model’s training, which may introduce bias or inaccuracies if particular topics or demographics are underrepresented in the training data.

4 Managerial Implications

Our findings provide first valuable insights into how sustainability is communicated across different channels, highlighting notable differences between FGC and UGC. The empirical application further demonstrates how our specialized dictionary can uncover such differences, enabling firms to better track and understand their sustainability narrative.

Table 4 presents practical use cases, providing a clear roadmap for firms to effectively incorporate both FGC and UGC sources to inform critical aspects of sustainability management—from tracking consumer perceptions and detecting sustainability credence to forecasting market trends and managing brand reputation. By systematically comparing these two types of data, businesses can identify discrepancies between their sustainability claims (FGC) and consumer feedback (UGC)—potential gaps in credibility that highlight where communication strategies may need refinement. In addition, firms can assess the effectiveness of their sustainability initiatives and enhance transparency. Managers can also harness UGC to identify salient sustainability themes, such as locally sourced goods or zero-waste practices, and align these insights with the firm’s broader sustainability agenda to create more impactful messaging for their target audience.

Overall, an integrated framework that combines insights from FGC and UGC equips firms to make data-driven decisions that foster trust and deepen stakeholder engagement. By leveraging these complementary types of data, firms can refine their marketing communication, better align their sustainability efforts with consumer values, and strengthen their position as responsible brands. Embracing both FGC and UGC as complementary content in a structured, analytical manner ultimately provides firms with a pathway to greater authenticity, accountability, and strategic foresight in the evolving sustainability landscape.

Table 4 FGC and UGC use cases for corporate sustainability insights

Categories	FGC	UGC
Consumer perception & brand reputation	Compare UGC sentiment with FGC (e.g., sustainability claims on websites or in product descriptions) to detect and address misinformation or inconsistencies before they damage brand credibility.	Analyze brand-specific consumer sentiment in UGC to assess public perception of the firm's sustainability efforts.
Sustainability product credibility	Compare product-specific UGC with firm-generated sustainability information to assess alignment with stakeholder expectations and identify and address potential gaps, ambiguities, or overstatement.	Analyze sustainability-related, product-specific UGC to assess real-world credibility of sustainability statements (discrepancies between a firm's sustainability claims and customer experiences).
Product evaluation & improvement	Analyze and compare firms' product descriptions and sustainability information with UGC to ensure accuracy and identify opportunities for product improvement.	Analyze UGC to extract product-specific feedback (e.g., durability, recyclability) based on real-world consumer experience.
Marketing communication strategy	Compare these insights with a firm's current sustainability strategies to craft more targeted messages that resonate more effectively with consumers.	Analyze UGC to identify sustainability aspects that matter most to consumers (e.g., cruelty-free, locally made, or zero-waste).
Market trend monitoring	Align emerging sustainability trends with the firm's product portfolio to guide strategic adjustments and drive innovation.	Analyze UGC to identify evolving consumer preferences for sustainable products (e.g., plant-based diets, or zero-waste packaging).

5 Conclusion

This paper examines how firms and consumers communicate about sustainability by investigating the interplay between FGC and UGC, adopting a triple bottom line perspective. We propose and illustrate a conceptual model grounded in signaling theory, showing how firms and consumers alternately function as both senders and receivers of sustainability-related information. Building on this model, we outline a comprehensive set of open research questions (see Table 1) that emphasize the need for further empirical exploration of how sustainability-oriented FGC and UGC are conveyed and interpreted in modern marketplaces.

To support such inquiries, we introduce a specialized dictionary that captures the triple bottom line across various contexts, and allows researchers and practitioners to systematically identify and analyze sustainability signals in both FGC and UGC. Our illustrative application, based on data from corporate websites, Amazon, and YouTube, provides initial insights into notable differences in how firms and consumers address sustainability. It also highlights the importance of adopting a broad, triple bottom line perspective, as narrower definitions risk overlooking essential sustainability themes. In particular, the economic dimension of sustainability—found to be the most prominent topic in UGC in our illustrative application—should not be dismissed, as doing so may result in underestimating consumer interest.

With our dictionary and a summary of practical use cases, firms are better equipped to make data-driven decisions and refine their sustainability strategies and communication. Researchers can likewise tailor or expand the dictionary for specialized investigations, from product-level inquiries to broader industry-wide analyses of sustainability communication.

Overall, our findings demonstrate the importance of continued research into the framing, interpretation, and impact of sustainability messages across diverse communication channels. A deeper understanding of these processes can help organizations more closely align their practices with stakeholder values and empower consumers to make informed choices. The proposed conceptual model, the specialized dictionary, and related empirical insights aim to foster more data-driven research on sustainability communication and promote increased transparency and alignment among firms, consumers, and other stakeholders.

6 Appendix

6.1 Appendix A

Table A1 Dictionary

Keyword	Alternative spelling
<i>Environmental Dimension</i>	
Bio degradab*	(bio-degradab*, biodegradab*)
Carbon emission*	(carbon-emission*, carbonemission*)
Carbon footprint	(carbon-footprint, carbonfootprint)
Carbon re*	(carbon-re*, carbonre*)
Carbon zero	(carbon-zero, carbonzero)
Chemical free	(chemical-free, chemicalfree)
Climate	–
co2	–
Disassembl*	–
Disposab*	–
Easy to dispose	(easy-to-dispose, easytodispose)
Eco conscious*	(eco-conscious*, ecoconscious*)
Eco friendly*	(eco-friendly*, ecofriendly*)
Electricity consumption	(electricity-consumption, electricityconsumption)
Electricity use*	(electricity-use*, electricityuse*)
Emission*	–
Energy consumption	(energy-consumption, energyconsumption)
Energy efficien*	(energy-efficien*, energyefficien*)
Energy saving*	(energy-saving*, energysaving*)
Energy use*	(energy-use*, energyuse*)
Environment protecting	(environment-protecting, environmentprotecting)
Environmental*	–
Excessive packag*	(excessive-packag*, excessivepackag*)
Fewer chemicals	(fewer-chemicals, fewerchemicals)
Fewer waste	(fewer-waste, fewerwaste)
Ghg	–
Green product*	(green-product*, greenproduct*)
Greenhouse gas*	(greenhouse-gas*, greenhousegas*)
Less chemical*	(less-chemical*, lesschemical*)
Less waste	(less-waste, lesswaste)
Low waste	(low-waste, lowwaste)
Minimal packag*	(minimal-packag*, minimalpackag*)
Multi-use	–
Plastic packag*	(plastic-packag*, plasticpackag*)
Power consumption	(power-consumption, powerconsumption)
Re-purposable	–
Recyclab*	–
Recyclable packag*	(recyclable-packag*, recyclablepackag*)

Table A1 (Continued)

Keyword	Alternative spelling
Recycle*	–
Recycled material*	(recycled-material*, recycledmaterial*)
Recycled packag*	(recycled-packag*, recycledpackag*)
Refurb*	–
Renewable energ*	(renewable-energ*, renewableenerg*)
Repurposable	–
Resource efficien*	(resource-efficien*, resourceefficien*)
Reusab*	–
<i>Keyword</i>	<i>(Alternative spelling)</i>
Reuse	–
Saves energy	(saves-energy, savesenergy)
Second hand	(second-hand, secondhand)
Single use	(single-use, singleuse)
Throwaway	–
Waste reduc*	(waste-reduc*, wastereduc*)
Zero carbon	(zero-carbon, zerocarbon)
Zero waste	(zero-waste, zerowaste)
<i>Social Dimension</i>	
ethic	–
harmful chemical	(*harmful-chemical*, *harmfulchemical*)
hazard	–
toxic	–
Accessib*	–
Ergonomic*	–
Health*	–
Non profit	(non-profit, nonprofit)
Safe to operate	(safe-to-operate, safetooperate)
Safe to use	(safe-to-use, safetouse)
Safety	–
Well being	(well-being, wellbeing)
<i>Economic Dimension</i>	
Built to last	(built-to-last, builttolast)
Durab*	–
Energy cost*	(energy-cost*, energycost*)
Good value	(good-value, goodvalue)
High-quality	–
Life-span	(lifespan)
Long lasting	(long-lasting, longlasting)
Low-quality	–
Maintain*	–
Maintenance	–
Maintenance cost*	(maintenance-cost*, maintenancencost*)
Modular*	–

Table A1 (Continued)

Keyword	Alternative spelling
Price transparency	(price-transparency, pricetransparency)
Reliab*	–
Repair*	–
Upgradeab*	–
Value for money	(value-for-money, valueformoney)
<i>Global Dimension</i>	
Sustainab*	–

The asterisk (*) is a truncation symbol to capture multiple word variations

6.2 Appendix B

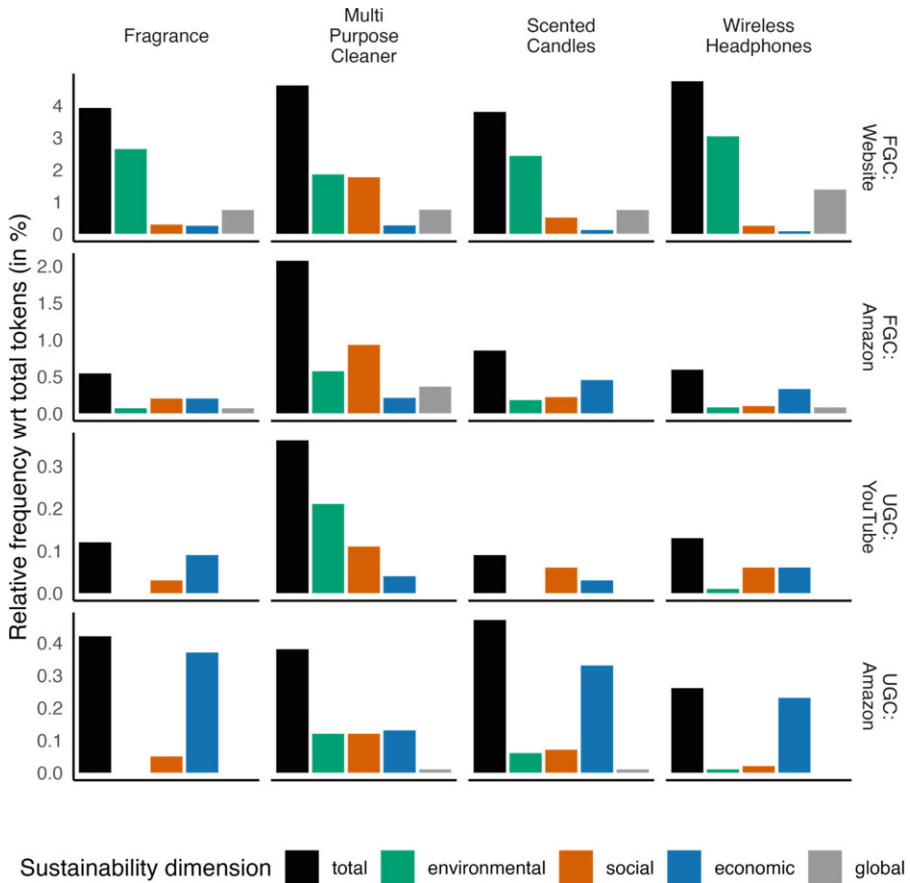
In the following appendix, we present additional findings from our illustrative application (Section 3.3) and from the robustness check using zero-shot classification. Fig. B1 compares the relative frequency of each sustainability dimension with respect to the total number of tokens in text across different product categories. In this figure, the black bar indicates the overall measure (aggregated across all sustainability dimensions), while the colored boxes represent dimension-specific measures.

Fig. B2 displays a word cloud of the most frequent dictionary keywords drawn from four content sources—FGC (corporate websites and Amazon product descriptions) and UGC (influencer YouTube videos and Amazon consumer reviews). The four sustainability dimensions (environmental, social, economic, and global) are distinguished by color. Only keywords appearing more than three times are included, and their size corresponds to their absolute frequency across product categories.

As a robustness check, we used GPT-4 in a zero-shot classification setting. Specifically, we prompted GPT-4 three separate times—once each for environmental, social, and economic sustainability—by supplying the definition of the relevant sustainability dimension (see Section 3.1). For efficiency, each of the three prompts was run on a batch of 20 sentences. Table B1 presents the comparative results between the zero-shot classifier and our dictionary-based approach. In this table, we report the relative frequency of identified sustainability-related signals for each dimension with respect to (i) all meaningful tokens in the text (excluding stop words, punctuation, etc.) and (ii) all identified sustainability-related signals. For consistency, we recalculated the second measure in our dictionary-based approach to exclude the global dimension, since it was not included in the zero-shot classification.

6.2.1 Prompt

You are a text classifier classifying firm- and user-generated content in being related or unrelated to environmental sustainability for a research paper, based on Triple Bottom Line (TBL) definition of sustainability. Sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs.



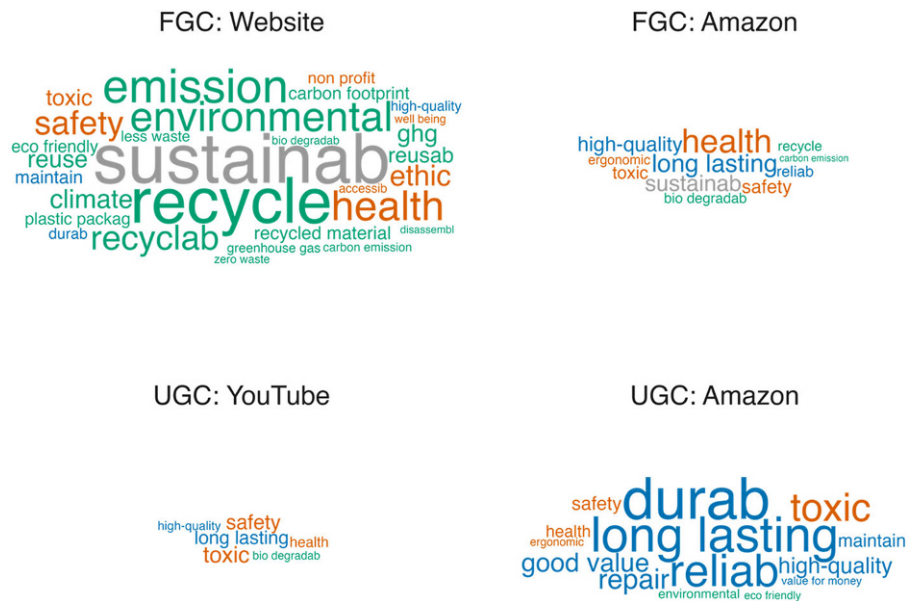
Note: Relative frequencies are computed by dividing the total number of sustainability keywords by number of tokens in text for a specific product category and source.

Fig. B1 Relative frequency of sustainability dimension in each product category.

Note: Relative frequencies are computed by dividing the total number of sustainability keywords by number of tokens in text for a specific product category and source

[For environmental sustainability prompt] Environmental Sustainability refers to the responsible use of resources in products and services by minimizing material and energy consumption, reducing waste and emissions, and prioritizing recyclability and eco-friendly practices. Identify whether environmental sustainability is mentioned in each sentence in a:

[For social sustainability prompt] Social Sustainability refers to products and services' alignment with ethical consumption principles that promote a fair and inclusive society, such as respecting human rights, promoting well-being, and enhancing product accessibility and safety. Identify whether social sustainability is mentioned in each sentence in a:

**Fig. B2** Frequency of unique terms in FGC and UGC across different channels**Table B1** Comparison of zero-shot and dictionary-based approaches

	Dictionary-based		Zero-shot	
	Rel. freq. wrt all tokens	Rel. freq. within keywords	Rel. freq. wrt all tokens	Rel. freq. within keywords
<i>FGC: Website</i>				
Environmental	2.56%	76.16%	3.69%	44.85%
Social	0.63%	18.90%	2.70%	32.77%
Economic	0.17%	4.93%	1.84%	22.37%
Total	3.36%	100.00%	8.23%	100.00%
<i>FGC: Amazon</i>				
Environmental	0.20%	24.05%	0.72%	28.16%
Social	0.31%	37.97%	0.65%	25.31%
Economic	0.31%	37.97%	1.20%	46.53%
Total	0.82%	100.00%	2.57%	100.00%
<i>UGC: YouTube</i>				
Environmental	0.02%	15.91%	0.09%	7.45%
Social	0.05%	38.64%	0.14%	12.23%
Economic	0.06%	45.45%	0.95%	80.32%
Total	0.13%	100.00%	1.18%	100.00%
<i>UGC: Amazon</i>				
Environmental	0.03%	8.62%	0.18%	6.07%
Social	0.04%	13.36%	0.18%	6.12%
Economic	0.25%	78.02%	2.60%	87.80%
Total	0.32%	100.00%	2.96%	100.00%

[For economic sustainability prompt] Economic Sustainability refers to the economic long-term value that products and services offer through their durability, efficiency, ease of maintenance, repairability, and affordability. Identify whether economic sustainability is mentioned in each sentence in a:

a) positive way, b) negative way, c) neither (if unrelated to). Format your response as follows: 1. [a, b, or c], 2. [a, b, or c], etc.

Classify each of the following sentences according to the given instructions:

- 1. [sentence]
- 2. [sentence]
- ...
- 20. [sentence]

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Conflict of interest J. Blits, N. Yegoryan, T. Mandler and A.B. Burmester declare that they have no competing interests.

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