A Mathematical Framework for the ACACAE Communication Model: Quantifying Degrees of Government–Citizen Dialogues

Abhay shukla

Research Scholar, UPRTOU Prayagraj

ARTICLE DETAILS	ABSTRACT
Research Paper **Accepted:** 20-09-2025 **Published:** 10-10-2025 **Keywords:** *E-Governance; Citizen Engagement; ACACAE Model; GC-Index; Communication Effectiveness; Participatory Governance; Quantitative Framework.*	The digital revolution has moved us from an era of two-valiance to a new, interactive mode of governing, based on dialogue and citizen-centrism instead of a one-way reading of information directed at an audience. Unfortunately, contemporary assessment frameworks continue to depend on the insufficient and inadequate practice of only using output-based measures, and in doing so, they neglect to measure either a deep, or lived experience of engagement. In this research, we bring forth a new quantitative framework – The Government–Citizen Communication Effectiveness Index (or "GC-Index") – which has been purpose built as a novel way to address this systemic gap The GC-Index provides a way to operationalize the ACACAE Communication Lifecycle (the Additive Stages were: Awareness-Education, Communication/Consultation, Adoption, Collaboration, Advocacy and Empowerment) in order to measure the intensity (or level) of direct engagement. This score is then taken and multiplied by Systemic Dampeners, which included trust, inclusivity, feedback effectiveness, and the inverse of barriers, to take into consideration the effects of institutional integrity and failure; and when utilized in this mathematical model, the extension of the dialogue can be quantified on a continuum from 0 (no dialogue) to 1 (fully empowered). This is a tool to provide policymakers with a diagnostic approach to continuously calibrate both the relative placement of the effectiveness

of government–citizen communication and manage prioritization of interventions.

Introduction

The 21st-century digital revolution has revolutionized governance from a largely administrative, one-way exercise to an interactive, participatory, and co-creative endeavor. Governments all over the world have increasingly employed e-governance models that strategically utilize Information and Communication Technologies (ICTs) to improve the delivery of services, increase citizen involvement, and build democratic discussion (Shukla, 2025). In contrast to conventional governance structures, which were driven by the logic of bureaucratic hierarchy and one-way communication, the new model prioritizes reciprocity, inclusivity, and co-production between citizens and governments. This change is not just technological but also systems-oriented re-engineering of governance—an effort to enhance legitimacy, accountability, and public trust.

However, as encouraging as the promise of e-governance is, government–citizen communication is notoriously hard to measure. Current frameworks of measurement depend on inappropriate, narrow, output-based indicators—like traffic to the website, number of consultations undertaken, or number of messages put out by government (Systems Theory, 2020). These measures are constrained in two senses. Firstly, they reward visible activity over depth of effect, thus neglecting the lived experience of the citizen. Second, they reaffirm a "single-loop" approach to governance, in which delivery efficiency is given more weight than dialogue quality, responsiveness, and citizen empowerment (Chatfield & Reddick, 2018).

As a result, government communication becomes flawed and tends to be viewed as unresponsive, untrustworthy, or ineffective, weakening the very causes of transparency and participatory governance (Parnell, 2024). The costs of this failure are especially clear in times of national crises—like public health crises—where failed communication has taken a direct toll in the dissemination of misinformation, panic, and diluted institutional legitimacy (Systems Theory, 2020). They indicate an urgent need for an integrated, citizen-focused, and measurable approach to evaluating the quality of government–citizen communication.

The Government–Citizen Communication Effectiveness Index (GC-Index)

To remedy this systemic void, this research proposes the Government–Citizen Communication Effectiveness Index (GC-Index) as a new quantitative diagnostic measure and framework for evaluating

effectiveness in dialogues between government and citizens. The GC-Index is a citizen centered diagnostic tool that considers each citizen's journey through sequential, ultimately linked stages of engagement and the systemic enablers and disablers that fundamentally determine whether the measure of dialogue will reliably achieve its democratic purpose. The GC-Index has two core conceptual foundations:

1. The ACACAE Communication Lifecycle (Additive Stages) - The ACACAE Communication Lifecycle quantifies the citizens' journey through six additive stages of engagement: Awareness, Communication/Consultation, Adoption, Collaboration, Advocacy, and Empowerment. Each stage is additive, in that each subsequent stage reflects a greater level of engagement (Shukla, 2025). The model begins with the idea that communication is not static, but cumulative, moving from basic awareness of information to meaningful engagement and ultimately empowerment.

2. Systemic Enablers and Inhibitors (Multiplicative Dampeners): We have included four systemic factors external to the pillars of communication—Trust (T), Inclusivity (I), Feedback (F), and Barriers (B) that will all act as multiplicative modifiers of communication effectiveness. The design reflects the insight that systemic deficits (e.g., Variations in trust, exclusion, or lack of responsiveness) can diminish strong communication initiatives disproportionately. The multiplicative structure ensures that even a single weak systemic factor can significantly lower the overall effectiveness score, modeling the practical realities of governance failure.

In formula to calculate, the GC-Index combines these two pillars into a single formula where all variables normalized on a scale of 0-1 enabling precision, comparability, and scalability to a different governance context.

The ACACAE Communication Lifecycle: Measuring Additive Progression

The ACACAE model illustrates a framework for evaluating government-citizen engagement that is organized hierarchically.

Awareness: The extent to which citizens are aware of a policy or program; this is the first stage, and involves a one-way flow of communication.

Communication/Consultation: The extent messages are clear, relevant, and accessible; this represents a two-way flow of communication.

Adoption: The demonstration of behavioral change, uptake of a service, or internalization of policy objectives or goals.

Collaboration: The extent to which citizens are engaged in policy discussions, co-designing, and dialogue.

Advocacy: The ability to understand enough to defend, explain or promote principles associated with policy.

Empowerment: The observable economic, social, political, legal, digital, and psychological impacts on citizens and their lives.

These phases are additive; each phase is dependent on the previous phase. The ACACAE model shows a method of assessing communication with an emphasis on cognitive and behavioral change that utilizes principles of participatory governance.

The Systemic Dampeners: Accounting for Institutional Integrity

Although sequential engagement is essential, it is inadequate without strong systemic enablers. The GC-Index incorporates four multiplicative dampeners:

Trust (T): The first and foremost component—trust in the credibility and integrity of government communications from citizens.

Inclusivity (I): The agency's ability to reach, especially, marginalized and vulnerable groups equitably.

Feedback effectiveness (F): agency's responsiveness, timeliness, and quality of the action addressed to citizen inputs.

Proportions of barriers (B): The extent of bureaucratic, technical, or social barriers, citizens experience to communicate.

The multiplicative architecture ensures that systemic weakness applies as "mighty dampers". For example, even when the outreach, communication, and adoption scores are strong, the overall effect of engagement is severely diminished by the lower score of feedback (e.g., 0.55 on a scale of 0 to 1). In practice, however, we know that unresponsiveness or exclusion overrides their strong outreach governance strategies.

2. Literature Review

The way in which government interacts with citizens is changing, given the rise of digital governance and the role of information and communication technology (ICTs). Traditional forms of governance that adhere to top-down service provision are slowly being replaced by dialogic governance that emphasizes inclusion, transparency, and citizen engagement (Malodia et al., 2021). Yet, despite progress, many e-governance initiatives still experience challenges with low uptake, one-way communication, and low levels of citizen trust (Tremblay-Cantin et al., 2023).

There have been several academic conceptual models proposed to explain various forms of government-citizen engagement. The ACACAE model is valued as an important model to support the framework for studying dialogue (Shukla, 2025). The six phases - Awareness, Consultation, Adoption, Collaborative Involvement, Advocacy, Empowerment - show an evolutionary process of civic engagement in digital governance. However, what is still absent is a mathematical framework to facilitate quantification of measures and plot the degree of dialogue on a continuous scale from 0 (no communication) to 1 (meaningful and fully empowered dialogue).

Evolution of E-Governance and Communication Models

The concept of e-governance emerged in the late 1990s with the spread of government websites and online portals (Mittal & Kaur, 2013). Early definitions emphasized administrative efficiency and the automation of transactions (Layne & Lee, 2001; Moon, 2002). These first-generation models positioned ICT as a tool for information dissemination and service delivery. Over time, the discourse expanded to include transparency, accountability, and citizen empowerment (Ndou, 2004; Ho, 2002).

Malodia et al. (2021) develop an integrated conceptual framework of e-governance that provides a connection between the two disciplines of public administration and information systems research. Their findings from 168 interviews with stakeholders reveal e-governance to be multi-faceted, identifying citizen orientation as the most significant factor contributing to project success, followed secondly by channel and technology orientation. Moreover, while focusing on citizen orientation as the main component for project successes, the authors highlight the moderating affects of the digital divide, political stability, and shared understanding. They argue that citizen dialogue is central to sustainable e-governance.

Notably, despite these theoretical advancements, many e-governance implementations in developing contexts are experienced as failures. Research suggests that 60%-80% of such public sector initiatives fail or only partially succeed (Furuholt & Wahid, 2008; Tremblay-Cantin et al., 2023). Additionally, Elkadi

(2013) argues that these failures do not simply waste resources but weaken citizen trust and political legitimacy. These observations reveal a gap in developing models which could quality and quantity the nature and depth of communication between governments and citizens.

Over the years, scholars have proposed a number of stage-based models of e-governance. For example, Layne and Lee (2001) conceptualized a four-stage model advancing from cataloguing, transaction, vertical integration, and then ultimately horizontal integration. Scholta et al. (2019) furthered this work by introducing proactive governance as a progression stage. Though each of these models is important to the overall understanding of e-governance, each remains heavily pointed towards the administrative. The ACACAE model represents a significant shift by explicitly embedding two-way communication and empowerment as integral elements of governance.

Citizen Adoption of E-Government Services

The question of citizen adoption remains one of the most urgent issues facing digital governance. Tremblay-Cantin et al. (2023) carried out a systematic review of 32 studies and created a high-level framework for adoption factors, organized into four groupings: individual factors, beliefs of individuals, government factors, and behavior of user adoption. Trust, perceived usefulness, and perceived ease of use were the factors identified with the strongest influence related to adoption, while interactivity and security awareness were less frequently studied. Individual factors, such as self-efficacy, autonomy, and awareness, are particularly strong factors in determining whether the citizen will engage with e-services (Ajzen, 1991; Venkatesh et al., 2003). Sociodemographic factors such as age and education and income level help shape digital inclusion (Tremblay-Cantin et al., 2023). As an example, older citizens or those whose academic education is limited, often experience difficulty in moving from paper-based to digital engagement.

Trust is noteworthy as it represents an especially important dimension. Citizens are much more likely to adopt e-services if they trust both the technology and the government offering the technology (Ejdys et al., 2020). Conversely, concerns that regard privacy, risk, and security also deter citizens from adopting e-services (Lopes et al., 2019). In India, for example, Mittal and Kaur (2013) state that "low literacy, lack of awareness and limited exposure to IT have compounded the digital divide."

In addition, economic and infrastructure barriers can be hindrances to greater adoption. Implementation costs are high, financial resources are limited, and per capita income is low, which impedes access to and sustainability of e-governance systems (Mittal & Kaur, 2013). Other technical barriers also limit the

effectiveness of digital platforms, including interoperability, scalability, and language localization (Bhatnagar, 2004). These barriers are relevant to the ACACAE framework, since they can stop citizens from moving beyond the early stages of awareness and consultation.

Participatory Communication and Networked Governance

Conventional governance models tended to be one-dimensional and focus on the flow of information from the government to citizens. The concepts of participatory communication and networked governance have emerged with an emphasis on dialogic and collaborative processes. For example, Misuraca (2007) and Chadwick (2011) suggest that two way communication can contribute to the development of some level of trust and facilitate participation in decision-making that goes beyond service delivery. Fung (2006) identifies deliberative democracy and the capacity for citizens to help formulate policies and govern as contributors. Networked governance may provide frameworks for collaborative planning and organizational action (OECD, 2001), which emphasize horizontal collaboration between multiple governments, citizens and intermediary organizations. Many of the deliberative perspectives are part of the ACACAE model (Shukla, 2025) of collaborative environmental action, where communication is viewed on a continuum from passive awareness to empowered participation.

Historical precedents also provide background for theoretical engagement with participatory, and governing response processes. For example, Kautilya's Arthashastra indicates the legitimacy of the ruler is premised on the good of the subjects (Shamasastry, 1929). UNDP (2008) and the World Bank (1994) also present governance at a minimum as the efficient administration of authority and the inclusiveness, accountability and participatory processes associated with the exercise of authority.

Digital tools such as social media, open data platforms, and mobile applications have accelerated this participatory turn. UNDESA et al. (2012) document how ICTs have created real-time feedback loops and decentralized decision-making. Yet, structural inequalities such as gender divides, rural–urban disparities, and resistance to political change remain significant obstacles (World Bank, 2016).

The ACACAE Communication Model

The ACACAE Communication Model, introduced by Shukla (2025), provides a systematic framework for analyzing government–citizen interactions in digital governance. Rooted in participatory communication and networked governance, the model conceptualizes six progressive stages through which citizen engagement evolves in e-government initiatives:

1. Awareness: The engagement process begins with generating awareness, where governments are informing the public about schemes, e-services, and ways to access them. Awareness is produced via mass media campaigns, digital advertisements, social media, local community meetings, and direct communications.

Nature of interaction: One-directional in nature, with information flowing from government to citizen.

Purpose: To introduce the public to the availability, purpose, and benefits of digital platforms.

Engagement level: Low, as citizens are still primarily recipients of information.

2. Communication and Consultation: There are now instances of two-way interaction between citizens and government officials. Citizens are beginning to provide feedback, ask questions, and clarify matters via surveys, public hearings, online forums, and grievance mechanisms.

Nature of interaction: Dialogue-based, but still in a preliminary stage.

Role of government: Answer questions, clarify processes, and build trust through responsiveness.

Purpose: To ensure that citizens understand the utility, processes and accessibility of e-government services.

3. Adoption: Once clarity and trust is reached, citizens begin to move towards the active adoption of digital services. They will begin to use e-government services for practical purposes, such as:

Applying for certificates or licenses, Paying bills or taxes, Accessing welfare schemes (e.g., direct cash payments), Submit grievance electronically.

Nature of interaction: Active and used of the services, indicating behavioral change.

Objective: To translate awareness and consultation into practical engagement and regular use of digital platforms.

4. Contribution: Citizens have transitioned from being passive recipients of services to active contributors. They provide feedback, suggestions, and complaints about the operation of platforms, and may be involved in co-designing policies or monitoring service delivery (e.g. platforms like MyGov in India).

Nature of relationship: Co-creation and participatory governance.

Government's role: Responsiveness is essential - being aware of and acting on what citizens have said to be more inclusive.

Focus: Creating a governance environment that places citizen inputs at the centre of service development.

5. Advocacy: At this point, satisfied citizens become advocates of e-government initiatives. After witnessing efficiency, transparency, and accountability, they help promote digital services voluntarily within their community and social networks.

Nature of relationship: Peer-to-peer influence and public endorsement.

Focus: Expanding the reach and credibility of the e-governance initiative through citizen-led promotion.

Positives: Increases uptake and contributes to a positive social environment related to digital governance.

6. Empowerment: Empowerment is the peak of engagement; citizens are not merely users of services; they are purely active participants in governance—for example, influencing decision-making, holding institutions accountable, and supporting ongoing democratic engagement.

Example: If a citizen filed a complaint on an online complaint portal and had their issue resolved in a timely manner on multiple occasions, the feeling of empowerment would grow alongside their trust in digital governance.

Nature of interaction: Shared responsibilities between state and citizen.

Goal: To create a shared psychological and institutional trust that citizens will see their needs addressed through digital governance.

Shukla (2025) points out that although the model serves as a solid theoretical guide, its empirical operationalization is constrained within rural India. The primary data from Purvanchal found awareness was typically informal, consultation mechanisms inadequate, and inter-agency collaboration absent. Adoption was primarily due to compulsion rather than empowerment. Only youth-led initiatives were advocacy-based, whereas empowerment was scarce owing to digital illiteracy, communication barriers, and infrastructural shortcomings.

This underscores the need to develop quantitative indicators to gauge advancement in these phases. With no measurable markers, governments stand to be stuck at preliminary phases of awareness and consultation, never reaching collaborative or empowered forms of governance.

Towards a Mathematical Framework for Quantification

The quantification challenge of government–citizen dialogues calls for a mathematical model. According to Malodia et al. (2021), e-governance research necessitates multi-dimensional, multi-level models that can encompass varying stakeholder viewpoints. Tremblay-Cantin et al. (2023) offer a framework of variables—trust, perceived usefulness, and ease of use—that might be used as input parameters to such a model.

Research Gaps and Future Directions

Although there are rich theoretical debates, the following research gaps remain. First, while the majority of studies concentrate on adoption and trust, they overlook the upper-level processes of advocacy and empowerment. Second, empirical models that model communication dynamics quantitatively are lacking. Third, the cultural, linguistic, and gendered dimensions of communication are understudied mathematically. Closing these gaps will necessitate interdisciplinary approaches that integrate political science, communication theory, and computational modeling.

The literature reviewed highlights the transformative power of e-governance in creating interactive, participatory government. Yet more remains to be done to progress beyond awareness and consultation to true empowerment. The ACACAE model presents a systematic route to thinking through this transformation, but it will only prove useful in practice if mathematical formulations exist that can measure levels of dialogue. Using the findings of e-governance adoption research, participatory communication models, and empirical observations from India, subsequent research can develop strong indices capturing the depth of government–citizen dialogue and inform policymakers towards inclusive democratic governance.

3. Research Question

How can a mathematical framework based on the ACACAE communication model be constructed and applied to quantify the degree of government–citizen dialogues between 0 and 1?

4. Research Objectives

1. To develop a mathematical framework for the ACACAE communication model that quantifies the degree of government–citizen dialogues on a scale ranging from 0 (absence of communication) to 1 (complete communication).

2. To empirically validate the proposed mathematical model by applying it to real-world e-governance (G2C) communication scenarios and assessing the effectiveness of government–citizen interaction across the six stages of the ACACAE model.

5. Research methodology

This investigation employs a mixed-method approach that will include quantitative measurement through mathematical modelling and empirical validation and qualitative representation through demonstrations. The ACACAE lifecycle is divided into six additive stages: Awareness (A1), Communication/Consultation (C1), Adoption (A2), Collaboration (C2), Advocacy (A3), and Empowerment (E1). Each stage is quantified on a 0-1 scale by cumulatively summarizing survey data, use of systems, and citizens' interviews. The additive stage score is expressed as:

S (Stage Score) =A1+C1+A2+C2+A3+E/6

This score is adjusted by systemic dampeners—**Trust (T), Inclusivity (I), Feedback effectiveness (F), and Barriers (B)**—to capture institutional integrity:

SF (Product of Systemic Factors) =$(S×T×I×F×(1−B))^{1/4}$

GC INDEX = (A1+C1+A2+C2+A3+E/6) $(S×T×I×F×(1−B))^{1/4}$

GC INDEX = S×SF

Data Collection and Illustration

A hypothetical dataset of 100 samples will be utilized to demonstrate the model, where respondents will be scored on each of the six stages and systemic factors. This allows us to demonstrate how scores for dialogue differ across a variety of citizen experiences.

Data Analysis

The survey responses are based on probabilities, and the scores are summed across all samples to determine the engagement index. Descriptive statistics, a regression model, and sensitivity analysis will provide validation of the framework.

Ethical Considerations

Regardless of hypothetical modeling, the design of the data is bound by privacy, informed consent, and fairness principles.

Expected Output

The study provides the government with a scalable engagement index to quantify and compare government–citizen dialogue, demonstrated with data based on 100 samples.

6. Discussion

This research question, "What empirical framework can be developed and applied, which is based on the ACACAE communication model, to quantify the extent of government–citizen dialogues, within a spectrum of 0 to 1?", identifies a significant gap in current e-governance research. Governments increasingly move away from the traditional top-down administrative model to dialogic governance where transparency, inclusion, and citizen engagement is at the forefront (Malodia et al., 2021; Tremblay-Cantin et al., 2023). Digital tools, and in particular, ICT, offer both promise and challenges as they serve to deepen the interaction in communication; low use rates, one-directional communication, structural inequality, and low levels of citizen trust still present challenges (Mittal & Kaur, 2013; Ejdys et al., 2020; Lopes et al., 2019). Existing frameworks describing the stages of citizen engagement (i.e., the ACACAE model) are largely conceptual and articulate the progression in potential engagement (Awareness, Consultation, Adoption, Contribution, Advocacy, and Empowerment), but do not provide opportunities to empirically assess movement between the stages (Shukla, 2025). Policymakers are limited in objectively measuring how far they moved along the engagement continuum to meaningful government–citizen dialogue without a mathematical framework, and they are unable to compare levels of engagement between regions or initiatives. Therefore, the development of a framework iterating the qualitative engagement stages into a continuum from 0 (no dialogue) to 1 (full dialogue and empowerment) is needed for measurement, assessment, and improvement of e-governance initiatives (Malodia et al., 2021; Tremblay-Cantin et al., 2023).

The primary research objective, aimed at building a mathematical framework to measure engagement, originates from a desire to operationalize the ACACAE model. Each phase represents a different type of interaction ranging from a passive consumption of information in the Awareness stage to a fully engaged relationship and shared decision-making with citizens in the Empowerment stage (Shukla, 2025). By assessing these phases based on quantifiable metrics, we can achieve a more robust understanding of citizen engagement and a normalized index of engagement on a continuum from zero to one. Indicators

could comprise of metrics like the percentage of citizens aware of services, frequency at which feedback is submitted, and an active or passive adoption of e-services, of actively participating in co-creation practices, or advocating for specific behaviors among peers and in communities, or overall empowerment, as propelled by surveys or behavioral proxies (Tremblay-Cantin et al., 2023; Mittal & Kaur, 2013). Weighting the indicators based on the relative importance of each phase can ensure the framework embodies the quantity and quality of citizen engagement (Malodia et al., 2021).

The empirical validation of the framework is the second research purpose in order to ensure that the framework, while not able to stand on its own as a theory, has practical meaning. Once the tool is applied to a real-world e-governance context (e.g., an online grievance portal, or a participatory platform such as MyGov), the researcher(s) will be able to collect data about how citizens utilize the tool, whether they provide feedback, and citizen perceptions of the e-government context (Ndou, 2004; Bhatnagar, 2004). Researchers can then calculate stage-wise scores and use these scores to normalize an overall dialogue index, which is useful for benchmarking, or comparing and monitoring engagement across initiatives. Empirical validation also helps to identify barriers that prevent citizens from progressing through the stages, including digital literacy, socioeconomic factors, trust issues, and infrastructural limitations, which are especially relevant in developing contexts (Mittal & Kaur, 2013; Furuholt & Wahid, 2008).

The literature emphasizes that stage-specific dynamics and citizen adoption aspects influence engagement. In general, early stages, such as Awareness and Consultation, can be scored and measured effectively by access and feedback metrics, whereas later stages, Contributions, Advocacy, and Empowerment, will require proxy measures for either behavior or attitude to interpret meaningful engagement (Shukla, 2025; Fung, 2006). Research also accounts for the moderating effects of trust, perceived usefulness, self-efficacy, and infrastructural and economic limitations, all of which must be included in the mathematical framework (Ajzen, 1991; Venkatesh et al., 2003; Ejdys et al., 2020). By combining quantitative indicators with these contextual factors, the proposed framework offers a comprehensive, multi-dimensional approach to measuring citizen–government dialogue (Malodia et al., 2021; Tremblay-Cantin et al., 2023).

Illustration Analysis of the ACACAE mathematical government citizen (GC) Formula

To better understand how the proposed **ACACAE mathematical framework** works in quantifying government–citizen dialogues, a **hypothetical dataset of 100 samples** is used. Each respondent is scored across the **six dialogue stages** (Awareness, Communication, Adoption, Collaboration, Advocacy, and Empowerment) along with key **systemic factors** (Trust, Inclusiveness, Feedback, and Barriers).

$$\text{GC INDEX} = (A1+C1+A2+C2+A3+E/6)\ (T\times I\times F\times(1-B))^{1/4}$$

This step-by-step example demonstrates how raw values are normalized, combined, and finally transformed into a single **GC Index**, which ranges between **0 and 1**.

Step 1: Normalization of Raw Scores

Raw scores collected from the survey or dataset must first be converted into a normalized scale (0–1) to allow comparability. The formula is:

 Normalized Value= (raw mean – minimum value)/ (Highest value - minimum value)

This ensures all stages and factors are expressed on the same scale.

For example, assume the following normalized values after applying the formula:

- Awareness (A1) = **0.68**

- Communication (C1) = **0.62**

- Adoption (A2) = **0.58**

- Collaboration (C2) = **0.70**

- Advocacy (A3) = **0.52**

- Empowerment (E) = **0.63**

Systemic Factors:

- Trust (t1) = **0.66**

- Inclusiveness (i1) = **0.69**

- Feedback (f1) = **0.72**

- Barrier (b1) = **0.43** (note: barriers reduce communication, so we later take *1 - b1* to capture its inverse effect).

Step 2: Calculation of Stage Score (S)

The six ACACAE dialogue stages are averaged to obtain the **Stage Score (S)**, which represents the **direct communication intensity** between government and citizens.

Stage score (S) =A1+C1+A2+C2+A3+E1/6

Stage score (S) = 0.68+0.62+0.58+0.70+0.52+0.63/6

$$S = 3.73/6 = .62166$$

Step 3: Calculation of Systemic Factors (SF)

Systemic factors capture the **environmental enablers or constraints** of dialogue. These are combined using the **geometric mean**, because it balances the influence of each factor and penalizes weak dimensions more than the arithmetic mean would.

Formula:

Product of Systemic Factors (SF) = $(T \times I \times F \times (1-B))^{1/4}$

$$SF = (0.66 \times 0.69 \times 0.72 \times (1-0.43))^{1/4}$$

$$SF = \sqrt[4]{.18689} = 0.66$$

Step 4: Calculation of Government–Citizen (GC) Index

The final **GC Index** combines the **Stage Score (S)** and the **Systemic Factors (SF)**:

GC Index=S×SF

Substituting values:

$$GC\ Index = .62166 \times 0.66 = .4102$$

Step 5: Interpretation of the GC Index

The final Government-Citizen (GC) Index score demonstrates the degree of dialogue between government institutions and citizens on the continuum from 0 to 1. Scores in the 0.00 to 0.33 range signify a low degree of dialogue, suggesting one-way communication whereby citizens wield little power within government decision-making. Scores in the 0.34 to 0.66 range signify a medium degree of

dialogue, suggesting two-way communication exists, though often inconsistent, not fully inclusive, and lacking institutional support. Scores above 0.67 indicate a high degree of dialogue, characterized by trust, belonging, empowerment, and mechanisms for sustained dialogue. In the current example, the GC Index score is 0.41, which falls within the medium range. This score suggests some communication exists, but the communication is only partially effective, and the government can make additional improvements and efforts to foster trust, reduce barriers, and expand citizen empowerment to increase the degree of government-citizen communication towards the high degree of communication.

Conclusion

The purpose of this study is to respond to the question: "What empirical framework can be developed and used, using the ACACAE communication model, to measure the amount of government–citizen dialogues that exist along a continuum of 0 to 1?" This project identifies a notable gap in the scholarship of e-governance, where the majority of models of citizen engagement are conceptual and identify a need for empirical measurement tools. With the development of a mathematical framework that operationalizes the stages of the ACACAE model—Awareness, Communication, Adoption, Collaboration, Advocacy, and Empowerment—into quantifiable measures, this study contributes a practical framework to measure the depth and inclusiveness of a government–citizen dialogue.

The proposed Government–Citizen (GC) Index captures a level of engagement that describes the continuum of stage-level engagement and how systemic influences (e.g., trust, inclusiveness, feedback on barriers) play a role within the government–citizen engagement process. As a measurement tool, the framework allows for the processes of normalization, aggregation, and geometric balancing to produce a quantity of available dialogue—from 0 or no dialogue to 1 or full empowerment and ongoing dialogue. The illustration of a hypothetical dataset demonstrates how governments can benchmark communication, identify weak stages, and prioritize interventions.

In the end, the framework provides a concrete empirical instrument for policymakers and researchers to track, compare, and promote citizen engagement across different initiatives and locations. Future research will indeed need to engage additional validation of the framework across different contexts, as well as actual datasets, fine-tune the indicators for applicability considering cultural, technological, and socio-economic contexts.

References

Bhatnagar, S. (2004). E-government: From vision to implementation. Sage Publications.

Chadwick, A. (2011). Explaining the failure of an online citizen engagement initiative: The role of internal institutional variables. Information Polity, 16(3), 233–249.

Ejdys, J., et al. (2020). Trust in government and technology as determinants of e-government adoption. Journal of Organizational Information Systems, 34(2), 245–263.

Elkadi, H. (2013). Success and failure factors for e-government projects. Egyptian Informatics Journal, 14(2), 165–173.

Fung, A. (2006). Varieties of participation in complex governance. Public Administration Review, 66(s1), 66–75.

Furuholt, B., & Wahid, F. (2008). E-government challenges and the role of usability in developing countries. Government Information Quarterly, 25(4), 717–728.

Ho, A. T. (2002). Reinventing local governments and the e-government initiative. Public Administration Review, 62(4), 434–444.

Ivanyna, M., & Shah, A. (2011). Citizen-centric governance indicators: Measuring and monitoring governance by listening to the people. *CESifo Forum*, *12*(1), 59-70.

Kim, D. K. D., & Kreps, G. L. (2020). An analysis of government communication in the United States during the COVID-19 pandemic: Recommendations for effective government health risk communication. *World Medical & Health Policy, 12*(4), 398–412. https://doi.org/10.1002/wmh3.363

Layne, K., & Lee, J. (2001). Developing fully functional e-government: A four-stage model. Government Information Quarterly, 18(2), 122–136.

Lopes, A., et al. (2019). Perceived risks and trust in the adoption of digital government services. Government Information Quarterly, 36(3), 493–502.

Mabillard, V., & Zumofen, R. (2025). A mixed-method approach to evaluating citizen engagement on government social-media pages. *Media and Communication*, *13*(1), 10354. https://doi.org/10.17645/mac.10354

Malodia, S., Dhir, A., Mishra, M., & Bhatti, Z. A. (2021). Future of e-Government: An integrated conceptual framework. Technological Forecasting and Social Change, 173, 121102. https://doi.org/10.1016/j.techfore.2021.121102

Mittal, P., & Kaur, A. (2013). E-governance – A challenge for India. International Journal of Advanced Research in Computer Engineering & Technology, 2(3), 1196–1199.

Moon, M. J. (2002). The evolution of e-government among municipalities: Rhetoric or reality? Public Administration Review, 62(4), 424–433.

Ndou, V. (2004). E-government for developing countries: Opportunities and challenges. The Electronic Journal of Information Systems in Developing Countries, 18(1), 1–24.

OECD. (2001). Citizens as partners: Information, consultation and public participation in policy-making. OECD Publishing.

Rita, P., Antonio, N., & Nassar, L. (2025). A critical analysis of government communication via X (Twitter). *Big Data and Cognitive Computing*, *9*(9), 242. https://doi.org/10.3390/bdcc9090242

Scholta, H., et al. (2019). From one-stop shop to no-stop shop: Configuring digital government. Government Information Quarterly, 36(1), 11–26.

Shamasastry, R. (1929). Kautilya's Arthashastra. Mysore Printing and Publishing House.

Shukla, A. (2025). The interactive government-citizen communication through e-governance: Introduction of the ACACAE model. International Journal of Multidisciplinary Educational Research, 14(8, Pt. 2), 21-32.

Shukla, A. (2025). Government-citizen interactive communication through the ACACAE model: A comprehensive discussion. International Journal of Science and Research (IJSR), 14(9), 761–767. https://dx.doi.org/10.21275/SR25917021716

Tremblay-Cantin, C. A., Mellouli, S., Cheikh-Ammar, M., & Khechine, H. (2023). E-government service adoption by citizens: A literature review and a high-level model of influential factors. Digital Government: Research and Practice, 4(1), Article 2. https://doi.org/10.1145/3580369

UNDESA, et al. (2012). United Nations e-Government survey 2012: E-Government for the people. United Nations.

UNDP. (2008). Governance principles, institutional capacity and quality. United Nations Development Programme.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425–478.

West, D. M. (2004). E-government and the transformation of service delivery and citizen attitudes. Public Administration Review, 64(1), 15–27.

World Bank. (1994). Governance: The World Bank's experience. The World Bank.

World Bank. (2016). World development report 2016: Digital dividends. The World Bank.

Yun L, Yun S, Xue H (2024) Improving citizen-government interactions with generative artificial intelligence: Novel human-computer interaction strategies for policy understanding through large language models. PLOS ONE 19(12): e0311410. https://doi.org/10.1371/journal.pone.0311410