

Exploring Social Media-Enabled Environmental Governance in India's Namami Gange Programme: An Expert-Based DEMATEL–ISM Study

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ABSTRACT

This study develops an exploratory expert-based structural model of social media-enabled environmental governance (SMeEG) in India's Namami Gange Programme. Drawing on collaborative governance, digital governance and public value perspectives, the study defines and examines thirteen interrelated constructs that may shape the perceived functioning of digitally mediated environmental governance. Judgements from a twelve-member expert panel were analysed using an integrated Decision-Making Trial and Evaluation Laboratory (DEMATEL)–Interpretive Structural Modelling (ISM) procedure. DEMATEL was used to identify relative influence, prominence and net-effect positions, while ISM was used to derive an interpretive reachability hierarchy. The analysis places digital infrastructure and platform accessibility, government commitment and policy support, governance transparency and accountability, and citizens' digital literacy among the most influential foundational conditions in the expert-perceived system. Multi-stakeholder collaboration occupies an intermediate coordinating position, while trust, social listening, communication, awareness, influencer participation and citizen engagement occupy progressively more dependent positions. Environmental governance effectiveness appears as the ultimate outcome node. These findings should be interpreted as expert-perceived structural relationships rather than estimates of observed causal effects or empirically validated temporal sequences. The study contributes an exploratory structural framework that can guide subsequent survey, case-based or longitudinal validation in the Namami Gange context and comparable environmental-governance settings.

Keywords: Social media; environmental governance; collaborative governance; digital governance; DEMATEL; ISM; expert-based structural modelling; Namami Gange

INTRODUCTION

In a developing economy like India, which is home to world's largest population, managing environmental degradation, particularly the degradation of its water resources poses huge challenge for the government. Traditionally, environmental governance has often relied on a top-down approach, which due to its bureaucratic procedures may constrain responsiveness, transparency, and opportunities for citizen participation (Purnomo et al. 2021). In today's digital era citizens' and stakeholders' participation in managing issues related to environment have appeared as the most prominent component of contemporary environmental governance (Eckerd and Heidelberg, 2020). In this context, social media platforms have emerged as important tools for facilitating information dissemination, citizen engagement, and two-way communication between governments and the public (Bertot et al., 2010). Social media platforms not only connect people with their friends and watch content but also provides opportunity for the netizens to express their views on varied topics,

environment being one of the important in that list. Through social media posts that may go viral, people can draw public and governmental attention to environmental concerns and potentially influence environmental governance processes (Wang and Jia, 2021).

The rapid proliferation of Internet in India, provides the public with an opportunity to participate in environmental governance through social media platforms, thereby creating additional channels for information exchange, interaction, and participation in environmental governance. Social media platforms provide people with the ubiquity and convenience leading to increasing participation in environmental governance issues (Saha and Mohr, 2013). Research suggests that stakeholders' opinion on the internet through various social media platforms is emerging as the main media to participate in environment related issues affecting the lives of the citizens (Ma et al., 2023). In this regard, social media facilitated environmental governance is emerging as a mechanism for facilitating communication, stakeholder interaction, and potentially more responsive governance. In addition to the accelerated information diffusion, social media also act as a "channel for voicing concerns" that allows people to complain about issues without resorting to collective disruptive action (Kay et al., 2014). By employing tools like data analytics and data mining on the data collected from their social media, governments can obtain information about stakeholder concerns and potentially support more responsive decision-making and citizen interaction (Sullivan, 2014).

The emergence of highly popular social media platforms provides the governments with an unparalleled opportunity to interact with its citizens and thereby adoption of social media in government is a major trend of e-government (Criado et al., 2013; Firmstone & Coleman, 2015). The instant reach of social media helps the government to reach out to its people and educate them about their programmes and policies related to environmental governance. These platforms can provide additional opportunities for citizens to communicate with public authorities and participate in governance processes (Armitage, De Loë, and Plummer, 2012). This process of the generation of knowledge related to environmental governance in which various stakeholders come together can be termed as 'coproduction of knowledge' (Forbes et al., 2006; Pohl et al., 2010). Additionally, the growing use of social media by governments for environmental governance may enhance access to relevant information and create additional opportunities for participation in addressing environmental problems such as pollution, depletion of natural resources, and climate change (Ten Brink, 2011).

From a governance perspective, these developments indicate that social media should not be viewed merely as a communication technology. Rather, it can be understood as a digitally mediated governance mechanism through which government agencies, citizens, civil-society organizations, and other stakeholders exchange information, communicate concerns, and potentially coordinate responses to complex environmental problems. This perspective is consistent with the broader understanding of environmental governance as involving multiple actors and interdependent processes rather than government action alone.

River Ganga, considered as a lifeline for many, holds a spiritual value in the heart of millions. Over the years, rapid industrialization and unchecked dumping of both human and industrial pollutants have led to severe pollution in the river. To address these challenges, the Government of India launched the Namami Gange Programme in 2014 as an integrated river conservation initiative aimed at improving water quality, restoring ecosystems, and promoting sustainable river management. Although existing studies have examined the role of social media in environmental governance, citizen participation, transparency, communication, trust, and stakeholder engagement, these factors are often examined individually or through relatively narrow relationships. Consequently, there remains limited understanding of how multiple institutional, technological, communicative, collaborative, and participation-related conditions are perceived to interact as an interconnected governance system. More specifically, the literature provides limited insight into the relative influence, dependence, and structural positioning of these factors within social media-enabled environmental governance.

To address this gap, the present study develops a Social Media-Enabled Environmental Governance framework in the context of India's Namami Gange Programme and identifies thirteen critical factors that are potentially relevant to governance effectiveness. Further, it presents an integrated Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Interpretive Structural Modelling (ISM) approach to explore expert-perceived

influence and dependence relationships among these factors and to develop an interpretive hierarchy of the resulting structural relationships.

The study is positioned as an exploratory expert-based structural modelling study rather than as an empirical test of causal effects. The DEMATEL–ISM analysis represents the informed perceptions of experts regarding the relationships among the identified factors; therefore, the resulting structure should be interpreted as an expert-informed representation of the governance system and as a basis for propositions that can subsequently be examined through empirical research. This study contributes to the electronic government and environmental governance literature in three ways. First, it proposes a comprehensive framework for understanding how social media can facilitate more participatory, responsive, and connected environmental governance. Second, the proposed framework has novelty in integrating DEMATEL and ISM to analyze complex governance systems, which are dependent on several interrelated variables. Rather than assuming a causal ordering among the thirteen factors *a priori*, the integrated approach enables their relative influence, dependence, and hierarchical positioning to be explored through expert judgement. Third, it identifies potential leverage points that may inform policymakers and programme managers in designing social media-enabled environmental governance strategies. These implications should, however, be understood as expert-informed recommendations rather than empirically validated prescriptions. The findings are expected to support the design of potentially more effective digital engagement strategies for environmental governance initiatives in India, while the transferability of the identified structure to other contexts requires further empirical validation.

LITERATURE REVIEW

This study is grounded primarily in collaborative governance, complemented by insights from digital governance and public value perspectives. Collaborative governance emphasizes the interaction of public agencies, citizens, civil-society organizations, and other stakeholders in addressing complex public problems (Ansell & Gash, 2008; Emerson et al., 2012). This perspective is particularly relevant to environmental governance because river-basin management involves multiple actors with interdependent responsibilities, resources, and interests. Digital governance extends this logic by recognizing that digital platforms can facilitate information exchange, interaction, transparency, and citizen participation between governments and stakeholders (Criado et al., 2013; Medaglia & Zheng, 2017). Public value further emphasizes the extent to which digital government interactions generate outcomes perceived as useful, trustworthy, accessible, and legitimate by citizens (Abdulkareem & Ramli, 2022).

Within this theoretical boundary, social media-enabled environmental governance (SMeEG) is conceptualized as a digitally mediated governance arrangement through which government agencies and other stakeholders exchange environmental information, coordinate activities, communicate with citizens, and facilitate participation. The study does not assume that any construct is inherently causally prior to another. Instead, the literature is used to establish the conceptual relevance of thirteen constructs, while their relative influence and structural positioning are subsequently explored through expert-based DEMATEL–ISM analysis.

Citizen Participation and Engagement

Organizations are increasingly acting on climate and environmental issues. However, to make the impact of these efforts visible, organizations need targeted communication with stakeholders, particularly citizens. Firms are using social media platforms to fulfil this purpose of environmental governance. Giacomini et al. (2020) find that Facebook-based environmental disclosure by Italian public utilities steadily increased, while Giacomini et al. (2021) find increasing use of Facebook by local governments for sustainability disclosure and growing citizen reactions to environmental posts. Nevertheless, citizen participation and engagement transform social media communication into meaningful environmental governance. For example, the Icelandic Coda Terminal case shows that social media can go beyond information sharing by enabling grassroots mobilization, collective agency, and demands for democratic accountability when citizens perceive environmental decision-making as insufficiently transparent or inclusive (Valsdóttir et al., 2026). Therefore, citizen participation and engagement are significant drivers of social media-enabled environmental governance. Citizen participation and engagement create pressure for responsible, accountable, and transparent environmental governance

mechanisms. Social media strengthens citizens' ability to have a collective voice regarding their environmental concerns, which largely necessitates that organizations and authorities act accordingly (Bonsón et al., 2012).

Government Commitment and Policy Support

Government commitment and policy support provide an institutional structure within which organizations can align their environmental actions with policy priorities. Private-sector firms may be weak in environmental governance, thereby reducing public confidence in their environmental actions. Government regulations can provide an accountability mechanism for firms' environmental behaviour and reduce the scope for greenwashing (Kolcava, 2023). Social media-enabled governance mechanisms can also provide a direct feedback channel from citizens to government, potentially strengthening government responses to firms' environmental governance. Government commitment to green policies may also promote energy conservation when supported by public investment and policy measures (Sheng & Liu, 2024), including taxes and subsidies (Villca-Pozo & Gonzales-Bustos, 2019). Government policy support may further motivate firms to improve their environmental governance (Valentine, 2012). Valentine (2012) argues that stronger government regulation may eventually be necessary to ensure long-term environmental sustainability.

Message Quality and Communication Effectiveness

Social media provides the much-needed channel of communication among multiple stakeholders, who can together make an effective realized outcome for environmental governance. However, the desired outcomes largely depend on the message quality of the content and its communication effectiveness. Message clarity and the composition of climate disclosures influence their effectiveness (Anand et al., 2026). Anand et al. (2026) further find that climate risk-management information like governance, strategies, and targets generates more positive outcomes than risk information alone. Environmental communication are mainly more impactful when messages clearly communicate climate change and encourage environmentally responsible behaviour (Chen et al., 2019). The quality and credibility of environmental communication are significant because stakeholders are likely to question sustainability information when firms selectively highlight positive performance or obscure negative outcomes (Diouf & Boiral, 2017).

Environmental Governance Effectiveness

The effectiveness of environmental governance depends on the ability of governance mechanisms to produce meaningful changes in public responses and behaviour. Not every governance tool may be effective. The effectiveness of environmental governance depends on the fulfilment of the needs and concerns of people and thereby having the least resistance from them (Xu et al., 2022). Further, environmental governance becomes more impactful when environmental priorities are embedded in organizational commitment and governance practices, instead of being taken as compliance requirements (Kusuma et al., 2026). Environmental governance strengthens the effectiveness of environmental policies by enabling policy instruments such as environmental taxes to achieve stronger environmental outcomes (Sen et al., 2025).

Digital Literacy of Citizens

Digital literacy among citizens is very important for social media-enabled environmental governance. Citizens should have adequate digital knowledge, along with the ability to access environmental information, participate through social media, and provide meaningful feedback. Without adequate digital literacy, citizens may be excluded from environmental discussions and, in turn, from decision-making in environmental governance. Digital literacy strengthens citizens' ability to understand, question, and participate in digitally mediated environmental governance (Vargas, 2026). Therefore, digital literacy is important for including citizens in digital governance and reducing digital gaps that can limit their participation (Amirova, 2025). Greater confidence in media skills is associated with greater online interaction and civic engagement (Park et al., 2023). In social media-enabled environmental governance, this literacy can help citizens understand environmental information, evaluate messages, express concerns, and participate more effectively in online environmental discussions and decision-making.

Multi-stakeholder Collaboration

Social media is a platform that brings multiple stakeholders in environmental governance, like corporates, governments, citizens, NGOs, etc., to share information and, accordingly, coordinate actions. This helps in connecting various perspectives and resources, making environmental governance more effective. Further, effective environmental policies demand the involvement of multiple stakeholders and participatory processes to incorporate citizens' perspectives into environmental policymaking (Zimmermann et al., 2026). However, effective multi-stakeholder collaboration further demands clarity in communication and the inclusion of diverse stakeholder voices. Managing differences in interests, knowledge, culture, and institutional priorities can improve collaboration and support better environmental outcomes (Rice, 2022). Multi-stakeholder collaboration can bring different stakeholders and previously excluded voices into environmental decision-making, supporting more participatory and sustainable governance. Moreover, effective collaboration depends on trust, cooperation, and the ability to manage unequal power among stakeholders (Acey, 2016).

Public Trust in Government Information

Public trust is created when people perceive government information as trustworthy, which further depends on the transparency and credibility of the same. For this purpose, government use of websites and social media can strengthen public trust by providing information and enabling government–citizen interaction as well as feedback. However, the quality of citizens' experience matters, as successful online interactions can build trust, while poor experiences can mostly ruin it (Hong, 2013). Also, social media-enabled environmental governance partly depends on how citizens receive government information (Porumbescu, 2017). Porumbescu (2017) states that accessible, clear, consistent, and credible information can form citizens' trust, whereas frequent exposure to information may also make citizens more critical of government performance. Further, public trust largely varies when citizens identify government information and online services as useful and reliable, thereby increasing trust and public value (Abdulkareem & Ramli, 2022).

Real-Time Communication and Information Dissemination

Social media-enabled environmental governance empowers firms and governments to share environmental information quickly and directly with citizens and other stakeholders. This improves the timeliness of information, increases awareness, and allows environmental concerns and responses to be communicated promptly. However, the speed and reach of information also create risks of misinformation and disinformation (Jing et al., 2023). Information shared on social media can spread rapidly and unevenly, with some users and sources contributing disproportionately to its dissemination. Content from trusted and suspicious sources can spread quickly, highlighting the importance of the source and user behaviour in information dissemination (Glenski et al., 2018). False or unverified information can spread just as quickly; therefore, detection and verification are important (Bondielli & Marcelloni, 2019). Overall, many factors are involved in real-time communication and information dissemination. Source characteristics, frequency, and user behaviour are among these factors.

Governance Transparency and Accountability

When environmental information, actions, and decisions are more visible to citizens and stakeholders, it allows them to question organizations, provide feedback, and monitor environmental commitments and performance. This makes a significant and effective contribution to environmental governance. Social media plays a pivotal role in this. First, transparency can support accountability in environmental governance by making information more visible. However, its effectiveness largely depends on how information is provided and used. Digital technologies can create new forms of real-time transparency that may strengthen environmental governance (Gupta et al., 2020). Good governance and environmental oversight can help firms provide more transparent carbon information and improve environmental accountability, especially where regulations are weak (Tuffour et al., 2026).

Real-Time Communication and Information Dissemination

Social media-enabled environmental governance strengthens the communication channel among corporate, government, and other stakeholders to disseminate environmental information, that too as real-time communication and information sharing, which makes it quick and targeted. This enables on-time delivery of information. Therefore, real-time communication and information dissemination increase awareness and allow environmental concerns and responses to be communicated speedily. However, the speed and reach of information also create risks of misinformation and disinformation (Jing et al., 2023). Social media is empowered to spread Information very rapidly and also unevenly, with some users and sources contributing to erratic dissemination. Content can originate from trusted and suspicious sources. Both spread quickly without discriminating against the source. This necessitates the importance of the source and user behaviour in information dissemination (Glenski et al., 2018). Detection and verification of sources are also very important (Bondielli & Marcelloni, 2019). Overall, many factors are involved in real-time communication and information dissemination. The source, frequency, and user behaviour are among many.

Governance Transparency and Accountability

Governance transparency and accountability increase when citizens and other stakeholders have more exposure to actions from government and firms. When environmental information, more exposure to actions from government and firms. Good governance and environmental oversight can benefit firms by providing more transparent carbon information and improving environmental accountability, especially where regulations are weak (Tuffour et al., 2026). The visibility of actions further enables the citizen to monitor organizations and provide feedback. This makes a significant and effective contribution to environmental governance. Social media has a significant role in the process of environmental governance, transparency, and accountability. In addition, transparency can support accountability in environmental governance by making information more visible. However, its effectiveness largely depends on how information is disseminated and used as well. Environmental governance is largely strengthened by digital technologies that may further start new forms of real-time transparency (Gupta et al., 2020).

Environmental Awareness and Education

Citizens are more likely to understand environmental problems when they have environmental awareness and education. This extends to how they react and respond to climate actions taken by firms and governments. Social media makes environmental information easier to access, share, and discuss. In this way, social media-enabled environmental governance can strengthen participation and engagement among various stakeholders in environmental governance. However, environmental awareness and education do not necessarily translate directly into improved environmental governance performance. They can increase public participation, which may in turn contribute to environmental governance performance (de Andrade, 2024; Niu et al., 2022). Stronger communication and stakeholder engagement are also required to translate awareness into effective sustainability governance (Alhusaini, 2025). Digital tools and communication can further expand access to environmental information and make environmental education more inclusive (Thanh & Thanh, 2026).

Data Analytics and Social Listening Capability

Data analytics and social listening capability enables organizations to identify and filter relevant discussions on social media when they concern environmental issues. However, effective use of these capabilities requires the ability to recognize diverse voices and avoid losing important information during analysis (Herrera & Gjøsæter, 2026). This can help authorities understand stakeholder views and respond to environmental concerns more effectively (Yavuz & Tire, 2023). Although social media analytics provides strategic value to organizations, firms need to be capable of collecting, analysing, and using social media data effectively (Fitzpatrick & Weissman, 2021).

Influencer and Community Leader Participation

Influencers and community leaders are role models for most of the citizens, who guide them towards what is

right and wrong. Where to accept and where to object is usually dependent on influencers' and leaders' opinions. Influencers and community leaders often have established trust and reach within communities. Opinion leaders guide online communities through active participation and the sharing of high-quality information, helping build relationships and expand their influence (Wu et al., 2021). They can therefore help spread environmental information, shape public awareness, and encourage people to participate in environmental issues. Their involvement can connect environmental initiatives with wider public audiences and encourage collective action. Influencers can shape users' decisions and participation through their position and reach within online communities (Arenas-Márquez et al., 2014).

Digital Infrastructure and Platform Accessibility

Infrastructure is an important component of all communication channels. This extends to social media-enabled environmental governance in terms of digital infrastructure and also to accessibility. Accessible digital platforms provide the infrastructure needed to support inclusive and sustainable digital participation, while unequal digital access may also limit these benefits (Zeqiri et al., 2025). The process is carried out, for example, when accessible public digital platforms support firms' environmental management by providing data and infrastructure that makes better carbon management and therefore reduce emission intensity (Jin & Wang, 2025). In addition, digital platforms make sustainability information more accessible and strengthen the monitoring of environmental performance through interactive tools and data dashboards (Dahab et al., 2025). Digital infrastructure and accessible online platforms can improve access to government information, reduce barriers to participation, and make public processes more transparent and responsive (Misal et al., 2026; Savitska, 2025).

Table 1 shows conceptual table defining all thirteen constructs, specifies their operational boundaries/dimensions, indicates the expected direction of influence, identifies the supporting theoretical lens, and gives possible measurement indicators.

Table 1: conceptual table with thirteen constructs

Code	Construct	Operational definition / boundary	Key dimensions	Expected direction	Theoretical basis / possible indicators
V1	Citizen participation and engagement	Citizen interaction with, feedback to, and involvement in environmental-governance processes through social and digital channels; excludes offline participation not connected to the SMeEG process.	Voice; feedback; interaction; participation	Positive toward governance effectiveness	Collaborative governance / public value; frequency of participation, quality of feedback, perceived influence (Fung, 2006; Eckerd & Heidelberg, 2020)
V2	Government commitment and policy support	Visible institutional commitment, policy direction, resources and administrative support for digital environmental governance; excludes general political commitment unrelated to the programme.	Policy clarity; resources; leadership support; enforcement	Positive	Collaborative governance / digital governance; policy clarity, resource availability, leadership support (Ansell & Gash, 2008; Criado et al., 2013)
V3	Message quality and communication effectiveness	Clarity, relevance, credibility and usefulness of environmental messages communicated through social media; excludes communication volume alone.	Clarity; relevance; credibility; usefulness	Positive	Digital governance / communication; message clarity, credibility, relevance (Lovejoy & Saxton, 2012; Anand et al., 2026)
V4	Environmental governance	Perceived ability of the governance system to respond to environmental issues	Responsiveness; implementation	Outcome (N/A as antecedent)	Public value / environmental governance; responsiveness, implementation quality,

	effectiveness	through effective coordination, responsiveness, accountability and implementation; not a direct ecological outcome measure.	on; accountability; perceived effectiveness		stakeholder-perceived effectiveness (Newig et al., 2018)
V5	Digital literacy of citizens	Citizens' ability to access, understand, evaluate and use digital/social-media information for environmental participation; excludes general education unrelated to digital use.	Access; comprehension; evaluation; use	Positive	Digital governance / participation; digital skills, information evaluation, online interaction (Park et al., 2023)
V6	Multi-stakeholder collaboration	Coordination and joint working among government, citizens, NGOs, communities, firms and other relevant actors; excludes one-way consultation.	Coordination; joint problem solving; inclusiveness; trust	Positive	Collaborative governance; coordination quality, inclusiveness, joint action (Ansell & Gash, 2008; Emerson et al., 2012)
V7	Public trust in government information	The extent to which citizens perceive government environmental information as credible, reliable, transparent and useful; excludes general political trust.	Credibility; reliability; consistency; usefulness	Positive	Public value / digital governance; perceived information credibility, reliability, usefulness (Hong, 2013; Porumbescu, 2017)
V8	Real-time communication and information dissemination	Timeliness, reach and responsiveness of digital environmental information flows; excludes message quality itself.	Timeliness; reach; responsiveness; frequency	Positive	Digital governance; response time, reach, information timeliness (Criado et al., 2013; Sullivan, 2014)
V9	Governance transparency and accountability	Visibility of environmental decisions, actions and performance information together with mechanisms that enable scrutiny and answerability; excludes transparency without accountability mechanisms.	Disclosure; traceability; scrutiny; answerability	Positive	Collaborative governance / public value; transparency, accountability, feedback mechanisms (Gupta et al., 2020; Meijer, 2013)
V10	Environmental awareness and education	Citizens' understanding of environmental problems, programme actions and responsible environmental behaviour arising from information and educational activity; excludes generic environmental attitudes.	Knowledge; awareness; understanding; behavioural orientation	Positive	Environmental governance / communication; environmental knowledge, awareness, education (Niu et al., 2022)
V11	Data analytics and social listening capability	Organisational ability to collect, interpret and use social-media signals to identify stakeholder concerns and support responsive action; excludes analytics unrelated to governance decisions.	Data collection; analysis; issue detection; responsiveness	Positive	Digital governance; analytical capability, issue detection, response use (Medaglia & Zheng, 2017; Fitzpatrick & Weissman, 2021)
V12	Influencer and community leader participation	Participation of trusted opinion leaders or community figures who disseminate information, frame environmental issues or mobilise audiences; excludes	Reach; credibility; framing; mobilisation	Positive	Collaborative/participatory governance; reach, credibility, mobilisation (Wu et al., 2021)

		paid promotion without community influence.			
V13	Digital infrastructure and platform accessibility	Availability, reliability, accessibility and usability of digital/social-media infrastructure required for inclusive participation and communication; excludes unrelated ICT infrastructure.	Availability; reliability; accessibility; usability	Positive	Digital governance; access, platform availability, usability (Amirova, 2025; Medaglia & Zheng, 2017)

Synthesis and Research Gap

The literature indicates that social media-enabled environmental governance is not a single-channel communication phenomenon. It involves an interconnected set of institutional, technological, communicative, informational, collaborative, and participation-related conditions. Collaborative governance explains the importance of coordination and stakeholder interaction; digital governance explains the role of digital infrastructure, communication, information exchange, and participation; and public-value perspectives highlight the importance of trust, accessibility, responsiveness, and usefulness.

However, the existing literature tends to examine these factors separately or within relatively narrow relationships. Consequently, it remains unclear how the thirteen constructs identified in this study are perceived by experienced practitioners and experts to interact as a system within a large-scale environmental governance programme. In particular, the literature does not establish whether institutional and technological conditions are perceived as upstream drivers, whether collaboration and trust operate as intermediary mechanisms, or whether communication and awareness function primarily as linkage conditions between enabling resources and participation.

This study therefore does not assume a priori that the literature establishes a causal hierarchy among the thirteen constructs. Instead, it uses the literature to establish their conceptual relevance and then applies an exploratory DEMATEL–ISM structural modelling approach to investigate expert-perceived patterns of influence and dependence in the context of India's Namami Gange Programme. The resulting structure should consequently be interpreted as an expert-informed structural representation and set of propositions for subsequent empirical validation, rather than as evidence of observed causal effects.

Before the main expert elicitation, the questionnaire was pretested with six participants who were not included in the final expert panel. The participants represented environmental governance, river-basin management, government digital communication, civil-society engagement, monitoring and evaluation, and environmental data analytics. The pretest assessed construct clarity, conceptual overlap, interpretation of the DEMATEL influence scale, directionality of pairwise judgements, questionnaire instructions, and completion burden. Participants also completed a trial 13×13 influence matrix using the 0–4 DEMATEL scale. Based on their feedback, construct definitions and questionnaire instructions were refined; an illustrative pairwise-judgement example was added; environmental awareness was distinguished from citizen participation; real-time communication was defined in terms of timeliness and responsiveness; multi-stakeholder collaboration was clarified; and self-influence cells were explicitly specified as zero. The pilot was intended to establish content clarity and procedural usability rather than statistical reliability or psychometric validity.

Integrated DEMATEL-ISM Model Development

The integrated model is developed in two sequential stages. First, employing DEMATEL (Decision-Making Trial and Evaluation Laboratory), with inputs from experts, variables are categorized into a cause group that acts on the system and an effect group that receives the impact. In the second stage, ISM (Interpretive Structural Modelling) uses the total-relation matrix to partition the variables into hierarchical levels and develop directed graph for the system to organize the variables in a hierarchy. Integration of these two methods provides a comprehensive understanding of the variables, as DEMATEL quantifies the strength and direction of influence and an ISM model arranges them into a hierarchy.

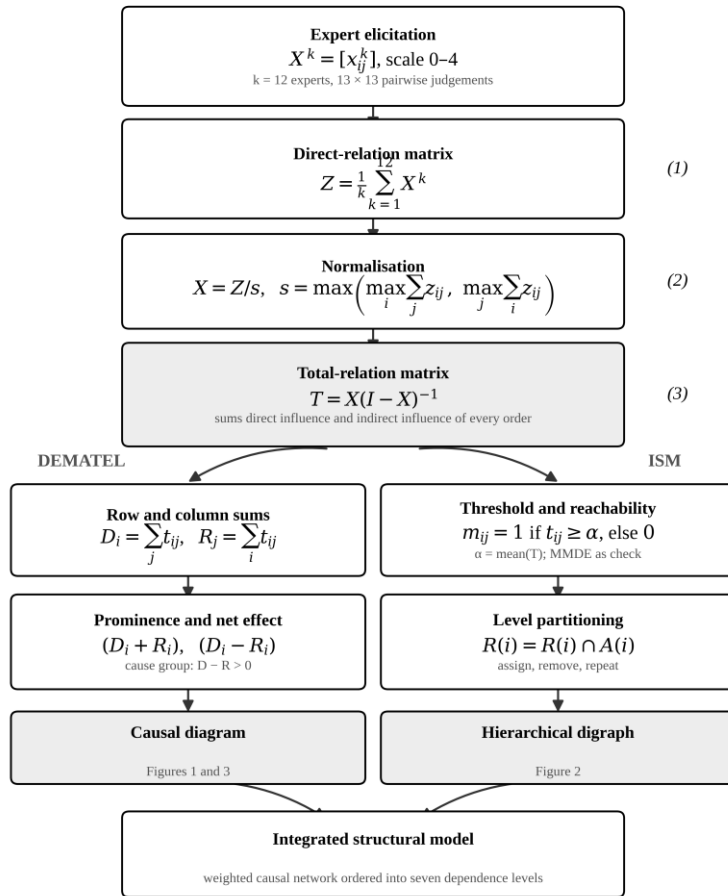


Figure 1. Methodological framework of the integrated DEMATEL–ISM procedure

Variables and expert panel

Thirteen variables were carried forward from the literature review. Rather than retaining the strategic–operational–outcome grouping implied by the review, the variables were entered into the elicitation without any imposed ordering, so that the hierarchy would emerge from the expert judgements themselves. Table 2 lists them with the layer subsequently identified by the analysis.

Table 2. Variables in the model

Code	Variable	Emergent layer
V13	Digital Infrastructure and Platform Accessibility	Level VII
V2	Government Commitment and Policy Support	Level VII
V5	Digital Literacy of Citizens	Level VII
V9	Governance Transparency and Accountability	Level VII
V6	Multi-Stakeholder Collaboration	Level VI
V11	Data Analytics and Social Listening Capability	Level V
V7	Public Trust in Government Information	Level V
V3	Message Quality and Communication Effectiveness	Level IV
V8	Real-Time Communication and Information Dissemination	Level IV
V10	Environmental Awareness and Education	Level III
V12	Influencer and Community Leader Participation	Level III
V1	Citizen Participation and Engagement	Level II
V4	Environmental Governance Effectiveness	Level I

A single elicitation serves both methods. Classical ISM requires its own structural self-interaction matrix, but

Alqahtani & Makki (2023) and Chen (2021) established that the total-relation matrix produced by DEMATEL carries more information than an ISM reachability matrix and can be converted into one directly. Therefore, there is no need for a second questionnaire and a substantial computational burden. This integrated procedure has since been applied widely, and it is the procedure followed here.

Judgements were collected from a panel of twelve respondents ($k = 12$) with direct involvement in river-basin governance, government digital communication, or environmental civil-society work in the study context. Each respondent assessed the direct influence of every variable on every other variable on the conventional five-point DEMATEL scale, where 0 denotes no influence, 1 very low, 2 low, 3 high and 4 very high influence. This produces twelve non-negative 13×13 matrices with zero diagonals.

Expert recruitment was purposive and criterion-based: eligibility required direct professional exposure to at least one of the governance domains represented in the model. The inclusion criteria: (i) at least five years of relevant professional or research experience; (ii) direct involvement in one or more of the governance domains represented by the study constructs; (iii) sufficient familiarity with environmental governance and/or digital/social media-enabled public engagement; and (iv) willingness to complete the expert elicitation independently.

Suggested exclusion criteria: individuals with less than five years of relevant experience; individuals whose work was unrelated to environmental/public/digital governance; respondents unable to assess pairwise influence among the constructs; duplicate respondents; or questionnaires with substantial unanswered items. Based on the criterion, the following experts were contacted (Table 3):

Table 3. Expert Panel

ID	Role / Sector	Governance domain represented	Relevant exp (years)
E01	Senior Programme Officer, river-basin/environmental mission (Govt)	River-basin governance; policy support; governance accountability	16
E02	Deputy Director, State Pollution Control Board	Environmental regulation; monitoring; transparency/accountability	14
E03	Digital Communications Lead, public-sector environmental programme	Digital governance; real-time communication; message quality	11
E04	District-level Water Resources / River Management Officer	River-basin governance; stakeholder coordination; policy implementation	18
E05	Programme Manager, Environmental NGO	Civil-society participation; multi-stakeholder collaboration; citizen engagement	12
E06	Senior Social Media / Public Engagement Specialist	Digital participation; social listening; citizen engagement	9
E07	Professor / Researcher, Environmental Governance	Collaborative governance; participation; environmental governance effectiveness	15
E08	Monitoring & Evaluation Specialist, public environmental programme	Governance effectiveness; data analytics; accountability	10
E09	Municipal / Urban Environmental Management Officer	Local environmental governance; citizen participation; digital services	13
E10	Community Engagement Coordinator, environmental civil	Community participation; environmental awareness;	8

	society	stakeholder collaboration	
E11	Public Policy / Digital Governance Consultant	Digital governance; policy support; public information; transparency	17
E12	Environmental Data / Analytics Specialist	Social listening; data analytics; information dissemination	7

Questionnaire development followed the construct definitions and operational boundaries in the conceptual table. The instrument asked experts to rate pairwise direct influence only; no respondent was asked to rank the final hierarchy. Because the current manuscript does not document incomplete questionnaires or item-level missingness, no unreported imputation rule has been assumed here.

DEMATEL computations

The individual matrices were aggregated by arithmetic means to form the initial direct-relation matrix $Z = [z_{ij}]$, reported in Table 4:

$$Z = (1/k) \sum X^k, \quad k = 1, \dots, 12 \quad (1)$$

Table 4. Aggregate direct-relation matrix Z

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13
V1	—	0.67	0.50	3.42	0.58	0.42	0.75	0.67	0.25	0.58	0.50	0.92	0.58
V2	0.92	—	1.67	1.17	1.33	3.50	2.42	1.33	3.17	1.08	2.67	0.92	0.83
V3	3.83	0.75	—	2.83	0.50	0.33	0.58	3.92	0.58	4.00	0.75	4.00	0.67
V4	0.75	0.83	0.92	—	0.67	0.42	0.42	0.67	0.75	0.75	0.58	0.67	0.50
V5	1.42	1.00	1.33	1.25	—	3.50	2.83	2.17	0.83	0.83	2.67	1.00	3.00
V6	1.58	0.42	2.83	0.83	0.83	—	3.50	2.42	0.58	1.67	3.58	1.67	0.83
V7	1.50	0.42	3.33	0.92	0.42	0.33	—	3.50	0.67	2.75	3.50	2.92	0.42
V8	3.67	0.33	4.00	2.58	0.42	0.67	0.75	—	0.67	3.92	1.00	3.92	0.33
V9	0.50	3.08	1.58	1.33	0.75	3.67	2.50	1.58	—	1.50	2.83	1.00	1.08
V10	3.50	0.58	0.33	2.75	0.92	0.42	0.00	0.92	0.50	—	0.75	3.58	0.33
V11	1.75	0.33	3.42	1.25	0.50	0.42	3.50	3.08	0.33	2.58	—	2.83	0.67
V12	3.50	0.50	0.83	2.50	0.67	0.33	0.25	0.67	0.50	3.00	0.50	—	0.17
V13	0.92	0.83	1.58	0.83	3.17	3.58	2.50	1.58	1.00	1.17	2.50	1.33	—

Z was normalised by the largest of its row and column sums, $s = 24.75$, giving the normalized direct-relation matrix X:

$$X = Z / s, \quad s = \max (\max \sum_j z_{ij}, \max \sum_i z_{ij}) \quad (2)$$

Because every element of X lies in [0, 1] and at least one row or column sums to unity, the power series of X converges, and the total-relation matrix T — capturing direct together with all higher-order indirect influence — is obtained in closed form:

$$T = X + X^2 + X^3 + \dots = X(I - X)^{-1} \quad (3)$$

Table 5. Total-relation matrix T

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13
V1	0.095	0.060	0.097	0.218	0.060	0.064	0.087	0.102	0.044	0.112	0.085	0.128	0.054
V2	0.279	0.088	0.276	0.264	0.140	0.256	0.261	0.265	0.201	0.282	0.286	0.286	0.112
V3	0.375	0.100	0.160	0.326	0.097	0.105	0.133	0.299	0.091	0.353	0.155	0.365	0.087
V4	0.121	0.065	0.108	0.085	0.060	0.064	0.074	0.100	0.061	0.116	0.086	0.117	0.049
V5	0.306	0.120	0.272	0.273	0.097	0.256	0.278	0.299	0.115	0.279	0.288	0.297	0.193
V6	0.306	0.090	0.303	0.252	0.112	0.096	0.270	0.291	0.094	0.300	0.288	0.312	0.101

V7	0.303	0.087	0.303	0.255	0.092	0.102	0.122	0.310	0.094	0.330	0.262	0.348	0.079
V8	0.368	0.085	0.298	0.314	0.091	0.111	0.136	0.162	0.091	0.349	0.161	0.361	0.074
V9	0.270	0.199	0.277	0.272	0.121	0.262	0.264	0.276	0.089	0.301	0.293	0.294	0.119
V10	0.266	0.069	0.110	0.237	0.084	0.077	0.076	0.130	0.063	0.120	0.110	0.255	0.055
V11	0.307	0.083	0.303	0.264	0.095	0.104	0.245	0.294	0.081	0.321	0.137	0.341	0.087
V12	0.256	0.063	0.119	0.220	0.071	0.068	0.077	0.115	0.059	0.220	0.094	0.119	0.045
V13	0.284	0.113	0.272	0.252	0.209	0.257	0.263	0.274	0.118	0.284	0.278	0.302	0.084

Row and column sums of T give the direct-plus-indirect influence exerted and received by each variable:

$$D_i = \sum_j t_{ij}, \quad R_j = \sum_i t_{ij} \quad (4)$$

Their sum ($D + R$) measures prominence, the total involvement of a variable in the system, and their difference ($D - R$) measures net effect: variables with a positive value belong to the cause group and are net transmitters of influence, while those with a negative value belong to the effect group and are net receivers. Table 6 reports both.

Table 6. Prominence, net effect and DEMATEL classification

Code	Variable	D	R	D + R	Prominence rank	D - R	Group	Role
V13	Digital Infrastructure and Platform Accessibility	2.991	1.138	4.129	13 of 13	+1.852	Cause	Strong driver
V9	Governance Transparency and Accountability	3.037	1.203	4.240	11 of 13	+1.835	Cause	Strong driver
V2	Government Commitment and Policy Support	2.995	1.221	4.215	12 of 13	+1.774	Cause	Strong driver
V5	Digital Literacy of Citizens	3.073	1.331	4.404	9 of 13	+1.742	Cause	Strong driver
V6	Multi-Stakeholder Collaboration	2.815	1.823	4.638	8 of 13	+0.992	Cause	Strong driver
V7	Public Trust in Government Information	2.686	2.285	4.970	6 of 13	+0.401	Cause	Secondary driver
V11	Data Analytics and Social Listening Capability	2.664	2.523	5.187	3 of 13	+0.140	Cause	Secondary driver
V3	Message Quality and Communication Effectiveness	2.645	2.897	5.542	1 of 13	-0.252	Effect	Linkage
V8	Real-Time Communication and Information Dissemination	2.602	2.917	5.519	2 of 13	-0.315	Effect	Linkage
V10	Environmental Awareness and Education	1.650	3.366	5.016	5 of 13	-1.716	Effect	Dependent

V12	Influencer and Community Leader Participation	1.527	3.525	5.052	4 of 13	-1.998	Effect	Dependent
V4	Environmental Governance Effectiveness	1.107	3.231	4.338	10 of 13	-2.124	Effect	Ultimate outcome
V1	Citizen Participation and Engagement	1.206	3.538	4.744	7 of 13	-2.332	Effect	Dependent

The Influence Structure Revealed by DEMATEL

Seven variables fall in the cause group. Four of them form a tightly clustered set of strong net transmitters, with net effects between +1.74 and +1.85. These four variables are digital infrastructure and platform accessibility (V13), governance transparency and accountability (V9), government commitment and policy support (V2), and digital literacy of citizens (V5). Multi-stakeholder collaboration (V6) follows at +0.99. Public trust in government information (V7) and data analytics and social listening capability (V11) sit close to the axis at +0.40 and +0.14. The remaining six variables are in the effect group, with citizen participation (V1, -2.33) and environmental governance effectiveness (V4, -2.12) occupying the most dependent positions in the system.

Prominence tells a different and complementary story. The two highest D + R values belong to message quality and communication effectiveness (V3, 5.54) and real-time communication and information dissemination (V8, 5.52). Therefore, these two variables are best read as linkage elements. They are the busiest nodes in the network, simultaneously highly driven and highly connected within the system. Accordingly, communication represents an important interface through which institutional capacity and public response are connected in the expert-perceived structure.

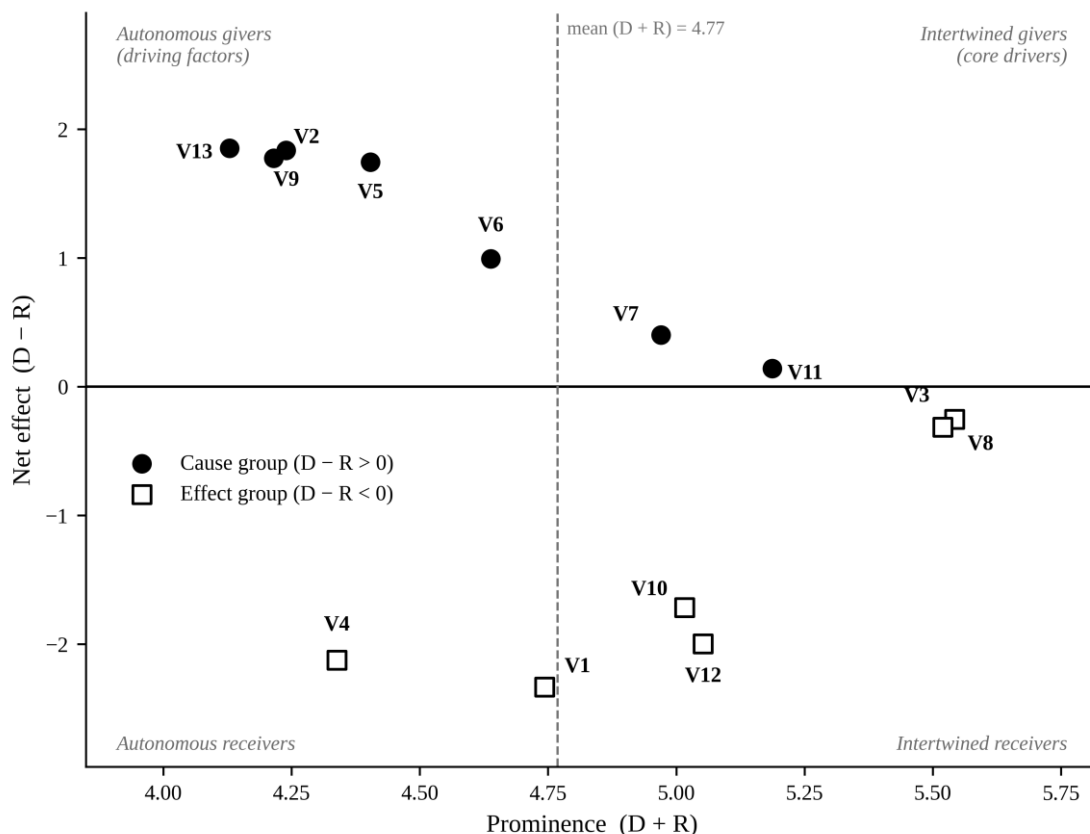


Figure 2. DEMATEL prominence–influence diagram

The four strongest net transmitters rank last on prominence. Digital infrastructure (V13) is thirteenth of thirteen at 4.13, with government commitment (V2), transparency (V9), and digital literacy (V5) immediately above it. The highest values of D in the system are between 2.99 and 3.07, and the lowest values of R are between 1.14 and 1.33. Low prominence does not imply weak involvement; rather, these variables appear foundational because few variables are positioned below them in the structure. In the DEMATEL analysis, none of the variables is positioned below these foundational variables; therefore, their R values are relatively small, leading to lower D + R values even when D is high. They therefore appear in the upper-left quadrant of Figure 2, which is consistent with their foundational position in the structure. This position contrasts with message quality (V3) and real-time communication (V8). These variables rank first and second on prominence at 5.54 and 5.52 because they both influence and are influenced by other variables, which is characteristic of linkage variables. Further, according to DEMATEL, citizen participation is the most dependent variable rather than governance effectiveness. Effectiveness receives slightly less total influence because much of the system's influence reaches it through participation. This indicates that participation occupies an important intermediary position between the other variables and environmental governance effectiveness in the expert-perceived structure.

ISM Model Development - Level Partitioning

To convert the weighted network into a hierarchy, T was dichotomized at a threshold α set to the mean of all its elements. Since every element reaches itself, it yields the initial reachability matrix in Table 7.

Table 7. Initial reachability matrix, with driving and dependence power

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	Driving power
V1	1	0	0	1	0	0	0	0	0	0	0	0	0	2
V2	1	1	1	1	0	1	1	1	1	1	1	1	0	11
V3	1	0	1	1	0	0	0	1	0	1	0	1	0	6
V4	0	0	0	1	0	0	0	0	0	0	0	0	0	1
V5	1	0	1	1	1	1	1	1	0	1	1	1	1	11
V6	1	0	1	1	0	1	1	1	0	1	1	1	0	9
V7	1	0	1	1	0	0	1	1	0	1	1	1	0	8
V8	1	0	1	1	0	0	0	1	0	1	0	1	0	6
V9	1	1	1	1	0	1	1	1	1	1	1	1	0	11
V10	1	0	0	1	0	0	0	0	0	1	0	1	0	4
V11	1	0	1	1	0	0	1	1	0	1	1	1	0	8
V12	1	0	0	1	0	0	0	0	0	1	0	1	0	4
V13	1	0	1	1	1	1	1	1	0	1	1	1	1	11
Dep.	12	2	9	13	2	5	7	9	2	11	7	11	2	

Level partitioning proceeded iteratively. For each variable the reachability set, the antecedent set and their intersection were derived. Any variable whose reachability set equals the intersection occupies the highest remaining level, since it influences nothing above itself. Such variables were assigned to that level and removed. The procedure was repeated on the reduced set. Seven iterations exhausted the variable set, producing the partition in Table 8.

Table 8. Level partition

Level	Variables	Structural role
I	V4 Environmental Governance Effectiveness	Ultimate outcome of the system
II	V1 Citizen Participation and Engagement	Sole direct antecedent of the outcome
III	V10 Environmental Awareness and Education; V12 Influencer and Community Leader Participation	Awareness and mobilization layer
IV	V3 Message Quality and Communication Effectiveness;	Communication mechanisms (linkage)

	V8 Real-Time Communication and Information Dissemination	
V	V7 Public Trust in Government Information; V11 Data Analytics and Social Listening Capability	Trust and intelligence capabilities
VI	V6 Multi-Stakeholder Collaboration	Pivotal coordination mechanism
VII	V2 Government Commitment and Policy Support; V5 Digital Literacy of Citizens; V9 Governance Transparency and Accountability; V13 Digital Infrastructure and Platform Accessibility	Foundational institutional and technical enablers

The digraph is shown in Figure 3 and is read from the bottom upward. Four foundational enablers are positioned beneath multi-stakeholder collaboration. The hierarchy then places trust and analytical capability above collaboration, followed by the two communication mechanisms, environmental awareness and influencer mobilization, citizen participation, and environmental governance effectiveness. This sequence represents the expert-perceived structural hierarchy rather than an empirically validated temporal or causal sequence.

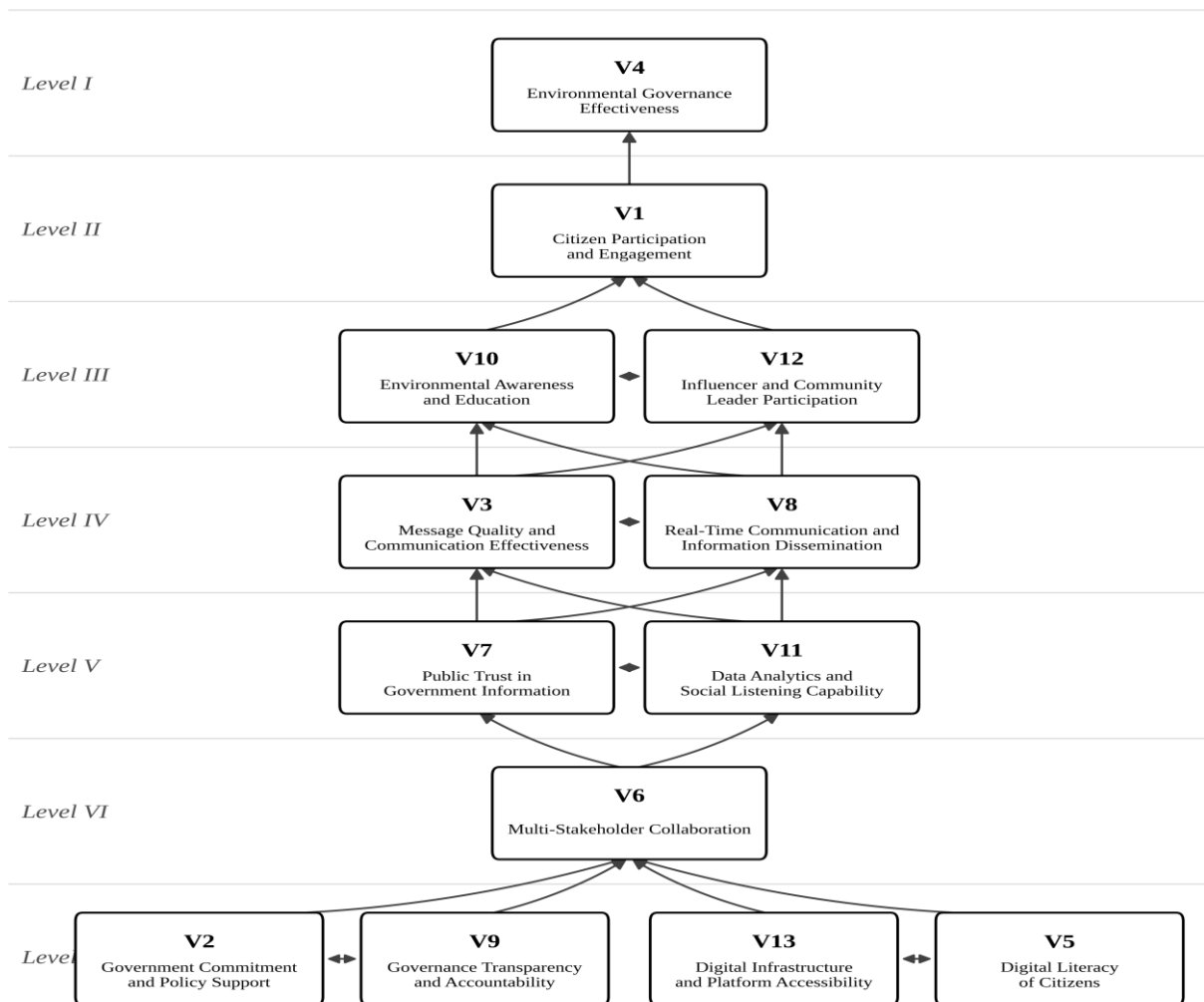


Figure 2. ISM digraph of the structural hierarchy.

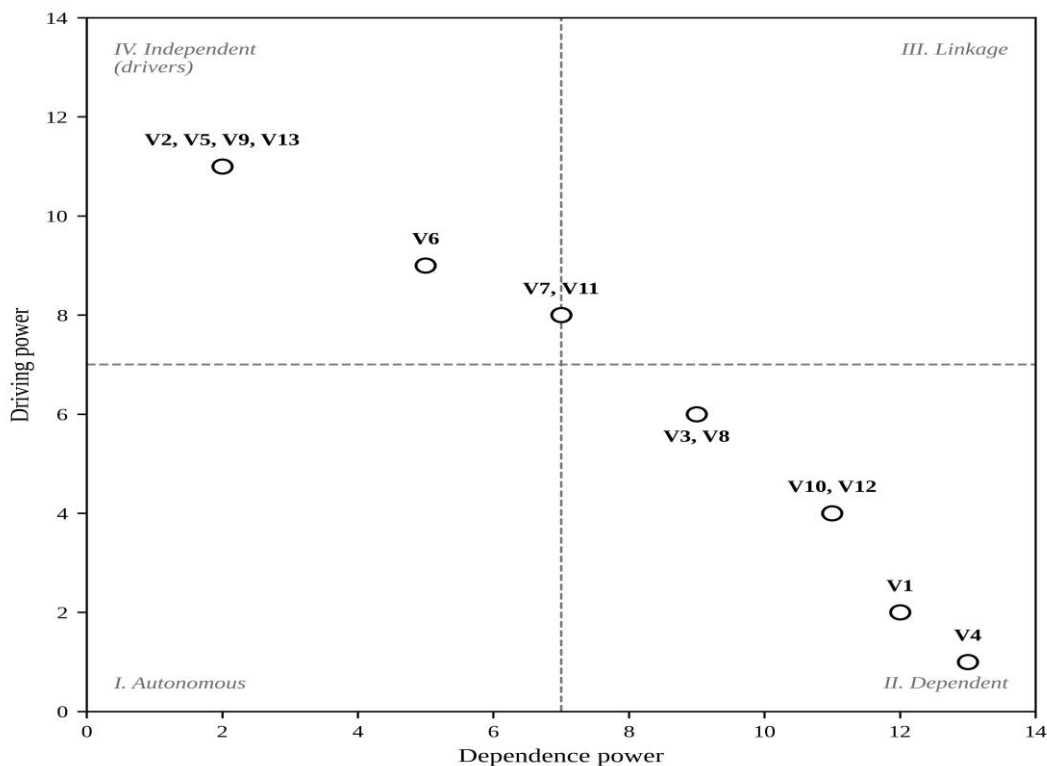
MICMAC classification

Plotting driving power against dependence power classifies the variables into four quadrants and provides an independent check on the hierarchy. Table 9 reports the result.

Table 9. MICMAC classification

Code	Variable	Driving power	Dependence power	Quadrant
V2	Government Commitment and Policy Support	11	2	Independent
V5	Digital Literacy of Citizens	11	2	Independent
V9	Governance Transparency and Accountability	11	2	Independent
V13	Digital Infrastructure and Platform Accessibility	11	2	Independent
V6	Multi-Stakeholder Collaboration	9	5	Independent
V7	Public Trust in Government Information	8	7	Linkage
V11	Data Analytics and Social Listening Capability	8	7	Linkage
V3	Message Quality and Communication Effectiveness	6	9	Dependent
V8	Real-Time Communication and Information Dissemination	6	9	Dependent
V10	Environmental Awareness and Education	4	11	Dependent
V12	Influencer and Community Leader Participation	4	11	Dependent
V1	Citizen Participation and Engagement	2	12	Dependent
V4	Environmental Governance Effectiveness	1	13	Dependent

As shown in Figure 3, no variable falls in the autonomous quadrant. This indicates that the thirteen variables form an interconnected system with no peripheral element identified by the model. The four foundational enablers appear as independent variables with maximal driving power and minimal dependence. The model highlights that governance effectiveness and citizen participation are strongly dependent variables. Further, public trust and data analytics occupy the linkage quadrant, indicating that these variables connect with higher levels of the hierarchy. The one divergence from the DEMATEL outcomes concerns message quality and real-time communication. DEMATEL identifies them as linkage variables on prominence grounds. However, MICMAC places them in the dependent quadrant because their driving power falls just below the midpoint. The two classifications measure different properties: weighted influence intensity versus binary reachability. These variables transmit substantial influence but to comparatively few destinations, all above them in the hierarchy.


Figure 3. MICMAC driving power–dependence power classification

DISCUSSION

The structure that emerges differs in an important respect from how the constructs are usually organized in the literature on social media and environmental governance. In general, the literature tends to sort variables into strategic, operational, and outcome categories; however, this arrangement provides less information about the interdependence among variables. The hierarchy derived in the present study provides an interpretive structural ordering rather than a taxonomy. Level VII contains two institutional variables and two technological ones. Government commitment and policy support are at the bottom of the model, which is consistent with the emphasis of Jenkins-Smith and Sabatier (1994) on stable institutional backing for policy processes. It is also in line with Bressers and Rosenbaum (2003) on the need for clear direction and adequate resourcing. Governance transparency and accountability is also positioned at the base of the model. Its importance is illustrated by Meijer (2013), which highlights the role of reduced information asymmetry in the visibility of governmental action. Digital infrastructure and digital literacy also appear at the same level. Huisman (2021) treats infrastructure as a prerequisite for meaningful participation in digital society, while Hamish et al. (2021) links it to the inclusiveness of e-government. Thus, the model places these variables at the base of the structural hierarchy.

This paper improves our understanding of collaborative governance. Research supports that collaboration improves problem solving capacity by pooling resources (Ansell and Gash, 2008; Emerson et al., 2012). The model hierarchy demonstrates that even when a programme has political commitment, digital infrastructure, still it would have no impact above Level VI. Emerson and Nabatchi (2015) note that collaborative mechanism depends on communication mechanisms encouraging transparency and continuous engagement. The ISM model places public trust in government information and data analytics and social listening capability at Level V, which precedes the communication layer. Song and Lee (2016) suggests that trust shapes citizens' willingness to engage with digital government services. Medaglia and Zheng (2017) and Criado et al. (2013) both argue that social media analytics improves governmental responsiveness. Trust and analytics are interdependent as without trust even well-targeted messages are not considered seriously by the public, while without analytics messages would not reach the targeted population. Both variables fall in the linkage quadrant of the MICMAC classification, where instability is expected. Both of these variables are an outcome of variables below their level and act positively on the effectiveness of communication above their level.

Message quality and real-time communication occupy Level IV. Lovejoy and Saxton (2012) report that clear communication strategies raise stakeholder participation. Both variables at Level IV have the two highest prominence scores in the DEMATEL system. Petty and Cacioppo (1986) highlighted that message quality governs attitude formation because credible and relevant information is more likely to be processed and acted upon. This credibility would lead to environmental awareness and education at Level III. The other variable at Level III is influencer and community leader participation, which along with environmental awareness lead to citizen participation. Kollmuss and Agyeman (2002) treat awareness as a precursor to pro-environmental behaviour and digital platform plays an important role in raising this awareness (Confetto et al., 2023). The role of opinion leaders in environmental awareness has been raised by Rogers (2003) while Ojala (2015) argues that motivation to produce more effective environmental action can be achieved by combining factual information with emotional engagement. According to the ISM model, citizen participation, which occupies Level II is a highly dependent variable in the system. This result is in line with Fung (2006), which treat participation as a resultant outcome. This is also supported by Newig et al. (2018) that confirms that participatory mechanisms generally improve environmental decision-making and implementation when stakeholders are meaningfully engaged.

Theoretical Implications

This paper provides three contributions. The first is a hierarchical rather than categorical account of social media-enabled environmental governance. The second is the identification of multi-stakeholder collaboration as a structural bottleneck, a claim considerably stronger and more falsifiable than the observation that collaboration is beneficial. The third is the relocation of public trust from the foundations of the framework to its causal core. Therefore, it brings the environmental communication literature into line with the broader

finding in public administration, associated with Porumbescu (2017) among others, that trust conditions the reception of state communication rather than simply preceding it. The pairing of methods itself is consequential. DEMATEL alone would have quantified prominence and net effect but left the system flat. ISM alone would have produced the hierarchy without revealing that the communication mechanisms are the most prominent nodes in the network despite occupying a middling level. Each result requires the other method to become visible.

Practical Implications

For managers of large river-basin programmes, the hierarchy functions as a sequencing rule. Resources committed to communication tooling and content will not yield participation unless collaboration at Level VI is operating and the trust and analytics capabilities at Level V are in place. Therefore, managers should formalize coordination between agencies and publish monitoring data as routine practice. Furthermore, managers should build social-listening capacity inside the programme rather than contracting it out. Indicators should be tracked from the bottom of the structure upward, since a failure at any level caps everything above it. An unexplained plateau in participation is diagnosed most efficiently by inspecting the levels beneath it in sequence rather than by intensifying activity at the top. The linkage position of trust and analytics identifies them as the most economical intervention points. Hence, it carries a large share of the system's influence and responds comparatively quickly to targeted effort.

LIMITATIONS AND SCOPE FOR FUTURE RESEARCH

Like all other research studies, the present study also suffers from some limitations. The structure rests on expert judgement, which captures informed belief about influence rather than influence as observed. A panel of different professional compositions might also weigh the enablers differently, and the present panel contains no citizen representatives. Both methods draw on a single questionnaire, as formalized by Chen (2021). Therefore, the ISM structure cannot serve as independent corroboration of the DEMATEL result. The model is finally static, specifying which variables depend on which but saying nothing about how long a change at the base takes to reach the top. Each of these limitations opens the avenue for future research. Future researchers could conduct robustness checks using alternative thresholds, alternative aggregation methods, and preferably fuzzy or grey DEMATEL–ISM, while reporting whether the hierarchy changes under those specifications. The findings are specific to Namami Gange, a nationally sponsored programme with high political visibility and a river of exceptional cultural significance. Comparative application across river-basin programmes in other developing economies would establish which parts of the hierarchy travel. It also would test the study's claim to relevance beyond India, which the present design cannot itself support. Stronger validation could be achieved through a second independent panel, stakeholder interviews, a citizen survey, social-media content analysis, structural equation modelling, or regression using participation and environmental-performance indicators from the Namami Gange Programme.

Ethical Considerations: Participation was voluntary, informed consent was obtained from all experts, and participant confidentiality and anonymity were maintained throughout the study.

Data Availability Statement: The aggregated data and methodological details are provided in the manuscript. Additional non-identifiable data may be available from the corresponding author upon reasonable request, subject to confidentiality considerations.

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