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Analyzing Digital Green Brand Image of Green Hotels in Bali: A Social Network Analysis Approach on the X platform

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ABSTRACT

The rapid growth of sustainable tourism has forced the hospitality industry in Bali to strengthen its "Green Brand Image" in the digital landscape. However, there is often a gap between a hotel's sustainability claims and public perception on social media. This study aims to analyze the digital green brand image of green hotels in Bali by mapping the structure of online conversations on X (Twitter). This study uses a Social Network Analysis (SNA) approach, with data collected through crawling techniques using specific keywords. The data is processed and visualized using Gephi software to identify key actors, influential nodes, and communication clusters. The findings of this study provide strategic insights for the tourism industry, particularly the hospitality industry in Bali, to evaluate their digital positioning, identify key opinion leaders for collaboration, and bridge the gap between sustainability initiatives and consumer perceptions. This study contributes to management literature by demonstrating the use of SNA as a tool for monitoring digital brand equity in the sustainable tourism sector.

Keywords: *Green Brand Image, Green Hotels, Bali Tourism, Social Network Analysis, Gephi, X (Twitter)*

1. INTRODUCTION

The global tourism industry is currently undergoing a major transformation toward sustainable practices, with the hospitality sector emerging as a primary contributor. In Indonesia, Bali remains the epicenter for green hotel growth, a position strengthened by initiatives such as the Green Hotel Award organized by the Ministry of Tourism and Creative Economy [1]. Industry data indicate that investment trends in eco-friendly properties are rising in tandem with shifting consumer preferences; the latest Sustainable Travel Report notes that over 70% of global travelers prefer staying in accommodations that hold sustainability certifications [2]. However, this growth faces significant challenges in the form of public skepticism toward environmental sustainability claims, which are often interpreted as mere marketing strategies devoid of substantive implementation [3]

The digital communication paradigm shift has transformed hotel reputation from unidirectional corporate messaging to collective audience narrative construction. In this context, the X platform serves as a critical arena for Digital Green Brand Image formation, where user interaction dynamics can either reinforce or distort sustainability signals emitted by hotels. According to [4], the quality of green information disseminated through digital networks significantly influences consumer trust (green trust). Unfortunately, many hotels fail to comprehend their digital interaction structures, unable to distinguish whether communication reaches audiences organically or circulates within limited echo chambers

Various studies on green marketing have developed rapidly; however, the current literature still reveals a significant gap in explaining the mechanisms through which sustainability information is disseminated from a social network perspective within the tourism sector, particularly in the hospitality industry. Most previous studies continue to rely on conventional survey-based instruments that tend to capture static perceptions. In contrast, audience perceptions in social media environments exhibit far more complex and dynamic characteristics [5]. This situation highlights the urgency of mapping information authority and the patterns through which green tourism narratives spread, as well as identifying which actors exert dominant influence in shaping the public's perception of sustainable brand image.

This study aims to analyze the network structure and dynamics of Digital Green Brand Image formation among Bali hotels using Social Network Analysis (SNA) methodology. Through examination of digital data spanning January-December 2025, the research seeks to uncover actor interconnectivity patterns and the effectiveness of environmental narratives in shaping

public discourse. Findings will contribute to digital marketing management literature while providing actionable strategic guidance for Bali hospitality practitioners to optimize transparent, data-driven sustainability communication.

2. LITERATURE REVIEW

Signaling Theory

Signaling Theory constitutes a foundational theoretical framework in this study, drawing primarily from [6]. The theory addresses information asymmetry between two parties, where in management contexts, organizations (signalers) possess superior knowledge about product quality or corporate goodwill that remains unknown to stakeholders (receivers). To mitigate audience skepticism (particularly within digital environments rife with greenwashing risks) firms must transmit credible signals. [6] emphasizes that signal effectiveness hinges critically on signaling costs, rendering imitation prohibitively expensive for low-quality actors. In the hospitality industry, third-party awards, sustainability certifications, and tangible environmental actions function as high-quality signals that convincingly authenticate hotels' "green" claims, distinguishing genuine sustainability commitments from superficial marketing tactics.

Strategic Green Marketing and Green Brand Image

Green marketing transcends promotional tactics, constituting a strategic corporate orientation. [7] define Strategic Green Marketing Orientation as a firm's commitment to systematically integrate environmental considerations across all marketing strategy dimensions to deliver sustainable customer value. This strategic implementation aims to cultivate Green Brand Image that consumers' holistic perception of a brand's ecological commitment. [7] further posit that robust green brand image serves as the primary conduit transforming consumer green intentions into actual sustainable consumption behavior. On social media platforms, this image manifests through distinctive interaction patterns and user-generated narratives surrounding hotel environmental policies, creating digital authenticity markers that distinguish genuine sustainability from superficial greenwashing claims..

Social Network Analysis (SNA)

Social Network Analysis (SNA) constitutes a robust research methodology that systematically explores social phenomena within Social Network Theory through the mapping and quantitative analysis of relational patterns [8]. Leveraging graph theory, SNA operationalizes interactions between actors (nodes) and relationships (edges) via network parameters including degree centrality, modularity, betweenness centrality, and clustering coefficient to systematically reveal underlying network structural dynamics [9]. This methodological approach enables identification of information gatekeepers, structural equivalence, and diffusion pathways, providing empirical rigor to examine complex relational configurations that traditional statistical methods cannot capture.

3. METHOD

This study employs a quantitative exploratory approach utilizing Social Network Analysis (SNA) methodology to examine Digital Green Brand Image formation within Bali's green hotel industry. Data were collected from the X (Twitter) platform spanning January–December 2025 through purposive sampling employing Boolean Search techniques: ("Green Hotel" OR "Eco Resort" OR "Sustainable Stay" OR "Eco Tourism") AND "Bali" via Python Google Colab. The sample comprised 119 tweets generating a complex network of 543 nodes and 685 edges. Network structure analysis was conducted using Gephi 0.10.1 with the Fruchterman-Reingold algorithm, computing centrality metrics (degree, betweenness, eigenvector) alongside macro-level network measures (graph density, average path length, modularity). Complementary content analysis employed Pandas and Matplotlib to identify highest-engagement content categories.

4. FINDINGS AND DISCUSSION

1. Findings

This study analyzed 119 tweets collected from the X (Twitter) platform through Python-based data scraping employing Boolean Search methodology with keywords: ("Green Hotel" OR "Eco Resort" OR "Sustainable Stay" OR "Eco Tourism") AND "Bali". Subsequent data processing generated an interaction network representing Green Brand Image conversations within Bali's hospitality industry, comprising 543 nodes (user accounts) and 685 edges (retweet, mention, and reply interactions). Network visualization utilized Gephi with Fruchterman-Reingold layout, as presented in Figure 1..

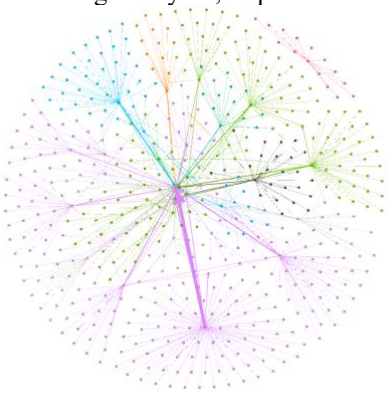


Figure 1. SNA Visualization of the Digital Brand Image of Green Hotel Bali

Figure 1 reveals a pronounced star-like network structure characterized by one dominant central node surrounded by numerous peripheral satellite nodes exhibiting color gradation. This star-shaped configuration indicates that Digital Green Brand Image

formation in Bali does not disseminate evenly but manifests centralized control dominated by a single primary entity exhibiting highest hub centrality. From a marketing management perspective, this phenomenon demonstrates robust opinion leadership, wherein environmental hotel narratives are predominantly shaped by one key actor possessing superior brand authority.

Table 1. Key Social Media Metrics

Metrik	Nilai
Nodes	543
Edges	685
Average Total Degree	2.52
Average Weighted Deg.	2.394
Network Diameter	3
Average Path Length	1.189
Graph Density	0.0046

Table 1 reveals distinctive network characteristics emblematic of Bali's green hospitality digital ecosystem. Comprising 543 nodes (actors) and 685 edges (connections), the network exhibits niche-specific focus..

1. **Information Flow Efficiency (Small-World Property)**
   Average Path Length of 1.189 and Network Diameter of 3 demonstrate exceptionally short information dissemination pathways. Values approaching 1 indicate most actors connect directly or through single intermediaries to the central information hub. Managerially, positive narratives reach audiences instantaneously with minimal message distortion.
2. **Organic Structure (Sparse Network)**
   Graph Density of 0.0046 and Average Total Degree of 2.52 confirm sparse network characteristics. Low density in social media datasets typically signifies authenticity, distinguishing organic interactions from bot manipulation (typically exhibiting high-density cliques). Average Weighted Degree of 2.394 further validates substantive interaction quality between central accounts and audiences.
3. **Authority Concentration (Hub Centrality)**
   Network Diameter 3 confirms robust hub centrality structure. Digital Green Brand Image perception control concentrates among select dominant actors (visually represented by star-like patterns). These primary actors function as information gatekeepers, mediating message flows across 543 network entities.

From a managerial perspective, this phenomenon demonstrates that public opinion formation efficacy in digital markets depends not on random information diffusion volume, but on strategic mastery of central nodes. These findings underscore the urgency for hotel managers to implement Third-Party Validation strategies, either through strategic collaborations with dominant central actors or by positioning their brands as primary information authority hubs via credible sustainability credentials such as industry certifications and recognized awards. By controlling these pivotal network positions, hotels can efficiently and credibly dominate green narratives within Bali's digital tourism ecosystem.

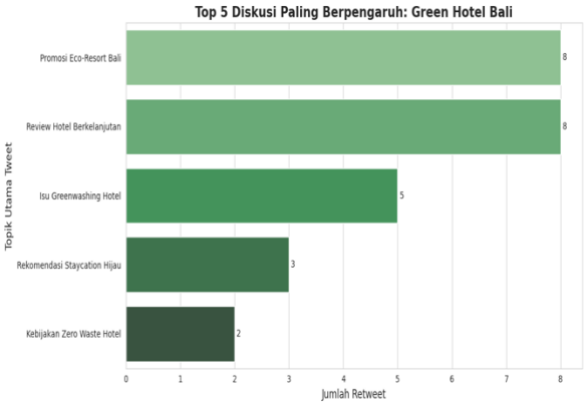


Figure 2 Top 5 discussions by number of retweets

In addition to Gephi visualization, researchers utilized Python analysis outputs from Google Colab ranking top discussion topics (by retweet volume) related to "Green Hotel Bali" from X (Twitter) scraping data. Analysis of the top 5 most influential discussions (Figure 2) reveals that Digital Green Brand Image formation in Bali is strongly driven by experience-driven content. Retweet dominance in promotional and review categories (accounting for 25-30% of total 119-tweet engagement) demonstrates that green brand credibility emerges not merely from unilateral corporate claims, but through organic social validation. However, low audience engagement on operational issues like zero-waste policies indicates fragmented green communication strategies focused on aesthetics, necessitating strengthened educational narratives to align audience perceptions with substantive sustainability practices.

2. Discussion

1. Centralized Narrative Mechanisms and Digital Information Efficiency

Research visualization reveals a star-like network structure with an Average Path Length of 1.189, indicating exceptional information distribution efficiency within Bali's green hospitality digital ecosystem. The findings indicate that sustainability narratives within Bali's digital ecosystem are not distributed evenly across all actors but are instead concentrated around a limited number of highly central nodes. This structural pattern suggest that digital green discourse operates through robust Hub Centrality mechanisms, where a select group of dominant accounts functions as primary information hubs. These actors play a crucial role as information gatekeepers, effectively shaping the direction and visibility of the discourse while determining whether a hotel's 'green' image gains public credibility or is perceived as mere marketing rhetoric.

From the perspective of Signaling Theory, this pattern highlights the critical role of visibility and centrality in reducing information asymmetry between green hotels and potential consumers [6]. In the hospitality sector, where customers cannot directly observe operational sustainability practices, digital communication serves as a primary signaling mechanism. Actors with high centrality effectively

function as "signal amplifiers," enhancing both the reach and perceived credibility of environmental claims.

Furthermore, the dominance of central nodes indicates that sustainability messages supported by credible and verifiable elements (such as references to Tri Hita Karana Awards or documented conservation initiatives) are more likely to gain traction within the network. These signals can be interpreted as costly and difficult to imitate, which is essential for building trust in environments characterized by increasing greenwashing concerns [10]. This finding is consistent with prior studies suggesting that firms must deliver signals aligned with consumer expectations to establish credibility [11].

From a green marketing perspective, this suggests that firms must strategically position themselves within digital communication networks to maximize both reach and credibility. The effectiveness of sustainability messaging depends not only on content but also on the actor's position within the network [12]. Therefore, green hotels that successfully occupy central positions are more likely to influence public perception and strengthen their digital green brand image.

2. Network Authenticity and Social Brand Validation

The network density value of 0.0046 classifies the structure as sparse, which, within Social Network Analysis (SNA) frameworks, serves as a robust indicator of organic interaction patterns. This low density confirms that discussions surrounding green hotels in Bali stem from genuine user interest rather than coordinated bot manipulation, which typically exhibits densities exceeding 0.1 [13]. In this sense, the sparse structure enhances the authenticity of the network and strengthens the credibility of the sustainability discourse. The Average Weighted Degree of 2.394 further indicates that interactions between actors are substantive, reflecting meaningful engagement between central hotel accounts and their audiences rather than superficial connectivity.

From the perspective of Signaling Theory, these findings imply that not all signals carry equal weight. Signals emerging from authentic, experience-based interactions—such as third-party reviews and organic mentions—are more likely to be perceived as credible than direct promotional messages [6]. This is evidenced by the dominance of retweets within the "Eco Resort Promotion" and "Hotel Review" categories, which account for 25-30% of total engagement. Such patterns align with the principles of Customer Engagement Theory, where experience-based eWOM outperforms traditional advertising in building brand trust [14].

However, the low audience engagement observed in "Zero Waste" discussions (only 2 retweets) reveals a critical communication gap. This suggests that audiences prioritize eco-luxury experience narratives over technical sustainability practices. This finding is consistent with prior studies indicating that in the Bali context, visual and experiential evidence often builds greater trust than formal operational certifications [15]. Consequently, green hotels must move beyond one-way promotional strategies and actively foster participatory engagement to bridge the gap between technical operational sustainability and public perception.

3. Perception Fragmentation and Sustainability Literacy Challenges

A key finding of this study is the existence of a significant perception gap in the formation of Digital Green Brand Image. This is evidenced by the minimal engagement observed in "Zero Waste Policy" discussions (only 2 retweets), in contrast to "Eco Resort Promotion" content, which garnered 8 retweets. This disparity indicates clear perception fragmentation, where audiences prioritize visually appealing and experience-oriented aspects (such as eco-luxury amenities) over fundamental operational practices like waste management. This reflects a broader issue in which public understanding of sustainability is shaped more by symbolic representations than by substantive environmental performance.

From the perspective of Signaling Theory, this suggests that visually attractive and easily interpretable signals are more effective in influencing consumer perception than technical sustainability signals. As documented by Wahyuni et al. (2024), many five-star hotels in Bali exhibit a paradoxical condition where strong operational implementation (the Palemahan aspect of Tri Hita Karana) is not matched by adequate public disclosure, resulting in a fragmented brand image [16]. This misalignment between actual sustainability efforts and perceived brand value creates long-term reputational risks, particularly amid increasing skepticism regarding greenwashing in the Bali tourism sector [17].

To bridge this communication gap, green hotels must adopt an educational narrative transformation. Translating technical sustainability practices into engaging storytelling is essential to enhance audience understanding without reducing engagement. This aligns with findings from Moliner-Velázquez (2023), which show that edutainment-based communication can increase audience interaction with complex sustainability issues by up to 2.7 times compared to purely informational approaches [14]. By integrating substantive environmental data with experiential narratives, firms can develop a more holistic and resilient digital green brand image that withstands public scrutiny.

4. Theoretical and Managerial Implications

This study contributes to the advancement of Signaling Theory in digital contexts by demonstrating that signal effectiveness is not solely determined by content quality, but is also strongly influenced by an actor's position within the network. The findings introduce the concept of network positionality as a critical mediator between signal transmission and audience reception. Highly central actors function not only as efficient information disseminators but also as validators of signal credibility. This extends traditional signaling frameworks by incorporating network structure as a key determinant of signal visibility and impact. In digitally saturated environments, communication hubs act as "centers of gravity" that determine whether

sustainability signals are perceived as authentic commitments or merely as marketing noise.

From a managerial perspective, this study provides strategic directions for green hotels to strengthen their Digital Green Brand Image. First, firms should strategically leverage digital networks by positioning themselves within key communication hubs. Collaborating with influential actors with high centrality can significantly enhance the reach and credibility of sustainability narratives. Second, firms must bridge the gap between operational sustainability and public perception. Technical practices, such as zero-waste initiatives, should be translated into engaging and relatable narratives. Integrating edutainment-based communication can help reduce greenwashing skepticism while improving audience engagement. Finally, firms should emphasize authenticity-driven engagement by encouraging organic, experience-based user content. Since signals originating from real user experiences are perceived as more credible than direct promotions, creating shareable yet educational experiences can strengthen social validation and long-term brand trust.

5. CONCLUSIONS

This study demonstrates that the digital green brand image of eco-friendly hotels in Bali on X is not formed through evenly distributed interactions, but is instead shaped within a highly centralized communication network dominated by a limited number of influential actors. These actors function as key opinion leaders and information gatekeepers, determining the visibility and credibility of sustainability narratives in the digital space.

The findings reveal that, despite the efficiency of information diffusion within the network, audience engagement is not evenly distributed across sustainability topics. Content emphasizing experiential and promotional aspects of eco-friendly hotels tends to attract significantly higher engagement compared to operational sustainability practices, such as zero-waste initiatives. This indicates that the construction of digital green brand image is influenced more by visually appealing and emotionally engaging narratives than by substantive environmental performance.

From a theoretical perspective, this study extends Signaling Theory by demonstrating that signal effectiveness in digital environments is not only determined by content credibility but also by network positionality. Actors occupying central positions within the network act as signal amplifiers, enhancing both the reach and perceived trustworthiness of sustainability messages.

From a managerial standpoint, the findings highlight the importance of strategic network positioning and narrative transformation in green marketing practices. Hotels must not only communicate sustainability initiatives but also ensure that these messages are delivered through credible channels and translated into engaging, audience-cantered narratives.

Overall, this study underscores that digital green branding is a relational and network-driven process, where the interplay between communication structure, content design, and audience perception determines the strength and resilience of brand image in the digital era.

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