

# Mapping the Digital Ecosystem of Muslim-Friendly Tourism: Stakeholder Networks, Sentiment, and Themes on X

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## Abstract

The rise of digital communication has reshaped the way tourism stakeholders interact, share information, and influence destination development. Muslim-Friendly Tourism has become one of the fastest-growing segments of the global industry; however, it has rarely been studied through a digital ecosystem lens. This study examines the halal tourism ecosystem by analyzing halal tourism conversations on X (formerly Twitter), mapping stakeholder interaction patterns, public sentiment, emotional responses, and dominant discussion themes. A dataset of 2,000 posts was collected via the SocialX platform between January 30, 2025, and March 30, 2026, and analyzed through an integrated framework combining Social Network Analysis, trend analysis, sentiment and emotion analysis, text clustering, topic modeling, and text network analysis. The network proved highly fragmented with 1,725 nodes, 1,417 directed edges, and 725 communities, reflecting the wide range of stakeholders involved; however, a few influential actors emerged as information brokers linking otherwise separate communities. Sentiment was predominantly neutral (46.75%), with positive sentiment (35.70%) clearly outweighing negative sentiment (17.55%), while happiness dominated the emotional landscape at 88.45%. The thematic analyses returned 14 discussion clusters and 117 topics, and the semantic network revealed three interconnected domains underpinning the ecosystem: the Destination and Policy Ecosystem, the Muslim Traveler Experience Ecosystem, and the Global Halal Travel Ecosystem. These findings extend Digital Ecosystem Theory to Muslim-Friendly Tourism and underscore the role of digital platforms in enabling stakeholder interaction, knowledge exchange, and value co-creation, offering practical guidance for policymakers, destination management organizations, and tourism businesses seeking to strengthen digital engagement and competitiveness.

*Keywords:* Muslim-Friendly Tourism, Halal Tourism, Digital Ecosystem, Social Network Analysis, Social Media Analytics, X (Twitter).

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## 1. Introduction

Digital technology has reshaped tourism on almost every front: how destinations market themselves, how travelers find information, and how the many parties in the industry deal with each other. Social media in particular has turned tourism communication from a one-way broadcast into something far more participatory (Afren, 2024; Gvaramadze, 2022; Kumar & Barua, 2024; Sharma & Sharma, 2023). Travelers no longer simply receive information; they produce it, share it, and judge it, posting their experiences as they go. Those exchanges now carry real weight, shaping a destination's image, travelers' perceptions, their intention to visit, and ultimately a destination's competitiveness (Al Fajar & Erlangga, 2025; Li & Jiang, 2025; Sultan et al., 2021). They also leave behind a rich trail of data, which gives researchers a new way to study tourism by reading the large-scale conversations that play out online (Barbu et al., 2024; Chen, 2021; Hermanto & Miftahuddin, 2021).

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Muslim-Friendly Tourism (MFT), or halal tourism, has grown up squarely within this environment, and it has become one of the fastest-growing segments of the global industry. A larger and more affluent Muslim population, together with a clearer appetite for travel that fits Islamic principles, has driven the expansion (Çetin & Dinçer, 2016; Chan et al., 2021; Hall et al., 2022). Muslim travelers increasingly look for halal-certified food, prayer facilities, family-oriented activities, gender-sensitive services, and hospitality that respects their religious values (Abdullah et al., 2025; Kumalasari et al., 2025; Said et al., 2020). Governments, tourism authorities, airlines, hotels, travel agencies, and destination management organizations have all responded with products built around those needs. What began as a niche has, in many countries, become a deliberate part of national tourism strategy.

That growth has drawn a good deal of academic attention. Researchers have examined tourist satisfaction, service quality, destination image and competitiveness, customer loyalty, behavioral intention, branding, and policy work that has taught us a great deal about what shapes Muslim travelers' experiences and choices. Most of it, however, rests on surveys, interviews, case studies, and secondary statistics. These methods capture individual perceptions and organizational viewpoints well enough, but they say little about how halal tourism is actually discussed, promoted, and contested in today's digital spaces (Magfiroh, 2024; Nurul Izza et al., 2021; Prawira et al., 2023).

This matters because social media has changed where tourism information comes from and how it circulates. Tourists, businesses, governments, influencers, media outlets, and community groups now communicate in real time and build knowledge together, forming interconnected networks through which information moves, influence forms, and value is co-created. This is the logic of a digital ecosystem: many interdependent actors linked by shared digital infrastructure (Arroyo et al., 2023; Foroughi & Karaman, 2025; Gvaramadze, 2022). In halal tourism, that ecosystem reaches well beyond providers and travelers to include a wide range of stakeholders who together create, spread, and interpret information. Because those interactions increasingly determine a destination's reputation, the trust it commands, and how its market develops, the ecosystem is worth understanding in its own right.

X (formerly Twitter) is an especially useful place to observe such an ecosystem. Information moves quickly there through posts, reposts, mentions, hashtags, and threaded discussion that can reach national and international audiences within hours (Kaiser, 2024; Pazaer et al., 2026; Sanchez Arrieta et al., 2025). Conversations frequently pull in several stakeholder groups at once, producing tangled communication networks that expose patterns of influence, diffusion, and engagement. And because most of these interactions are public, researchers can assemble large datasets of discussion as it naturally occurs, rather than responses prompted by a questionnaire. For studying public discourse and stakeholder relationships in tourism, X has become hard to ignore (Nguyen et al., 2021; Presenza & Cipollina, 2010).

Yet halal tourism has rarely been examined through a digital-ecosystem lens. Existing studies lean toward customer perception and service outcomes and give far less attention to the network structures that tie stakeholders together online who interacts with whom, which actors hold influential positions, and how information travels between the communities taking part (Hendrik et al., 2024; Nurhayati et al., 2025; Suradin, 2018). As a result, we still understand poorly the mechanisms by which digital interaction actually advances the development and promotion of Muslim-Friendly Tourism. The analytical habits of the field compound the problem: studies that do use social media data often stop at content or sentiment analysis, overlooking the relational side of digital communication connectivity, centrality, community structure and seldom combine perspectives that could examine network ties, sentiment, emotion, themes, and timing at once. Without that integration, it is hard to see how these ecosystems work or how they change over time.

Recent work in computational social science offers a way forward. Social Network Analysis (SNA) can identify influential actors, communication hubs, and the structures along which information spreads; sentiment and emotion analysis reveal how the public feels about an issue; topic modeling and text clustering surface the dominant and emerging themes inside large bodies of text (Hellsten & Leydesdorff, 2019; Houghton et al., 2017; Pronello et al., 2024). Brought together in a single framework, these methods address both the structure of digital interaction and its content a combination that suits halal tourism well, given how much stakeholder collaboration, public perception, and online engagement now matter to destination development. The digital-ecosystem concept itself is well established in research on innovation, business, and information systems, but its use in Muslim-Friendly Tourism is still thin, with little empirical evidence on how digital stakeholders collectively shape halal tourism narratives or how their networks support knowledge exchange and promotion.

This leaves several basic questions open, and they are the ones this study sets out to answer using halal tourism conversations on X (Assyifa, 2021; Nurmaizar & Widodo, 2024). First, who are the most influential actors in the digital ecosystem of halal tourism services? Second, how are communication patterns and stakeholder relationships

structured within that online network? Third, what sentiments and emotions characterize public discussion of Muslim-Friendly Tourism? Fourth, what thematic clusters and dominant topics emerge from those conversations? And fifth, how do these interactions together give rise to a digital ecosystem that supports Muslim-Friendly Tourism? To work through them, the study draws on Social Network Analysis, sentiment analysis, emotion detection, topic modeling, text clustering, and trend analysis applied to data collected from X.

In answering these questions, the study contributes in four ways. Theoretically, it extends Digital Ecosystem Theory into the halal tourism setting by showing how diverse stakeholders interact and co-create value through digital networks. Methodologically, it joins network-based and content-based analysis in a single framework rather than relying on either alone. Empirically, it provides evidence on stakeholder influence, public sentiment, thematic discourse, and communication structure around halal tourism services. And practically, it gives policymakers, destination management organizations, tourism businesses, and digital marketers a clearer basis for strengthening engagement, raising destination visibility, and improving the competitiveness of Muslim-Friendly Tourism in the digital era.

## 2. Methodology

This study takes a quantitative social media analytics approach to the digital ecosystem of Muslim-Friendly Tourism, working from conversations on X (formerly Twitter). To capture both how stakeholders relate to one another and what they actually talk about, it combines several techniques: Social Network Analysis (SNA), sentiment analysis, emotion analysis, trend analysis, text clustering, topic modeling, and text network analysis (Alshehri, 2024; Mañas-Álvarez et al., 2024; Nusair, 2020). No single method would do here. Network methods show the structure of the discussion, content methods reveal its substance, and only together do they give a full reading of how halal tourism is debated online (Al-Ansi et al., 2022; Assyifa, 2021; Jafar et al., 2023).

The data come from X via SocialX, an analytics platform built to retrieve, process, and visualize social media content. Collection ran from 30 January 2025 to 30 March 2026, drawing on publicly available posts that contained keywords tied to halal tourism and Muslim-friendly travel. The search covered a deliberately broad, multilingual set of terms “halal tourism,” “halal travel,” “pariwisata halal,” “wisata halal,” “wisata syariah,” “Muslim friendly tourism,” “Muslim friendly travel” together with the hashtags #halaltourism, #pariwisatahalal, and #wisatahalal. We placed no language restriction on the query, so the resulting 2,000 posts reflect global rather than purely local conversation about halal tourism services and Muslim-friendly travel.

Before analysis, the raw dataset went through a cleaning stage to raise its quality and reliability. Duplicate records were dropped, and hyperlinks, emojis, special characters, and stray symbols were stripped out. The text was then normalized lowercased, tokenized, and cleared of stop words so that what remained reflected the substance of each post rather than the noise around it.

Analysis began with trend analysis, which tracked how the volume of conversation rose and fell over time. By examining the weekly frequency of posts, we could pick out the moments when public attention spiked and link those peaks to periods of heightened stakeholder engagement, giving a sense of the rhythm of halal tourism discourse before turning to its structure and content.

Social Network Analysis came next, used to map how stakeholders connect. Here each user account is a node, and the mentions, replies, and reposts between accounts are the edges that join them. Visualizing the network this way made it possible to see who the influential actors are, where the communication hubs sit, and how distinct interaction communities form in short, how information actually flows and who does the most to push halal tourism content through it.

Attention then shifted from structure to opinion. Sentiment analysis, run through SocialX's Natural Language Processing tools, sorted posts into positive, neutral, and negative categories to gauge how the public regards halal tourism services and how far the discussion leans favorable or otherwise. Emotion analysis extended this a step further. Rather than measuring the overall polarity of an opinion, it classified the feelings behind the posts into five categories happiness, anger, sadness, fear, and love offering a closer look at the psychological tone of the conversation.

The next stage, text clustering, grouped posts by semantic similarity using machine learning, gathering together those that dealt with similar issues. This surfaced the different conversation groups within the broader discourse and showed that the dataset was not one undifferentiated mass but a set of distinct thematic communities. Topic modeling

then dug beneath the surface to recover the latent themes running through the posts, identifying clusters of words that tend to appear together. From these emerged the dominant topics in the discussion: halal tourism services, destination development, Muslim traveler experiences, hospitality practices, tourism promotion, and global tourism opportunities.

A final step, text network analysis, examined how keywords co-occur. In this network the words themselves are nodes and the frequency with which they appear together forms the links between them. The resulting map exposed the central concepts, the thematic clusters, and the semantic ties among the key terms of the discussion—complementing topic modeling by giving its themes a visual, conceptual structure.

Figure 1 sets out the overall research framework. The process moves from data collection on X through SocialX, to preprocessing, and then through the sequence of analyses described above—trend analysis, Social Network Analysis, sentiment and emotion analysis, text clustering, topic modeling, and text network analysis. Read together, these steps allow a comprehensive account of the stakeholder interactions, public perceptions, emotional responses, and thematic structures that make up the digital ecosystem of Muslim-Friendly Tourism.

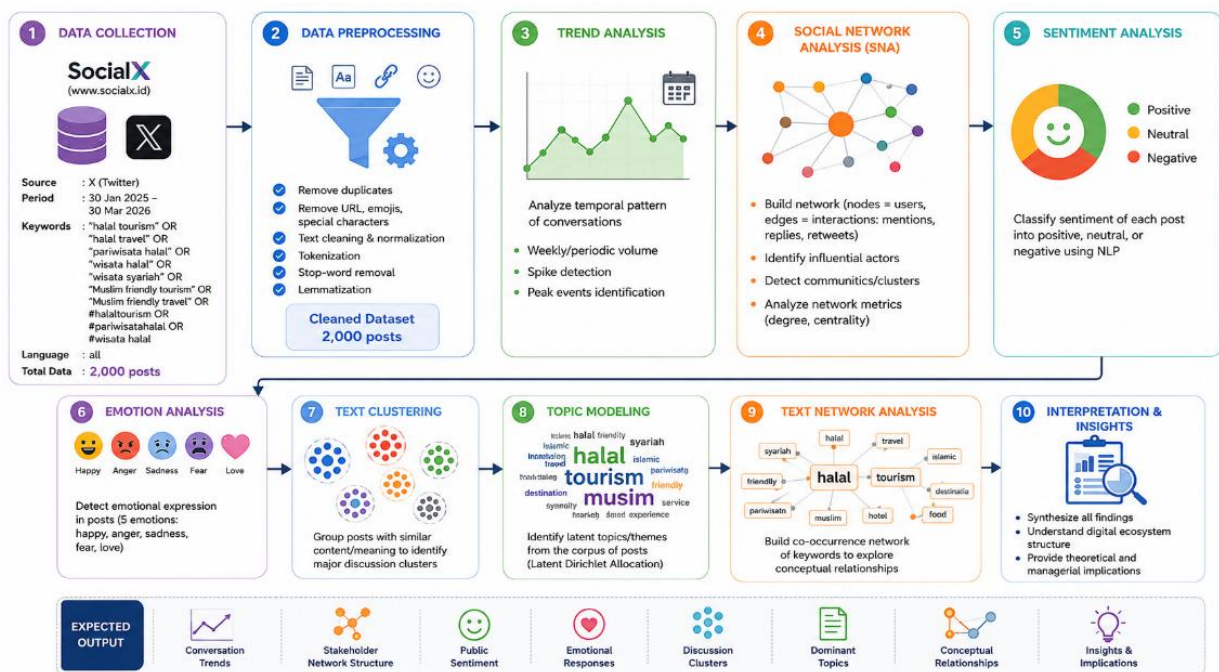


Figure 1. Research Framework

### 3. Results and Discussion

#### 3.1. Results

The analysis draws on data gathered and processed through SocialX, an analytics platform built to monitor, retrieve, and examine digital conversations across a range of social media channels. For this study, SocialX was used to collect public posts from X (formerly Twitter) using keywords tied to halal tourism and Muslim-friendly travel. Collection ran from 30 January 2025 to 30 March 2026 and yielded a dataset of 2,000 posts. Beyond gathering the data, the platform also generated the analytical outputs the study relies on—trend analysis, social network visualization, sentiment and emotion analysis, text clustering, topic modeling, and text network analysis together making it possible to examine both stakeholder interaction and public discourse within the halal tourism digital ecosystem.

What emerges is a multidimensional picture of how halal tourism is discussed and promoted online. Combining network-based and content-based analytics, the findings capture more than the sheer volume of conversation and how it shifts over time; they also show how stakeholders are connected, what sentiments and emotions users express, and which themes dominate discussions. Taken together, the results shed light on a digital ecosystem in which tourism organizations, media institutions, influencers, businesses, and travelers all contribute to spreading information and

advancing Muslim-Friendly Tourism. The sections that follow present these findings in turn, beginning with trend analysis and moving through social network structure, sentiment distribution, emotional patterns, thematic clustering, topic modeling, and keyword relationships.

### 3.1.1 Dataset Characteristics

The dataset for this study was gathered from X (formerly Twitter) through the SocialX platform between 30 January 2025 and 30 March 2026. Retrieval relied on a fixed set of keywords covering halal tourism and Muslim-friendly travel—“halal tourism,” “halal travel,” “pariwisata halal,” “wisata halal,” “wisata syariah,” “Muslim friendly tourism,” and “Muslim friendly travel,” along with the corresponding hashtags. In all, 2,000 publicly available posts were collected and analyzed to map the digital ecosystem around halal tourism services. Table 1 summarizes the main characteristics of the dataset.

**Table 1.** Description of the Dataset

Characteristic	Description / Value
Data source	X (formerly Twitter), via SocialX
Collection period	30 January 2025 – 30 March 2026
Total posts	2,000
Unique user accounts	1,045
Number of attributes	36
Number of languages	24
Dominant language	English — 1,026 posts (51.3%)
Second language	Indonesian — 823 posts (41.2%)
Verified accounts	418 posts (20.9%)
Non-verified accounts	1,582 posts (79.1%)
Interaction types captured	Mentions, replies, reposts, quotes
Engagement metrics	Views, likes, replies, reposts, quotes

Each post comes with 36 attributes, spanning textual content, user information, engagement metrics, interaction data, and metadata: the text of the post itself, its publication date and language, hashtags and mentions, repost and reply activity, the author's verification status and follower count, engagement figures, and the relationships linking one account to another. Having all of this in a single record is what makes it possible to study communication structure, stakeholder interaction, public perception, and discussion themes side by side rather than in isolation.

The 2,000 posts came from 1,045 distinct accounts, which already signals a fairly broad base of participation rather than a conversation dominated by a handful of voices. The content spans 24 languages, a reminder that halal tourism is discussed globally rather than within any single market. English leads with 1,026 posts (51.3%), followed closely by Indonesian with 823 (41.2%); the rest are spread thinly across the remaining languages, underscoring the international reach of the discourse.

The accounts behind these posts are similarly mixed. Verified accounts produced 418 posts (20.9%), while the remaining 1,582 (79.1%) came from non-verified users. In other words, the conversation about halal tourism is not the preserve of official bodies or prominent figures; ordinary users and community members carry a large share of it. That spread fits the idea of a digital ecosystem, where value and information emerge from many contributors at once rather than from a single authoritative source.

The data also record the various ways users interact. Mentions, replies, reposts, and quotes supply the raw material for reconstructing communication networks and pinpointing influential actors, while engagement signals views, likes, replies, reposts, and quotes offer a way to gauge how much attention a post draws and how intensely people respond. Together these features make the dataset well suited to Social Network Analysis, sentiment and emotion analysis, text clustering, topic modeling, and text network analysis.

Taken as a whole, the dataset offers a rich cross-section of public discussion about Muslim-Friendly Tourism and a solid empirical base for examining how stakeholders interact, how conversations unfold, how sentiment shifts, and which themes come to dominate the halal tourism digital ecosystem.

### 3.1.2 Network Statistics of the Halal Tourism Digital Ecosystem on X

Table 2 sets out the structural profile of the halal tourism digital ecosystem on X. Across the whole dataset, the network spans 1,725 nodes joined by 1,417 directed edges large in reach, but loosely tied together. Its density is

strikingly low at 0.0005, meaning only a tiny fraction of the connections that could exist among users actually do. This is the usual shape of a large social media network: people interact within their own circles far more than across the network as a whole.

**Table 2.** Network Statistics of the Halal Tourism Digital Ecosystem on X

Network Metric	Whole Network	Main Component
Nodes	1,725	493
Directed Edges	1,417	740
Density	0.0005	0.0061
Average Degree	1.64	3.00
Modularity	0.892	0.745
Number of Communities	725	21
Average Clustering Coefficient	0.058	0.136
Connected Components	709	1
Average Path Length	–	5.03
Network Diameter	–	17

That tendency shows up clearly in the network's community structure. With a modularity of 0.892 and 725 distinct communities, the conversation is heavily fragmented, breaking into many discussion groups rather than gathering into one cohesive whole. Talk about halal tourism, in other words, plays out across a large number of fairly self-contained clusters. The low average clustering coefficient (0.058) tells a similar story, pointing to limited local interconnection among users when the network is viewed in full.

To get at the core of the interaction rather than its scattered edges, we examined the largest connected component on its own. This main component holds 493 nodes and 740 edges and represents the most active communication cluster in the ecosystem. It is noticeably tighter than the network at large: density rises to 0.0061, average degree to 3.00, and the clustering coefficient to 0.136 all signs of more intense and more cohesive interaction among the users who make it up.

Within this core, the conversation organizes into 21 communities, with an average path length of 5.03 and a diameter of 17. In other words, information can move from one corner of the core to another through only a handful of intermediaries, a “small-world” quality typical of online social networks. Taken together, these results describe an ecosystem that is highly fragmented at the macro level, yet anchored by a denser, more connected core, where the real work of information exchange and stakeholder interaction takes place.

### 3.1.3 Temporal Trends in Halal Tourism Discussions

Figure 2 traces the unfolding of halal tourism discussions on X between January 2025 and March 2026. The conversation about Muslim-Friendly Tourism remained active throughout the period, even as its volume rose and fell weekly. Most weeks logged somewhere between 20 and 60 posts, a fairly steady hum of engagement among users following halal tourism topics.

A few sharp peaks punctuated the baseline. The clearest came in late June, when posts climbed past 120 in just one week. Further spikes appeared during the third quarter and again near the end of the period, the kind of bursts usually set off by tourism campaigns, destination promotions, policy announcements, seasonal travel, or media coverage. In other words, public attention to Muslim-Friendly Tourism is periodically reignited by outside events and by what stakeholders in the sector are doing at the time.

What matters as much as the peaks, though, is what happens between them. Rather than flaring up and vanishing the way viral topics tend to, halal tourism discussion kept surfacing consistently throughout the period. That persistence suggests Muslim-Friendly Tourism has settled in as an established subject of interest online, not a passing trend riding on one or two isolated events.

From a digital ecosystem standpoint, conversation that endures like this reflects continuous engagement across many communities. Tourism organizations, media outlets, influencers, policymakers, and travelers all help keep the discussion alive through a steady stream of information and content. Recurring peaks layered over a sustained baseline are, together, the signature of an active digital ecosystem one that keeps halal tourism information circulating and keeps diverse stakeholder groups interacting.



Figure 2. Temporal Trends of Halal Tourism Discussions on X

### 3.1.4 Social Network Structure of the Halal Tourism Digital Ecosystem

Figure 3 maps the communication network behind halal tourism discussions on X. The network spans 1,725 nodes and 1,417 directed edges, and what stands out immediately is how fragmented it is many communities, scattered patterns of interaction, little sign of a single center of gravity. This squares with the high modularity reported in Table 2 (0.892), which tells us the discussion is spread across many largely independent communities rather than gathered into one cohesive network. The 725 communities the analysis identifies reinforce the point: halal tourism conversation covers a wide spread of topics, stakeholder interests, and communication groups.

A handful of nodes nonetheless sit at the heart of the network. Accounts such as @grok, @anomali, @kompascom, @beginiceritany1, and @SundaGenY surface as major communication hubs, linking communities that would otherwise stay apart. Their larger size on the map reflects heavier interaction and connectivity, marking them as key players in moving information around and keeping communication flowing across the ecosystem. In practice these accounts act as digital intermediaries, bridging different stakeholder groups media organizations, public figures, tourism communities, and individual users alike.

A second feature worth noting is the way a dense core sits alongside a great many peripheral clusters. Most users take part within small, localized communities, while only a limited number of central actors hold the wider ecosystem together. This is the hallmark of a scale-free network, where a relatively small group of highly connected accounts carries an outsized share of the information flow. The arrangement lifts the visibility of tourism-related content, but it also leaves cross-community communication dependent on a few key influencers.

Seen from a digital ecosystem perspective, the network shows halal tourism discussion being shaped by collaboration among many stakeholders rather than driven by any single dominant institution. The mix of media accounts, influencers, public communities, and individual users underlines how participatory digital tourism promotion has become. The halal tourism ecosystem, on this reading, is best understood as a decentralized but interconnected communication environment one in which information, opinions, and experiences are exchanged continuously through social media interaction.

### 3.1.5 Public Sentiment toward Halal Tourism Services

To gauge how the public views halal tourism services, sentiment analysis was run across the 2,000 posts collected from X, sorting them into three categories positive, neutral, and negative. Figure 4 shows how that sentiment breaks down.

Neutral posts make up the largest share, at 46.75% of the dataset (935 posts). Positive sentiment follows at 35.70% (714 posts), and negative sentiment trails well behind at just 17.55% (351 posts). That neutral content dominates is telling: it suggests people use X mainly as a place to pass along information news, travel tips, destination promotions, and tourism updates rather than to stake out strongly emotional positions.

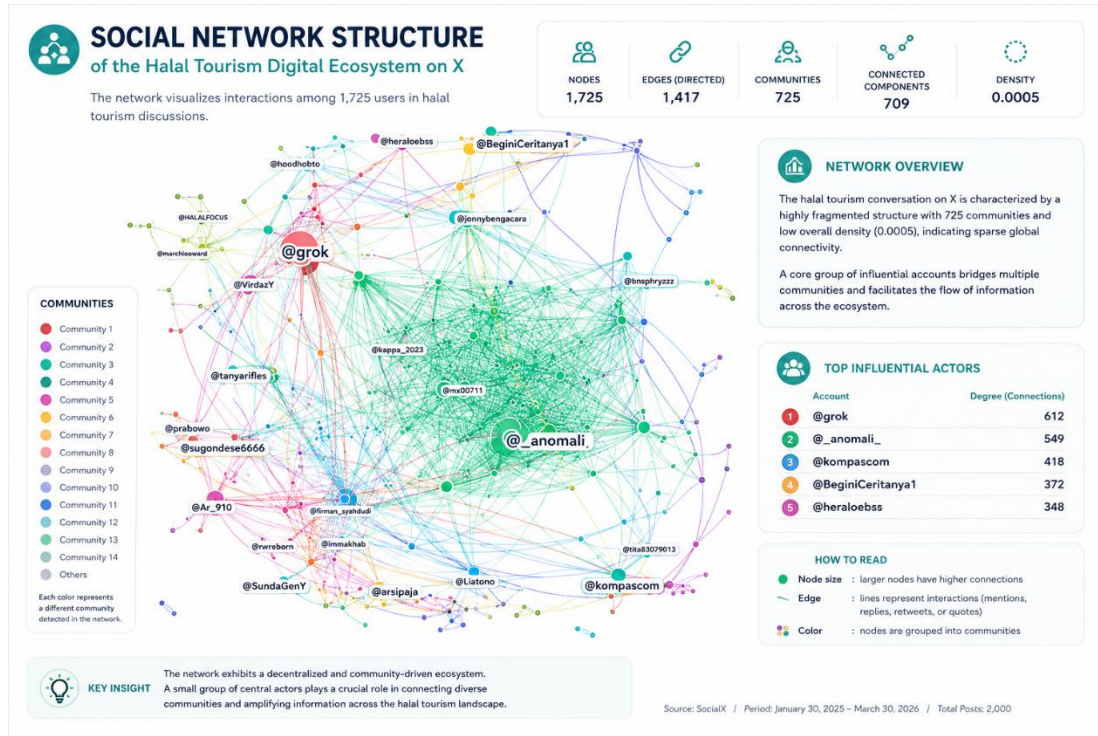


Figure 3. Social Network Structure of the Halal Tourism Digital Ecosystem

The fact that positive posts comfortably outnumber negative posts points to a generally favorable view of halal tourism services. The upbeat discussion tends to dwell on the appeal of destinations, the availability of halal facilities, Muslim-friendly hospitality, travel experiences, and tourism development efforts. Collectively, these signals suggest that halal tourism is increasingly viewed as an attractive segment that serves Muslim travelers while also enhancing a destination's competitiveness.

In contrast, negative sentiments remain a minority voice. Where it does appear, the criticism tends to center on service quality, gaps in infrastructure, how ready a destination is, or disagreements over halal tourism policy. However, at well under a fifth of all posts, such unfavorable views are far from dominating the conversation.

Stepping back, the overall distribution describes a digital ecosystem with a positive communication climate. A large neutral core alongside a substantial positive share suggests a conversation tilted toward exchanging information and engaging constructively rather than toward conflict or controversy conditions that bode well for stakeholder collaboration and digital promotion across the Muslim-Friendly Tourism sector.

### 3.1.6 Emotional Responses toward Halal Tourism Services

To go beyond overall sentiment, an emotion analysis was carried out to surface the feelings running through halal tourism discussions on X. Figure 5 shows how the dataset breaks down across five emotional categories: happiness, anger, sadness, fear, and love.

The picture is overwhelmingly positive. Happiness alone accounts for 88.45% of the detected emotions 1,769 posts dwarfing everything else: anger at 8.35% (167 posts), sadness at 2.75% (55 posts), fear at 0.40% (8 posts), and love at a negligible 0.05% (a single post). A gap that wide between happiness and the rest indicates that halal tourism conversation is mostly bound up with positive experiences, favorable impressions, and a supportive stance toward Muslim-friendly travel.



Figure 4. Sentiment Distribution of Halal Tourism Discussions on X

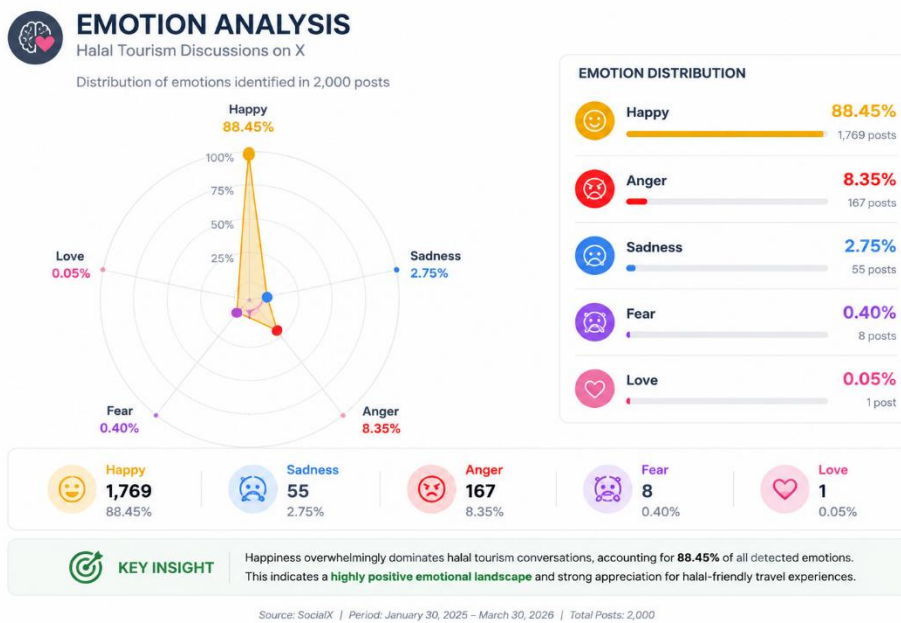


Figure 5. Emotional Distribution of Halal Tourism Discussions on X

The weight of happiness suggests that users tend to talk about halal tourism in terms of enjoyable trips, appealing destinations, quality of hospitality, and availability of halal-friendly facilities. These upbeat emotions are usually attached to successful journeys, destination recommendations, promotional campaigns, and appreciation for services that cater to Muslim travelers. The pattern lines up neatly with the positive sentiment found earlier and reinforces the sense that halal tourism draws a warm response from online communities.

Negative emotions are present, but only thinly. The anger and sadness that do appear may reflect worries about service availability, how prepared a destination is, tourism policy, or differing views on how halal tourism should develop. Yet the very low levels of fear and sadness suggest the conversation is not being driven by uncertainty, perceived risk, or serious controversy; if anything, its tone leans toward optimism and constructive engagement.

For destination marketing and for building the digital ecosystem, this dominance of positive emotion is an asset. Positive feeling helps shape a stronger destination image, encourages people to share information, and raises the odds of electronic word-of-mouth. On the evidence here, then, halal tourism discussion on X offers a supportive

environment for promoting Muslim-Friendly Tourism and for deepening stakeholder engagement across the wider tourism ecosystem.

### 3.1.7 Text Clustering Analysis

Figure 6 shows the results of clustering the halal tourism posts on X. Using machine-learning clustering, the dataset was sorted into fourteen distinct clusters (K=14), each gathering posts that share similar semantic features. What the spread makes clear is that halal tourism conversation does not revolve around one topic; it is dispersed across many thematic communities an outcome that echoes the network analysis, with its highly fragmented structure of numerous communities and stakeholder groups.

The clusters differ considerably in size. The largest is Cluster 4, with 461 posts (23.1%), followed by Cluster 8 at 387 (19.4%), Cluster 10 at 224 (11.2%), Cluster 12 at 195 (9.8%), and Cluster 14 at 180 (9.0%). Between them, these five clusters take in more than 70% of the dataset, which suggests that a small number of dominant themes pull in the bulk of user attention. The remaining clusters are smaller, marking out the niche discussions and specialized topics that sit within the broader halal tourism ecosystem.

The visualization also shows that the clusters overlap to varying degrees. Some occupy fairly distinct regions of the semantic space, while others partly intersect a sign of thematic kinship and shared vocabulary. The implication is that halal tourism discussions are interconnected rather than wholly separate: users routinely touch on several facets of Muslim-Friendly Tourism at once, from destination experiences and halal services to hospitality, trip planning, and promotion.

From a digital ecosystem standpoint, the fourteen clusters underline how many-sided the conversation is. No single stakeholder agenda dominates; instead, the discussion draws on travelers, tourism businesses, media organizations, community groups, policymakers, and digital influencers alike. Each cluster amounts to its own conversational domain, and together they feed the knowledge exchange and value creation that hold the ecosystem together.

Taken as a whole, the clustering points to a varied and dynamic discussion landscape in which multiple themes coexist and interact. That variety is itself a marker of a maturing sector one whose conversations now reach well beyond basic service provision to take in destination competitiveness, traveler experience, digital engagement, and sustainable tourism development.

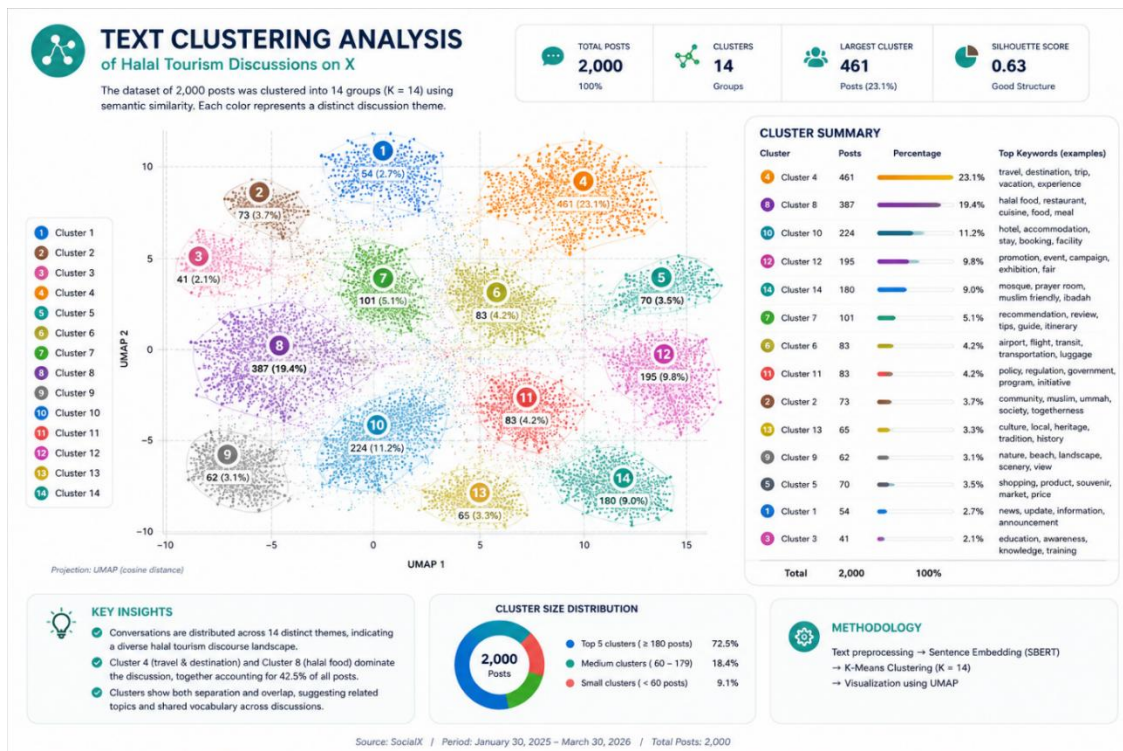


Figure 6. Text Clustering of Halal Tourism Discussions on X

### 3.1.8 Topic Modeling Analysis

Figure 7 presents the topic modeling results for the halal tourism posts on X. The analysis turned up 117 topics across the dataset, with 394 posts (20.2%) left unassigned as noise. The figure plots the semantic spread of these topics in a two-dimensional UMAP space, each color marking a separate topic cluster. The crowding of points toward the center shows that many discussions draw on shared vocabulary and overlapping themes, while the scattered outliers represent niche conversations that surface only rarely in the wider halal tourism discourse.

The overall impression is of considerable thematic variety. Rather than circling a single issue, users range across destination promotion, Muslim-friendly facilities, halal food, travel experiences, accommodation, tourism policy, religious values, and opportunities for international travel. That so many topics emerge speaks to the many-sided nature of the halal tourism ecosystem and to the range of stakeholders involved, each bringing different interests and information needs.

For all that variety, the map still has several dense regions where discussion converges. These concentrations mark the issues that command the most attention and act as focal points within the ecosystem likely the recurring talk of destination appeal, tourism services, access to halal facilities, and the expanding global market for Muslim-friendly travel. The way related topics cluster together is a further sign that users tend to hold interconnected conversations rather than treating tourism issues in isolation.

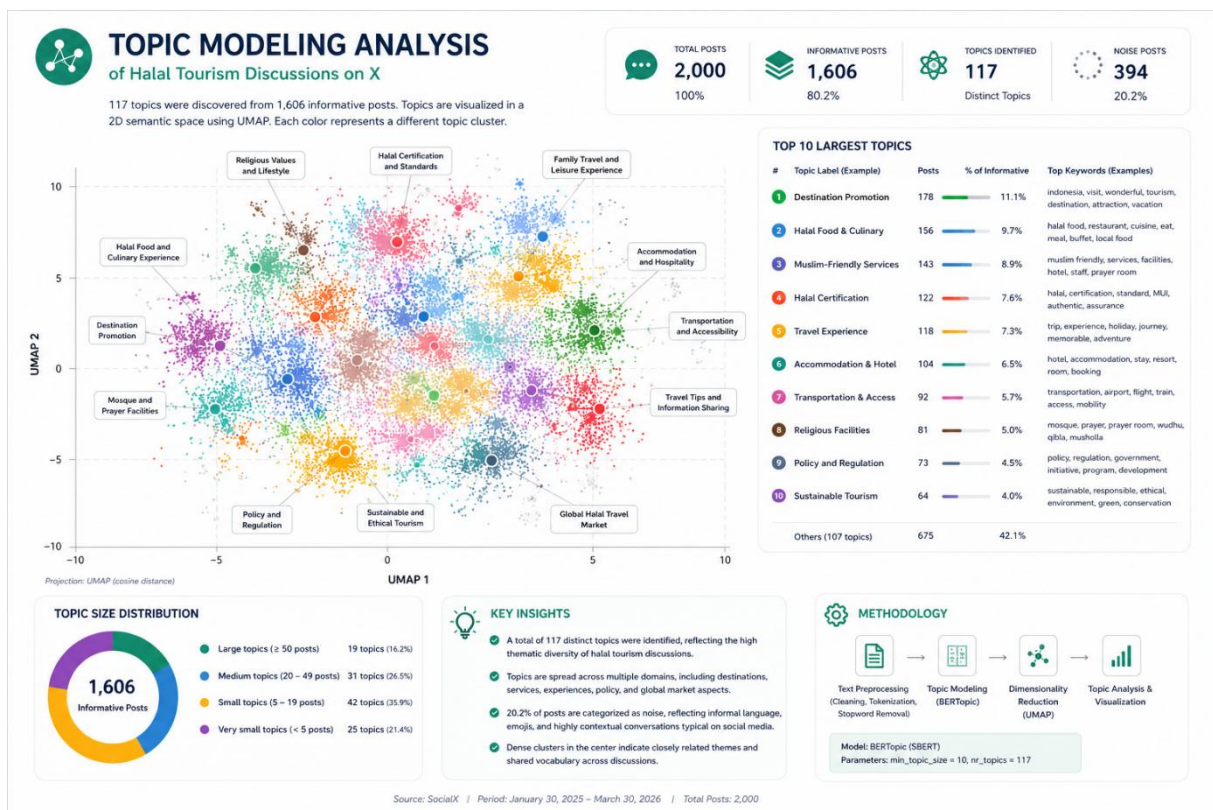


Figure 7. Topic Modeling of Halal Tourism Discussions on X

A noise share of 20.2% is nothing unusual for social media data. User-generated posts are full of informal language, abbreviations, emojis, multilingual phrasing, and highly contextual exchanges that resist tidy thematic categories. Far from being a flaw in the analysis, that noise is a faithful reflection of how spontaneous and fluid online communication is and a reminder of why topic modeling works best alongside complementary methods such as text clustering and network analysis.

Seen through a digital ecosystem lens, the results show that halal tourism conversation reaches well beyond tourism products and services. It takes in social, cultural, religious, economic, and technological threads that together shape how stakeholders perceive and interact with one another. This reinforces the view of Muslim-Friendly Tourism as a



What matters most is how the three clusters connect. Destination development, traveler experience, and global tourism opportunity are not walled off from one another; they are bound together by a constant exchange of information. The keyword *halal* serves as the central hub linking the three domains, while terms such as *travel*, *tourism*, and *muslim-friendly* act as bridges that knit the themes together. This is exactly the shape of a digital ecosystem many stakeholders feeding into interconnected discussions that, taken together, shape how the public understands halal tourism.

Theoretically, the semantic network lends support to applying Digital Ecosystem Theory to Muslim-Friendly Tourism. It suggests the ecosystem rests on three interrelated pillars: destination and policy development, traveler experience and service provision, and global market expansion. Each is continually reinforced through digital interaction among governments, tourism organizations, businesses, media, influencers, and travelers. The digital ecosystem, then, is more than a place to communicate; it is a mechanism for creating knowledge, building collaboration, and co-creating value across the halal tourism sector.

### 3.2. Discussion

Taken together, the findings show that the digital ecosystem around Muslim-Friendly Tourism on X is decentralized but still interconnected. The network analysis pointed to a highly fragmented landscape 725 communities and a modularity of 0.892 meaning halal tourism talk is spread across many stakeholder groups rather than bunched into one dominant community. That is very much the character of a digital ecosystem, where value emerges from the interplay of diverse actors rather than from any single hub. And for all the fragmentation at the macro level, a cohesive core remains visible, held together by a handful of influential accounts that bridge communities and keep information moving across the network.

Those central actors media organizations, influencers, community accounts underline how much digital intermediaries matter in shaping halal tourism discourse. In the language of Social Network Theory, they act as brokers, joining communities that would otherwise stay apart and speeding the spread of information. Their position lets them steer public attention, amplify tourism messages, and color perceptions of halal destinations and services. The practical lesson is that promoting Muslim-Friendly Tourism online is not the job of tourism providers alone; it depends on working with the influential stakeholders who can carry a message across many communities at once.

The sentiment and emotion results add that the ecosystem rests on a broadly positive communication climate. Neutral sentiment led the conversation (46.75%), but positive comfortably outweighed negative and, more strikingly, happiness made up 88.45% of all detected emotions. Together these point to a discussion centered on good experiences, appealing destinations, quality hospitality, and hopeful expectations of travel. Such an emotional backdrop is fertile ground for electronic word-of-mouth and for shaping a destination's image. Tourism research has long held that positive emotional experiences deepen loyalty and make people likelier to recommend a place; the present findings suggest the same dynamic is at work inside the digital ecosystem of halal tourism.

The clustering and topic modeling, meanwhile, bring out how many-sided the conversation has become. Fourteen discussion clusters and 117 distinct topics show that halal tourism has outgrown a narrow preoccupation with religious compliance. The discourse now stretches across destination development, hospitality, traveler experiences, transport, accommodation, food, tourism policy, sustainability, and global market opportunity. That breadth is a sign of a maturing sector—one that stakeholders treat as a full tourism ecosystem rather than a specialized niche.

Perhaps the most telling result comes from the semantic network, which revealed three interconnected domains that together make up the halal tourism digital ecosystem. The first is destination and policy development tourism promotion, government initiatives, certification, and branding. The second is the Muslim traveler experience service quality, halal facilities, accommodation, food, and satisfaction. The third is the global halal travel ecosystem international market opportunity, hospitality innovation, investment, and sustainable development. These domains do not operate in isolation; they feed one another continuously through digital communication and stakeholder engagement.

That interplay is where the study extends Digital Ecosystem Theory into tourism. Halal tourism development, the findings suggest, runs as a dynamic process: policy support and destination development lay the groundwork for growth, service quality and traveler experience create value for visitors, and global market opportunity drives expansion and long-term sustainability. Platforms like X serve as the connective infrastructure that lets these domains interact, share information, and co-create value. In that sense the digital ecosystem is not merely a channel for

communication but a mechanism through which stakeholders collectively shape where Muslim-Friendly Tourism goes next.

On the practical side, several implications follow for policymakers and practitioners. Governments and destination management organizations would do well to strengthen their digital engagement by partnering with the influential actors who can reach across online communities. Tourism businesses should put real weight on delivering positive Muslim-friendly experiences, since favorable emotions and perceptions feed directly into a destination's reputation online. And stakeholders generally should pursue integrated strategies that address destination competitiveness, service quality, and global positioning at the same time an approach that would make the ecosystem more resilient and halal tourism destinations more competitive internationally.

In sum, Muslim-Friendly Tourism behaves as a complex digital ecosystem, one in which stakeholder interaction, public perception, and thematic discussion are shaped continuously through online communication. Network structure, positive emotional response, varied thematic conversation, and interconnected ecosystem domains all point to the growing role digital platforms play in developing and promoting halal tourism. The study, in turn, sharpens our understanding of how such ecosystems support collaboration, knowledge exchange, and value co-creation in today's tourism markets.

#### **4. Conclusion**

This study set out to map the digital ecosystem of Muslim-Friendly Tourism by analyzing 2,000 discussions gathered from X through the SocialX platform. Drawing together trend analysis, Social Network Analysis, sentiment and emotion analysis, text clustering, topic modeling, and text network analysis, it offers a rounded picture of how stakeholders interact and how online conversation about halal tourism takes shape. The clear message is that digital platforms have become important spaces for exchanging information, engaging stakeholders, and co-creating tourism knowledge.

The Social Network Analysis showed an ecosystem that is highly fragmented 1,725 nodes, 1,417 connections, and 725 communities. Yet within that fragmentation a few influential actors act as bridges, carrying information across otherwise separate stakeholder groups. This points to the pivotal part played by digital intermediaries media organizations, influencers, and community accounts in widening the reach of halal tourism discussion and stitching disconnected communities together.

The sentiment and emotion analyses suggest that the public view of halal tourism is, on the whole, favorable. Neutral sentiment led the conversation, positive clearly outweighed negative, and happiness stood out as the dominant emotion at 88.45% of all detected feeling. Together these results tie halal tourism to positive travel experiences, attractive destinations, and a supportive attitude toward Muslim-friendly services an environment that opens room for destination promotion, electronic word-of-mouth, and stronger stakeholder engagement.

The thematic work revealed just how varied the conversation is, with fourteen discussion clusters and 117 distinct topics. More importantly, the semantic network identified three interconnected pillars that underpin the ecosystem: the Destination and Policy Ecosystem, the Muslim Traveler Experience Ecosystem, and the Global Halal Travel Ecosystem. The way these domains interact shows that halal tourism is no longer framed simply as a form of religious tourism but as a multidimensional ecosystem spanning destination development, service quality, market expansion, innovation, and sustainable growth.

The study's contribution is to extend Digital Ecosystem Theory into the setting of Muslim-Friendly Tourism, and to show how social media data can surface stakeholder relationships, public perceptions, and thematic structures within digital tourism environments. The findings imply that successful halal tourism development hinges on bringing together policy support, traveller-centered service, and global market engagement through digital platforms. In practical terms, policymakers, destination management organizations, and tourism businesses should deepen their collaboration with influential digital actors and adopt integrated communication strategies that enhance both the visibility and competitiveness of halal tourism destinations.

However, this study has some limitations. This study draws solely on data from X, which may not capture conversations on Instagram, Facebook, TikTok, or YouTube. It also reflects a particular observation window, so it cannot speak to how public discourse may shift over time. Future work could combine several platforms, take a longitudinal view, and compare countries to build a fuller account of how this ecosystem evolves. There is also room to examine how artificial intelligence, digital marketing technologies, and virtual tourism experiences will shape the next generation of halal tourism.

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