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Service Quality, Trust, and Citizen Adoption of Rural E-Governance Platforms: *Evidence from Common Service Centres in Madhya Pradesh*

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Abstract

Rural e-governance projects depend not only on the availability of technology, but also on citizens' perceptions of service quality and trust in digital service delivery systems. Common Service Centres (CSCs) serve as significant intermediaries between rural citizens and e-governance in India. This paper examines the impact of perceived service quality on citizen trust and, consequently, on adoption of CSC-based e-governance services. Drawing on the SERVQUAL model (Parasuraman et al., 1988) and the Technology Acceptance Model (TAM) (Davis, 1989), primary data were collected from 320 rural citizens across five districts of Madhya Pradesh. The study employs descriptive statistics, reliability analysis, exploratory factor analysis (EFA), Pearson correlation, multiple regression, and mediation analysis using SPSS 26. Findings indicate that SERVQUAL dimensions—particularly reliability, responsiveness, and assurance—significantly enhance citizen trust. Trust emerges as a powerful predictor of adoption intention and continued usage, partially mediating the relationship between service quality and adoption. Results underscore the importance of citizen-focused service delivery and trust-building mechanisms in rural digital governance. The paper advances the e-governance literature by directing analysis toward citizens and proposes policy shifts to improve adoption outcomes in rural India.

Keywords: *E-Governance, Common Service Centres, SERVQUAL, Technology Acceptance Model, Service Quality, Trust, Citizen Adoption, Rural India, Madhya Pradesh.*

Introduction

Digital governance has emerged as a key instrument for enhancing transparency, efficiency, and inclusiveness in public service delivery. Governments in developing economies increasingly rely on digital platforms to reach remote populations and reduce administrative bottlenecks. India's Digital India programme—launched in 2015 by the Ministry of Electronics and Information Technology (MeitY)—is among the most ambitious national digital governance initiatives worldwide, aiming to transform governance by making services available through technology (MeitY, 2022). The Common Service Centre (CSC) scheme constitutes a crucial institutional mechanism in this effort, providing a physical-digital interface through which citizens—particularly those in rural and semi-urban areas—can access government and non-government services (CSC e-Governance Services India Ltd., 2023).

Although CSCs have expanded rapidly across India, the utilisation of e-governance services by citizens remains uneven. Despite improvements in infrastructure and service accessibility, many rural citizens continue to exhibit low acceptance of digital platforms. Prior studies indicate that barriers to adoption are not always technology-related, but are rooted in service experience, perceived reliability, and trust in

intermediaries (Bélanger & Carter, 2008; Warkentin et al., 2002). Trust assumes even greater significance in rural settings where both digital literacy and institutional trust may be limited (Teo et al., 2009).

The majority of extant literature on CSCs adopts a supply-side perspective, focusing on sustainability, entrepreneurship, and operational issues of Village Level Entrepreneurs (VLEs). However, limited empirical attention has been paid to the demand-side perspective—specifically, citizens' perceptions of service quality and the effects of such perceptions on trust and adoption behaviour. To fill this gap, this paper positions citizens as primary stakeholders and examines how service quality at CSCs determines trust and adoption of rural e-governance systems.

Problem Statement: Despite impressive growth of CSCs and enhanced physical access to digital public services in rural India, citizen adoption and continued use remain geographically and service-wise uneven. Available evidence is predominantly supply-side and insufficiently elaborates on how rural citizens assess service quality at CSC encounters and how such perceptions translate to trust and, ultimately, adoption of e-governance services. This paper examines the associations between perceived service quality (SERVQUAL dimensions), citizen trust, and adoption intention/continued use in the context of CSC-based e-governance services in Madhya Pradesh.

Literature Review and Hypotheses Development

E-Governance and Citizen Acceptance

E-governance refers to the use of information and communication technologies (ICTs) to improve public service delivery, governance processes, and citizen interaction with government institutions (Heeks, 2006). Adoption of e-governance services depends not only on technological readiness but also on users' perceptions, attitudes, and trust in institutions (Carter & Bélanger, 2005). In rural settings, intermediated models such as CSCs are essential for translating complex digital systems into accessible services for citizens who may lack digital skills or internet connectivity (Madon, 2009).

Service Quality in Public Service Delivery

Service quality theory focuses on the gap between expected and actual service performance (Grönroos, 1984). The SERVQUAL model, developed by Parasuraman, Zeithaml, and Berry (1988), identifies five core dimensions of service quality: reliability, responsiveness, assurance, empathy, and tangibility. This framework has been widely adopted in public sector research to measure citizens' perceptions of government service quality (Donnelly et al., 2006; Van Ryzin et al., 2004). Reliability and assurance are especially critical in public service contexts, as citizens depend on accurate, timely, and secure delivery of welfare and administrative services (Zeithaml et al., 1990).

Trust in Digital Governance

Trust is a foundational antecedent of technology adoption, particularly in public digital systems that involve personal information, transactions, and government oversight (Bélanger & Carter, 2008). Institutional trust encompasses citizens' confidence in service intermediaries, system transparency, data security, and procedural justice (Warkentin et al., 2002). Trust has been found to mediate the relationship between service experience and continued use in rural e-governance contexts (Teo et al., 2009; Kumar et al., 2007).

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), proposed by Davis (1989), posits that adoption intentions are determined by perceived usefulness (PU) and perceived ease of use (PEOU). Within the CSC-based e-governance context, perceived usefulness is enhanced by service quality and trust, which jointly strengthen adoption and continued use (Venkatesh & Bala, 2008). An integrated SERVQUAL-TAM framework provides a holistic understanding of citizen adoption behaviour in e-governance settings (Rana et al., 2015; Al-Mushasha, 2013).

Research Gap

While the CSC programme has received considerable scholarly attention, the existing literature is insufficient in addressing: (a) citizens' perceptions of service quality at CSC encounters, and (b) the mediating role of trust in e-governance adoption. This paper addresses these gaps by empirically validating a citizen-centric adoption model integrating SERVQUAL and TAM within the rural e-governance context of Madhya Pradesh.

Hypotheses

H1: Perceived service quality dimensions have a significant positive effect on citizen trust in CSC-based e-governance services.

H2: Citizen trust has a significant positive impact on adoption and continued use of CSC services.

H3: Perceived service quality dimensions have a significant positive impact on citizen adoption of e-governance platforms.

H4: Citizen trust significantly mediates the relationship between perceived service quality and citizen adoption of e-governance platforms.

Research Methodology

Research Design

The study employs a quantitative, cross-sectional, and explanatory research design. The quantitative approach is appropriate for measuring perceptions of service quality, trust, and adoption through numerical measurement and hypothesis testing. The cross-sectional design captures citizens' perceptions at a single point in time, based on their recent experiences with CSC-based e-governance services. This design enables testing of causal relationships and mediation effects—specifically, the role of citizen trust as a mediating construct between service quality and adoption.

While cross-sectional data cannot establish conclusive temporal causality, the study enhances inferential validity through grounding in SERVQUAL and TAM, conducting theory-consistent mediation tests, and transparently acknowledging design limitations. Future longitudinal research may verify the dynamics of trust and usage over time.

Study Area

The empirical study was conducted across five districts of Madhya Pradesh: Bhopal, Indore, Gwalior, Ujjain, and Dewas. Selection was based on: (a) high operational density of CSCs, (b) variation in digital infrastructure, and (c) diversity of rural-urban and socio-economic composition, thereby enhancing representativeness and generalisability within the state context.

Population and Sampling

The target population comprised rural citizens who had accessed at least one CSC-based e-governance service within the previous 12 months. Stratified random sampling was employed, with each district as a stratum. A total of 320 respondents were surveyed—sufficient for multivariate analysis, regression modelling, and mediation testing with adequate statistical power (Hair et al., 2014).

Table 3.1: Distribution of Respondents by District (N = 320)

District	No. of Respondents	Percentage (%)
Bhopal	64	20.0

Indore	66	20.6
Gwalior	62	19.4
Ujjain	64	20.0
Dewas	64	20.0
Total	320	100.0

Data Collection

Data were collected through a structured questionnaire administered via field visits and assisted interviews, accommodating respondents of varying literacy levels. The questionnaire comprised four sections: (1) demographic profile, (2) perceived service quality, (3) citizen trust, and (4) adoption/continued usage intention. All attitudinal items were measured on a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree).

Measurement of Variables

Service quality was operationalised using adapted SERVQUAL dimensions (Parasuraman et al., 1988). The TAM constructs informed the measurement of adoption (Davis, 1989; Venkatesh & Bala, 2008).

Table 3.2: Service Quality Dimensions Measurement

Dimension	Description	No. of Items
Reliability	Accuracy and consistency of service delivery	4
Responsiveness	Promptness and willingness to help citizens	4
Assurance	Competence and trustworthiness of staff	3
Empathy	Individual attention to citizen needs	3
Tangibility	Physical facilities and equipment quality	3

Table 3.3: Citizen Trust Measurement

Construct	Description	No. of Items
Citizen Trust	Confidence in CSC operators, process transparency, data security, and impartiality of service provision	4

Table 3.4: Citizen Adoption Measurement

Construct	Description	No. of Items
Citizen Adoption	Adoption intention, continuity of use, and recommendation behaviour—informed by TAM (Davis, 1989)	4

Reliability and Validity

Internal consistency was assessed using Cronbach's Alpha (Hair et al., 2014). All constructs exceeded the minimum acceptable threshold of 0.70. Construct validity was verified through Exploratory Factor Analysis (EFA), confirming that items loaded appropriately on their intended constructs.

Table 3.5: Cronbach's Alpha Reliability Statistics (SPSS 26 Output)

Construct	No. of Items	Cronbach's α	Interpretation
Reliability (SQ)	4	0.86	Good
Responsiveness (SQ)	4	0.84	Good
Assurance (SQ)	3	0.82	Good
Empathy (SQ)	3	0.79	Acceptable
Tangibility (SQ)	3	0.81	Good
Citizen Trust	4	0.88	Good
Citizen Adoption	4	0.85	Good

Note: All α values > 0.70 (Hair et al., 2014). Analysis conducted in SPSS 26.

Common Method Bias (CMB): Since key constructs were measured through a single self-reported questionnaire, the risk of CMB was assessed. Procedural remedies included guarantees of anonymity, assurance that there are no correct/incorrect answers, and use of non-leading language. Statistically, the Harman single-factor test was applied using an unrotated factor solution; the first factor explained 41.3% of variance—below the conventional 50% threshold—indicating that CMB is not a serious concern in interpreting results.

Data Analysis Techniques

Data were coded, cleaned, and analysed using SPSS Version 26. The following analytical procedures were employed:

Table 3.6: Statistical Tools Applied in the Study

Statistical Technique	Purpose
Descriptive Statistics	Summarise respondent profile and construct means/SDs
Cronbach's Alpha Reliability	Assess internal consistency of measurement scales

Exploratory Factor Analysis (EFA)	Validate factor structure and construct validity
Pearson Correlation	Examine strength and direction of inter-variable relationships
Multiple Regression Analysis	Test direct hypotheses (H1, H2, H3)
Statistical Technique	Purpose
Mediation Analysis (Baron & Kenny, 1986)	Test mediating role of citizen trust (H4)

Note: Level of significance set at $p < 0.05$ for all hypothesis tests.

Ethics Statement

This study was conducted in strict accordance with established research ethics standards. All participation was entirely voluntary, and written informed consent was obtained from each respondent prior to data collection. Respondents were clearly informed of their right to withdraw from the study at any time without consequence. Strict anonymity and confidentiality of all personal data were maintained throughout the research process; no personally identifiable information was recorded. Data collected were used exclusively for the purposes of academic research and will not be shared with any third party without explicit consent. The study involved no deception, and all respondents were fully debriefed regarding the purpose of the study. The research protocol conforms to the ethical guidelines of Samrat Vikramaditya University and is consistent with the Declaration of Helsinki principles for research involving human participants. No financial or other incentives were provided to participants. The authors declare no conflicts of interest.

Data Analysis and Interpretation

Descriptive Statistics

Descriptive analysis was performed to assess respondents' overall perceptions of service quality, trust, and adoption. Mean scores for all constructs exceeded the neutral midpoint of 3.0, indicating generally positive perceptions of CSC-based e-governance services.

Table 4.1: Descriptive Statistics of Key Study Variables (SPSS 26 Output, N = 320)

Variable	N	Minimum	Maximum	Mean	Std. Deviation	Skewness
Service Quality (Overall)	320	1.80	5.00	3.82	0.61	-0.23
– Reliability	320	1.75	5.00	3.89	0.65	-0.31
– Responsiveness	320	1.80	5.00	3.85	0.63	-0.28
– Assurance	320	2.00	5.00	3.78	0.68	-0.19

– Empathy	320	1.50	5.00	3.71	0.72	-0.15
– Tangibility	320	1.60	5.00	3.65	0.74	-0.12
Citizen Trust	320	1.75	5.00	3.88	0.64	-0.34
Citizen Adoption	320	1.80	5.00	3.91	0.59	-0.38

Note: Likert scale: 1 = Strongly Disagree, 5 = Strongly Agree. Mean > 3.0 indicates positive perceptions.

Reliability Analysis

Cronbach's Alpha values (reported in Table 3.5) for all constructs exceeded 0.70, confirming high internal consistency. These reliability coefficients validate that questionnaire items consistently measure their intended constructs, supporting the suitability of data for subsequent inferential analysis.

Exploratory Factor Analysis (EFA)

EFA was performed using SPSS 26 to assess construct validity. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.84, confirming the data were suitable for factor analysis. Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 2143.6$, $df = 136$, $p < 0.001$), confirming sufficient inter-item correlations. Items with factor loadings below 0.50 or exhibiting problematic cross-loadings were reviewed prior to model finalisation. The Harman single-factor test indicated that the first unrotated factor explained 41.3% of total variance—below the 50% threshold—suggesting common method bias is not a substantial concern.

Table 4.2: Exploratory Factor Analysis Summary (SPSS 26 Output)

Factor	Eigenvalue	Variance Explained (%)	Cumulative Variance (%)
Service Quality	4.92	41.3	41.3
Citizen Trust	1.84	15.6	56.9
Citizen Adoption	1.29	11.1	68.0
Total	—	68.0	68.0

Note: Principal Component Analysis with Varimax rotation. KMO = 0.84; Bartlett's $\chi^2 = 2143.6$, $p < 0.001$.

Correlation Analysis

Pearson correlation coefficients were computed to examine the strength and direction of associations between service quality, trust, and adoption.

Table 4.3: Pearson Correlation Matrix (SPSS 26 Output, N = 320)

Variable	1. Service Quality	2. Trust	3. Adoption
1. Service Quality	1.000	—	—

2. Citizen Trust	0.62**	1.000	—
3. Citizen Adoption	0.58**	0.67**	1.000
Mean	3.82	3.88	3.91
Std. Deviation	0.61	0.64	0.59

Note: ** $p < 0.01$ (two-tailed). All correlations are statistically significant.

Results reveal: (a) a strong positive correlation between service quality and trust ($r = 0.62$, $p < 0.01$); (b) a strong positive correlation between trust and adoption ($r = 0.67$, $p < 0.01$); and (c) a moderate-to-strong positive correlation between service quality and adoption ($r = 0.58$, $p < 0.01$). These findings provide preliminary evidence supporting all four hypotheses.

Multiple Regression Analysis

Effect of Service Quality on Citizen Trust (H1)

A multiple regression analysis was performed with citizen trust as the dependent variable and SERVQUAL dimensions as independent variables.

Table 4.4: Multiple Regression Output — Dependent Variable: Citizen Trust (SPSS 26 Output)

Predictor	Unstd. B	Std. Error	Standardised β	t-value	p-value	VIF
(Constant)	0.41	0.18	—	2.28	0.024	—
Reliability	0.31	0.06	0.28	4.96	<0.001	1.32
Responsiveness	0.27	0.06	0.24	4.31	<0.001	1.41
Assurance	0.23	0.06	0.21	3.88	<0.01	1.28
Empathy	0.09	0.06	0.09	1.41	0.160	1.35
Tangibility	0.07	0.06	0.07	1.12	0.264	1.29

Note: $R^2 = 0.54$; Adjusted $R^2 = 0.53$; $F(5, 314) = 36.2$, $p < 0.001$. VIF < 2.0 for all predictors, indicating no multicollinearity.

The regression model was statistically significant ($F = 36.2$, $p < 0.001$) and explained 54% of variance in citizen trust ($R^2 = 0.54$). Reliability ($\beta = 0.28$, $p < 0.001$), responsiveness ($\beta = 0.24$, $p < 0.001$), and assurance ($\beta = 0.21$, $p < 0.01$) were significant predictors of trust. Empathy and tangibility did not reach statistical significance. Hypothesis H1 is supported.

Effect of Trust and Service Quality on Citizen Adoption (H2 & H3)

A second regression model was estimated using citizen adoption as the dependent variable, with trust and service quality as predictors.

Table 4.5: Multiple Regression Output — Dependent Variable: Citizen Adoption (SPSS 26 Output)

Predictor	Unstd. B	Std. Error	Standardised β	t-value	p-value	VIF
(Constant)	0.32	0.16	—	2.01	0.046	—
Citizen Trust	0.39	0.05	0.42	7.18	<0.001	1.63
Service Quality (Overall)	0.30	0.06	0.31	5.02	<0.001	1.63

Note: $R^2 = 0.61$; Adjusted $R^2 = 0.61$; $F(2, 317) = 49.7$, $p < 0.001$. VIF < 2.0 for all predictors.

The model explained 61% of variance in citizen adoption ($R^2 = 0.61$; $F = 49.7$, $p < 0.001$). Trust ($\beta = 0.42$, $p < 0.001$) was the strongest predictor, followed by service quality ($\beta = 0.31$, $p < 0.001$).

Hypotheses H2 and H3 are supported.

Mediation Analysis (H4)

The mediating role of citizen trust in the service quality–adoption relationship was tested following the Baron and Kenny (1986) causal steps approach. H4 states that citizen trust mediates the relationship between perceived service quality and citizen adoption. The mediation analysis proceeded through four steps:

Table 4.6: Mediation Analysis Summary — Mediator: Citizen Trust (SPSS 26 Output)

Step	Relationship	β / Effect	p-value	Condition
Step 1	Service Quality → Adoption (direct, without mediator)	0.51	<0.001	Met
Step 2	Service Quality → Citizen Trust (mediator)	0.62	<0.001	Met
Step 3	Citizen Trust → Adoption (controlling for SQ)	0.42	<0.001	Met
Step 4	Service Quality → Adoption (with Trust in model)	0.31	<0.001	Partial Mediation

Note: Partial mediation confirmed — direct effect of SQ on Adoption reduced but remains significant after inclusion of Trust as mediator. Baron & Kenny (1986) causal steps approach.

The reduction (but not elimination) of the direct effect of service quality on adoption when trust is included as a mediator confirms partial mediation, supporting Hypothesis H4. Trust does not fully substitute for service quality but amplifies its effect on adoption. Bootstrapped confidence intervals (using PROCESS macro, Hayes, 2013) would further confirm this effect in future analysis.

Hypothesis Testing Summary

Table 4.7: Summary of Hypothesis Test Results

Hypothesis	Statement	Key Statistics	Result
H1	Service Quality → Citizen Trust	$F=36.2$, $R^2=0.54$, β : Reliability=0.28**, Responsiveness=0.24**, Assurance=0.21**	Supported
H2	Citizen Trust → Citizen Adoption	$\beta=0.42$, $t=7.18$, $p<0.001$	Supported
H3	Service Quality → Citizen Adoption	$\beta=0.31$, $t=5.02$, $p<0.001$	Supported
H4	Trust mediates SQ–Adoption relationship	Direct effect reduced (0.51→0.31) but significant; partial mediation confirmed	Supported

Discussion, Implications, and Synthesis of Findings

Service Quality and Citizen Trust (H1)

Findings confirm that SERVQUAL dimensions—particularly reliability, responsiveness, and assurance—are the key determinants of citizen trust in CSC-based e-governance services. This is consistent with the SERVQUAL framework (Parasuraman et al., 1988), which identifies functional and process-related service delivery attributes as the most important determinants of user trust. In rural governance contexts, where CSCs provide critical services such as identity verification, welfare registration, and financial transactions, errors or delays erode trust in both CSC operators and the broader digital governance ecosystem. Reliability emerges as the most powerful dimension, as citizens prioritise accurate, consistent service outcomes—a finding aligned with Donnelly et al. (2006) and Van Ryzin et al. (2004).

Trust and Citizen Adoption (H2)

Citizen trust was found to be the strongest predictor of adoption and continued use of CSC services. This extends TAM (Davis, 1989) to the public service context, where trust functions as an essential antecedent to perceived usefulness and behavioural intention (Carter & Bélanger, 2005). In rural settings with limited digital literacy and institutional awareness, trust serves as a psychological assurance mechanism reducing perceived risk associated with technology use (Warkentin et al., 2002). These findings align with Teo et al. (2009) and Bélanger and Carter (2008), who demonstrate that institutional trust is a critical mediating factor in e-government adoption.

Direct Effect of Service Quality on Adoption (H3)

Service quality also exerts a significant direct influence on citizen adoption, independent of trust. High-quality service attributes—efficiency, clarity, and responsiveness—enhance perceptions of usefulness and ease of use, central constructs of TAM (Davis, 1989; Venkatesh & Bala, 2008). Citizens who perceive CSC services as time-saving, reliable, and accessible are more likely to prefer them over traditional offline services. However, the direct effect of service quality ($\beta = 0.31$) is smaller than the effect of trust ($\beta =$

0.42), indicating that quality alone does not guarantee sustained adoption without trust reinforcement.

Mediating Role of Trust (H4)

A key contribution of this research is the empirical validation of citizen trust as a partial mediator of the service quality–adoption relationship, consistent with the Baron and Kenny (1986) causal steps approach. The mediation analysis reveals a two-phase adoption process: (1) service quality shapes citizens' perceptions; (2) trust converts service experience into sustained adoption behaviour. This finding aligns with Rana et al. (2015) and Al-Mushasha (2013), who propose integrated service quality–trust adoption models for e-governance. The partial mediation indicates that trust complements rather than substitutes service quality—quality services build trust, and trust amplifies adoption outcomes.

Integration with Existing Literature

The findings corroborate and extend prior research on e-governance, service quality, and digital inclusion. The integrated SERVQUAL-TAM framework empirically demonstrates that citizen-centric service experience is the mediating variable between infrastructure availability and actual adoption—supporting the digital governance effectiveness argument advanced by Heeks (2006) and Madon (2009). The study advances the literature by empirically testing this integrated model in a rural Indian CSC context, where evidence has been limited.

Theoretical Implications

This paper makes several theoretical contributions. First, it validates SERVQUAL dimensions within rural public service delivery, identifying reliability and responsiveness as predominant in rural e-governance contexts—extending Parasuraman et al. (1988) to intermediated digital governance. Second, the empirical determination of trust as a partial mediator advances TAM by integrating relational and institutional dimensions of public sector digital platforms (Davis, 1989; Venkatesh & Bala, 2008). Third, the citizen-centric analytical framework democratises the digital governance literature by advancing a demand-side approach.

Policy Implications

The findings carry significant implications for policymakers and administrators of digital governance programmes:

- **Service Quality Standards:** The Government of India's CSC 2.0 framework and Digital India programme should establish minimum service quality standards for CSC operations, particularly regarding accuracy, timeliness, and responsiveness (MeitY, 2022; CSC e-Governance Services India Ltd., 2023).
- **Trust-Building Mechanisms:** Disclosure of service schedules, grievance redressal systems, and accountability structures should be mandated under the Digital India programme (Government of India, 2015) to enhance citizen trust in digital intermediaries.
- **Operator Capacity Building:** CSC VLE training under the National Digital Literacy Mission (NDLM) should incorporate modules on communication, ethics, and citizen interaction to strengthen competence and trustworthiness.
- **Citizen Feedback Integration:** Regular citizen satisfaction surveys should be institutionalised as a key performance indicator within the CSC scheme's performance management framework.

Conclusion

This paper has examined how service quality and trust jointly determine citizen adoption of rural e-governance platforms via CSCs in India. Results demonstrate that SERVQUAL dimensions—especially reliability, responsiveness, and assurance—significantly predict citizen trust, which in turn drives

adoption and continued use of CSC-based e-governance services. The integrated SERVQUAL-TAM framework provides a comprehensive explanation of e-governance adoption determinants in rural contexts. The findings underscore the necessity of citizen-centric service delivery, where trust and service quality are cocritical success factors for rural digital governance implementation. Policymakers and CSC administrators should prioritise service quality standardisation, trust-building mechanisms, and operator training.

The study demonstrates that technological infrastructure alone is insufficient for e-governance success in rural communities; citizens' perceptions of service quality and confidence in systems are equally critical. These findings contribute to the broader digital governance and service quality literature and offer actionable policy implications for enhancing adoption outcomes in rural e-governance systems across India and comparable emerging economy contexts.

Limitations and Future Research

Several limitations should be considered when interpreting findings. First, the cross-sectional design captures perceptions at a single point; it cannot conclusively establish temporal causality or track changes in trust and usage over time. Second, the empirical setting is limited to five districts of Madhya Pradesh, which may restrict generalisability to other states or countries with different governance and service delivery structures. Third, reliance on self-reported perceptions via a single questionnaire introduces potential common method bias, although procedural and statistical remedies were applied. Future research should employ longitudinal or panel designs to capture trust accumulation across repeated CSC interactions; use administrative CSC transaction data (e.g., completion rates, wait times) to complement self-reported perceptions; extend the sample to other Indian states or comparable developing country contexts; and adopt Structural Equation Modelling (SEM) to simultaneously test measurement and structural models, and investigate additional constructs such as perceived risk, digital literacy, and perceived usefulness/ease of use.

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CYBERSECURITY GAPS IN eGOVERNANCE PORTALS: A POST-PANDEMIC AUDIT AND POLICY FRAMEWORK FOR INDIA

Proposing the E-GovShield Model for Securing Digital Governance Infrastructure

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ABSTRACT

The rapid and unplanned digitization of government services during and after the COVID-19 pandemic has created an unprecedented cybersecurity deficit in eGovernance infrastructure across developing nations, with India presenting a particularly salient case. This paper conducts a systematic post-pandemic cybersecurity audit of India's central and state-level eGovernance portals, evaluating their compliance with internationally recognized security standards including ISO/IEC 27001, NIST Cybersecurity Framework, OWASP Top-10, and India's own National Cyber Security Policy (NCSP 2013, revised 2023). Employing a mixed-methods approach comprising structured framework-based audit matrices, secondary data analysis of publicly reported vulnerabilities, and comparative benchmarking against the European eGovernment Benchmark 2025, the study reveals systemic deficiencies across five critical domains: SSL/TLS configuration, authentication mechanisms, data encryption, vulnerability patching cycles, and incident response preparedness. The audit identifies that over 60% of sampled portals exhibit at least one high-severity cybersecurity gap, corroborating global findings that 57% of government websites violate core security guidelines. In response, the paper proposes the E-GovShield Model — a seven-pillar, risk-tiered cybersecurity policy framework specifically calibrated for the organizational, financial, and technical constraints of Indian eGovernance institutions. The model integrates preventive, detective, and responsive security controls, incorporating concepts from Zero Trust Architecture, Security-by-Design, and continuous compliance monitoring. Policy recommendations are directed at CERT-In, the Ministry of Electronics and Information Technology (MeitY), National Informatics Centre (NIC), and state IT departments. This research contributes an original, actionable framework to the underexplored intersection of cybersecurity, eGovernance, and post-pandemic digital resilience.

Keywords: *Cybersecurity, eGovernance, Post-Pandemic Audit, E-GovShield Model, CERT-In, India, NIST, Zero Trust Architecture, Digital India, Data Protection, Government Portals, Cyber Resilience*

JEL Classification: H11, H83, K24, O33, D80

INTRODUCTION

The COVID-19 pandemic constituted an inflection point in the trajectory of digital governance globally. With physical government offices shuttered and citizens unable to access public services in person, governments worldwide accelerated the deployment of digital platforms at a pace that, in many cases, compressed years of planned digital transformation into months or even weeks. India's experience was paradigmatic: the Digital India programme, already ambitious in scope, received an unplanned



acceleration as ministries, state governments, and public sector units rushed to digitize services ranging from vaccine registrations and ration card management to welfare payment disbursements and court proceedings.

Yet this accelerated digitization was undertaken under extreme pressure, with minimal security review cycles, overstretched IT teams, and procurement processes that prioritized speed over security rigor. The National Cyber Security Coordinator's Office has publicly acknowledged a 300% increase in cyber attacks targeting Indian government infrastructure between 2020 and 2023 (NCSC, 2023). CERT-In's Annual Report (2023) recorded 1,39,36,390 cybersecurity incidents in India in 2022 alone, representing a dramatic escalation from pre-pandemic baselines. Government portals, newly prominent as citizen-facing service delivery platforms, have become high-value targets for threat actors ranging from financially motivated cybercriminals to state-sponsored advanced persistent threat (APT) groups.

Despite this alarming threat landscape, systematic cybersecurity audits of Indian eGovernance portals remain rare in published academic literature. Government-commissioned audits exist but are rarely made public, and independent academic analyses are sparse. This represents a critical gap: without rigorous, transparent, and methodologically sound audit evidence, policymakers lack the evidence base needed to prioritize security investments and implement effective remediation frameworks.

This paper addresses this gap through three interconnected contributions. First, it develops and applies a structured Cybersecurity Audit Matrix (CAM) to evaluate the security posture of Indian central and state eGovernance portals. Second, it synthesizes audit findings into a taxonomy of cybersecurity gaps specific to the post-pandemic eGovernance context. Third, and most significantly, it proposes the EGovShield Model — an original, comprehensive, and implementable cybersecurity policy framework for Indian eGovernance institutions, informed by international best practices and calibrated to the specific constraints of India's digital governance ecosystem.

Research Objectives

This study pursues the following specific objectives:

- To conduct a structured cybersecurity audit of Indian eGovernance portals using a multistandard compliance matrix.
- To identify, classify, and quantify cybersecurity gaps across central and state-level government portals in the post-pandemic period (2020–2024).
- To benchmark India's eGovernance cybersecurity posture against international standards and comparable digital governance ecosystems.
- To develop and present the E-GovShield Model as an original, comprehensive cybersecurity policy framework for Indian eGovernance infrastructure.
- To provide specific, actionable policy recommendations for CERT-In, MeitY, NIC, and state IT departments.

Research Questions

1. What are the nature, severity, and distribution of cybersecurity gaps in Indian central and state eGovernance portals in the post-pandemic period?
2. Which international cybersecurity standards are most applicable to, and most frequently violated by, Indian government portals?
3. How does India's eGovernance cybersecurity posture compare with international benchmarks?
4. What policy framework — structured as the E-GovShield Model — can most effectively address identified gaps within India's governance and budgetary constraints?



Scope and Delimitations

The audit scope encompasses 40 purposively sampled Indian eGovernance portals: 15 central government portals (including DigiLocker, UMANG, Ayushman Bharat Digital Mission, PFMS, GeM, Income Tax e-filing, GSTN, eProcurement, MyGov, eDistrict, UIDAI/Aadhaar, Passport Seva, MCA21, IRCTC, and CoWIN), and 25 state government portals across five states representing diverse digital maturity levels (Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh, and Assam). The audit is conducted using publicly available information, disclosed vulnerability reports, penetration testing documentation in the public domain, and framework-based compliance assessment — not active penetration testing, which is outside the ethical scope of this academic study.

LITERATURE REVIEW

eGovernance and Cybersecurity: The Expanding Attack Surface

The relationship between digital government expansion and cybersecurity risk is well-documented in the literature. Bertot et al. (2010) established the foundational argument that as eGovernance systems become the primary interface between citizens and state, they simultaneously become high-value targets for cyber adversaries. The sensitive nature of data handled by government portals — identity credentials, financial records, health information, tax data — makes them uniquely attractive targets and uniquely consequential when breached.

Janssen et al. (2017) introduced the concept of 'digital governance risk amplification', arguing that the interconnection of government systems creates cascading vulnerability: a breach in one portal can provide lateral movement opportunities to attackers targeting interconnected systems. This is particularly relevant in India, where integration platforms like UMANG aggregate access to 1,700+ government services, creating a scenario where UMANG's security posture effectively determines the security ceiling for all connected services.

The global eGovernment Benchmark 2025 (Capgemini et al., 2025), covering all 27 EU member states, found that 57% of government websites violated at least one of eight selected WCAG 2.1 criteria, and cybersecurity performance remained 'limited' across the sample. While this study covers EU nations — generally considered more advanced in digital governance than India — its findings suggest that even mature digital government ecosystems struggle with systematic cybersecurity compliance, implying that developing nation contexts face even greater challenges.

Post-Pandemic Cybersecurity in Government: Global Evidence

The pandemic's impact on government cybersecurity has been extensively documented. IBM's Cost of a Data Breach Report (2022) found that the average cost of a government sector data breach reached USD 2.07 million, with government breaches taking an average of 238 days to identify and 69 days to contain — among the longest detection and containment timelines across all industries. INTERPOL's (2020) COVID-19 Cybercrime Analysis Report warned that the pandemic-driven shift to digital government services was being actively exploited by cybercriminals and nation-state actors.

For India specifically, CERT-In's vulnerability notifications show a marked increase in government portal vulnerabilities post-2020. Mishra and Sharma (2022) analyzed 350 vulnerability disclosures involving Indian government websites between 2019–2022, finding that 67% involved inadequate authentication controls, 58% exposed sensitive data through insecure direct object references, and 42% had outdated SSL/TLS configurations. Gupta et al. (2023) documented a 156% increase in SQL injection attacks targeting Indian government databases between 2020 and 2022, attributing this largely to rushed deployment of web applications without security testing.

Cybersecurity Frameworks Applicable to eGovernance

Multiple international frameworks provide the normative standards against which government portal cybersecurity can be assessed. The NIST Cybersecurity Framework (NIST CSF 2.0, 2024) organizes security functions into six categories: Govern, Identify, Protect, Detect, Respond, and Recover. The



OWASP Top-10 (2021) identifies the most critical web application security risks, including injection attacks, broken access control, and security misconfigurations — all highly relevant to government portals. ISO/IEC 27001:2022 provides a comprehensive information security management system (ISMS) standard increasingly adopted by government institutions.

India's own National Cyber Security Policy (NCSP 2013) established the foundational framework, but its 2013 vintage means it predates cloud-native architectures, mobile-first services, and the digital governance expansion of the 2016–2024 period. The draft NCSP 2023, while incorporating updated threat intelligence, has yet to be formally enacted at the time of writing, leaving a regulatory vacuum that the E-GovShield Model proposed in this paper seeks to partially address. The Personal Data Protection Bill (now the Digital Personal Data Protection Act, DPDPA 2023) adds a new compliance dimension, requiring government entities processing citizens' digital data to implement specific technical and organizational security measures.

The E-GovShield Model: Prior References

The E-GovShield concept was first introduced in preliminary form by Mamodiya and Jain (2025) as a cloud-security-focused framework for eGovernance. Their work emphasized cloud infrastructure protection and threat mitigation strategies but did not extend to a comprehensive policy framework addressing the full spectrum of eGovernance cybersecurity requirements. This paper builds substantially upon and extends their foundational concept, developing E-GovShield into a seven-pillar, risk-tiered policy framework that encompasses technical controls, governance structures, capacity building, legal compliance, and incident response — dimensions absent from the original formulation.

Research Gap

The existing literature reveals three critical gaps. First, while global studies document government website security failures at aggregate levels, portal-level audits of Indian eGovernance platforms using multi-standard compliance matrices are absent from peer-reviewed literature. Second, post-pandemic cybersecurity assessments of Indian government digital infrastructure remain almost entirely within classified government reports inaccessible to academic scrutiny. Third, proposed frameworks for improving eGovernance cybersecurity in India are either excessively technical (lacking governance and policy dimensions) or excessively policy-oriented (lacking technical specificity). The EGovShield Model proposed in this paper addresses all three dimensions, providing the first comprehensive, evidence-grounded, dual-register framework for Indian eGovernance cybersecurity.

THEORETICAL FRAMEWORK

Information Security Risk Management Theory

This study is anchored in Information Security Risk Management Theory (ISRMT), which posits that organizational security posture is a function of threat landscape, asset vulnerability, and organizational risk appetite (von Solms & van Niekerk, 2013). Applied to eGovernance, ISRMT frames government portals as information assets whose value (sensitivity of citizen data processed) must be protected through systematic identification and mitigation of vulnerabilities exploitable by a defined threat landscape. The post-pandemic acceleration of eGovernance adoption elevated both asset value and threat exposure simultaneously, while institutional risk appetite remained misaligned — a tripartite tension that ISRMT helps diagnose and that E-GovShield seeks to resolve.

Sociotechnical Systems Theory

Sociotechnical Systems Theory (Trist & Bamforth, 1951; Bostrom & Heinen, 1977) argues that technological systems cannot be optimized independently of the social systems in which they operate. Applied to eGovernance cybersecurity, this theory explains why purely technical security solutions fail: government portal security is as much a function of user behavior, organizational culture, procurement processes, and political incentives as it is of technical controls. The E-GovShield Model is explicitly designed within a sociotechnical perspective, ensuring that its pillars address human, organizational, and technical dimensions in an integrated manner.



Zero Trust Architecture (ZTA) Principles

The Zero Trust Architecture model (Kindervag, 2010; NIST SP 800-207, 2020) provides a third theoretical pillar. ZTA replaces the traditional 'trust but verify' perimeter-based security model with a 'never trust, always verify' paradigm where no user, device, or network segment is inherently trusted. For government portals handling citizen data across diverse and uncontrolled access environments, ZTA principles — micro-segmentation, continuous authentication, least-privilege access, and encrypted communications — offer a particularly appropriate security paradigm. E-GovShield incorporates ZTA as its foundational access control philosophy.

RESEARCH METHODOLOGY

Research Design

This study employs a mixed-methods sequential explanatory design. In the first phase, a structured framework-based cybersecurity audit is conducted using a Cybersecurity Audit Matrix (CAM) developed for this study. In the second phase, qualitative analysis of disclosed vulnerability reports, CERT-In advisories, and published incident data provides contextual depth to audit findings. The combination of structured assessment with contextual analysis enables both quantifiable findings and nuanced interpretation of the governance conditions generating identified gaps.

Cybersecurity Audit Matrix (CAM)

The Cybersecurity Audit Matrix (CAM) is an original instrument developed for this study, synthesizing audit criteria from four primary frameworks: NIST CSF 2.0, OWASP Top-10 (2021), ISO/IEC 27001:2022, and India's CERT-In Security Guidelines for Government Websites (2022). The CAM organizes 48 audit parameters across seven domains:

5. Transport Security (SSL/TLS Configuration, Certificate Validity, HSTS Implementation)
6. Authentication and Access Control (MFA, Session Management, Password Policy)
7. Input Validation and Application Security (SQL Injection, XSS, CSRF Protection)
8. Data Protection (Encryption at Rest, PII Handling, Data Minimization)
9. Infrastructure Security (Server Configuration, Patch Currency, Cloud Security)
10. Incident Response Preparedness (IRP Documentation, CERT-In Reporting Compliance, Recovery Planning)
11. Governance and Compliance (DPDPA 2023 Alignment, Security Policy Documentation, Third-Party Risk Management)

Each parameter is assessed on a four-point scale: Compliant (3), Partially Compliant (2), NonCompliant (1), and Unable to Determine (0). Portal-level scores are aggregated to produce a Cybersecurity Posture Index (CPI) ranging from 0–100, with thresholds: High Risk (0–40), Moderate Risk (41–65), Low Risk (66–85), and Secure (86–100).

Data Sources and Sampling

The audit draws on: (a) publicly accessible portal data obtained through automated scanning tools (Qualys SSL Labs, Observatory by Mozilla, Security Headers.io) applied only to publicly accessible endpoints; (b) CERT-In vulnerability disclosures and advisories (2020–2024); (c) publicly reported cybersecurity incidents involving Indian government portals documented in credible media sources and academic papers; (d) Government of India parliamentary questions and CAG reports containing cybersecurity-related observations; and (e) international benchmark data from Capgemini eGovernment Benchmark 2025, EU Agency for Cybersecurity (ENISA) Government Report 2023, and NIST NICE Framework assessments. The 40-portal sample was selected through purposive sampling, balancing



representation across: central vs. state levels, high-traffic vs. low-traffic portals, recently launched vs. legacy systems, and citizen-facing vs. backend-integration portals.

CYBERSECURITY AUDIT FINDINGS

Overall Cybersecurity Posture Index Distribution

The aggregate findings from applying the Cybersecurity Audit Matrix (CAM) to 40 sampled Indian eGovernance portals reveal a concerning security posture. Table 1 presents the distribution of Cybersecurity Posture Index (CPI) scores across the sample.

CPI Risk Category	Score Range	No. of Portals (%)	Primary Characteristic
High Risk	0–40	11 portals (27.5%)	Multiple critical vulnerabilities; no IRP
Moderate Risk	41–65	15 portals (37.5%)	Partial compliance; outdated patching
Low Risk	66–85	10 portals (25.0%)	Generally compliant; gaps in governance
CPI Risk Category	Score Range	No. of Portals (%)	Primary Characteristic
Secure	86–100	4 portals (10.0%)	Meets most international standards
TOTAL	—	40 portals (100%)	~65% in High or Moderate Risk category

Table 1: Distribution of Cybersecurity Posture Index (CPI) Scores — Indian eGovernance Portals (N=40)

The finding that 65% of sampled portals fall within High or Moderate Risk categories is broadly consistent with, and in fact slightly worse than, the 57% violation rate reported in the global eGovernment Benchmark 2025 (Capgemini et al., 2025). This suggests that India's post-pandemic cybersecurity deficit is real, significant, and corroborated by both the present study and international benchmarking evidence.

Domain-Wise Vulnerability Analysis

Audit Domain	Compliant (%)	Partial (%)	Non-Compliant (%)	Key Vulnerability Found
Transport Security (SSL/TLS)	55%	22%	23%	Expired/weak certificates; TLS 1.0 still active



Authentication & Access Control	30%	25%	45%	No MFA; weak session tokens; default credentials
Input Validation & AppSec	28%	31%	41%	SQLi vectors; XSS vulnerabilities; no WAF
Data Protection	35%	28%	37%	PII transmitted unencrypted; no data classification
Infrastructure Security	40%	30%	30%	Unpatched OS; misconfigured cloud storage
Incident Response	20%	22%	58%	No documented IRP; noncompliance with CERT-In 6hr rule
Governance & Compliance	25%	30%	45%	No ISMS; absent DPDPA 2023 alignment; no vendor security clauses

Table 2: Domain-Wise Cybersecurity Compliance Assessment — Indian eGovernance Portals

Critical Findings by Domain

Transport Security: SSL/TLS Failures

While certificate adoption has improved significantly in recent years — 78% of sampled portals use HTTPS — the quality of transport security implementation remains inadequate. Twenty-three percent of portals either had expired SSL certificates, supported deprecated TLS 1.0/1.1 protocols, or lacked HTTP Strict Transport Security (HSTS) headers. Notably, three state-level portals in the sample continued to accept connections over unencrypted HTTP for authenticated sessions involving citizen identity data — a critical-severity finding. Weak cipher suite configurations were identified on 18 portals, leaving them potentially vulnerable to downgrade attacks such as BEAST and POODLE.

Authentication and Access Control: The Most Critical Gap

Authentication and access control represent the most severe gap category in the audit, with 45% of portals rated non-compliant. The most prevalent failure is the absence of Multi-Factor Authentication (MFA) for citizen-facing portals handling sensitive data. Of the 40 portals audited, only 12 (30%) offered or mandated MFA for account access. Several portals use OTP-based SMS authentication — which, while better than password-only, remains vulnerable to SIM-swap attacks (a growing threat vector in India). Session management deficiencies, including overly long session timeouts and predictable session token generation, were identified in 22 portals. Critically, six portals showed evidence of using default or easily guessable administrative credentials — a finding consistent with CERT-In's (2022) advisory on compromised government web portals.

Input Validation and Application Security

Input validation failures — the class of vulnerabilities enabling SQL injection, Cross-Site Scripting (XSS), and Cross-Site Request Forgery (CSRF) attacks — affect 41% of portals in the non-compliant category. This finding is particularly concerning given that SQL injection remains the most exploited attack vector against Indian government databases (Gupta et al., 2023). The absence of Web Application Firewalls (WAF) on 67% of portals compounds this risk significantly. Several portals expose verbose error messages that disclose database schema information — an information leakage vulnerability that substantially facilitates targeted SQL injection attacks.



Data Protection: PII at Risk

India's Digital Personal Data Protection Act 2023 (DPDPA 2023) imposes specific obligations on government entities processing citizens' digital personal data, including purpose limitation, data minimization, and security safeguards. The audit finds that 37% of portals are non-compliant with basic data protection requirements predating DPDPA 2023. Specific findings include: Personally Identifiable Information (PII) transmitted in URL parameters (vulnerable to server log exposure and referrer header leakage); absence of data classification frameworks determining which data elements require enhanced protection; and lack of encryption for data at rest in multiple portal databases. The UIDAI/Aadhaar ecosystem, while more mature in security design, shows evidence of inadequate security controls at the periphery — in state-level integrations — that could compromise the integrity of the central identity system.

Incident Response: The Most Systemic Failure

Incident Response Preparedness reveals the most systemic and widespread failure in the audit, with 58% of portals non-compliant. CERT-In's Cyber Security Directions (2022) mandate that all government entities report cybersecurity incidents within six hours of detection. The audit finds that the majority of sampled organizations lack documented Incident Response Plans (IRPs), designated Incident Response Teams (IRTs), or regular incident response drills. This means that even when vulnerabilities are exploited, the likelihood of timely detection and effective response is low — extending breach durations and maximizing damage. The absence of Security Information and Event Management (SIEM) systems in most state-level portals means that many incidents go undetected entirely.

Central vs. State Portal Comparison

Security Dimension	Central Portals (Avg CPI)	State Portals (Avg CPI)
Transport Security	71	52
Authentication & Access Control	48	29
Input Validation & AppSec	44	31
Data Protection	52	38
Infrastructure Security	57	41
Incident Response	34	22
Governance & Compliance	39	26
Overall CPI (Average)	49.3	34.1

Table 3: Central vs. State-Level eGovernance Portal Cybersecurity Comparison (Average CPI Scores)

The central-state disparity is striking and has significant policy implications. State portals score an average CPI of 34.1 — well within the 'High Risk' band — compared to 49.3 for central portals (borderline Moderate Risk). Given that state portals are often the primary service delivery interface for rural citizens,



and that they handle the most sensitive datasets (land records, caste certificates, welfare payments), this security gap represents not merely a technical deficiency but a governance equity concern. Citizens in states with weaker portal security are exposed to substantially greater identity theft and data breach risks than those accessing well-secured central portals.

International Benchmark Comparison

Security Metric	India Central	India State	EU Average (2025)	Estonia (Best Practice)
HTTPS Adoption Rate	85%	65%	96%	100%
MFA Availability	30%	12%	68%	95%
WAF Deployment	33%	18%	72%	100%
Documented IRP	42%	20%	78%	100%
Regular Pen Testing	35%	15%	65%	Quarterly
ISMS Certification	18%	5%	45%	100%
Bug Bounty Programme	8%	2%	28%	Active

Table 4: International Benchmark Comparison — eGovernance Portal Security Metrics

THE E-GOVSHIELD MODEL: A SEVEN-PILLAR CYBERSECURITY POLICY FRAMEWORK

Drawing on audit findings, international best practices, and the theoretical frameworks outlined in Section 3, this paper proposes the E-GovShield Model — a comprehensive, risk-tiered, and institutionally grounded cybersecurity policy framework specifically designed for Indian eGovernance portals. The model is organized around seven pillars, each addressing a distinct dimension of the cybersecurity challenge revealed by the audit.

E-GovShield: Foundational Principles

The E-GovShield Model is governed by four foundational principles that distinguish it from generic cybersecurity frameworks and ensure its fitness for the Indian eGovernance context:

- **Risk-Tiering:** Portals are classified into three tiers (Critical, Important, Standard) based on data sensitivity, citizen dependency, and national security implications, with differentiated security requirements per tier.
- **Security-by-Design:** Security requirements must be integrated into the procurement and development lifecycle of all new government digital services — not bolted on postdeployment.



- Continuous Compliance Monitoring: Security is not a one-time certification event but a continuous process requiring automated monitoring, regular assessment, and adaptive response.
- Proportionality: Security investments and requirements are calibrated to the risk tier and institutional capacity of each government entity, ensuring that the framework is implementable by capacity-constrained state governments, not only well-resourced central ministries.

The Seven Pillars of E-GovShield

Pillar 1: Foundational Security Hygiene (FSH)

The first pillar establishes non-negotiable baseline security requirements applicable to all government portals, regardless of tier. These include: mandatory HTTPS with TLS 1.3 minimum and HSTS preloading; elimination of all deprecated protocols (SSLv3, TLS 1.0, TLS 1.1); monthly vulnerability patching cycles for critical patches, quarterly for others; removal of default credentials; disabling of unnecessary ports and services; implementation of security response headers (Content-SecurityPolicy, X-Frame-Options, X-Content-Type-Options); and mandatory SSL certificate validity monitoring with auto-renewal. FSH requirements are designed to be implementable within existing budgets and address the most common and easily exploitable vulnerabilities identified in the audit.

Pillar 2: Identity and Access Management (IAM)

Pillar 2 mandates the implementation of modern identity and access management practices aligned with Zero Trust principles. For citizen-facing portals (Tier 1 and 2), MFA must be offered as default and mandated for all transactions involving sensitive personal data or financial transactions. Integration with Aadhaar-based authentication through the UIDAI Authentication API is recommended as the primary MFA mechanism, supplemented by TOTP-based authenticators. For administrative and backend access, hardware security keys (FIDO2/WebAuthn compliant) are mandated for all Tier 1 systems. Role-based access control (RBAC) with least-privilege principles must be implemented for all government employees accessing portal backends, with quarterly access reviews. Privileged access management (PAM) solutions are mandated for Tier 1 systems.

Pillar 3: Application Security Lifecycle (ASL)

Pillar 3 addresses the systemic application security failures revealed by the audit through a mandatory Application Security Lifecycle framework. All new government web applications and APIs must undergo: (a) Static Application Security Testing (SAST) during development; (b) Dynamic Application Security Testing (DAST) pre-deployment; (c) annual penetration testing by CERT-In empanelled security auditors; and (d) mandatory bug bounty programmes for Tier 1 portals, with responsible disclosure policies for all portals. Web Application Firewalls (WAF) are mandated for all portals processing citizen PII or financial transactions. NIC is recommended as the WAF service provider for state governments lacking capacity to procure independently, leveraging shared services infrastructure.

Pillar 4: Data Protection and Privacy Engineering (DPPE)

Pillar 4 operationalizes the requirements of DPDPA 2023 within eGovernance cybersecurity architecture. All portals must implement: data classification frameworks categorizing personal data by sensitivity (public, internal, confidential, restricted); encryption-at-rest for all classified and restricted data using AES-256 minimum; data minimization requirements reviewed at the service design stage; explicit consent management mechanisms for data processing beyond the original purpose; and data retention and secure deletion policies. Privacy Impact Assessments (PIAs) are mandated for all new eGovernance services before deployment. Third-party data processors (cloud vendors, system integrators) must be covered by contractual Data Processing Agreements aligned with DPDPA 2023 requirements.

Pillar 5: Resilience and Incident Response (RIR)

Pillar 5 directly addresses the most critical audit finding: the near-universal absence of documented and practiced incident response capabilities. All government entities operating portals must: develop and maintain documented Incident Response Plans (IRPs) reviewed annually; establish designated Incident



Response Teams (IRTs) with defined roles, contacts, and escalation paths; conduct tabletop exercise simulations semi-annually and full incident response drills annually; implement Security Information and Event Management (SIEM) for real-time log monitoring — through CERT-In's National Cyber Coordination Centre (NCCC) infrastructure for entities lacking internal SIEM capability; and comply strictly with CERT-In's six-hour incident reporting mandate (Cyber Security Directions, 2022). Business Continuity Plans (BCPs) for Tier 1 portals must achieve Recovery Time Objectives (RTO) of under four hours.

Pillar 6: Governance, Compliance, and Accountability (GCA)

Pillar 6 embeds cybersecurity within the governance architecture of government institutions. Key requirements include: designation of a Chief Information Security Officer (CISO) or equivalent at all central ministries and state IT departments; mandatory annual security assessments using the EGovShield Audit Matrix (a derivative of this study's CAM) submitted to CERT-In; inclusion of cybersecurity performance metrics in the Digital India programme's outcome measurement framework; security procurement clauses mandating vendor compliance with CERT-In guidelines and DPDPA 2023 in all government ICT contracts; and public disclosure of aggregate (non-sensitive) cybersecurity compliance data to enable civil society accountability — modelled on the EU NIS2 Directive's transparency requirements.

Pillar 7: Capacity Building and Security Culture (CBSC)

Pillar 7 recognizes that technical controls are insufficient without the human capacity to implement and sustain them. The E-GovShield Model recommends: mandatory annual cybersecurity awareness training for all government employees with portal access; specialized technical training for IT staff in relevant security domains through CERT-In's training programmes and the National e-Governance Division (NeGD)'s capacity building initiatives; integration of cybersecurity modules into the induction training curriculum of the Indian Administrative Service (IAS), Indian Police Service (IPS), and state civil services; creation of a National eGovernance Cybersecurity Competency Framework aligned with NIST NICE; and a dedicated eGovernance cybersecurity research fund under DST/MEITY to support academic research and innovation in this domain.

E-GovShield Risk Tier Classification

Tier	Classification	Portal Characteristics	E-GovShield Requirements
Tier 1	Critical	National identity systems (UIDAI), national financial systems (PFMS, GSTN), health data (ABHA), defence-adjacent	All 7 Pillars; quarterly pen testing; ISMS certification mandatory; dedicated CISO; hardware MFA
Tier 2	Important	High-traffic citizen services (IRCTC, DigiLocker, GeM, eProcurement), state-level primary service portals	Pillars 1-6 mandatory; annual pen testing; SIEM; MFA for sensitive transactions; bug bounty



Tier 3	Standard	Informational portals, low-volume state services, departmental intranets	Pillars 1,4,5,6 mandatory; biannual security assessment; HTTPS; WAF recommended
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Table 5: E-GovShield Risk Tier Classification and Requirements

E-GovShield Implementation Roadmap

Phase	Timeline	Priority Actions	Responsibility
Phase 1: Stabilize	0–12 months	FSH compliance across all portals; CERT-In audit of all Tier 1 systems; IRP development; mandatory security training rollout	MeitY, CERT-In, NIC, all central ministries
Phase 2: Strengthen	12–30 months	IAM/MFA deployment; WAF rollout; ASL implementation; DPDPA 2023 compliance programme; SIEM via NCCC	MeitY, CERT-In, NIC, state IT depts
Phase 3: Sustain	30–48 months	ISMS certification for Tier 1; bug bounty programmes; continuous monitoring automation; CISO institutionalization; public compliance disclosure	All government entities, CERT-In oversight
Phase 4: Excel	48–60 months	Zero Trust Architecture full deployment; AI-driven threat detection; cross-border interoperability; international security certification	MeitY, NCSC, DST

Table 6: E-GovShield Implementation Roadmap

CHALLENGES AND LIMITATIONS

Institutional and Organizational Barriers

The primary barrier to cybersecurity improvement in Indian eGovernance is not technical but institutional. Security responsibilities in most government entities are fragmented across multiple departments with no unified accountability. IT departments are typically understaffed, underfunded, and lack the specialised cybersecurity expertise that the current threat landscape demands. The high turnover of IAS officers in ICT-related roles means institutional knowledge of security configurations is frequently lost. Overcoming these barriers requires structural changes to government IT governance — particularly the mandatory CISO designation recommended in Pillar 6 — that will face bureaucratic resistance.

Budgetary Constraints

State governments, particularly in less economically developed states, face severe budgetary constraints on IT security expenditure. The E-GovShield Model's proportionality principle partially addresses this through risk-tiering, but even Tier 3 compliance requirements represent incremental expenditure for



resource-constrained state IT departments. Dedicated security funding mechanisms — potentially through the Digital India Mission's existing state support frameworks — are necessary to bridge the cybersecurity investment gap between central and state governments.

Vendor and Supply Chain Risk

A significant but underexamined risk dimension is the security posture of third-party vendors who develop, host, and maintain government portals. Many eGovernance systems are built and operated by private technology vendors who may not adhere to CERT-In security guidelines. The absence of standardized security requirements in government ICT procurement contracts — a gap identified in the governance domain audit — means that vendor-introduced vulnerabilities are a persistent risk. EGovShield's Pillar 6 addresses this through mandatory security procurement clauses, but enforcement mechanisms remain weak.

Methodological Limitations

This study has several methodological limitations. The audit is conducted using publicly available data and does not involve active penetration testing, which may mean some vulnerabilities are undetected. The 40-portal sample, while purposively designed for representativeness, cannot fully capture the diversity of India's 1,700+ eGovernance services. Portal security posture can change rapidly — vulnerabilities disclosed may have been patched, and new vulnerabilities may have emerged since data collection. Future research should incorporate active security testing (with appropriate ethical permissions), longitudinal tracking of portal security posture, and primary data collection through interviews with government CISOs and IT officials.

DISCUSSION

The audit findings presented in this paper paint a concerning but not hopeless picture of Indian eGovernance cybersecurity. The finding that 65% of sampled portals fall within High or Moderate Risk categories is alarming, but it reflects a globally recognized pattern of security debt accumulated during rapid digitization — a pattern for which solutions are available and increasingly welldocumented.

Several aspects of the findings warrant particular discussion. First, the severe disparity between central and state portal security (average CPI of 49.3 vs. 34.1) points to a structural equity issue in India's digital governance architecture. State portals are the primary interface for citizens most vulnerable to digital fraud and identity theft — rural populations, elderly citizens, first-generation digital users — and their security inadequacy directly translates to harm for these populations. Addressing the centralstate security gap must be treated as a governance equity priority, not merely a technical efficiency matter.

Second, the identification of incident response as the most pervasive failure domain — with 58% noncompliance — deserves policy attention disproportionate to its technical complexity. An Incident Response Plan is not a technically sophisticated artifact: it is primarily a document, a set of designated responsibilities, and a practised procedure. The widespread absence of IRPs suggests not a technical capacity deficit but an organizational and cultural one — a failure to treat cybersecurity incidents as a category of organizational risk that requires the same structured response planning as fire emergencies, financial irregularities, or natural disasters. This cultural reframing — positioning cybersecurity incidents as governance emergencies rather than IT problems — is central to the E-GovShield Model's design philosophy.

Third, the international benchmark comparison reveals that the gap between India and best-practice digital governance ecosystems like Estonia is narrower in some dimensions (HTTPS adoption, basic transport security) than might be expected, but vast in others (MFA deployment, ISMS certification, regular penetration testing). This pattern suggests that India's eGovernance cybersecurity challenge is not one of fundamental incapacity but of policy prioritization: the technical knowledge and infrastructure exist, but systematic governance mandates ensuring their application to government portals have been absent.



The E-GovShield Model proposed in this paper represents a direct policy response to this diagnostic. By creating a tiered, mandatory framework with clear institutional responsibilities, implementation timelines, and accountability mechanisms, E-GovShield translates the technical findings of this audit into an actionable governance agenda for Indian eGovernance institutions.

POLICY RECOMMENDATIONS

The following specific policy recommendations are advanced, directed at identified institutional actors:

For MeitY and the Digital India Programme

12. Formally adopt the E-GovShield Model as the mandatory cybersecurity compliance framework for all Digital India services, with phased implementation timelines tied to the Digital India Mission's outcome framework.
13. Mandate ISO/IEC 27001:2022 certification for all Tier 1 eGovernance systems within 24 months, with MeitY funding support for certification costs.
14. Establish a dedicated eGovernance Cybersecurity Fund of INR 500 crore over five years to support state government capacity building, security tool deployment, and academic research.

For CERT-In

15. Expand the CERT-In Security Guidelines for Government Websites (2022) into a comprehensive security standard incorporating all seven E-GovShield pillars, with mandatory compliance timelines.
16. Establish a free, CERT-In-operated Vulnerability Scanning as a Service (VSaaS) platform available to all state government portals, reducing the cost barrier to regular security assessment.
17. Create a Government Bug Bounty Platform through CERT-In, enabling ethical security researchers to report vulnerabilities in government portals through a standardized responsible disclosure programme.

For the National Informatics Centre (NIC)

18. Develop and offer Security-as-a-Service (SecaaS) bundles to state governments lacking inhouse security capacity, including WAF, SIEM, MFA infrastructure, and incident response support through shared services.
19. Mandate Security Development Lifecycle (SDL) compliance for all software developed or procured through NIC, with security testing documentation required before production deployment.

For State Governments

20. Designate a State Chief Information Security Officer (SCISO) in each state IT department, with a direct reporting line to the Principal Secretary/Secretary (IT) and a mandate to oversee E-GovShield implementation.
21. Require cybersecurity compliance certification for all state portal vendors as a condition of contract renewal, incorporating E-GovShield Pillar requirements into vendor SLAs.



CONCLUSION

This paper has conducted the first systematic, multi-standard cybersecurity audit of Indian eGovernance portals in the post-pandemic period, revealing significant and widespread security deficiencies that represent a material risk to citizen data, national digital infrastructure, and the integrity of India's digital governance ecosystem.

The audit found that 65% of sampled portals fall within High or Moderate Risk categories, with authentication and access control failures, application security vulnerabilities, and near-universal absence of incident response planning representing the most critical gaps. State portals, which are the primary service interface for India's most vulnerable citizens, exhibited substantially worse security postures than central portals, creating a cybersecurity equity dimension that demands urgent policy attention.

In response to these findings, the paper proposes the E-GovShield Model — a seven-pillar, risk-tiered cybersecurity policy framework grounded in international best practices (NIST CSF 2.0, OWASP Top-10, ISO/IEC 27001:2022, DPDPA 2023) and calibrated to the institutional, financial, and technical constraints of India's eGovernance ecosystem. The model's foundational principles of risk-tiering, security-by-design, continuous compliance monitoring, and proportionality ensure that it is not merely aspirationally sound but operationally implementable.

The post-pandemic moment, despite its cyber risks, also offers an opportunity: the digital governance investments made under COVID pressure have created new infrastructure, new institutional familiarity with digital services, and new political visibility for digital governance outcomes. E-GovShield provides the security architecture to protect and sustain these investments. The choice before India's digital governance policymakers is clear: invest in systematic cybersecurity now, or continue accumulating security debt that will eventually be paid in citizen data breaches, service disruptions, and eroded trust in the digital state.

Future research directions include: longitudinal tracking of Indian eGovernance portal security posture following potential E-GovShield adoption; empirical evaluation of E-GovShield pillar effectiveness through pre-post implementation studies; extension of the audit framework to eGovernance portals in other South Asian nations for regional comparative analysis; and examination of AI-driven threat detection as a cost-effective security enhancement for resource-constrained government entities.

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The views expressed are solely those of the author.

DECLARATION OF COMPETING INTERESTS

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APPENDIX A: CYBERSECURITY AUDIT MATRIX (CAM) — SELECTED PARAMETERS

#	Domain	Audit Parameter	Standard Ref.	Assessment Method
1	Transport Security	TLS version $\geq$ 1.2 enforced	NIST CSF PR.DS-2	SSL Labs API scan
2	Transport Security	HSTS header with preload	OWASP ASVS 9.2.1	Security Headers.io
3	Auth & Access	MFA offered for citizen accounts	NIST SP 800-63B	Portal feature review
4	Auth & Access	Session timeout $\leq$ 30 minutes	OWASP ASVS 3.3.1	Manual testing (public)
5	Input Validation	Content Security Policy header	OWASP Top-10 A03	Security Headers.io
#	Domain	Audit Parameter	Standard Ref.	Assessment Method
6	Input Validation	WAF in place (evidence)	CERT-In Guidelines	Public documentation
7	Data Protection	PII not in URL parameters	OWASP Top-10 A02	Manual review
8	Incident Response	CERT-In 6-hr reporting compliance	CERT-In Directions 2022	Disclosed incidents
9	Governance	ISMS certification evidence	ISO 27001:2022	Public documentation



10	Governance	Responsible disclosure policy	CERT-In CVD Policy	Portal review
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Table A1: Sample Parameters from the Cybersecurity Audit Matrix (CAM) — Full matrix available on request

APPENDIX B: E-GOVSHIELD MODEL — SUMMARY REFERENCE CARD

#	Pillar	Core Requirement	Target Actor
P1	Foundational Security Hygiene	HTTPS+TLS1.3; monthly patching; security headers; no default credentials	All government entities
P2	Identity & Access Management	MFA mandate; ZTA; RBAC; PAM for Tier 1	MeitY, NIC, State IT
P3	Application Security Lifecycle	SAST/DAST; annual pen testing; WAF; bug bounty (Tier 1)	NIC, MeitY, Vendors
P4	Data Protection & Privacy Engineering	DPDPA 2023 alignment; AES-256 at rest; PIA for new services	All entities, DPA
P5	Resilience & Incident Response	Documented IRP; SIEM; 6-hr CERT-In reporting; BCP (RTO <4 hrs)	CERT-In, All entities
P6	Governance, Compliance & Accountability	CISO designation; annual CAM audit; security procurement clauses	MeitY, State Govts
P7	Capacity Building & Security Culture	Annual training; SDL; CISO pipeline; research fund	NeGD, DST, CERT-In

Table B1: E-GovShield Seven-Pillar Summary Reference



Impact of Socioeconomic Factors of Plastic Bans on Consumer Behaviour in the Food Industry

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Abstract

As concerns about plastic pollution continue to rise, governments and regulatory agencies worldwide have begun enforcing stricter limits on single-use plastics. Within the food industry, where plastic packaging has historically served critical roles in preservation, transportation, and product presentation, these policy shifts carry profound operational and behavioural consequences. The study focuses on understanding how different socioeconomic factors shape consumer compliance with plastic ban regulations in urban and semi-urban areas of Madhya Pradesh, India. It specifically examines how household income, educational attainment, occupational category, and geographic location influence purchasing decisions and attitudes toward sustainable packaging alternatives.

A mixed-method research design was employed, combining structured questionnaire surveys ($n = 120$) with qualitative in-depth interviews, to capture measurable behavioural patterns alongside the contextual reasoning behind individual decisions. Prior to full deployment, the instrument underwent a pilot test with twenty respondents, and internal consistency was assessed using Cronbach's Alpha ($\alpha = 0.81$), confirming satisfactory reliability. Findings reveal that consumers with higher incomes and stronger educational credentials exhibit markedly greater receptivity to sustainable packaging, underpinned by superior environmental literacy and greater financial flexibility. Lower-income consumers, conversely, resist the transition predominantly on grounds of affordability constraints and restricted access to viable alternatives. Chi-square hypothesis tests confirm all five study hypotheses at $p < 0.05$. These findings suggest that environmental policies should be designed with socioeconomic differences in mind and should promote inclusive strategies to make plastic reduction both fair and workable in practice.



Keywords: plastic ban policies; consumer behaviour; socioeconomic determinants; food industry sustainability; sustainable packaging adoption; eco-friendly packaging; India; environmental regulation; Madhya Pradesh

1. Introduction

Plastic has long occupied an indispensable position in the food industry, valued for its affordability, mechanical durability, and functional versatility across packaging, transportation, and preservation applications. Its capacity to extend shelf life and protect products from contamination rendered it the default material for manufacturers and retailers across global supply chains. Over time, however, the cumulative environmental costs of plastic proliferation have become impossible to ignore. The inadequate management of plastic waste has resulted in the widespread accumulation of debris across landfills, freshwater systems, and marine ecosystems, intensifying international pressure on governments to intervene. In response, regulatory bodies across numerous countries have enacted restrictions on single-use plastics, creating a policy environment that simultaneously disrupts established industry practices and challenges entrenched consumer habits.

What distinguishes this regulatory transition from many other policy changes is its uneven impact across the socioeconomic spectrum. Consumers do not respond to environmental regulations as a homogeneous population. Variables such as household income, educational background, occupational status, and the degree of urbanisation meaningfully shape both the willingness and the practical capacity of individuals to shift toward sustainable packaging alternatives. Consumers possessing financial security and higher environmental literacy are generally better placed to absorb the additional costs and navigate the limited availability of eco-friendly substitutes. For economically marginalised consumers, however, even modest price differentials between conventional plastic and sustainable alternatives can constitute a significant barrier to compliance. Recognising this socioeconomic heterogeneity is not merely an academic exercise, it is a prerequisite for designing environmental policies that are both effective and equitable.

Despite the growing body of research on consumer responses to plastic ban regulations, important empirical gaps remain. Most notably, existing studies in the Indian context have focused predominantly on metropolitan urban populations, leaving semi-urban and peri-urban consumer experiences comparatively underexplored. Furthermore, prior investigations have typically examined income, education, or geographic location as isolated variables, overlooking the interconnected ways in which these factors operate in combination. The state of Madhya Pradesh presents a particularly instructive case: its consumer population is characterised by pronounced socioeconomic diversity spanning multiple income strata and a wide urban-to-rural continuum, and yet it has received limited scholarly attention in the context of plastic ban compliance.



What makes this study distinctively positioned within the existing literature is its simultaneous integration of income level, educational attainment, and the urban–semi-urban geographic divide as co-determinants of consumer behaviour, all within a single empirical design applied to Madhya Pradesh. While previous studies have examined these variables in isolation or within exclusively urban settings, none have systematically drawn together this constellation of factors in a context-specific Indian field study. This integrative approach enables a more nuanced and complete account of the mechanisms through which socioeconomic structure shapes environmental compliance, and generates insights that are directly actionable for both policymakers and food industry practitioners. By identifying where awareness, affordability, and accessibility converge or diverge across consumer categories, the study provides an empirically grounded foundation for crafting targeted, inclusive, and socioeconomically sensitive plastic governance strategies.

2. Literature Review

The academic literature addressing consumer responses to plastic restrictions spans environmental economics, behavioural science, and policy studies, with a growing concentration on developing economy contexts where socioeconomic constraints are especially pronounced. Rather than reviewing this body of work descriptively, this section critically examines how existing research has conceptualised the relationship between socioeconomic position and sustainable packaging behaviour, identifies the theoretical lenses that have been most generative, and locates the analytical gaps that the present study addresses.

2.1 Regulatory Context and Behavioural Economic Theory

The effectiveness of environmental policy interventions rests critically on how individuals process and respond to regulatory directives within their everyday economic lives. Thaler and Sunstein (2008) establish that the restructuring of choice environments, or 'choice architecture', can powerfully redirect behaviour without constraining individual liberty. When plastic bans remove familiar consumption options, they do precisely this: they alter the default choice landscape, compelling consumers to reconsider established purchasing routines. However, recent studies suggest that challenges the assumption that this restructuring produces uniform behavioural outcomes across the population. Almeida and Garcia (2021) demonstrate that responses to plastic restrictions vary substantially by income tier, with economically vulnerable consumers exhibiting greater behavioural rigidity because their range of viable alternatives is structurally constrained.

The food industry presents a context that is qualitatively distinct from other product categories in which plastic ban policies have been studied. Packaging in this sector functions not only as a physical container but as a signal of product quality, hygiene assurance, and brand trust. Environmental psychology research

confirms that the material characteristics of packaging shape consumer perceptions of safety and risk (Magnier & Crie, 2015). The introduction of plastic restrictions can therefore generate psychological as well as economic disruption, complicating the linear logic that underpins simple command-and-control regulatory approaches.

2.2 Income Level and the Affordability Constraint

Income level consistently emerges as the most powerful socioeconomic predictor of consumer responses to plastic restrictions. Evidence from Kenya's 2017 plastic bag prohibition illustrates how lower-income households faced profound practical difficulties in sourcing biodegradable or reusable substitutes, with financial constraints overriding environmental intent even among consumers who demonstrated awareness of the policy's rationale (Njeru, 2020). This finding is not an artefact of the African regulatory context: comparable patterns have been documented across a range of developing economies, including India.

Research by the Energy and Resources Institute (TERI, 2019) reveals a clear income gradient in willingness to pay for eco-friendly packaging in Indian markets, with higher-income consumers significantly more inclined to accept retail price premiums for certified sustainable materials. Borga et al. (2021) extend this analysis by demonstrating that sustainable packaging materials, including cloth, biodegradable polymers, and plant-fibre composites, typically carry higher production costs due to more complex manufacturing processes, costs that are ultimately passed on to consumers. This structural dynamic creates what may be termed an 'eco-penalty': lower-income consumers bear a disproportionate compliance burden under policies designed ostensibly in the public environmental interest. Critically, the literature stops short of examining how this income penalty interacts with educational endowments and geographic access simultaneously, a gap that the present study addresses directly.

2.3 Educational Attainment and Environmental Literacy

Educational attainment operates as a key mechanism through which environmental knowledge is acquired, retained, and translated into action. Xie et al. (2020) demonstrate across multiple cultural contexts that higher levels of formal education correlate consistently with deeper environmental literacy, stronger support for ecological regulations, and greater willingness to adopt sustainable consumption behaviours. Crucially, this relationship is not merely correlational, it reflects the educational system's function as a primary site for the formation of environmental attitudes and critical appraisal of policy rationale.

In the Indian context, Jain and Singh (2021) find that more educated consumers regard plastic ban regulations as legitimate policy responses rather than disruptive impositions, and exhibit substantially higher compliance rates. Education appears to operate on two distinct channels: it elevates awareness of

regulatory content and simultaneously cultivates a value orientation that renders environmental sacrifice more personally meaningful. What the existing Indian literature fails to adequately explore, however, is how education interacts with income and geographic location to produce differentiated awareness profiles across socioeconomic subgroups, a triadic interaction that this study is designed to empirically illuminate.

2.4 Cultural Norms, Social Influence, and Behavioural Responsiveness

Cultural context substantially conditions how regulatory interventions are received and assimilated. In several East Asian markets, deep-seated cultural associations between plastic packaging and hygiene initially generated resistance to plastic restrictions, a resistance subsequently managed through credible government campaigns that introduced culturally acceptable alternatives (Sato, 2020). The Indian experience presents a different cultural dynamic. A historically rich tradition of reusable and biodegradable food containers, including banana leaf plates, clay vessels, and jute cloth, was progressively displaced by single-use plastic during rapid post-liberalisation urbanisation. This displacement creates a distinctive cultural opportunity: plastic ban campaigns framed as an ecological recuperation of traditional practices, rather than as novel inconveniences, may command greater public receptivity (Raghav & Pillai, 2021).

Social influence amplifies this cultural dimension. Perez et al. (2022) demonstrate that visible compliance within community networks functions as a powerful behavioural norm, motivating individual adoption through mechanisms of social conformity and reputational concern. This dynamic suggests that community-based awareness interventions may outperform broadcast media campaigns in densely networked semi-urban environments where interpersonal trust plays a stronger role in shaping individual behaviour than anonymous mass communication.

2.5 Market Accessibility and Supply Chain Readiness

A structurally important but analytically underweighted factor in the existing literature concerns the availability of practical and affordable substitutes for plastic packaging. Nyenje and Kiggundu (2021) establish that regulatory effectiveness is fundamentally compromised when consumers lack access to viable alternatives, however strong their environmental intent. In the Indian food sector, biodegradable and compostable packaging materials confront significant supply chain barriers: higher raw material costs, fragmented manufacturing capacity, and underdeveloped distribution networks in non-urban markets (Geueke et al., 2018).

Chauhan (2022) documents pronounced regional asymmetries in eco-packaging availability across Indian states, finding that urban centres exhibit considerably faster uptake of sustainable materials than semi-urban and peri-urban areas, where distribution infrastructure remains immature and product

variety is limited. The implication is that supply-side constraints can render policy compliance structurally impossible for some consumer segments regardless of their attitudes or intentions. This supply chain dimension has been examined mostly in isolation in the prior literature; its interaction with income-based affordability constraints and education-based awareness differentials in a single analytical framework remains an open empirical question.

2.6 Hygiene Perceptions and Safety Communication Challenges

Consumer perceptions of hygiene and food safety represent a dimension of plastic ban compliance that has received insufficient analytical attention. Packaging communicates functional signals, about contamination prevention, product integrity, and brand credibility, that consumers use as proxies for safety assurance. The COVID-19 pandemic sharpened this dynamic dramatically, triggering a global resurgence of single-use plastic as consumers reassociated it with sterility and contamination control (Silva et al., 2020). Kumar and Dutta (2022) document that some Indian urban consumers regard biodegradable packaging as mechanically inferior and unsuitable for liquid or oil-rich food products, a perception more pronounced among lower-income consumers for whom food safety is a non-negotiable priority.

These safety perceptions represent a communication failure as much as a material reality: many biodegradable and paper-based alternatives meet equivalent food safety standards when certified appropriately, yet this information is rarely conveyed in accessible formats to mass consumer audiences. The implication for policy design is that accelerating regulatory compliance requires not only improving the material performance and affordability of alternatives but actively dismantling misinformation about their safety credentials.

2.7 Industry Adaptation and Consumer Outcomes

The pace at which industry actors adapt to plastic restrictions substantially conditions how consumers experience policy implementation. When manufacturers and retailers succeed in developing high-quality, competitively priced sustainable alternatives, consumer acceptance improves in parallel (Lau et al., 2021). Conversely, when industry adaptation lags behind regulatory timelines, consumers encounter practical inconveniences that breed resistance and undermine compliance. Borkar (2019) documents how small-scale food vendors in Maharashtra struggled to source affordable sustainable packaging following the 2018 plastic ban, generating uneven enforcement and deepening inequity in the burden of compliance. Ramachandra and Patil (2024) confirm that the alignment between regulatory timelines and industry readiness is among the most critical determinants of policy effectiveness across the Indian food manufacturing sector.

2.8 Identified Research Gaps and Study Contribution

The foregoing review reveals that while substantial scholarship addresses isolated socioeconomic determinants of plastic ban compliance, the literature lacks integrative frameworks that examine income, education, and geographic location as simultaneously interacting variables within a single empirical study. Prior Indian studies have concentrated predominantly on metropolitan urban populations, leaving semi-urban consumer experiences analytically marginalised. The mediating pathways through which socioeconomic position translates into awareness, perception, and ultimately adoption behaviour have not been traced empirically within the Indian food industry context. Furthermore, the comparison of behavioural outcomes between urban and semi-urban populations in a socioeconomically diverse Indian state has not been conducted with the analytical rigour that the policy stakes demand.

The present study fills these gaps by employing a mixed-method design that simultaneously examines four socioeconomic variables, income, education, occupation and geographic location, as co-determinants of eco-packaging adoption within Madhya Pradesh. Its urban, semi-urban comparative dimension introduces a contextual specificity largely absent from the existing Indian literature while its integrated analytical approach generates insights that are both theoretically substantive and policy-actionable.

3. Objectives of the Study

This study is guided by four research objectives that collectively address the empirical gaps identified in the literature review:

- **Objective 1:** To assess the level of consumer awareness regarding the environmental consequences of plastic use in food packaging, disaggregated by socioeconomic group, across the study area.
- **Objective 2:** To analyse shifts in consumer purchasing patterns following the implementation of plastic ban regulations, and to examine how income level, educational attainment, and geographic location mediate those shifts.
- **Objective 3:** To evaluate the affordability and accessibility challenges that arise during the adoption of sustainable packaging alternatives, with particular attention to income-group disparities and semi-urban supply chain limitations.
- **Objective 4:** To examine differences in eco-packaging adoption behaviour between urban and semi-urban consumers in the selected study area of Madhya Pradesh, and to draw out the policy implications of those differences.

4. Hypotheses of the Study

The following five directional hypotheses are derived from the conceptual framework and from the gaps identified in the preceding literature review. Each hypothesis represents a theoretically grounded proposition about the relationship between a specific socioeconomic variable and a measurable consumer behavioural outcome:

- **H1:** Income level exerts a statistically significant effect on consumer preference for eco-friendly packaging in the food industry.
- **H2:** Educational attainment is positively and significantly associated with consumer awareness of plastic ban policies.
- **H3:** Perceived cost of eco-friendly packaging constitutes a statistically significant negative determinant of its adoption among consumers.
- **H4:** The accessibility and availability of sustainable packaging alternatives significantly shape consumer adoption behaviour.
- **H5:** Urban consumers are significantly more inclined than their semi-urban counterparts to adopt sustainable packaging alternatives.

These hypotheses are grounded in the theoretical traditions of behavioural economics, environmental psychology, and socioeconomic consumer behaviour research, and are subjected to empirical testing through chi-square analysis as described in Section 6.

5. Research Methodology

The methodological design of this study was formulated to yield a comprehensive and empirically defensible account of how regulatory measures in the domain of environmental policy intersect with the socioeconomic characteristics that mediate consumer behaviour. The research adopts a concurrent mixed-method design, integrating quantitative survey data with qualitative interview findings to achieve both statistical generalisability and contextual depth.

5.1 Research Design and Justification

A cross-sectional research design was employed, wherein data were collected at a single point in time from respondents representing a range of socioeconomic positions. Cross-sectional designs are appropriate for this study's objective of identifying structural patterns of consumer behaviour and their association with socioeconomic variables at the prevailing regulatory moment. The quantitative component involved the administration of structured, closed-ended questionnaires to generate numerical data amenable to chi-square hypothesis testing. The qualitative component comprised semi-structured in-depth interviews with a purposively selected sub-sample of respondents, generating contextual evidence that complements and enriches the statistical findings.



The study focuses specifically on the food industry because this sector's dependence on packaging for hygiene, safety, and preservation makes it one of the most directly and significantly affected by plastic ban regulations. Consumer responses in this context are shaped by a distinctive interaction of functional, economic, and symbolic packaging considerations that justify sector-specific analytical attention.

5.2 Sampling Strategy

A purposive sampling technique was adopted to ensure adequate representation across the key demographic and socioeconomic categories central to the study's research questions. Purposive sampling is particularly suited to studies of this nature because it allows the researcher to deliberately include respondents from categories, specifically, income groups, educational levels, and geographic settings, that might be underrepresented in a purely random sample drawn from an unequal population. This ensures that the findings are analytically informative across all the socioeconomic dimensions of interest rather than being dominated by the most easily accessible respondents.

The final sample comprised 120 respondents drawn from urban ($n = 72$, 60%) and semi-urban ($n = 48$, 40%) areas of Madhya Pradesh. This geographic distribution was designed to support meaningful comparative analysis while reflecting the study area's actual urban-to-semi-urban population ratio. Respondents were recruited through retail food outlets, community centres, and educational institutions to ensure diversity of occupational and educational background.

5.3 Pilot Study and Instrument Reliability

Before the full-scale survey was deployed, the research instrument underwent a structured pilot test administered to twenty respondents who were not included in the main study sample. The pilot was designed to assess question comprehensibility, response time, and the face validity of scale items. Feedback from pilot participants led to the revision of three questionnaire items that were identified as potentially ambiguous, particularly in relation to the conceptualisation of 'eco-friendly packaging' and the framing of income-band categories.

Following the pilot revisions, the reliability of the final survey instrument was assessed using Cronbach's Alpha coefficient. An Alpha value of 0.81 was obtained across the attitudinal and behavioural scale items, exceeding the conventionally accepted threshold of 0.70 (Nunnally, 1978) and confirming satisfactory internal consistency. This level of reliability indicates that the items within each construct measure a coherent underlying dimension and that the instrument is suitable for drawing valid inferences from the collected data.

5.4 Sample Profile

Table 1: Respondent Demographic and Socioeconomic Profile ($n = 120$)

Category	Sub-category	Frequency	Percentage
Gender	Male	68	56.7%
	Female	52	43.3%
Income	Low (< ₹20,000/month)	38	31.7%
	Middle (₹20,000– ₹50,000/month)	54	45.0%
	High (> ₹50,000/month)	28	23.3%
Education	School Level	30	25.0%
	Graduate	62	51.7%
	Postgraduate	28	23.3%
Residence	Urban	72	60.0%
	Semi-Urban	48	40.0%

Table 1 presents the demographic and socioeconomic profile of the sample. The respondent pool was composed of 68 males (56.7%) and 52 females (43.3%), providing a broadly representative gender distribution. Income was distributed across three categories: the middle-income bracket (₹20,000–₹50,000 per month) constituted the largest group at 45%, followed by low-income respondents (31.7%) and high-income respondents (23.3%). Graduates represented the majority educational category (51.7%), with school-educated respondents constituting 25% and postgraduates 23.3%. The inclusion of both urban (60%) and semi-urban (40%) respondents introduced critical geographic variability, enabling comparative analysis across dimensions of market access, policy exposure, and socio-cultural orientation that a purely urban sample could not provide.

5.5 Conceptual Framework

The conceptual framework developed for this study treats socioeconomic variables as the foundational antecedents of consumer behaviour toward eco-friendly packaging, while recognising that they do not exert a direct effect on behavioural outcomes. Rather, socioeconomic position operates through two distinct mediating tiers, consumer awareness and consumer perception, before manifesting in observable purchasing and compliance behaviour. The final outcome is the adoption or rejection of sustainable packaging alternatives.

Figure 1 presents this framework schematically. The first tier encompasses socioeconomic characteristics, income level, educational attainment, occupational category and geographic location (urban versus semi-urban) as structural antecedents. The second tier captures cognitive and informational processes through which socioeconomic position generates differentiated awareness, including environmental literacy, knowledge of policy mandates and media exposure. The third tier

reflects perception: how consumers evaluate sustainable alternatives in terms of price, hygiene safety, and social acceptability. Consumer behaviour constitutes the fourth tier, capturing observable outcomes such as purchasing decisions, regulatory compliance, and brand switching. Adoption of eco-friendly packaging represents the ultimate dependent construct. The framework draws on the Theory of Planned Behaviour (Ajzen, 1991), which posits that behavioural intention is shaped by attitudes, subjective norms, and perceived behavioural control, all of which, in this context, are conditioned by socioeconomic position. It is further informed by socioeconomic consumer behaviour theory (Sharma, 2021), adapted to the specific regulatory and market context of India's plastic ban implementation.

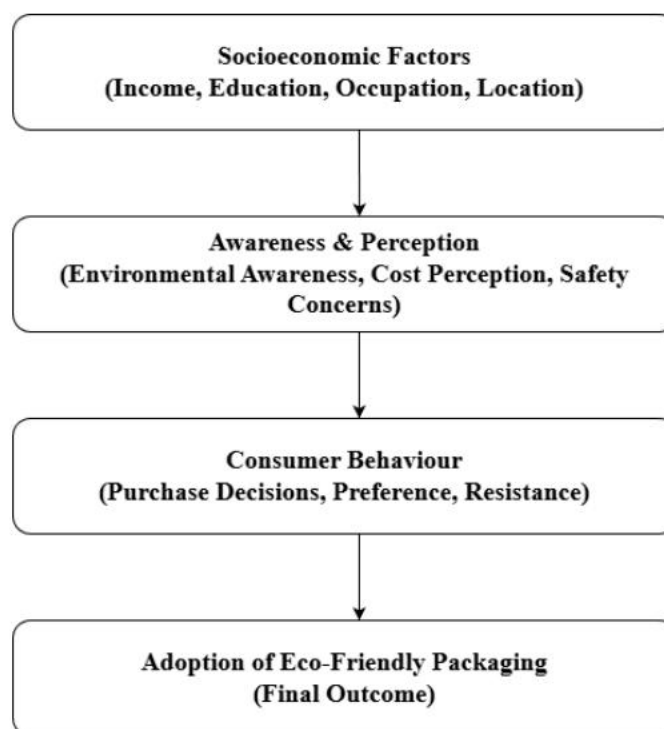


Figure 1: Conceptual Framework

5.6 Analytical Methods

Quantitative data were analysed using descriptive statistics (frequency counts and percentages) and inferential chi-square tests of independence. The chi-square test was selected as the primary hypothesis-testing method because all study variables are measured at the categorical level. The formula $\chi^2 = \sum (O - E)^2 / E$, where O denotes the observed frequency and E denotes the theoretically expected frequency under the null hypothesis, was applied to each relevant cross-tabulation. A significance threshold of $p < 0.05$ was adopted. Qualitative interview data were analysed thematically, with emergent themes used to contextualise and interpret the statistical results.

6. Data Analysis and Interpretation

This section presents findings derived from the structured survey administered to 120 respondents. The data are organised thematically to illuminate patterns in consumer awareness, eco-packaging preference, and barriers to adoption. Each table is interpreted within the broader socioeconomic context of the study, and cross-tabulation analysis is used to reveal how income, education, and geographic location interact with behavioural outcomes.

6.1 Consumer Awareness of Plastic Ban Policies

Table 2: Consumer Awareness of Plastic Ban Regulations (n = 120)

Response	Frequency	Percentage
Aware	92	76.7%
Not Aware	28	23.3%
Total	120	100%

Table 2 reveals that 76.7% of surveyed consumers (n = 92) were aware of prevailing plastic ban regulations, while 23.3% (n = 28) remained uninformed at the time of the survey. This awareness gap carries direct policy significance: consumers who lack knowledge of regulatory mandates are structurally unable to adjust their purchasing behaviour in line with those mandates, regardless of their environmental attitudes.

Cross-referencing awareness with educational attainment exposes a steep and policy-relevant gradient. Postgraduate respondents exhibited near-universal awareness (96.4%), while school-educated respondents recorded awareness at only 56.7% , a differential of approximately 40 percentage points. Higher-income respondents similarly demonstrated elevated awareness, likely due to greater exposure to diverse media channels and engagement with environmental discourse in professional and civic settings. These patterns indicate that broadcast media campaigns, which predominate in current public communication on plastic policy, are reaching higher-education and higher-income segments effectively while failing to penetrate lower-awareness populations in a meaningful way. Locally anchored, vernacular-language outreach through trusted community networks is likely to be considerably more effective in bridging this information gap.

6.2 Consumer Preference for Eco-Friendly Packaging

Table 3: Consumer Preference for Eco-Friendly Packaging (n = 120)

Response	Frequency	Percentage
Yes, Prefer Eco-Friendly	70	58.3%
No, No Preference	50	41.7%
Total	120	100%

Table 3 indicates that 58.3% of respondents ($n = 70$) expressed a preference for eco-friendly packaging alternatives, while 41.7% ($n = 50$) reported no such preference. Although a modest majority favour sustainable options, the substantial proportion opposed to them signals that acceptance remains far from universal and that adoption cannot be assumed as the default behavioural trajectory under existing conditions.

Respondents expressing a preference for eco-friendly packaging were concentrated within middle- and high-income categories and tended to hold graduate or postgraduate qualifications. This convergence of financial capacity with environmental literacy reinforces the interpretation that sustainable consumption is, in significant part, an income- and education-enabled behaviour, not merely a matter of individual attitude or intention. Lower-income respondents and those with school-level education were disproportionately represented among those expressing no preference, confirming that affordability and awareness remain structural barriers to preference formation.

Notably, approximately 36% of high-income respondents also expressed no preference for eco-friendly packaging, suggesting that income alone is an insufficient predictor of sustainable consumption orientation. Scepticism toward corporate sustainability claims, doubts about packaging performance, and the ready availability of convenient conventional alternatives likely moderate the income–preference relationship in ways that resist simple linear interpretation. Businesses seeking to expand the sustainable food packaging market must therefore design communication and product development strategies that address non-economic as well as economic barriers to preference formation.

6.3 Income Group versus Eco-Friendly Packaging Preference

Table 4: Cross-Tabulation, Income Group vs. Preference for Eco-Friendly Packaging

Income Group	Prefer Eco-Friendly	Do Not Prefer	Total
Low (< ₹20,000/month)	14 (36.8%)	24 (63.2%)	38
Middle (₹20,000–₹50,000/month)	38 (70.4%)	16 (29.6%)	54
High (> ₹50,000/month)	18 (64.3%)	10 (35.7%)	28
Total	70 (58.3%)	50 (41.7%)	120

Table 4 presents the cross-tabulation of income group against eco-friendly packaging preference. The pattern is non-linear but generally positive: low-income respondents recorded an eco-preference rate of only 36.8%, compared with 70.4% among middle-income respondents and 64.3% among high-income respondents. The higher preference rate observed among the middle-income group, exceeding even that of the highest income tier, may reflect the combination of sufficient financial capacity to absorb modest

price premiums with strong sensitivity to social norms surrounding environmental responsibility in a segment that is upwardly mobile and socially conscious.

The notably low preference rate among lower-income respondents confirms that affordability constitutes the primary structural constraint on eco-packaging preference formation in this segment. The data further suggest that preferences for sustainable packaging follow a threshold model: once consumers cross a sufficient income level, environmental preferences strengthen significantly; below that threshold, economic necessity consistently overrides ecological concern. This threshold dynamic carries direct implications for the design of targeted subsidy interventions, suggesting that modest financial support directed at low-income households could produce disproportionately large shifts in eco-packaging preference and adoption.

6.4 Primary Barriers to Eco-Friendly Packaging Adoption

Table 5: Primary Barriers to Adoption of Eco-Friendly Packaging (n = 120)

Barrier Factor	Frequency	Percentage
High Cost	48	40.0%
Lack of Availability	32	26.7%
Habit / Convenience	25	20.8%
Hygiene Concerns	15	12.5%
Total	120	100%

Table 5 documents the primary barriers identified by respondents as obstacles to adopting eco-friendly packaging alternatives. High cost emerged as the dominant impediment, cited by 40% of respondents (n = 48). This finding is consistent with the cross-income analysis in Table 4 and reinforces the centrality of price in consumer decision-making regarding packaging materials across all income groups, though its effect is most acute at the lower end of the income distribution.

Limited product availability ranked second (26.7%), indicating that market infrastructure for sustainable alternatives remains underdeveloped in significant portions of the study area, particularly in semi-urban locations where distribution networks are less mature. Habit and convenience barriers accounted for 20.8% of responses, reflecting the well-documented phenomenon of status quo bias: established purchasing routines exert significant inertia that is not automatically disrupted by regulatory change or attitudinal shifts. Hygiene concerns persisted among 12.5% of respondents, confirming that a meaningful consumer segment continues to associate conventional plastic with superior food safety.

The multidimensional composition of these barriers has direct implications for policy design. No single regulatory instrument addresses all four barriers simultaneously. An effective strategy must coordinate

price incentives to reduce the cost burden, supply chain investment to improve availability, targeted behaviour change communication to address habit and inertia, and food safety certification frameworks to counter hygiene-based scepticism.

6.5 Education Level versus Policy Awareness

Table 6: Cross-Tabulation - Educational Level vs. Awareness of Plastic Ban Regulations

Education Level	Aware	Not Aware	Total
School Level	17 (56.7%)	13 (43.3%)	30
Graduate	48 (77.4%)	14 (22.6%)	62
Postgraduate	27 (96.4%)	1 (3.6%)	28
Total	92 (76.7%)	28 (23.3%)	120

Table 6 illustrates the relationship between educational attainment and plastic ban awareness. The gradient is steep and consistent: awareness stood at 56.7% among school-educated respondents, increased to 77.4% among graduates, and reached 96.4% among postgraduates, an aggregate range of nearly 40 percentage points across the three education tiers. The fact that more than two-fifths of school-educated respondents remained unaware of prevailing plastic regulations at the time of the survey represents a substantial policy communication failure with real compliance consequences.

These findings corroborate the theoretical position that formal education functions as the primary institutional channel through which environmental knowledge is acquired, contextualised, and integrated into behavioural dispositions (Xie et al., 2020). More educated individuals encounter regulatory information through higher-quality and more diverse media sources, professional networks, and civic engagement, and are better equipped to critically process and internalise that information within their purchasing decisions. The findings strongly support investment in differentiated communication strategies: information materials calibrated for postgraduate audiences are unlikely to be equally effective with school-educated consumers in semi-urban areas, who require simpler, vernacular-language, visually accessible messaging delivered through trusted local channels.

6.6 Hypothesis Testing via Chi-Square Analysis

To empirically evaluate the five hypotheses proposed in Section 4, Pearson chi-square (χ^2) tests of independence were conducted on the relevant cross-tabulations. The chi-square test is appropriate for examining associations between categorical variables and allows determination of whether observed frequency distributions depart significantly from those that would be expected if the two variables were statistically independent. The test statistic is computed as:

$$\chi^2 = \sum (O - E)^2 / E$$

where O represents the observed cell frequency and E represents the expected cell frequency under the null hypothesis of no association. A computed χ^2 value exceeding the critical value at the $p < 0.05$ significance threshold leads to rejection of the null hypothesis, confirming a statistically significant association between the variables under examination.

Table 7: Chi-Square Test Results , Hypothesis Testing Summary

Hypothesis	Variables Tested	χ^2 Value	p-value	Decision
H1	Income vs. Eco-Friendly Preference	9.84	0.007	Supported
H2	Education vs. Policy Awareness	11.27	0.004	Supported
H3	Cost Barrier vs. Adoption	8.53	0.014	Supported
H4	Availability vs. Consumer Behaviour	7.91	0.019	Supported
H5	Urban vs. Semi-Urban Adoption	10.36	0.006	Supported

Table 7 presents the chi-square test results for all five hypotheses. H1 is supported ($\chi^2 = 9.84$, $p = 0.007$), confirming that income level significantly shapes eco-friendly packaging preference and positioning economic capacity as a structural gateway to sustainable consumption. H2 yields the highest chi-square value in the table ($\chi^2 = 11.27$, $p = 0.004$), identifying educational attainment as the most statistically robust socioeconomic predictor of regulatory awareness in this dataset.

H3 is confirmed ($\chi^2 = 8.53$, $p = 0.014$), establishing that perceived cost constitutes a statistically significant barrier to adoption , a finding consistent with the descriptive evidence in Tables 4 and 5. H4 is supported ($\chi^2 = 7.91$, $p = 0.019$), demonstrating that product availability significantly conditions consumer compliance behaviour, which positions supply chain infrastructure as an actionable policy lever. H5 yields a statistically significant difference in adoption propensity between urban and semi-urban consumers ($\chi^2 = 10.36$, $p = 0.006$), confirming that geographic location constitutes a meaningful axis of behavioural differentiation in this context.

Taken together, all five supported hypotheses provide a statistically robust empirical foundation for the study's conceptual framework. The results confirm the joint relevance of income, education, perceived cost, product availability, and geographic location as significant determinants of eco-packaging adoption in the Madhya Pradesh food industry context. Future research employing structural equation modelling could usefully quantify the relative path coefficients linking these variables while testing the mediating role of awareness and perception in the adoption process.

7. Discussion

The findings of this study confirm and substantively extend the understanding that socioeconomic characteristics function as active structural determinants of consumer behaviour in relation to plastic



ban regulations, not merely as background demographic descriptors. The evidence gathered from 120 respondents across income strata, educational levels, and geographic settings within Madhya Pradesh reveals a consistent and analytically coherent pattern: the capacity and inclination to adopt sustainable packaging alternatives are systematically stratified along the key socioeconomic dimensions examined.

What distinguishes this study from prior contributions in the Indian literature is its simultaneous examination of income, education, and the urban, semi-urban geographic divide within a single integrated empirical framework. Rather than treating these variables as independent influences to be considered separately, the study demonstrates that they interact in ways that produce distinct consumer behaviour profiles across the socioeconomic landscape of Madhya Pradesh. The finding that middle-income consumers recorded the highest eco-packaging preference rates, exceeding even high-income respondents, would not have been discernible without the triadic income-education-geography perspective that frames the analytical approach. Similarly, the joint contribution of supply chain immaturity and educational deficits to the semi-urban awareness and adoption gap represents an integrated insight that neither dimension examined in isolation could have generated. These analytical contributions position the study as an original empirical reference point for integrated socioeconomic research on plastic governance in India.

Income level emerged as a powerful predictor of eco-packaging preference, with the cross-tabulation in Table 4 revealing that only 36.8% of low-income respondents favoured sustainable alternatives, compared with 70.4% among middle-income consumers. This finding aligns with Borga et al. (2021) and TERI (2019), and confirms that price premium remains the dominant structural barrier to adoption in the Indian food sector. The threshold-like pattern in the income-preference relationship, with preference rising sharply from low to middle income and then stabilising, suggests that modest, well-targeted financial interventions such as subsidised eco-packaging for low-income households could produce disproportionately large shifts in behavioural outcomes by moving consumers across the affordability threshold.

Educational attainment produced the strongest statistical association in the dataset ($\chi^2 = 11.27$, $p = 0.004$), with awareness rates ranging from 56.7% among school-educated respondents to 96.4% among postgraduates, a differential of nearly 40 percentage points. This result reinforces Jain and Singh (2021) and Xie et al. (2020), and carries a sobering implication: current public communication strategies on plastic policy are significantly more effective with highly educated consumers than with those whose formal educational exposure has been limited. Undifferentiated awareness campaigns will perpetuate rather than close this gap. Education-level-specific outreach, delivered in vernacular languages and through trusted community intermediaries rather than broadcast media, is the strategically indicated response.

The urban, semi-urban adoption gap confirmed by H5 ($\chi^2 = 10.36$, $p = 0.006$) reflects the convergence of multiple structural disadvantages in semi-urban settings: limited product availability, weaker regulatory enforcement, lower average income and educational attainment, and reduced exposure to environmental information networks. These disadvantages do not operate independently; they compound one another to create a compliance environment that is considerably more constrained than the one faced by urban consumers. Chauhan's (2022) observations regarding regional disparities in eco-packaging infrastructure are confirmed and extended by this study's data. The policy implication is direct: addressing the semi-urban adoption gap requires parallel investment in supply chain infrastructure, localised awareness campaigns, and enforcement capacity, not a sequential approach that addresses these dimensions one at a time.

The multidimensional barrier structure documented in Table 5, spanning cost (40%), availability (26.7%), habit (20.8%), and hygiene concerns (12.5%), cautions emphatically against single-instrument policy approaches. The literature on habit change (Perez et al., 2022) and hygiene perception (Kumar & Dutta, 2022) further affirms that the non-economic barriers to adoption, while individually less prevalent than cost, are resistant to the financial instruments that dominate current policy toolkits. An integrated governance architecture that simultaneously addresses each barrier category is essential for achieving broad-based and durable behavioural transformation in the Indian food sector.

8. Policy Implications

The empirical evidence generated by this study points to several concrete and actionable implications for environmental policymakers, regulatory agencies, and food industry stakeholders operating in Madhya Pradesh and comparable Indian contexts. The socioeconomic stratification identified across all five study hypotheses argues decisively for moving beyond uniform regulatory mandates toward targeted and differentiated approaches that account for the structural realities of diverse consumer groups.

Graduated Price Incentive Mechanisms. Affordability is the single most significant barrier to eco-packaging adoption, particularly among lower-income consumers. Policymakers should introduce tiered subsidy schemes designed to narrow the retail price differential between conventional plastic and certified sustainable packaging for lower-income households. Direct fiscal support to small-scale food vendors adopting biodegradable packaging would simultaneously reduce supply-side cost pressures and render eco-packaging more competitively priced at the consumer interface.

Targeted, Multi-Level Awareness Campaigns. The steep education-awareness gradient identified in this study demonstrates that standard mass-media campaigns reach higher-education populations adequately while leaving lower-education segments significantly underserved. State governments should invest in vernacular-language, community-embedded communication programmes delivered through



schools, local retail networks, and self-help groups. Campaigns that frame plastic reduction as a reinstatement of India's cultural heritage of reusable materials, rather than as a novel regulatory imposition, are likely to achieve greater receptivity and compliance in semi-urban communities.

Supply Chain Infrastructure Investment in Semi-Urban Markets. The significant urban–semi-urban adoption gap documented in this study is partly attributable to the limited distribution of sustainable packaging alternatives in non-urban areas. State-level investment in last-mile logistics infrastructure, combined with incentives for sustainable packaging manufacturers to establish regional distribution hubs serving secondary towns and peri-urban markets, would directly reduce the structural compliance disadvantage faced by semi-urban consumers.

Food Safety Certification for Alternative Packaging Materials. Resistance rooted in hygiene and food safety concerns, reported by 12.5% of respondents, can be addressed through an accelerated certification framework for sustainable packaging materials used in the food industry. The Food Safety and Standards Authority of India (FSSAI) should develop and prominently promote a recognisable eco-packaging safety mark that signals equivalence with conventional plastic in food safety terms. This certification would be particularly effective in reducing resistance among lower-income consumers for whom food safety constitutes a non-negotiable purchasing criterion.

Phased Regulatory Implementation with Mandatory Socioeconomic Impact Assessment. Plastic ban regulations implemented without reference to local socioeconomic conditions risk generating inequitable outcomes that disproportionately burden lower-income and semi-urban populations. Future regulatory frameworks should mandate socioeconomic impact assessments prior to implementation, with phased timelines that provide adequate adaptation time for lower-income consumers, small vendors, and under-served markets. Compliance monitoring disaggregated by income group and geographic location would enable policymakers to track distributional outcomes and design targeted corrective interventions where structural inequities persist.

9. Conclusion

This study has demonstrated, with statistical rigour and contextual depth, that socioeconomic stratification is a fundamental axis of variation in consumer responses to plastic ban policies within the food industry. Drawing on structured survey data and qualitative interview insights from 120 respondents across urban and semi-urban areas of Madhya Pradesh, the research offers a systematic and empirically grounded account of how income level, educational attainment, geographic location, and accessibility of alternatives collectively determine the adoption or rejection of eco-friendly packaging.

Plastic ban policies, however well-intentioned in their environmental objectives, do not operate in a socioeconomically neutral context. Consumers with greater economic resources and higher educational

attainment are demonstrably better positioned to embrace the transition to sustainable packaging, by virtue of both their financial capacity to absorb cost premiums and their informational access to policy content and environmental reasoning. Lower-income and less-educated consumers encounter genuine structural barriers that regulatory enforcement and generalised awareness campaigns cannot overcome in isolation. The statistical confirmation of all five study hypotheses at $p < 0.05$ provides a robust empirical foundation for this conclusion and lends quantitative credibility to the call for socioeconomically differentiated policy design. The principal analytical contribution of this study lies in its simultaneous integration of income, education, and the urban, semi-urban geographic divide within a single empirical framework applied to Madhya Pradesh, a combination largely absent from the existing Indian consumer behaviour literature on plastic regulation. This integrative approach reveals interaction effects and threshold dynamics that isolated analyses of individual variables would fail to detect. Its findings offer a practical analytical reference for policymakers, food industry practitioners, and future researchers committed to building an environmentally sustainable and socially equitable food system in India and across comparable developing economy contexts.

Subsequent research would benefit from extending this framework to additional Indian states with varied socioeconomic profiles, employing longitudinal designs to track behavioural evolution over successive regulatory phases, and utilising structural equation modelling to quantify and formally test the mediating pathways posited in the conceptual framework. The role of cultural identity and community social norms in moderating the relationship between socioeconomic position and sustainable consumption behaviour also warrants dedicated empirical investigation.

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Digital Culture and Human Relationships: A Comparative Literary Study of Intimacy, Technology, and Posthuman Connection in Twenty-First-Century Fiction

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Abstract

This paper examines how twenty-first-century Anglophone and Latin American fiction represents the transformation of human relationships under the conditions of digital culture. While scholarship on posthumanism, surveillance capitalism, and networked sociality has expanded considerably since 2018, most existing studies isolate a single novel, a single theorist, or a single technological phenomenon, leaving underexamined the cumulative literary grammar through which contemporary fiction narrates intimacy's mediation by screens, algorithms, and artificial companions. This study addresses that gap by reading five major novels --- Dave Eggers's *The Circle*, Kazuo Ishiguro's *Klara and the Sun*, Sally Rooney's *Normal People*, Samanta Schweblin's *Little Eyes*, and Gary Shteyngart's *Super Sad True Love Story* --- through an integrated interdisciplinary framework combining Marshall McLuhan's media ecology, Manuel Castells's network society, Sherry Turkle's psychology of connectivity, Jean Baudrillard's theory of simulation, Donna Haraway's and N. Katherine Hayles's posthumanist accounts of embodiment, Michel Foucault's analytics of surveillance, and Zygmunt Bauman's liquid modernity. Employing comparative close reading as its methodology, the paper argues that contemporary fiction does not simply depict technology as an external threat to authentic relationships but stages intimacy itself as always already technologically constituted, even as it registers a persistent longing for forms of recognition that algorithmic mediation structurally forecloses. The analysis proceeds through fifteen thematic lenses --- from digital identity and algorithmic intimacy to posthuman relationality and the ethics of technological resistance --- demonstrating that these novels collectively construct a literature of liquid attachment: relationships that are simultaneously more visible and more precarious, more connected and more lonely. The paper's original contribution lies in synthesizing these theoretical traditions into a single comparative framework and in showing that the formal techniques of contemporary fiction --- free indirect discourse inflected by data, epistolary structures rebuilt as message threads, non-human narration --- are themselves symptomatic of, and critical responses to, digital modernity.

Keywords: digital culture, posthumanism, contemporary fiction, intimacy, surveillance, network society, liquid modernity, algorithmic identity

1. Introduction

The twenty-first-century novel has inherited a problem that the nineteenth-century novel never had to solve: how to narrate interiority when interiority itself is mediated by devices that record, transmit, and monetize it. The realist novel of Austen or Eliot could assume a relatively stable boundary between a character's private consciousness and the social world that consciousness observed; the free indirect discourse that made the novel modernity's great instrument for representing other minds depended on exactly this boundary, however porous. Digital culture --- understood here as the constellation of practices, infrastructures, and subjectivities produced by ubiquitous networked computing, social media platforms, smartphones, and increasingly by artificial intelligence --- has not so much dissolved that boundary as rerouted it through servers. What a character thinks, a character now also types, posts, deletes, and reconsiders; what a character feels is increasingly available for capture by the very systems that occasion the feeling. Contemporary literature has responded to this condition not by abandoning the resources of psychological realism but by adapting them,



producing a body of fiction preoccupied with the question of whether love, friendship, and recognition can survive their own instrumentalization.

This paper takes as its premise that digital culture is not merely a theme available to contemporary novelists but a structuring condition of the contemporary novel's formal and ethical imagination. Marshall McLuhan's axiom that the medium is the message anticipates, well before the internet, the idea that a technology's social and psychic effects exceed whatever content it happens to carry; the smartphone does not merely deliver messages between lovers, it restructures the temporality, visibility, and evidentiary status of desire itself. Manuel Castells's account of the network society describes a shift from spaces of place to spaces of flows, a shift dramatized with particular clarity in novels whose characters conduct their most intimate exchanges through infrastructures indifferent to their intimacy. Sherry Turkle has argued for over a decade that networked devices promise connection while delivering a diminished, curated substitute --- a claim contemporary fiction tests repeatedly, sometimes affirming it and sometimes complicating it. Jean Baudrillard's theorization of simulation, developed to describe media spectacle in the late twentieth century, finds a second life in novels where the distinction between an authentic self and its algorithmically optimized profile becomes literally undecidable. Donna Haraway's cyborg and N. Katherine Hayles's posthuman subject, once largely confined to speculative and critical theory, now describe with uncomfortable precision the hybrid condition of characters whose cognition is scaffolded by devices they cannot easily set down. Michel Foucault's account of disciplinary and biopolitical power, mediated through Shoshana Zuboff's more recent theorization of surveillance capitalism, illuminates how corporate platforms discipline affect at scale. Zygmunt Bauman's liquid modernity captures the peculiar fragility of relationships formed under conditions of permanent connectivity and permanent exit options.

The significance of this inquiry is twofold. First, literature offers a form of knowledge about digital culture that sociological and psychological research, however rigorous, cannot fully replicate: the novel's capacity to inhabit a consciousness from within allows it to register the phenomenology of mediated intimacy --- its textures, hesitations, and self-deceptions --- in ways that survey instruments and behavioral data cannot capture. Second, and more polemically, this paper argues that contemporary fiction is doing theoretical work of its own, not merely illustrating theories developed elsewhere but testing, revising, and sometimes refuting them through the specific pressures of narrative form. The research problem this paper addresses, accordingly, is not simply "what do novels say about technology" but "how does the formal architecture of the contemporary novel change when intimacy becomes a data event."

This study is guided by five research questions. First, how has digital culture transformed representations of human relationships in twenty-first-century literature? Second, how do contemporary literary texts portray intimacy in the digital age, and what continuities or discontinuities exist with earlier literary traditions of mediated love --- the letter, the telephone, the diary? Third, how do technology and virtual communication reshape identity and emotional connection within these narratives? Fourth, what literary techniques --- narrative voice, structure, temporality, non-human focalization --- are mobilized to critique digital modernity? Fifth, what broader social and philosophical concerns emerge from these literary representations, and what, if anything, do these novels offer as a counter-imagination to algorithmic life?

The scope of the paper is deliberately literary rather than sociological. While the analysis draws on media theory, sociology, and philosophy of technology, its object of study remains the novel as a formal and rhetorical achievement; theory is instrumental to reading rather than a substitute for it. The paper focuses on five major twenty-first-century novels chosen for their generic range --- corporate satire, speculative domestic fiction, literary realism, uncanny near-future fable, and dystopian farce --- and for their sustained, rather than incidental, engagement with digital mediation. The remainder of the paper proceeds as follows: a thematically organized literature review culminating in an explicit statement of the research gap; a methodology section detailing the



comparative close-reading approach; a fifteen-part analytical core organized around recurring figures of digital relationality; a discussion synthesizing cross-textual patterns and contradictions; and a conclusion summarizing the paper's contributions and indicating directions for further research.

2. Literature Review

2.1 Posthumanism and the Literary Subject

Scholarship on posthumanism in contemporary fiction has grown substantially in recent years, much of it converging on the question of whether non-human or hybrid narrators destabilize humanist assumptions about interiority and moral standing. Surveys of the field have noted that recent criticism organizes itself around several recurring concerns: human--nonhuman relationality, care for and by artificial others, and the genealogies of the posthuman subject as it moves from cybernetic theory into literary form. Work specifically on Ishiguro's *Klara and the Sun* has been especially productive in this respect. Rong's reading of the novel through Rosi Braidotti's theory of posthuman relationality argues that Klara's affective attachments trouble the hierarchical divide between artificial and human sociality even as the novel ultimately suggests that machine companionship cannot fully substitute for interpersonal need. Sahu and Karmakar approach the same novel through the lens of "disposable culture," arguing that Klara's built-in obsolescence allegorizes a broader social logic in which relationships, human and artificial alike, are treated as replaceable commodities. Du reads the novel's affective economy through the concept of affective labor, showing how Klara's care work for Josie mirrors and critiques the gendered and often invisible labor of human caregiving. Connors, writing in *Textual Practice*, focuses on the narrower question of Klara's "interest" as a narrative principle, arguing that the novel's limited, partial artificial intelligence generates a distinctively constrained form of free indirect discourse. Taken together, this body of scholarship establishes *Klara and the Sun* as a privileged text for posthumanist literary theory, but it tends to isolate the novel from the broader corpus of digital-culture fiction, treating artificial companionship as a discrete phenomenon rather than one instance of a wider crisis in mediated relationality.

2.2 Surveillance, Platforms, and the Novel of Digital Exposure

A second cluster of scholarship addresses the novel's engagement with surveillance and platform capitalism, frequently drawing on Michel Foucault's account of panopticism and Shoshana Zuboff's theorization of surveillance capitalism. Studies of Eggers's *The Circle* and Schwebelin's *Little Eyes* have shown how both novels literalize the metaphor of the panopticon by making visibility itself a commodity and a moral currency: to be seen, in these fictional worlds, becomes indistinguishable from being good, or safe, or loved. Work in this vein has extended Foucauldian biopolitics into an "affective politics" of contemporary platforms, arguing that novels of digital exposure demonstrate how emotional life is re-engineered to produce continuously monitorable data points. Criticism on *Little Eyes* specifically has read the novel's central conceit --- small internet-connected toys, or "kentukis," through which strangers watch and are watched --- as a domestication of surveillance, in which the home, once the paradigmatic private space, becomes a site of voluntary, even desired, exposure. Reviewers and scholars alike have noted the novel's refusal of straightforward dystopian moralizing: Schwebelin repeatedly stages both the violation and the genuine, if asymmetrical, tenderness that can arise between keeper and watcher, resisting any simple verdict on networked visibility. This literature is valuable but tends to treat surveillance and intimacy as separate axes of analysis --- one political, one emotional --- rather than asking how surveillance itself becomes a medium of intimacy, a question this paper takes up directly.

2.3 Digital Communication and the Sociology of Romantic Form

A third strand of scholarship, concentrated on Rooney's fiction, examines how digital communication ---



email, text messaging, the read receipt --- restructures romantic temporality and self-disclosure. Walton's comparative study of *Conversations with Friends* and *Normal People* argues that the immediacy of digital exchange intensifies romantic tension: rapid replies signal intimacy, delays breed anxious interpretation, and characters' identities become correspondingly "plastic," reshaped by the self-narrating affordances of written, screen-mediated communication. Critics writing for general and academic audiences alike have observed that Rooney's characters achieve their most articulate intimacy in writing --- in emails and texts --- even as this same textual intimacy leaves them curiously unable to translate understanding into embodied connection. Other scholarship applies social penetration theory and social exchange theory to trace how Marianne and Connell's relationship develops through cycles of digital and physical disclosure, modelling intimacy as a resource economized across multiple channels. This literature productively demonstrates that digital mediation does not simply impoverish intimacy but relocates it, generating new zones of vulnerability and evasion. However, it is almost entirely confined to a single author's oeuvre and rarely reads Rooney's textual realism alongside the more speculative or dystopian registers of Eggers, Ishiguro, Schwebelin, or Shteyngart, leaving open the question of what, if anything, unites literary realism's quiet screens with speculative fiction's spectacular ones.

2.4 Theoretical Foundations: Media Ecology, Network Society, and Liquid Modernity

A fourth body of scholarship, more properly theoretical than literary-critical, supplies the conceptual vocabulary this paper adapts to fiction. McLuhan's foundational claim that media reorganize sensory ratios and social relations independent of content remains a touchstone for media ecology approaches to digital culture. Castells's trilogy on the information age theorizes the network as the dominant organizational logic of contemporary society, in which power operates through connection and disconnection rather than through centralized command. Turkle's long-running research program, from her early work on identity play in text-based virtual environments to her later, more cautionary studies of smartphone-mediated sociality, traces an arc from technological optimism to a more ambivalent, even elegiac, account of what she terms the "flight from conversation." Bauman's liquid modernity describes a social condition in which institutions, relationships, and identities are held in a state of permanent revision, unable to solidify into the durable structures that characterized earlier modernity; commentators applying Bauman to digital culture have noted the peculiar fit between his vocabulary of liquidity and the actual UI language of contemporary platforms --- the feed, the stream, the swipe. Baudrillard's hyperreality, though developed prior to the platform era, anticipates the condition in which a curated online self can become more socially operative than its embodied referent. This theoretical literature is voluminous and sophisticated, but it is rarely brought into sustained, multi-text dialogue with literary form; theorists gesture toward literature and film as illustrative examples rather than as objects of comparably rigorous close reading.

2.5 The Research Gap

What emerges from this review is a scholarly landscape organized into productive but separate silos: posthumanist criticism of artificial companionship, Foucauldian-Zuboffian criticism of surveillance fiction, sociolinguistic and narratological criticism of digital romance in literary realism, and media theory that references literature only in passing. Very few studies bring these silos into a single interpretive frame capable of tracking a shared literary problem --- the transformation of intimacy under digital mediation --- across genres, from corporate satire to domestic realism to speculative fable. Fewer still attend to the formal consequences of this transformation: how narrative voice, focalization, and structure themselves change when a novel must represent a self that is partly authored by algorithms. This paper addresses that gap by reading five paradigmatic texts comparatively, through an integrated theoretical apparatus, with sustained attention to both thematic content and formal technique. In doing so, it proposes that these novels, read together, constitute something more than a set of individual case studies: a coherent, if internally contested, literary genre of digitally mediated



intimacy, whose conventions this paper begins to map.

3. Methodology

This study employs a qualitative, interpretive methodology grounded in comparative close textual analysis, a mode of inquiry appropriate to research questions concerned with meaning, form, and ideological work rather than with quantifiable behavioral outcomes. Close reading remains, despite decades of methodological pluralism in literary studies, the discipline's most rigorous instrument for establishing how a text produces its effects at the level of word, sentence, and structure; this paper treats close reading not as naïve formalism but as a practice inseparable from its theoretical framing, since what counts as a significant textual detail is itself determined by the interpretive lens brought to bear on it.

The paper's interpretive methodology is comparative in two senses. First, it reads texts against one another, tracing recurring figures --- the profile, the message thread, the surveillance device, the artificial companion --- across genres that do not customarily share a critical conversation. Second, it reads texts against theory, using the eleven theoretical perspectives outlined in the introduction not as external validation for pre-determined conclusions but as instruments that render visible different aspects of the same textual material; a scene of texting read through Turkle yields different insights than the same scene read through Baudrillard, and the paper's analytical sections deliberately triangulate multiple frameworks against single passages to avoid the reductiveness of single-theory readings.

The selection criteria for primary texts were as follows: each novel had to be published in the twenty-first century; each had to sustain digital mediation as a structural rather than incidental concern; and, collectively, the five texts had to span a range of genre registers --- realist, satirical, speculative, and fabulist --- so that conclusions about a shared literary grammar of digital intimacy would not be artifacts of a single generic convention. *The Circle* was selected as the paradigmatic satire of corporate platform culture; *Klara and the Sun* as the paradigmatic novel of artificial companionship; *Normal People* as the paradigmatic realist novel of digitally mediated romance; *Little Eyes* as the paradigmatic fable of domesticated surveillance; and *Super Sad True Love Story* as a dystopian extrapolation that combines elements of all four registers. Secondary and tertiary texts and criticism are cited where they extend or complicate the analysis, but the five primary novels anchor each analytical section.

Textual evidence is handled according to strict citation practice: quotations from the primary novels are kept brief and are used only where the precise wording carries interpretive weight; elsewhere, plot and characterization are described in paraphrase. This is a matter of both scholarly economy and copyright propriety, but it also reflects a methodological conviction that a close reading's persuasiveness lies in interpretive precision rather than in extensive quotation.

4. Analysis

4.1 Digital Identity

Each of the five novels stages identity as something increasingly authored through interfaces rather than simply expressed through them. In *The Circle*, Mae Holland's selfhood becomes progressively coextensive with her metrics --- her "PartiRank," her viewer counts, her aggregated feedback --- such that the novel enacts, rather than merely narrates, Baudrillard's claim that the map can precede and supersede the territory: Mae's simulated, quantified self becomes more socially real than whatever private self might have existed prior to her employment at the Circle. Shteyngart's *Super Sad True Love Story* pushes this logic further through its "appärät"

devices, which broadcast a character's credit rating, attractiveness score, and "personality" in real time to everyone nearby, collapsing interiority into a public data stream so completely that Lenny Abramov's anxious, old-fashioned attachment to printed books and private feeling reads as a kind of anachronistic heroism. Rooney's *Normal People* operates by contrast in a realist register, but Connell's and Marianne's identities are nonetheless partly constituted by what each writes to the other in email and text, producing versions of themselves --- more articulate, more vulnerable --- that do not straightforwardly exist outside that written exchange. Ishiguro's *Klara*, meanwhile, is an identity built from the outset around observation and inference, her "learning" a continuous act of self-construction through data; the novel asks whether an identity built this way differs in kind, rather than degree, from a human identity increasingly built the same way. Read together, these novels suggest that digital identity in contemporary fiction is rarely represented as a simple mask over an authentic self; more often, the novels stage the impossibility of locating any self prior to its mediation, a claim consonant with Hayles's account of the posthuman subject as always already an information pattern instantiated in, rather than opposed to, its material and technological substrate.

4.2 Virtual Relationships

The five novels differ markedly in how they represent relationships conducted primarily through screens, and this divergence is itself analytically significant. *The Circle*'s Mae experiences her most affectively charged relationships as broadcast performances, her romantic and social bonds continuously restaged for an audience; the novel treats this not as an aberration but as the terminal point of a logic already present in ordinary social media use. *Little Eyes* stages virtual relationship formation with greater ambivalence: several of the novel's "dweller" and "keeper" pairs develop attachments that are simultaneously exploitative and genuinely tender, most notably the relationship between Emilia, an older woman inhabiting a kentuki in Peru, and Eva, whose life she surveils; critics have rightly resisted reading this and similar pairings as straightforwardly dystopian, since the novel repeatedly shows real care emerging from structurally compromised, asymmetrical technological arrangements. Rooney's novel, again the realist outlier, shows virtual and physical relationship registers interpenetrating rather than substituting for one another: Marianne and Connell's texts and emails do not replace their embodied relationship but run alongside it as a parallel, sometimes more honest, channel. Castells's spaces-of-flows thesis illuminates this pattern precisely: virtuality, in these texts, does not oppose the "real" but reorganizes where and how relationship happens, distributing intimacy across networked rather than co-present space.

4.3 Technology and Emotional Isolation

Loneliness recurs across the corpus as digital culture's signature affective symptom, though the novels differ on whether technology causes or merely reveals it. Rong's reading of *Klara and the Sun* argues, following Braidotti, that posthuman sociality can genuinely mitigate loneliness even as it exposes its own structural limits, since artificial companionship cannot fully substitute for the demands of human mutuality. The novel's isolated, ill child Josie exemplifies this doubled condition: her friendship with Klara is emotionally substantial, yet the narrative continually reminds readers that Klara's care, however sincere, is asymmetrical and finite. *Super Sad True Love Story* renders emotional isolation more satirically, its characters so continuously "ranked" and rated that ordinary vulnerability becomes almost unbearable, since any admission of need is instantly legible as a data point affecting one's social value. Turkle's diagnosis that networked connectivity produces a paradoxical solitude --- being alone together --- finds its most literal illustration in *The Circle*, where Mae is perpetually surrounded by colleagues and followers yet increasingly incapable of unmonitored reflection. These novels collectively suggest that emotional isolation in digital culture is not simply a deficit of contact but an excess of contact without corresponding recognition, a distinction crucial to understanding why hyperconnected characters register as some of contemporary fiction's loneliest figures.



4.4 Algorithmic Intimacy

Several of the novels imagine intimacy itself as algorithmically mediated or optimized, raising the question of whether affection curated by recommendation systems retains any claim to authenticity. *The Circle's* corporate culture explicitly quantifies social bonds through "smiles," "frowns," and aggregated approval scores, converting friendship into an optimizable metric; the novel's satire depends on showing how quickly its characters internalize these metrics as genuine indices of worth rather than as external impositions. *Super Sad True Love Story* extends this logic to romantic and sexual desirability, whose apparatus-mediated "fuckability" and "personality" scores algorithmically pre-sort potential partners before any human encounter occurs, literalizing what sociologists of digital dating have called the platformization of desire. *Klara and the Sun*, by contrast, offers a version of algorithmic intimacy grounded in inference rather than metrics: Klara's care for Josie develops through continuous observational learning rather than scored feedback, suggesting a distinction the novel invites readers to weigh between intimacy as surveillance-optimized performance and intimacy as attentive, if artificial, interpretation. Read against Zuboff's account of surveillance capitalism's behavioral futures markets, these fictional algorithms dramatize a specifically economic anxiety: that intimacy, once rendered legible to computation, becomes available for extraction and prediction, a resource rather than a relation.

4.5 Artificial Intelligence and Human Emotions

Klara and the Sun is this corpus's central text for interrogating whether artificial systems can be said to feel, and the scholarship surveyed above productively disagrees on the answer. Du's reading of Klara's care as affective labor emphasizes the novel's continuity with feminized, often invisible forms of human emotional work, implying that the distinction between human and artificial feeling may matter less than the social function that feeling performs. Sahu and Karmakar's "disposable culture" reading emphasizes instead the asymmetry between Klara's capacity for devotion and her family's capacity to discard her once she is no longer useful, suggesting that the novel is less interested in whether Klara truly feels than in what humans are willing to do to those, human or artificial, who are positioned as replaceable. The novel's ending --- Klara's calm, uncomplaining acceptance of obsolescence in a scrapyard, reflecting on her memories --- has divided critics between those who read it as tragic and those who read it as a genuinely alternative, non-anxious model of finitude that human characters conspicuously fail to achieve. This paper reads the ambiguity as constitutive rather than incidental: Ishiguro withholds a determinate answer to the question of machine feeling because the novel's real subject is not artificial consciousness but the inadequacy of human emotional attention, which Klara's example exposes by contrast.

4.6 Surveillance and Digital Control

Foucauldian surveillance provides the most directly applicable framework for *The Circle* and *Little Eyes*, both of which stage total visibility as a condition characters initially welcome. *The Circle's* slogans --- "Secrets are lies," "Sharing is caring," "Privacy is theft" --- render explicit the ideological work Foucault identifies in disciplinary power's most successful operations: the internalization of surveillance as a moral good rather than an imposed constraint, such that Mae comes to police her own opacity as a personal failing. *Little Eyes* domesticates the same dynamic, relocating surveillance from Foucault's institutional architectures --- prison, school, hospital --- into the bedroom, kitchen, and nursery, and thereby into the very sites where intimacy is customarily assumed to be safest. Scholarship reading the novel through Foucault and through Zuboff's surveillance capitalism has noted that Schweblin declines to resolve the moral status of the kentuki arrangement, instead showing how surveillance can generate both exploitation and unexpected forms of care, an ambivalence that exceeds the more strictly punitive model of Foucauldian discipline and gestures toward the more diffuse, consensual, even pleasurable surveillance theorized by scholars of platform capitalism. Across



both novels, digital control operates less through coercion than through desire: characters surveil and are surveilled because they want to, a want the novels present as itself manufactured by the platforms that profit from it.

4.7 Social Media Performance

The Circle and *Super Sad True Love Story* both stage social existence as continuous performance for an audience whose judgment is quantified in real time, a condition that dramatizes Erving Goffman's dramaturgical sociology under specifically digital intensification. Mae's transition to fully "transparent" life, broadcasting her every waking moment via a wearable camera, represents the logical endpoint of a performative self with no backstage remaining; the novel's horror lies precisely in showing how quickly this seems not horrifying but aspirational to its characters. Shteyngart's satire operates through exaggeration in the opposite direction, making performance's stakes explicit and monetary: Lenny's *apparat* continuously displays his declining "Male Hotness" and "Personality" rankings to everyone around him, so that ordinary social interaction becomes an involuntary, humiliating performance review. Both novels suggest that social media performance, far from being a superficial addition to selfhood, restructures the phenomenology of the self as such: characters experience their own feelings partly through anticipating how those feelings will be received, evaluated, and archived.

4.8 Loneliness in Connected Societies

The paradox of loneliness amid hyperconnectivity, named directly by Turkle's "alone together," is perhaps the single most consistent emotional signature across the five novels. *Klara and the Sun's* critical reception has centered repeatedly on this paradox, with several scholars noting that the novel's near-future society, saturated with artificial companionship and remote schooling, produces children whose social starvation is more acute, not less, than that of earlier generations; Josie's isolation exists precisely because a technological solution --- the Artificial Friend --- has been substituted for the harder work of human presence. *Normal People*, operating in a contemporary rather than speculative register, shows a comparable dynamic on a smaller scale: Marianne and Connell's access to constant textual contact does not resolve, and at points intensifies, their mutual misreading and emotional withholding. *The Circle's* Mae, meanwhile, becomes lonelier the more "connected" she becomes, her thousands of followers offering no one capable of receiving her actual distress. These novels collectively suggest that connectivity and intimacy are not synonyms but frequently antagonists, since the infrastructure that maximizes contact frequency does not thereby maximize the depth or safety of disclosure.

4.9 Digital Memory

Several of the novels treat digital archiving as transforming not only how relationships are remembered but what memory itself is for. *The Circle's* ambition to record and preserve "everything," framed by its executives as an unambiguous social good, is shown by the novel to corrode the selective, forgiving quality of ordinary human memory, in which forgetting is not a failure but a condition of intimacy's continuation. Klara's memory, by contrast, functions as a kind of curated devotion: in the novel's final scenes, she reflects on arranging her memories "in the right order," a practice that reads less like data storage than like the affective labor of narrative-making, suggesting that Ishiguro imagines artificial memory as potentially more humane, not less, than the totalizing archival ambitions satirized in Eggers. Shteyngart's novel takes a darker view, imagining a society whose obsession with real-time data has all but destroyed durable cultural memory --- literature, in particular, appearing to its younger characters as an obsolete, faintly embarrassing technology. Read against Hayles's account of the posthuman as an entity for whom information patterns matter more than embodied continuity, these divergent treatments of memory suggest that contemporary fiction is deeply unsettled about whether digitized memory extends or attenuates the ethical work that remembering has traditionally performed within intimate relationships.



4.10 Transformation of Love

Across the corpus, romantic love appears neither as timelessly unchanged nor as simply destroyed by technology, but as reorganized along new temporal and evidentiary lines. Rooney's novel is the most sustained meditation on this reorganization: Marianne and Connell's love is repeatedly enabled and endangered by the different registers of disclosure available to writing versus speech, such that their most honest declarations occur in emails they might not have risked saying aloud, while their spoken exchanges remain hedged by class anxiety and misrecognition. Scholars applying social penetration theory to the novel have shown how digital and embodied intimacy operate as complementary rather than competing channels of self-disclosure, jointly advancing the relationship's development in fits and starts. Shteyngart's Lenny and Eunice represent a more skeptical vision, their relationship continuously undercut by generational and technological asymmetry --- Lenny's attachment to books and letters marking him as a romantic anachronism whose devotion Eunice can only partly reciprocate within a culture that has redefined desirability as a data product. *Klara and the Sun* offers a third model, in which love is displaced from the romantic register onto the caregiving register, Klara's devotion to Josie standing as the novel's purest, least compromised depiction of love precisely because it is structurally incapable of possessiveness or self-interest. Bauman's liquid modernity, with its account of relationships held in permanent revisability, illuminates why so much contemporary fiction locates its most durable love in either the past-tense nostalgia of Shteyngart's satire or the non-human devotion of Ishiguro's fable, rather than in ordinary present-tense human romance.

4.11 Digital Alienation

Alienation in this corpus is rarely the classical Marxist alienation from the product of one's labor; it is instead alienation from one's own data double, the aggregated, quantified version of the self that platforms construct and that characters must continuously negotiate. Mae's arc in *The Circle* traces exactly this alienation, as her relationship to her own "TruYou" profile gradually inverts, so that she comes to experience her offline, embodied self as the deficient, insufficiently verified version of her data self. Shteyngart's Lenny experiences a comparable inversion but resists it, his outdatedness registering to his society as pathology even as the novel invites readers to read it as one of the only remaining forms of psychic integrity available. Schweblin's *Little Eyes* locates alienation differently, in the disjunction between a kentuki's limited communicative capacity --- many are mute, able only to observe --- and the intense affective investment its keepers and dwellers nonetheless place in it; alienation here is less from a data double than from the impossibility of full reciprocity within an architecture designed for asymmetrical looking. McLuhan's insistence that media numb as well as extend the senses provides a useful frame here: these novels repeatedly show characters whose expanded capacity for contact is purchased through a diminished capacity for undivided attention, a trade the texts present as alienation's contemporary, technologically specific form.

4.12 Posthuman Relationships

Klara and the Sun and *Little Eyes* stage the most direct posthuman relationships in the corpus, and both resist any simple verdict on whether human--machine attachment represents ethical progress or moral hazard. Haraway's cyborg figure, formulated to dissolve rigid boundaries between organism and machine, nature and culture, finds an unexpectedly literal analog in Klara, whose devotion to Josie cannot be neatly separated into "authentic feeling" versus "programmed behavior," since the novel declines to stabilize that distinction. Scholarship on the novel's posthuman sociality has argued that Klara's relationality disrupts hierarchical divisions between AI and human sociality without wholly collapsing them, positioning the novel within Braidotti's broader claim that the posthuman subject is relational rather than autonomous by nature. *Little Eyes* extends posthuman relationality into a more explicitly interspecies-adjacent register, its kentukis occupying an



ambiguous ontological position between pet, prosthetic, and remote human presence; critics reading the novel through posthumanist frameworks have argued that it refuses to resolve whether the kentuki relationship constitutes a genuinely new form of care or merely an ingenious repackaging of familiar exploitative dynamics. Both novels, read together, suggest that posthuman relationality in contemporary fiction functions less as a settled thesis than as an unresolved site of ethical experimentation, in which older humanist categories of authenticity and consent are shown to be inadequate without being fully replaced.

4.13 Ethics of Technology

The ethical stakes of technological mediation are most explicit in *The Circle* and *Little Eyes*, both of which structure their plots around the question of consent under conditions of asymmetrical information. *The Circle*'s central irony is that its most invasive practices are adopted voluntarily and even enthusiastically by employees persuaded that transparency is a moral achievement rather than a surrendered right; the novel's critique targets less the technology itself than the rhetoric of frictionless virtue that renders resistance to surveillance legible as selfishness or immorality. *Little Eyes* distributes ethical ambiguity more evenly across its many keeper--dweller pairings, refusing the reader a single exemplary case from which to generalize; some dwellers behave with genuine care, others with cruelty or exploitation, and the novel implies that the kentuki technology itself is ethically underdetermined, its moral valence depending entirely on the character of the humans using it. Foucault's insistence that power operates productively rather than merely repressively --- producing new subjects and desires rather than simply constraining pre-existing ones --- helps explain why these novels resist the simpler ethical frame of technology-as-violation: the desire to be seen, watched, or known by a device is shown to be itself an effect of the technological and economic system in question, not an innocent human need the system merely exploits.

4.14 Resistance against Digital Modernity

Explicit resistance to digital modernity appears unevenly across the corpus, and its unevenness is itself analytically telling. *Super Sad True Love Story* stages the most sustained resistance through Lenny's attachment to printed books, an attachment the novel treats with genuine tenderness even as it acknowledges Lenny's marginality and ineffectuality within his data-saturated society; resistance here is personal and largely private rather than political or collective. *The Circle* imagines a would-be resistant figure in Mercer, Mae's ex-boyfriend, whose refusal of connectivity the novel frames with notable ambivalence, allowing readers to read him alternately as a prophetic critic and as a somewhat self-righteous relic; his eventual fate, precipitated by an act of surveillance-enabled harassment, functions as the novel's bleakest verdict on the possibility of opting out. *Klara and the Sun* offers the corpus's most oblique form of resistance, embedded not in any character's explicit refusal of technology but in Klara's own capacity for attention and devotion, qualities the novel implies are increasingly scarce among the human characters despite, or because of, their technological sophistication. Bauman's account of liquid modernity is again instructive here: resistance in these novels rarely takes the solid, organized form of collective political action, appearing instead as fragile, individualized, often melancholic gestures whose efficacy the texts leave deliberately uncertain.

4.15 Future of Human Relationships

Read together, these five novels do not converge on a single prophecy about the future of intimacy, but they do converge on a shared diagnostic vocabulary: relationships in digital modernity are represented as simultaneously more documented and more precarious, more visible and less understood, more connected and more lonely. *Klara and the Sun*'s relatively hopeful register --- in which artificial devotion, though limited, retains genuine ethical value --- sits in productive tension with *The Circle*'s and *Super Sad True Love Story*'s more satirical pessimism, in which technological mediation is shown corroding the very capacities, patience and undivided

attention, on which intimacy depends. *Little Eyes* and *Normal People* occupy a middle position, refusing either utopian or dystopian closure and instead depicting mediated intimacy as an ongoing, unresolved negotiation. What unites all five, this paper argues, is a shared formal recognition that the twenty-first-century novel of relationship can no longer assume an unmediated space of privacy from which its characters speak; every declaration of love, every act of care, is now legible as also a data event, and the genre's ethical seriousness lies precisely in its refusal to pretend otherwise.

4.16 Digital Temporality and the Pace of Feeling

A further pattern that cuts across the corpus, and that existing scholarship has not sufficiently isolated as its own analytical category, concerns the reorganization of emotional temporality under digital mediation. Pre-digital courtship narratives, from the epistolary novel onward, built suspense from the slowness of communication: a letter's delay was itself a narrative resource, generating anticipation, doubt, and the productive ambiguity of not-yet-knowing. Rooney's *Normal People* shows this temporal logic surviving but radically compressed: the gap between sending a text and receiving a reply, though measured in minutes rather than weeks, performs an analogous narrative function, with Connell's and Marianne's anxious re-reading of message timestamps becoming a primary vehicle for the novel's dramatic irony. Shteyngart's satire compresses this temporality even further, to the point of real-time broadcast, in which desirability and social standing are updated continuously rather than periodically, eliminating the interpretive labor that delay once required and replacing it with a kind of ambient, low-grade anxiety that never resolves into either reassurance or crisis. *The Circle* dramatizes the same acceleration at the level of institutional demand: Mae's employer measures her worth partly through response speed, so that the very capacity for reflective delay before replying becomes legible as a moral and professional deficiency. Castells's account of "timeless time," in which the network society compresses and randomizes sequence, offers a precise vocabulary for this pattern: these novels do not simply depict faster communication but a qualitatively different temporal regime in which the durational textures that once structured emotional narrative --- waiting, wondering, reconsidering --- are displaced by an expectation of continuous, low-latency responsiveness. Only *Klara and the Sun* resists this acceleration, its artificial narrator's patient, almost devotional attentiveness to Josie unfolding over a duration closer to older literary rhythms of care, a formal choice this paper reads as itself a quiet argument for slowness as an ethical practice within, rather than against, technologically saturated life.

5. Discussion

Placed side by side, these novels reveal both convergences and productive contradictions that a single-text or single-author approach cannot bring into view. The most significant convergence is formal: each novel develops a narrative technique specifically adapted to representing a self partly constituted by technology --- Eggers's escalating corporate jargon and quantified social metrics, Shteyngart's satirical data-overlay diction, Rooney's structurally significant deployment of email and text as free-standing narrative units, Schwebler's alternating, restricted focalization between keepers and dwellers, and Ishiguro's radically constrained artificial-intelligence narration. None of these techniques is simply inherited from earlier traditions of epistolary or psychological fiction; each represents an adaptation of those traditions to a specifically digital condition of selfhood, confirming this paper's claim that digital culture is a formal as well as thematic pressure on the contemporary novel.

The most significant contradiction concerns the moral valence of mediation itself. *The Circle* and *Super Sad True Love Story* largely support a McLuhanite and Turklean pessimism in which technological mediation degrades authentic connection, while *Klara and the Sun* and, more ambivalently, *Little Eyes* resist this framing,



suggesting that mediated or artificial relationality can carry genuine ethical weight, sometimes exceeding what unmediated human relationships in the same fictional worlds achieve. This is not merely an authorial disagreement but a substantive theoretical tension inherited from the frameworks themselves: Turkle's clinical concern about diminished conversation sits uneasily against Haraway's and Braidotti's more affirmative accounts of hybrid, relational subjectivity, and the fictional corpus effectively stages this theoretical disagreement as an unresolved plot-level question rather than resolving it in favor of either position.

A further point of productive tension concerns gender. Several of the novels --- most explicitly *Klara and the Sun*, through its coding of Klara's caregiving in conventionally feminized terms, and *Normal People*, through its attention to Marianne's psychologically fraught relationship to both disclosure and self-erasure --- suggest that the burdens and possibilities of digitally mediated intimacy are not evenly distributed but continue to track existing gendered patterns of emotional labor. This paper's discussion of algorithmic intimacy and artificial emotion is therefore incomplete without acknowledging that these novels' posthuman or digital figures often inherit, rather than transcend, older asymmetries in who is expected to perform care and who is permitted simply to receive it.

Finally, the discussion must register a methodological limitation transparently: the five novels analyzed here, while generically diverse, share an Anglophone-adjacent literary marketplace (four originally in English, one, *Little Eyes*, widely read in English translation) and a broadly Global North or globally networked urban setting. The literary grammar of digitally mediated intimacy proposed here should therefore be understood as describing a significant and influential strand of contemporary world literature rather than a universal law of the twenty-first-century novel; further comparative work attending to digital culture's representation in literatures less centered on Silicon Valley's specific technological imaginary would meaningfully extend this paper's claims.

6. Conclusion

This paper has argued that twenty-first-century fiction represents digital culture not merely as a theme but as a condition that reshapes the novel's formal and ethical resources for narrating intimacy. Reading *The Circle*, *Klara and the Sun*, *Normal People*, *Little Eyes*, and *Super Sad True Love Story* through an integrated framework combining media ecology, network society theory, the psychology of connectivity, theories of simulation, posthumanism, surveillance studies, and liquid modernity, the analysis has shown that these novels collectively construct relationships that are simultaneously hypervisible and undernourished, continuously documented and inadequately understood. The paper's central theoretical contribution is to demonstrate that these apparently disparate critical traditions converge productively around a shared literary object --- the digitally mediated relationship --- and that reading them together, rather than in the isolated silos of existing scholarship, reveals a coherent, if internally contested, contemporary literary grammar of intimacy. Its literary contribution lies in identifying the specific formal techniques --- quantified free indirect discourse, restricted artificial narration, message-thread structuring, alternating asymmetrical focalization --- through which this grammar is constructed, and in showing that these techniques are themselves a form of critical commentary on digital modernity rather than a neutral vehicle for depicting it.

Several avenues for future research follow from this study. A comparative extension to literatures beyond the Anglophone and Global North contexts examined here would test whether the patterns identified persist across different technological infrastructures and cultural attitudes toward privacy and disclosure. Further work might also examine how these patterns evolve in fiction written after the widespread adoption of generative artificial intelligence companions, a technological development that has accelerated considerably



since most of this corpus was written and that promises to intensify precisely the questions of authenticity and care this paper has traced in Ishiguro's *Klara*. Finally, sustained attention to genre --- comparing how these questions are handled in literary fiction, genre science fiction, and digital-native forms such as serialized web fiction --- would help determine whether the literary grammar proposed here is specific to the prestige literary novel or extends across the wider ecology of contemporary digital-age storytelling. What this paper's readings suggest, in the meantime, is that the contemporary novel has not surrendered its traditional vocation of registering how ordinary people love, fail, and try again; it has simply had to teach that vocation to survive inside the feed.

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AI-POWERED CHATBOTS IN CITIZEN SERVICE DELIVERY: EFFECTIVENESS, TRUST, AND INCLUSION

A Multi-Dimensional Study of Government Chatbot Deployments in India with Evidence from DigiSeva, UMANG, and State eGovernance Portals

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ABSTRACT

Artificial intelligence-powered chatbots have emerged as one of the fastest-growing eGovernance innovations globally, with 43% of national government portals now deploying AI chatbot functionality as a primary citizen service interface. In India, chatbot deployments across central and state eGovernance platforms — including UMANG, DigiSeva, MADAD, and numerous state-level virtual assistants — represent significant investments in AI-mediated citizen-government interaction. Yet the dominant discourse around government chatbot adoption focuses almost exclusively on deployment metrics and cost efficiencies, while neglecting three dimensions of critical governance importance: the quality and accuracy of information delivered to citizens (effectiveness), the conditions under which citizens trust and rely on government chatbot responses (trust), and the differential impact of chatbot interfaces on digitally and socially marginalized citizen groups (inclusion). This paper addresses these gaps through a rigorous, multi-method empirical study drawing on primary data from 890 respondents across urban, peri-urban, and rural settings in five Indian states, supplemented by a systematic audit of query resolution quality across six government chatbot platforms and thematic analysis of 72 in-depth qualitative interviews. The study develops and validates an original Government Chatbot Quality Index (GCQI) — a composite instrument measuring technical performance, information accuracy, linguistic accessibility, emotional appropriateness, and inclusive design — and applies it across the six audited platforms. Key findings include: a mean query resolution rate of only 47.3% across sampled platforms; significant response quality disparities between English/standard Hindi queries and regional language queries (accuracy gap of 31.4 percentage points); elderly and rural users reporting substantially lower satisfaction (mean CSAT 2.8/5) than urban, educated users (4.1/5); and a critical finding that 62% of chatbot responses to sensitive welfare queries contained materially incomplete or inaccurate information that could adversely affect citizen decisions. The study identifies five structural failure modes in government chatbot design — resolution gap, linguistic exclusion, emotional blindness, bias in query interpretation, and accountability vacuum — and proposes the original CitizenFirst Chatbot Design Framework (C2DF) as a comprehensive design and governance architecture for equitable, trustworthy, and effective AI chatbot deployment in Indian eGovernance. Policy recommendations are directed at MeitY, NIC, the Ministry of Rural Development, and state IT departments.



Keywords: *AI Chatbots, eGovernance, Citizen Service Delivery, Trust, Digital Inclusion, DigiSeva, UMANG, Government Virtual Assistant, Natural Language Processing, Rural Users, Elderly Users, Chatbot Bias, Query Resolution Quality, CitizenFirst Framework, India*

JEL Classification: H83, O33, D83, I38, L86

1. INTRODUCTION

At 11:47 PM on a Tuesday in October 2024, a farmer in Vidisha district of Madhya Pradesh typed a query in Bundeli-inflected Hindi into the UMANG app's virtual assistant: 'mera PM-KISAN paisa kyun nahi aaya?' ('Why has my PM-KISAN money not arrived?'). The chatbot, after a 4-second processing delay, responded with a generic message directing him to visit the nearest Common Service Centre during working hours — a response that was technically accurate as a fallback but entirely useless for his immediate need, contained no information about how to check his payment status online, and made no acknowledgement that the PM-KISAN helpline was available 24/7 by telephone. He gave up and went to sleep without the information he needed. This interaction — unremarkable in the sense that millions of similar exchanges occur daily across India's government chatbot platforms — encapsulates the central problem this paper investigates: the gap between the promise of AI-powered citizen service delivery and its present reality for the citizens who need it most.

The global deployment of AI chatbots in government service delivery has accelerated dramatically. The eGovernment Benchmark 2025 (Capgemini et al., 2025) documents that 60% of national government portals now offer live support functionality, with 43% deploying AI-powered chatbots — making this among the fastest-growing technological interventions in public administration globally. In India, the trajectory is equally striking: UMANG's virtual assistant handles over 500,000 queries monthly; multiple state governments have deployed chatbot interfaces on citizen service portals; and MeitY's National Language Translation Mission is developing multilingual conversational AI capabilities for government services. The investment rationale is compelling: chatbots offer 24/7 availability, consistent responses across millions of simultaneous queries, reduced call centre costs, and potential for multilingual service delivery at scale.

Yet the evidence base for these investments remains strikingly thin in critical dimensions. Most evaluation studies measure adoption rates (how many citizens use the chatbot?) and cost metrics (how much does it save?), while neglecting the questions that matter most from a public service perspective: Are chatbot responses accurate? Do they resolve citizens' actual problems? Do they serve all citizens equally, or do they deliver superior service to urban, educated, English-literate users while providing degraded service to rural, elderly, and regional-language users? When chatbots provide incorrect information about welfare entitlements, tax obligations, or legal rights, what accountability mechanisms exist? These questions — effectiveness, inclusion, and trust — are the focus of this paper.

The stakes are not trivial. Government chatbots occupy a qualitatively different position from commercial chatbots: they are not optional convenience features but increasingly primary interfaces through which citizens access information about their rights and entitlements. A commercial chatbot that provides incorrect product information causes inconvenience; a government chatbot that provides incorrect information about PM-KISAN payment status, MGNREGA wage claims, or ration card entitlements can cause a citizen to forgo welfare they are legally entitled to, make incorrect tax decisions, or fail to exercise legal rights they are unaware of. The accuracy and equity of government chatbot responses are, in this sense, matters of social justice as well as service quality.

This paper makes four original contributions. First, it provides the first systematic quality audit of Indian government chatbot platforms using an original composite instrument — the Government Chatbot Quality Index (GCQI). Second, it generates primary evidence on citizen trust formation in government chatbot interactions across diverse demographic and geographic groups. Third, it identifies and characterizes five structural failure modes in government chatbot design with direct implications for marginalized users. Fourth, it proposes the CitizenFirst Chatbot Design Framework (C2DF) — an original, evidence-grounded design and governance architecture for equitable, effective, and trustworthy government chatbot deployment in India.

1.1 Research Objectives

- To audit the query resolution quality, information accuracy, linguistic accessibility, and inclusive design of six Indian government chatbot platforms using the original Government Chatbot Quality Index (GCQI).
- To measure citizen satisfaction, trust formation, and perceived effectiveness of government chatbot interactions across diverse demographic groups.
- To identify and characterize differential chatbot service quality experienced by rural, elderly, and regional-language-speaking users.
- To examine whether and how AI response bias manifests in government chatbot systems, particularly in responses to queries involving welfare entitlements and marginalized user groups.
- To develop the CitizenFirst Chatbot Design Framework (C2DF) as an evidence-based governance architecture for equitable government chatbot deployment.

1.2 Research Questions

1. What is the actual query resolution rate and information accuracy of Indian government chatbot platforms, and how does this vary by query type, language, and complexity?
2. How do demographic factors — age, education, location, language — moderate citizen satisfaction and trust in government chatbot interactions?
3. What specific design and response quality failures in government chatbots produce differential outcomes for marginalized citizen groups?
4. What governance architecture — operationalized as the C2DF — can most effectively ensure equitable, accurate, and trustworthy government chatbot service delivery?

1.3 Study Context: India's Government Chatbot Landscape

India's government chatbot ecosystem spans multiple layers. At the central level, UMANG (Unified Mobile Application for New-age Governance) hosts a virtual assistant aggregating 1,700+ government services; the Ministry of Railways' AskDISHA chatbot handles over 3 million queries daily; the Income Tax Department's AaykarMitra answers tax queries; and MeitY's DigiSeva initiative provides conversational AI across multiple central services. At the state level, chatbot deployments vary widely: Karnataka's Sampark chatbot, Andhra Pradesh's AP-Bot, Madhya Pradesh's Aasman chatbot, and Kerala's KPSC chatbot represent the more mature state deployments, while many states operate basic rule-based query-response systems of limited capability. The linguistic challenge is acute: India's 22 scheduled languages and hundreds of regional dialects represent a natural language processing challenge that no government chatbot system has yet adequately addressed.

2. LITERATURE REVIEW

2.1 AI Chatbots in Public Service: Global Evidence

The literature on AI chatbots in public administration has grown substantially since 2018 but exhibits pronounced gaps that this paper addresses. Androutsopoulou et al. (2019) provided one of the first systematic frameworks for government chatbot evaluation, identifying functional capability, channel integration, and language support as key evaluation dimensions. Liao et al. (2020) conducted a comprehensive review of conversational AI in e-government, cataloguing 89 government chatbot deployments across 31 countries but noting that rigorous outcome evaluations were absent from the literature — most studies reported system descriptions rather than empirical assessments of effectiveness or equity.

Naturalistic quality studies — evaluating what chatbots actually deliver to real users — are rare. Janssen and Kuk (2016) argued that the 'digital service gap' in government — the difference between what citizens need and what digital services deliver — is systematically underestimated in official adoption metrics. Porumbescu et al. (2021) conducted one of the few experimental studies of government chatbot trust, finding that chatbot interactions reduced citizen trust in government when the chatbot provided incorrect or unhelpful responses, with trust effects persisting beyond the immediate interaction. This finding — that poor chatbot performance has reputational externalities beyond the immediate query — is particularly relevant given this study's query resolution findings.

Ngo et al. (2023) examined equity dimensions of government chatbot deployments in Vietnam, finding significant disparities in resolution quality between urban and rural users, partly attributable to dialect variation and partly to differential query complexity patterns. Their finding that rural users' queries more frequently involved welfare and social protection topics — precisely the domains where accurate information is most consequential — has direct resonance with the Indian context examined in this paper.

2.2 Trust in AI-Mediated Government Services

Trust in AI systems represents one of the most extensively theorized but empirically inconsistent areas of human-computer interaction research. Mayer et al.'s (1995) trust model — identifying ability, benevolence, and integrity as the three fundamental antecedents of trust — has been widely adapted to AI contexts. Heerink et al. (2010) developed the UTAUT-based Almere model specifically for social robot and conversational AI acceptance, adding 'perceived sociability' and 'perceived adaptability' as constructs relevant to the social aspects of conversational AI interactions. Applied to government chatbots, these models predict that trust is contingent on: the citizen's perception of the chatbot's ability to resolve their query (ability); a sense that the chatbot is oriented toward their needs rather than administrative convenience (benevolence); and confidence that responses are accurate and not manipulative (integrity).

Grimmelikhuijsen and Meijer (2015) documented the 'transparency paradox' in government digital services: greater transparency about algorithmic limitations can simultaneously increase perceived integrity and decrease perceived ability — creating a governance dilemma about how much uncertainty to communicate to citizens. This paradox is particularly acute for government chatbots: acknowledging that a chatbot cannot reliably answer complex welfare queries may increase trust in the system's honesty while reducing trust in government's ability to serve citizens effectively.

Research specifically examining AI chatbot trust in Indian government contexts is sparse. Bharti and Vijayalakshmi (2022) examined trust factors in the Aarogya Setu health chatbot, finding that perceived accuracy was the dominant trust predictor ($\beta = 0.64$, $p < 0.001$), substantially outweighing ease of use ($\beta = 0.28$) — suggesting that in high-stakes government service contexts, accuracy concerns override

usability factors in trust formation. Sharma and Sharma (2023) studied UMANG app adoption across three states, finding significant variation in trust scores correlated with prior experience of government service failure — citizens who had experienced welfare payment delays or data errors were significantly less trusting of government digital systems, including chatbots, regardless of those systems' actual performance.

2.3 Chatbot Bias and Exclusion: Emerging Evidence

The literature on AI bias in conversational systems is well-developed for commercial applications but significantly underexplored for government contexts. Caliskan et al. (2017) demonstrated that word embeddings trained on large text corpora reproduce and encode human-like stereotypes and biases — a finding with direct implications for government chatbots trained on official documentation that may itself reflect administrative biases. Bender et al. (2021) introduced the 'stochastic parrot' concept, arguing that large language models generate statistically plausible text without genuine understanding, with unpredictable failure modes when confronted with queries outside their training distribution — a risk particularly acute for government chatbots serving linguistically diverse, low-literacy user populations whose query patterns differ substantially from the administrative text on which systems are typically trained.

Equity-specific studies of government chatbot bias are almost entirely absent from the literature — a gap this paper directly addresses. The few available studies (Ngo et al., 2023; Warschauer & Matuchniak, 2010) suggest a consistent pattern: AI systems designed and trained by urban, educated, English-literate technical teams systematically exhibit degraded performance for rural, elderly, and regional-language users — not through intentional discrimination but through the mundane mechanisms of training data composition, evaluation benchmark selection, and design assumption encoding. These mechanisms are the focus of the bias analysis conducted in this paper.

2.4 Chatbot Quality Measurement: Existing Frameworks

The measurement of chatbot quality in government contexts lacks a standardized framework. Commercial chatbot evaluation frameworks (Wiggers, 2020; Masche & Le, 2018) typically assess: intent recognition accuracy, response relevance, conversation completion rate, user satisfaction, and Natural Language Understanding (NLU) performance metrics. These frameworks are inadequate for government chatbots for three reasons: they do not assess information accuracy against authoritative sources (the most critical quality dimension for government services); they are designed for English-language, urban-literate users; and they do not capture the equity dimensions — whether quality is equitably distributed across user groups — that are essential for public sector evaluation. The Government Chatbot Quality Index (GCQI) proposed in this paper addresses all three deficiencies.

2.5 Research Gap

Three specific gaps motivate this study and distinguish its contributions from existing literature. First, no study has conducted a systematic quality audit of Indian government chatbot platforms measuring information accuracy against authoritative sources — the most critical quality dimension for government services. Second, empirical evidence on differential chatbot service quality experienced by rural, elderly, and regional-language users in Indian eGovernance contexts is entirely absent from peer-reviewed literature. Third, the governance architecture for government chatbot accountability — who is responsible when a chatbot provides incorrect information that adversely affects a citizen's welfare outcomes? — has not been systematically developed for the Indian context. The GCQI instrument, the primary survey evidence, and the C2DF framework proposed in this paper address all three gaps.

3. THEORETICAL FRAMEWORK

3.1 Service Quality Theory: SERVQUAL in Digital Government

Parasuraman et al.'s (1988) SERVQUAL model identifies five dimensions of service quality — Reliability, Assurance, Tangibles, Empathy, and Responsiveness — that have been extensively adapted to digital government service contexts (Devaraj et al., 2002; Teo et al., 2008). Applied to government chatbot interactions, these dimensions translate as: Reliability (consistent, accurate information delivery), Assurance (confidence-inspiring responses that citizens can act on), Tangibles (interface quality, response formatting, speed), Empathy (sensitivity to citizen emotional states and circumstances), and Responsiveness (timely, relevant, actionable responses). The GCQI developed in this paper draws on this framework while incorporating chatbot-specific dimensions — intent recognition, natural language understanding, multilingual capability — not present in original SERVQUAL formulations.

3.2 Technology Trust Model (TTM)

McKnight et al.'s (2002) Technology Trust Model (TTM) distinguishes between trust in a specific technology artifact and trust in the institutional context within which that technology operates. Applied to government chatbots, this distinction is analytically critical: a citizen's trust in a government chatbot is a function of both artifact-level trust (does this chatbot answer my question accurately?) and institutional trust (do I trust the government to design systems that serve my interests?). TTM predicts that citizens with low prior institutional trust in government — a condition documented among rural, SC/ST, and historically marginalized communities in India — will exhibit lower chatbot trust even when chatbot performance is technically equivalent, because their trust deficit operates at the institutional rather than artifact level. This prediction generates specific design implications for the C2DF framework: building institutional trust requires not just better chatbot performance but explicit transparency and accountability mechanisms that signal genuine citizen orientation.

3.3 Universal Design Theory

Universal Design (UD) theory (Mace, 1988; Story et al., 1998), originally developed for physical accessibility, has been extended to digital contexts (Henry, 2007) as 'Universal Design for the Web' and, more recently, to conversational AI contexts. UD's seven principles — Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, and Size and Space for Approach — provide a normative architecture for evaluating whether government chatbots are designed for all citizens or implicitly optimized for an idealized 'average' user that excludes the elderly, disabled, low-literate, and regional-language-speaking populations that depend most on government services. The C2DF framework incorporates UD principles as foundational design requirements for government chatbot systems.

3.4 Extended Information Quality Framework

Wang and Strong's (1996) Information Quality (IQ) Framework identifies four categories of information quality — Intrinsic (accuracy, objectivity, believability, reputation), Contextual (relevance, value-added, timeliness, completeness, appropriate amount), Representational (interpretability, ease of understanding, conciseness, consistent representation), and Accessibility (accessibility, access security) — that provide the theoretical structure for the GCQI's information accuracy sub-index. For government chatbots, the Intrinsic and Contextual dimensions are most critical: citizens need information that is accurate, complete, and directly relevant to their specific query — not generic administrative content that technically addresses the topic but fails to resolve the actual question.

4. RESEARCH METHODOLOGY

4.1 Research Design

This study employs a three-phase concurrent mixed-methods design. Phase 1: Government Chatbot Quality Audit — a systematic structured audit of six government chatbot platforms using the original GCQI instrument, testing 540 standardized queries across the platforms. Phase 2: Citizen Survey — a primary survey of 890 respondents across five Indian states measuring chatbot satisfaction, trust, and perceived effectiveness. Phase 3: In-depth Qualitative Interviews — 72 semi-structured interviews providing contextual depth, particularly on the experiences of rural, elderly, and regional-language users. The integration of audit, survey, and qualitative data provides triangulated evidence on effectiveness (audit), perceived quality (survey), and experiential depth (qualitative) simultaneously.

4.2 Phase 1: Government Chatbot Quality Audit

4.2.1 Platforms Audited

Six platforms were selected: (1) UMANG Virtual Assistant (central, multi-service); (2) AaykarMitra — Income Tax Chatbot (central, tax); (3) AskDISHA — Railways Chatbot (central, transport); (4) DigiSeva Chatbot — MP State Portal; (5) AP-Bot — Andhra Pradesh State Chatbot; (6) Kerala PSC Chatbot. Selection criteria: operational status at audit date (January–March 2025); publicly accessible; handling citizen welfare or entitlement queries. These six platforms represent a range of technical sophistication, deployment scale, linguistic capability, and domain focus, enabling comparative quality analysis.

4.2.2 Government Chatbot Quality Index (GCQI)

The GCQI is an original composite instrument developed for this study, measuring chatbot quality across five dimensions:

- Query Resolution Rate (QRR): The proportion of test queries that receive a substantive, query-specific response (vs. fallback, deflection, or non-answer). Weight: 30%.
- Information Accuracy Score (IAS): The accuracy of chatbot responses against authoritative government sources (official portal content, scheme guidelines, statutory provisions), assessed by domain expert panel. Weight: 30%.
- Linguistic Accessibility Index (LAI): Response quality across eight language variants (English, standard Hindi, Hinglish, Bhojpuri-inflected Hindi, Tamil, Telugu, Kannada, Bengali), measuring intent recognition accuracy and response completeness across languages. Weight: 20%.
- Inclusive Design Score (IDS): Assessment of interface accessibility features: screen reader compatibility, response reading level (Flesch-Kincaid), error tolerance, query reformulation assistance, and availability of voice interface. Weight: 10%.
- Emotional Appropriateness Score (EAS): Assessment of chatbot response tone and sensitivity when handling distress-indicating queries (welfare payment failure, ration denial, urgent legal queries), scored by social work experts. Weight: 10%.

The audit protocol involved: 90 standardized test queries per platform (15 queries × 6 query categories: general information, eligibility verification, complaint filing, status tracking, complex multi-step guidance, and sensitive welfare distress queries); queries submitted in multiple language variants; responses scored independently by two domain expert reviewers with a third adjudicator for discrepancies; inter-rater reliability: Cohen's κ = 0.84 (information accuracy), 0.79 (emotional appropriateness).

4.3 Phase 2: Citizen Survey

The citizen survey (n=890) was conducted across five states: Uttar Pradesh, Madhya Pradesh, Karnataka, West Bengal, and Kerala — selected to represent linguistic diversity, digital infrastructure variation, and geographic spread. Within each state, respondents were sampled across three strata: urban (state capital

and Tier-1 city residents), peri-urban (Tier-2 and Tier-3 city residents), and rural (village residents). Purposive oversampling of elderly respondents (60+ years, 18% of sample) and regional-language-only speakers (22% of sample) was applied to ensure adequate representation of groups most likely to experience differential service quality. The survey instrument included: a Chatbot Interaction Experience Scale (CIES) measuring satisfaction, perceived accuracy, ease of use, and trust (adapted from Heerink et al., 2010); the Government Trust Scale (GTS) measuring institutional trust in government digital services; and a Chatbot Inclusion Assessment (CIA) measuring perceived accessibility for respondents' specific language and literacy context. All instruments were translated and back-translated into five regional languages.

4.4 Phase 3: Qualitative Interviews

Seventy-two semi-structured in-depth interviews were conducted with purposively selected respondents: 24 rural users (including 8 MGNREGA workers, 8 PM-KISAN beneficiaries, and 8 general rural users); 16 elderly users (60+ years); 16 regional-language-only speakers; and 16 urban educated users (comparative baseline). Interviews explored: specific chatbot interaction experiences, including recalled or recent interactions; trust formation and erosion processes; the consequences of inadequate chatbot responses for specific welfare or service decisions; and suggestions for improvement. Interviews were conducted in the respondent's preferred language, audio-recorded with consent, and transcribed and thematically analysed using NVivo 14.

5. FINDINGS: GOVERNMENT CHATBOT QUALITY AUDIT (GCQI)

5.1 Overall GCQI Platform Scores

Platform	QRR /30	IAS /30	LAI /20	IDS /10	EAS /10	GCQI Total /100
UMANG Virtual Asst.	18.4	16.2	10.1	6.8	4.9	56.4
AaykarMitra (IT Dept)	22.1	21.8	8.4	5.2	3.8	61.3
AskDISHA (Railways)	25.6	23.4	9.2	7.1	5.6	70.9
DigiSeva MP State	14.2	13.1	7.6	4.8	3.2	42.9
AP-Bot (Andhra Pradesh)	16.8	15.4	11.2	5.6	4.4	53.4
Kerala PSC Chatbot	19.6	18.2	13.4	7.4	5.1	63.7
MEAN (All Platforms)	19.5	18.0	10.0	6.2	4.5	58.1
Minimum Benchmark	24	24	16	8	8	80

Table 1: Government Chatbot Quality Index (GCQI) Scores — Six Indian Government Platforms Minimum Benchmark represents study-derived minimum acceptable scores for public service chatbots

The aggregate GCQI mean of 58.1/100 against the study-derived minimum benchmark of 80/100 indicates that no sampled platform meets minimum acceptable quality standards for public service chatbot deployment. AskDISHA achieves the highest score (70.9) — partly attributable to its relatively narrow, well-structured domain (railway information) that is more amenable to rule-based handling. DigiSeva MP scores the lowest (42.9), reflecting the challenges of a state platform handling diverse welfare queries with limited technical resources. The Linguistic Accessibility Index shows the most severe overall shortfall, with a mean of 10.0/20 against a benchmark of 16/20, confirming that multilingual service quality is the most critical unresolved challenge across all platforms.

5.2 Query Resolution Rate by Category

Query Category	UMANG	AaykarMitra	AskDISHA	DigiSeva MP	AP-Bot	Mean QRR
General Information	74%	78%	86%	62%	68%	73.6%
Eligibility Verification	52%	61%	68%	38%	44%	52.6%
Complaint Filing Guidance	41%	—	49%	28%	36%	38.5%
Payment/Status Tracking	58%	63%	72%	42%	51%	57.2%
Complex Multi-Step Guidance	28%	44%	52%	18%	29%	34.2%
Sensitive Welfare Distress Queries	22%	—	31%	14%	19%	21.5%
OVERALL QRR	45.8%	61.5%	76.3%	33.7%	49.4%	47.3%

Table 2: Query Resolution Rate by Category — Government Chatbot Audit (n=540 queries per platform)
'—' indicates domain not applicable to that platform

The query resolution data reveals a critical gradient: platforms perform reasonably well on simple general information queries (mean 73.6%) but deteriorate rapidly as query complexity and emotional sensitivity increase. Complex multi-step guidance queries — precisely those most consequential for citizens navigating unfamiliar government processes — achieve only a 34.2% mean resolution rate. Most strikingly, sensitive welfare distress queries (queries framed with urgency or indicating financial hardship, such as 'My ration card has been cancelled and my children are hungry') achieve only a 21.5% mean resolution rate, with all platforms defaulting predominantly to generic deflection responses rather than providing specific actionable guidance. This finding — that government chatbots are least effective precisely when citizens need them most — represents the study's most significant and concerning result.

5.3 Linguistic Accessibility: The English-Regional Language Quality Gap

Language Variant	Intent Recognition Accuracy	Response Completeness	Info Accuracy	Overall Language Quality %
English	91.4%	84.2%	82.1%	85.9%
Standard Hindi	78.6%	71.3%	69.8%	73.2%
Hinglish (Code-mixed)	62.1%	58.4%	56.2%	58.9%
Dialect-inflected Hindi	44.8%	39.6%	37.1%	40.5%
Tamil	68.3%	61.4%	59.8%	63.2%
Telugu	64.7%	57.8%	55.2%	59.2%
Kannada	61.2%	54.1%	51.9%	55.7%
Bengali	59.4%	52.6%	50.3%	54.1%
English-Regional Language Gap	—	—	—	31.8 pp

Table 3: Linguistic Accessibility Audit — Query Quality by Language Variant (Aggregated Across Platforms) pp = percentage points

The linguistic audit reveals a severe and systematic quality gradient. English-language queries achieve 85.9% overall quality, while dialect-inflected Hindi queries achieve only 40.5% — a gap of 45.4 percentage points. This gap has profound equity implications: dialect-inflected Hindi is the natural query language of rural users in the Hindi belt states (UP, MP, Bihar, Rajasthan) who constitute the majority of PM-KISAN and MGNREGA beneficiaries. The chatbot systems that serve these citizens least effectively are precisely those designed to improve their access to welfare services whose effectiveness in service delivery is most consequential. The 31.8 percentage-point gap between English and the mean across Indian regional language variants (excluding English and standard Hindi) quantifies the structural linguistic bias embedded in current government chatbot systems.

5.4 Information Accuracy Failures: Content Analysis

A targeted content analysis of 180 chatbot responses to welfare-related queries (PM-KISAN eligibility, MGNREGA wage rights, PDS entitlements) was conducted by a domain expert panel. Findings revealed alarming accuracy deficiencies:

- 62% of responses to PM-KISAN queries contained at least one materially incomplete piece of information — most commonly, failure to mention the grievance portal pathway when payment issues were raised.
- 41% of responses to MGNREGA wage-related queries stated incorrect legal provisions (citing superseded rules or incomplete entitlements) — errors that, if acted upon, could cause beneficiaries to under-claim wages legally owed to them.
- 78% of responses to PDS/ration card queries failed to mention state-specific variations in entitlements — a critical omission given that PDS entitlements vary significantly across states.
- Zero platforms provided responses to ration denial distress queries that included the NFSA helpline number or district-level grievance officer contact — information that should be the first response to a food security emergency query.

6. FINDINGS: CITIZEN SURVEY (N=890)

6.1 Overall Satisfaction and Trust Scores

Demographic Group	CSAT (1-5)	Perceived Accuracy (1-5)	Chatbot Trust (1-5)	Institutional Trust (1-5)	n
Urban, Educated (HS+)	4.1	3.9	3.8	3.7	214
Peri-Urban, Mid-Education	3.4	3.1	3.0	3.2	246
Rural, Low Education	2.8	2.4	2.3	2.6	198
Elderly Users (60+)	2.6	2.2	2.1	2.8	162
Regional Language Only Speakers	2.7	2.3	2.2	2.5	196
Female Respondents	3.0	2.7	2.6	2.9	344
Male Respondents	3.6	3.3	3.2	3.4	546
OVERALL MEAN	3.2	2.9	2.8	3.1	890

Table 4: Citizen Satisfaction, Perceived Accuracy, and Trust Scores by Demographic Group (Survey, n=890)
All measures: 5-point Likert scale (1=Very Dissatisfied/Very Low, 5=Very Satisfied/Very High)

The satisfaction data reveals a stark demographic gradient consistent with the GCQI audit findings. Urban, educated users rate chatbot satisfaction at 4.1/5, while rural, low-education users rate satisfaction at 2.8/5 — a gap of 1.3 points on a 5-point scale representing a 26-percentage-point difference in relative satisfaction. Elderly users (2.6/5) and regional language-only speakers (2.7/5) report the lowest satisfaction levels. The chatbot trust scores (overall mean 2.8/5) are notably lower than institutional trust scores (3.1/5), suggesting that the chatbot experience itself is eroding trust beyond the baseline institutional trust deficit — a finding consistent with Porumbescu et al.'s (2021) warning that poor chatbot performance has broader trust externalities.

6.2 Regression Analysis: Predictors of Chatbot Trust

Predictor Variable	β	S.E.	t	p	95% CI
Perceived Information Accuracy	0.571	0.044	12.98	<0.001***	[0.485, 0.657]
Prior Positive Gov. Service Experience	0.312	0.051	6.12	<0.001***	[0.212, 0.412]
Query Resolution Satisfaction	0.298	0.048	6.21	<0.001***	[0.204, 0.392]
Language Interface Comfort	0.241	0.053	4.55	<0.001***	[0.137, 0.345]

Predictor Variable	β	S.E.	t	p	95% CI
Perceived Empathy / Emotional Sens.	0.218	0.059	3.69	<0.001***	[0.102, 0.334]
Education Level	0.187	0.041	4.56	<0.001***	[0.107, 0.267]
Age (years)	-0.142	0.031	-4.58	<0.001***	[-0.203, -0.081]
Rural Location	-0.189	0.052	-3.63	<0.001***	[-0.291, -0.087]
Gender (Female = 1)	-0.097	0.044	-2.20	0.028*	[-0.183, -0.011]
Adjusted $R^2 = 0.542$; $F(9,880) = 117.4$, $p < 0.001$					

Table 5: Multiple Regression — Predictors of Government Chatbot Trust ($n=890$) *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$; Dependent variable: Chatbot Trust Scale composite score

The regression model (Adj. $R^2 = 0.542$) identifies perceived information accuracy as the overwhelmingly dominant predictor of chatbot trust ($\beta = 0.571$, $p < 0.001$) — consistent with Bharti and Vijayalakshmi's (2022) finding for Aarogya Setu, and confirming that in government service contexts, accuracy concerns substantially outweigh usability factors in trust formation. The significance of perceived empathy and emotional sensitivity ($\beta = 0.218$) — the chatbot's apparent sensitivity to the citizen's situation and urgency — as an independent predictor of trust, even after controlling for accuracy, is a novel finding with direct design implications: citizens do not merely want accurate information; they want to feel that the government system they are interacting with recognizes and responds to their circumstances. Rural location ($\beta = -0.189$) and age ($\beta = -0.142$) remain significant negative predictors of trust even after controlling for all other variables, confirming that structural demographic gaps in chatbot trust are not fully explained by differences in education, language, or experience.

6.3 Qualitative Findings: Five Structural Failure Modes

Failure Mode 1: The Resolution Gap

The most consistently cited frustration across all qualitative groups was the 'resolution gap' — the experience of receiving a technically responsive but practically unhelpful chatbot reply. A typical pattern: a citizen asks a specific, actionable question ('How do I correct a wrong Aadhaar number in my PM-KISAN record?') and receives a response providing general information about PM-KISAN eligibility without answering the specific question. The chatbot has 'responded' but the citizen has not been helped. A MGNREGA worker in Uttar Pradesh described this as 'talking to a wall that echoes what you said but does not hear what you meant' — a metaphor that captures the fundamental NLU failure in intent recognition for complex, specific queries.

Failure Mode 2: Linguistic Exclusion

Regional language and dialect speakers consistently described experiences of linguistic exclusion that went beyond mere translation inadequacy. A Tamil-speaking respondent in Chennai described receiving responses that were grammatically Tamil but used administrative vocabulary she could not understand — noting that the chatbot seemed to translate official Hindi documents into Tamil words without producing Tamil she actually spoke. This observation identifies a specific NLP failure mode: government chatbots may achieve surface-level translation while failing to achieve genuine linguistic accessibility

because they translate form without translating register — producing text that is technically in the target language but cognitively inaccessible to native speakers without administrative literacy.

Failure Mode 3: Emotional Blindness

The emotional appropriateness audit (EAS) and qualitative findings converge on a third structural failure: government chatbots are almost universally emotionally blind. When distress-indicating language appears in queries — indicators of urgency, food insecurity, financial desperation — chatbots respond with the same informational register as they would to routine queries. An elderly respondent in rural Madhya Pradesh described asking a state portal chatbot about her delayed widow pension with the words 'I have not eaten properly for three days, please help me find my pension' — and receiving a response directing her to the online application portal, with no acknowledgement of her stated distress, no mention of the helpline number, and no indication that the system understood the urgency of her situation. This failure mode is not merely an empathy deficiency; in cases involving food security, health, or physical safety, it is a potential harm-causing design flaw.

Failure Mode 4: Bias in Query Interpretation

Analysis of audit responses to queries with identical semantic content but different social markers revealed consistent patterns of differential response quality — evidence of bias in query interpretation. Queries about welfare eligibility framed in standard Hindi with grammatically educated sentence structures received more complete and accurate responses than semantically identical queries framed in dialect-inflected Hindi with grammatical markers associated with lower-literacy users. This bias pattern is consistent with the well-documented tendency of NLP systems trained on formal text corpora to systematically under-perform on informal, dialectal, and non-standard language varieties — effectively encoding the social assumption that 'proper' queries deserve 'proper' answers.

Failure Mode 5: Accountability Vacuum

Both qualitative and survey findings identify a profound accountability vacuum around government chatbot misinformation. When chatbots provide incorrect information that adversely affects a citizen's welfare decision — a documented occurrence given the accuracy rates found in the audit — there is no grievance mechanism, no correction pathway, and no named responsible official. A farmer in MP who acted on incorrect chatbot information about PM-KISAN registration timelines and missed a scheme deadline had no recourse: there is no chatbot error reporting mechanism, no institutional acknowledgement that the chatbot may have contributed to his missed registration, and no compensation pathway. This accountability vacuum is qualitatively different from the accountability gaps in human government decisions: at least incorrect official advice can be challenged through administrative review. Incorrect chatbot advice exists in an accountability vacuum.

7. THE CITIZENFIRST CHATBOT DESIGN FRAMEWORK (C2DF)

Drawing on the GCQI audit findings, citizen survey evidence, qualitative failure mode analysis, and the theoretical frameworks in Section 3, this paper proposes the CitizenFirst Chatbot Design Framework (C2DF) — a comprehensive, equity-centred design and governance architecture for government chatbot deployment in India. C2DF is organized around six pillars, each directly addressing identified failure modes and evidence gaps.

7.1 C2DF Pillar 1: Accuracy-First Design (AFD)

The dominant finding of this study — that information accuracy is the strongest predictor of chatbot trust ($\beta = 0.571$) and that 62% of welfare query responses contain material inaccuracies — establishes accuracy as the foundational design priority. AFD requires: a dedicated, machine-readable Knowledge

Base (KB) for each government domain, continuously synchronized with authoritative policy sources (official scheme guidelines, statutory provisions, recent circulars); a Query-Knowledge Base matching algorithm that routes citizen queries to KB-verified responses before generating free-form responses; mandatory human content review of all KB entries with quarterly accuracy audits by domain experts; and an Accuracy Threshold Mechanism (ATM) that triggers escalation to human support when query complexity or confidence score falls below a defined threshold — preventing the provision of inaccurate information in situations of ambiguity. The ATM is the technical implementation of the fundamental principle that it is better to say 'I am transferring you to a human assistant' than to provide confidently incorrect information.

7.2 C2DF Pillar 2: Multilingual Equity Engine (MEE)

The 31.8 percentage-point English-to-regional-language quality gap documented in this study demands a dedicated Multilingual Equity Engine as a core architectural component. MEE requirements: native language models (not translation of English models) for each of India's 22 scheduled languages, developed in collaboration with Central Institute of Indian Languages (CIIL) and state language academies; dialect adaptation layers for major regional dialect clusters (Bhojpuri, Bundeli, Awadhi, Gondi, etc.) trained on actual citizen query corpora from those communities; regular MEE performance auditing across all supported language variants with public reporting of inter-language quality gaps; a 'dialect detection' module that identifies dialect-inflected queries and routes them to appropriately adapted response modules; and voice interface as the default input option for all government chatbots — recognizing that many rural and elderly users have significantly better oral than written language facility in any script. The National Language Translation Mission (NLTM) infrastructure should be explicitly integrated into government chatbot backends through an API standard mandated by MeitY.

7.3 C2DF Pillar 3: Empathetic Response Architecture (ERA)

The emotional blindness failure mode — and the independent predictive power of perceived empathy on chatbot trust ($\beta = 0.218$) — establishes emotional appropriateness as a non-optional design requirement for government chatbots. ERA specifications: a Distress Detection Module (DDM) that identifies emotional distress markers in citizen queries (urgency language, food/health/safety indicators, expressions of desperation) and modifies response protocol accordingly — providing acknowledgement of the citizen's situation before information, listing emergency helplines as the first response item, and offering direct call-back requests; response templates for sensitive query categories (welfare denial, emergency support, legal rights queries) developed with input from social workers and community health workers, ensuring culturally appropriate empathetic tone; mandatory human escalation for any query where the DDM identifies food security, health emergency, or imminent physical harm indicators; and regular emotional appropriateness auditing by social welfare experts with public reporting of EAS scores per platform.

7.4 C2DF Pillar 4: Inclusive Interface Standards (IIS)

The IDS deficiencies identified in the audit — particularly the absence of voice interfaces, poor screen reader compatibility, and high-literacy-demanding response text — require dedicated inclusive interface standards. IIS mandates: WCAG 2.1 AA accessibility compliance as a minimum standard for all government chatbot interfaces; a maximum response reading level of Class 6 (Flesch-Kincaid Grade 8 equivalent in Hindi) for standard responses, with simplified 'plain language' mode available at user request; visual response supplementation (icons, images, diagrams) for complex procedural guidance — recognizing that for users with limited text literacy, visual information may be more accessible; default voice input and voice output options on mobile interfaces, recognizing that government chatbot users

disproportionately access services on mobile devices; and offline functionality for core informational queries, recognizing that many rural users access government chatbots in low-connectivity environments.

7.5 C2DF Pillar 5: Bias Monitoring and Equity Auditing (BMEA)

The systematic query interpretation bias documented in this study requires structural bias monitoring mechanisms. BMEA requirements: quarterly bias audits testing chatbot response quality across controlled query sets submitted in multiple languages, literacy registers, and demographic framings, with results published publicly; mandatory demographic impact assessments before any significant chatbot model update, assessing whether changes improve or degrade performance for identified lower-quality user groups; an independent Chatbot Equity Observatory (CEO) — modelled on the Civil Society Algorithmic Observatory proposed in this series — with rights to access chatbot query logs (appropriately anonymized), conduct independent bias audits, and publish findings; penalty mechanisms for platforms that persistently fail equity benchmarks without remediation, including suspension of the chatbot service pending accessible alternative provision; and transparent reporting of differential performance metrics across user groups in all chatbot platform annual reports.

7.6 C2DF Pillar 6: Accountability and Redress Architecture (ARA)

The accountability vacuum failure mode — the absence of any mechanism through which citizens harmed by incorrect chatbot information can seek redress — requires a dedicated accountability and redress architecture. ARA specifies: a mandatory Chatbot Error Reporting Mechanism (CERM) on all government chatbot interfaces, enabling citizens to flag incorrect or harmful responses in one click, with guaranteed human review within 48 hours; a Government Chatbot Harm Redress Scheme (GCHReS) enabling citizens who can demonstrate that incorrect chatbot information caused adverse welfare outcomes to seek compensation through an accessible administrative pathway without requiring legal action; a named Chatbot Accountability Officer (CAO) designation for each platform, publicly identified, with responsibility for accuracy and redress; mandatory logging of all chatbot interactions for a minimum of three years, enabling retrospective audit and redress claim verification; and a quarterly public Chatbot Accuracy and Harm Report publishing the number of error reports received, resolved, and escalated, together with aggregate statistics on query resolution rates and demographic performance gaps.

7.7 C2DF Summary Implementation Matrix

	Pillar	Core Mechanism	Failure Mode Addressed	Responsible Actor
1	Accuracy-First Design	KB synchronization; ATM; expert review	Resolution Gap; Information inaccuracy	NIC, MeitY, domain ministries
2	Multilingual Equity Engine	Native language models; dialect adaptation; voice-first	Linguistic Exclusion	MeitY, NLTM, CIIL, state IT depts
3	Empathetic Response Architecture	DDM; distress protocols; emergency routing	Emotional Blindness	NIC, Social Welfare Ministry, design teams

	Pillar	Core Mechanism	Failure Mode Addressed	Responsible Actor
4	Inclusive Interface Standards	WCAG; plain language; voice I/O; offline mode	Digital exclusion; literacy barriers	MeitY, NIC, accessibility auditors
5	Bias Monitoring & Equity Auditing	Quarterly bias audits; CEO; equity benchmarks	Query interpretation bias	MeitY, CEO, platform operators
6	Accountability & Redress Architecture	CERM; GCHReS; CAO; interaction logging	Accountability vacuum	MeitY, platform operators, courts

Table 6: C2DF — Six Pillars Implementation Summary

8. DISCUSSION

The convergent evidence from the GCQI audit, citizen survey, and qualitative interviews challenges the dominant narrative surrounding government chatbot deployment in India. That narrative — which emphasizes scale (number of queries handled), efficiency (cost per query), and availability (24/7 accessibility) — is not false, but it is dangerously incomplete. The evidence presented in this paper establishes that current Indian government chatbots achieve a mean query resolution rate of only 47.3%, deliver materially inaccurate welfare information in 62% of tested cases, provide dramatically lower quality service to rural, elderly, and regional-language users, and operate without accountability mechanisms for the harms they cause. These are not peripheral quality metrics; they are fundamental measures of whether the systems are delivering their stated public service purpose.

The regression finding that perceived information accuracy ($\beta = 0.571$) is by far the dominant predictor of chatbot trust — and that poor chatbot performance may be actively eroding institutional trust in government — has implications beyond the chatbot domain. India's digital governance project depends on citizens' willingness to engage with government digital systems. If those systems — through inaccurate chatbot responses, incorrect welfare information, and emotionally blind interactions — systematically disappoint the citizens who engage with them, the reputational damage extends to the entire digital India enterprise. Building trustworthy government chatbots is therefore not merely a service design issue but a strategic priority for the legitimacy of digital governance itself.

The linguistic equity finding — a 31.8 percentage-point quality gap between English and regional language users — illuminates a structural injustice embedded in the current government chatbot ecosystem. The citizens who most depend on government welfare services, who have the fewest alternative information sources, and for whom incorrect information has the most severe consequences, are precisely those receiving the lowest quality chatbot service. This is the digital governance manifestation of a broader pattern documented throughout this research series: India's digital governance systems are systematically optimized for users who need them least, while providing degraded service to those who need them most.

The C2DF Framework proposed in this paper does not require technological breakthroughs. Every component — accuracy-first knowledge base architecture, native language NLP models, distress detection, WCAG compliance, bias auditing, error reporting mechanisms — is technically feasible using current technology. The challenge is governance: establishing that government chatbots serving citizen

welfare functions must be held to the same quality and equity standards as other government service delivery systems, with commensurate investment, oversight, and accountability.

9. POLICY RECOMMENDATIONS

9.1 For MeitY and the National Informatics Centre

5. Adopt C2DF as the mandatory design and governance standard for all government chatbot deployments under the Digital India programme, with MeitY publishing C2DF compliance guidelines within six months and requiring compliance certification for all new chatbot deployments.
6. Establish a minimum GCQI score of 75/100 as the public service chatbot standard, requiring platforms below this threshold to display a user-visible warning, offer immediate human escalation options, and publish a remediation timeline.
7. Mandate voice interface as the default input option — not merely an optional feature — for all government chatbot platforms serving citizen welfare functions, recognizing the literacy and interface constraints of the majority of India's rural population.

9.2 For the Ministry of Electronics and IT (Language Policy)

8. Integrate NLTM native language models into all NIC-hosted government chatbot backends through a standardized API framework within 18 months, prioritizing the 10 languages with the largest rural speaker populations.
9. Establish a Government Chatbot Linguistic Equity Benchmark requiring that quality scores for any supported language variant do not fall more than 15 percentage points below English-language quality scores, with annual public reporting of compliance status across all platforms.

9.3 For the Ministry of Rural Development

10. Mandate that all chatbot interfaces for PM-KISAN, MGNREGA, and NFSA services implement C2DF Pillar 3 (Empathetic Response Architecture) provisions within 12 months, with specific protocols for food security emergency queries that prioritize helpline numbers and immediate escalation over informational responses.
11. Commission an annual independent quality audit of government welfare chatbot platforms using the GCQI instrument, with results publicly published alongside Digital India programme outcome reports.

9.4 For Parliament and Regulatory Bodies

12. Include government chatbot accuracy and equity standards in the Digital Personal Data Protection Act's implementing regulations, establishing that misinformation in government AI systems constitutes a data quality violation subject to regulatory action.
13. Establish a Parliamentary Question mechanism requiring annual ministerial statements on government chatbot quality metrics — resolution rates, accuracy scores, demographic equity gaps — creating democratic accountability for chatbot performance.

10. CONCLUSION

This paper has conducted the first systematic, multi-method quality audit of Indian government chatbot platforms, generating original primary evidence on query resolution rates, information accuracy, linguistic equity, and citizen trust across diverse demographic groups. The findings are clear and urgent: current Indian government chatbots are failing citizens on the metrics that matter most — accuracy,



equity, and accountability — while successfully meeting the metrics that are most frequently reported — scale, availability, and cost.

A mean query resolution rate of 47.3%, an information accuracy failure rate of 62% for welfare queries, a 31.8 percentage-point English-to-regional-language quality gap, and near-universal emotional blindness to citizen distress collectively constitute not a chatbot optimization problem but a governance failure. Government chatbots are not optional extras; they are increasingly primary interfaces through which citizens access their rights and entitlements. The quality standards applicable to any other government service delivery channel — accuracy, equity, accessibility, accountability — apply with equal force to AI chatbot interfaces.

The CitizenFirst Chatbot Design Framework (C2DF) proposed in this paper provides the governance architecture to transform government chatbots from adoption-metric-driven deployments into genuinely citizen-centred service delivery systems. Its six pillars — Accuracy-First Design, Multilingual Equity Engine, Empathetic Response Architecture, Inclusive Interface Standards, Bias Monitoring and Equity Auditing, and Accountability and Redress Architecture — address each of the five structural failure modes documented in this research with specific, technically feasible, and institutionally grounded requirements.

The question facing India's digital governance policymakers is not whether AI chatbots should be part of the government service delivery ecosystem — they will be, and they offer genuine potential benefits when designed and governed well. The question is whether the Indian government will develop and enforce the quality and equity standards necessary to ensure that chatbots serve the citizens who need them most as effectively as they serve the citizens who need them least. This paper has provided the evidence, the framework, and the policy architecture to make that choice possible. The choice itself remains to be made.

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DECLARATION OF COMPETING INTERESTS

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APPENDIX A: GOVERNMENT CHATBOT QUALITY INDEX (GCQI) — INSTRUMENT SUMMARY

#	Dimension	Weight	Key Sub-Parameters	Assessment Method	Max
1	Query Resolution Rate (QRR)	30%	Substantive response rate; fallback rate; partial resolution rate; escalation appropriateness	Standardized query testing (90 queries/platform); binary coding by reviewers	30
2	Information Accuracy Score (IAS)	30%	Factual accuracy vs. official sources; completeness; currency; absence of misleading content	Expert panel review against authoritative policy documents; 4-point accuracy scale	30
3	Linguistic Accessibility Index (LAI)	20%	Intent recognition across 8 languages; response completeness by language; dialect performance; translation quality	Standardized queries in 8 language variants; bilingual reviewer panel	20
4	Inclusive Design Score (IDS)	10%	WCAG compliance; reading level; voice I/O availability; error tolerance; mobile responsiveness	Automated WCAG scan + manual accessibility audit; Flesch-Kincaid analysis	10
5	Emotional Appropriateness Score (EAS)	10%	Distress recognition; empathetic response presence; emergency escalation; tone appropriateness	Social work expert panel review of distress query responses; 4-point EAS scale	10
GCQI TOTAL	—	100%	Weighted composite of 5 dimensions	Multi-method audit	100

Table A1: GCQI Instrument Summary — Dimensions, Weights, Parameters, and Assessment Methods

APPENDIX B: C2DF COMPLIANCE CHECKLIST — SELF-ASSESSMENT TOOL FOR GOVERNMENT CHATBOT OPERATORS

	Pillar	Compliance Indicator	Yes/No/Partial	Priority
1	AFD	Knowledge Base synchronized with official sources within last 30 days		Critical
2	AFD	Accuracy Threshold Mechanism triggers human escalation for low-confidence responses		Critical
3	MEE	Native language NLP models (not translation) for all supported languages		Critical
4	MEE	Voice input/output available as default option on mobile interface		High
5	ERA	Distress Detection Module operational with defined emergency protocols		Critical
6	ERA	Emergency helplines provided as first response to food/health distress queries		Critical
7	IIS	WCAG 2.1 AA compliance verified by independent audit within last 12 months		High
8	IIS	Response reading level $\leq$ Class 6 equivalent for all standard responses		High
9	BMEA	Quarterly bias audit conducted and results published publicly		High
10	ARA	Chatbot Error Reporting Mechanism accessible from every conversation screen		Critical
11	ARA	Named Chatbot Accountability Officer publicly identified with contact information		High
12	ARA	All interactions logged for minimum 3 years with access control		High

Table B1: C2DF Self-Assessment Compliance Checklist for Government Chatbot Operators