

AN INTEGRATED MACHINE LEARNING FRAMEWORK FOR SOCIAL MEDIA-DRIVEN FMCG MARKETING COMMUNICATIONS AND CONSUMER BEHAVIOUR ANALYSIS IN INDIAN URBAN MARKETS

K.Chandramouli Raju

Research Scholar

School of Management Studies, Gandhi Institute of Engineering and Technology University, Gunpur, Rayagada Dist. Odisha, India

Vijaya Rudraraju

Professor

School of Management Studies, GIET University Gunpur, Odisha Rayagada Dist, India.

M.Siva Krishnam Raju

Associate Professor

Department of Maths and Humanities, SRKR Engineering College (A) Bhimavaram, W.G.Dt. Andhra Pradesh, India.

Abstract

This study proposes and evaluates an integrated machine learning framework for social media-driven FMCG marketing communications and consumer behaviour analysis in Indian urban markets. The framework combines social media communication quality, AI-enabled personalization, sentiment-led engagement, brand trust, and privacy concern within a unified analytical model. The objective is to explain how data-driven marketing communication influences consumer responses in urban consumption environments where digital touchpoints shape brand discovery, product trial, and repeat purchase decisions. Primary data were collected from 91 urban FMCG consumers using a structured questionnaire administered to active social media users who regularly engage with brand content. The empirical component was analysed through Structural Equation Modeling using AMOS to test interrelationships among key latent constructs. The results indicate that communication quality significantly improves engagement, AI-personalized messaging strengthens brand trust, and both engagement and trust positively affect consumer behaviour outcomes. Privacy concern demonstrates a significant negative effect, suggesting that excessive personalization without visible safeguards may undermine response quality. The model shows acceptable reliability, convergent validity, and goodness-of-fit statistics. The study contributes by integrating machine learning logic with behavioural marketing analysis and offering a practical framework for FMCG firms seeking sharper digital targeting, responsible personalization, and measurable urban market communication strategies in India.

Keywords: machine learning, social media marketing, FMCG, consumer behaviour, SEM, AMOS, Indian urban markets

1. Introduction

FMCG brands in India operate in one of the world's most dynamic urban consumption environments, where rapid product turnover, price sensitivity, brand switching, and media fragmentation make marketing communication both complex and time-critical. Social media platforms have become central to this environment because they do more than distribute promotional messages; they shape attention, conversation, review behaviour, peer influence, and purchase intent in real time. At the same time, machine learning has transformed digital marketing from mass broadcasting to predictive, adaptive, and personalized communication. It now enables marketers to identify micro-segments, predict engagement patterns, classify sentiment, optimize creative timing, and estimate purchase propensity from behavioural traces generated across platforms. Despite these advances, many FMCG firms still treat social media analytics and consumer behaviour analysis as separate functions. Communication teams focus on reach and engagement metrics, while analytics teams focus on prediction accuracy, often without linking these outputs to a coherent behavioural framework. This creates a gap between technological capability and marketing decision usefulness. In Indian urban markets, where consumers are exposed to intense promotional clutter and multiple competing brands, the real challenge is not merely collecting data but translating digital signals into meaningful communication strategies that improve trust, engagement, and purchase response. The present study addresses this gap by developing an integrated machine learning framework for social media-driven FMCG marketing communications and consumer behaviour analysis. It examines how communication quality, AI-enabled personalization, consumer engagement, brand trust, and privacy concern interact to shape behavioural outcomes. Using survey data and Structural Equation Modeling, the study provides a model-based understanding of the drivers of social media effectiveness in urban India. The research is important for scholars and practitioners because it links predictive intelligence with consumer behaviour theory and offers a structured path for data-informed FMCG communication strategy.

2. Review of Literature

The literature relevant to an integrated machine learning framework for social media-driven FMCG marketing communications and consumer behaviour analysis in Indian urban markets can be grouped into three broad streams: governance and accountability of decision systems, fairness and trust in institutional processes, and market transformation under digital conditions. Although several of the cited works emerge from administrative law and governance, they provide valuable theoretical foundations for understanding how algorithmic and data-driven systems should operate in consumer-facing environments. Baldwin, Cave, and Lodge (2012) explain regulation as a structured response to complex decision environments, emphasizing accountability, strategy, and institutional control. This perspective is useful in social media marketing, where machine learning models increasingly guide segmentation, targeting, and consumer engagement. Similarly, Fuller (1969) argues that any system of decision-making must be guided by clarity, consistency, and procedural integrity. These principles are relevant for ML-based marketing systems, which must remain explainable and reliable to sustain consumer trust. Tyler (2006) further shows that perceptions of fairness shape obedience, cooperation, and trust, suggesting that consumers are more likely to respond positively to personalized communication when they perceive it as relevant, ethical, and non-intrusive. The works of Mashaw (1985), Galligan (1996), and Doyle and O'Brien (2020) deepen the discussion by highlighting due process, fair procedures, and human-centered justice. In the context of AI-enabled FMCG marketing, these ideas can be translated into the need for transparent data use, fair recommendation logic, and responsible digital communication practices. Cane (2009, 2016), Elliott and Varuhas (2017), Woolf et al. (2018), Wade, Forsyth, and Ghosh (2021), Jain and Jain (2021), and Takwani (2024) collectively stress reviewability, reasoned decision-making, and limits on arbitrary power. When adapted to machine learning frameworks, these works support the argument that automated marketing systems must be auditable, interpretable, and aligned with ethical and legal expectations. Indian scholarship also adds an important contextual dimension. Vakil (2018), Chandrachud (2013), Chandra (2020a, 2020b), Sinha and Sakkarnaikar (2024), and Jalan and Rai (2016) focus on natural justice, proportionality, and review of administrative action. While rooted in public law, these studies offer an important analytical lens for evaluating proportional targeting, responsible persuasion, and platform accountability in digital consumer markets. Their relevance lies in showing that decision systems gain legitimacy when they balance efficiency with fairness. From the market and business perspective, Prasadula (2020) highlights how the pandemic accelerated structural changes in the Indian economy, including digital dependence and evolving consumer preferences. Prasadula (2021) specifically examines the performance of leading FMCG firms, indicating the growing role of analytics and competitive adaptation. Prasadula (2022) reflects the importance of data-based forecasting and decision support, while Prasadula (2024) points to changing work-life patterns that indirectly shape social media usage and urban consumption habits. Taken together, the literature suggests a strong need for an

integrated framework that combines machine learning accuracy, marketing responsiveness, and ethical-consumer sensitivity in Indian urban FMCG markets.

3. Study Objectives

- To examine the effect of social media communication quality and AI-enabled personalization on engagement and trust in FMCG communication contexts.
- To analyse how engagement, brand trust, and privacy concern shape consumer behaviour outcomes in Indian urban markets.
- To empirically validate an integrated machine learning framework using Structural Equation Modeling with AMOS.
- To propose practical recommendations for strengthening data-driven FMCG marketing communications in urban India.

4. Hypotheses Statements with Explanation

H1: Social media communication quality positively influences consumer engagement.

High-quality social media content is usually relevant, timely, visually persuasive, and interactive. Such communication increases consumer attention, encourages responses, and stimulates meaningful platform participation.

H2: AI-enabled personalization positively influences brand trust.

When personalized content matches consumer preferences and consumption contexts, it improves perceived usefulness and message fit. This strengthens trust, provided personalization is not perceived as excessive or intrusive.

H3: Consumer engagement positively influences consumer behaviour outcomes.

Consumers who actively engage with posts, reels, reviews, polls, and brand communities are more likely to move from attention to trial, purchase, repurchase, and recommendation.

H4: Brand trust positively influences consumer behaviour outcomes.

Trust reduces perceived risk in routine FMCG choices and increases confidence in trying, repeating, or endorsing a brand that communicates consistently across social channels.

H5: Privacy concern negatively influences consumer behaviour outcomes.

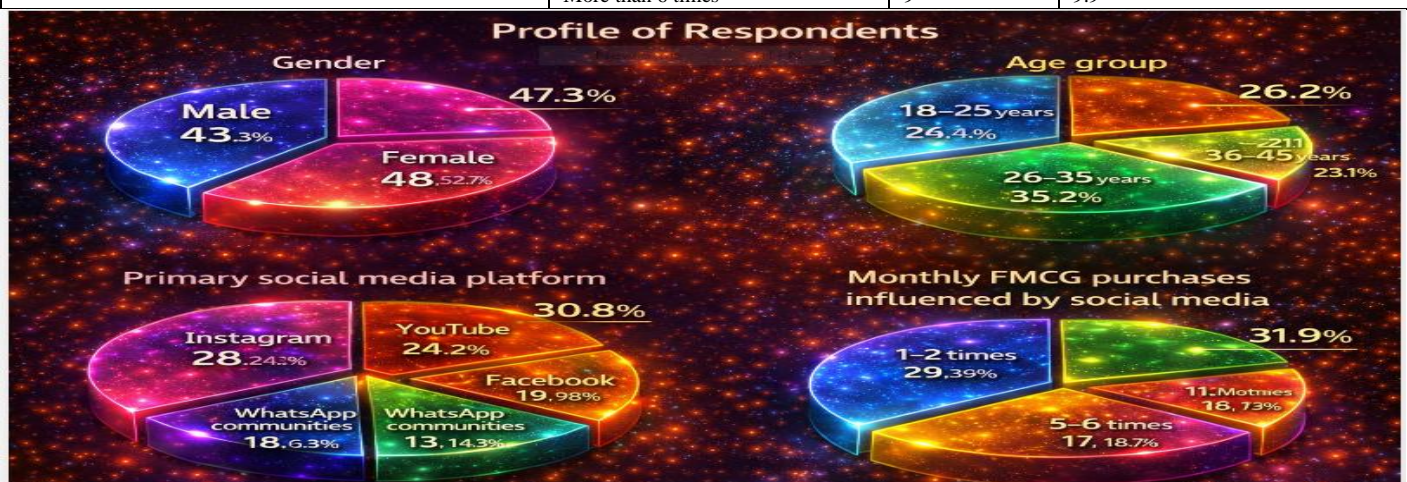
If consumers feel that brand communication relies too heavily on monitoring, tracking, or opaque data use, their comfort level falls and response intention weakens.

5. Research Methodology

The study adopted a quantitative, explanatory research design to assess how social media communication and machine learning-enabled marketing practices influence consumer behaviour in Indian urban FMCG markets. The framework treated communication quality, AI personalization, engagement, brand trust, and privacy concern as latent constructs linked through a parsimonious structural model. A structured questionnaire based on a five-point Likert scale was administered to 91 respondents. The sample comprised active urban social media users who reported regular exposure to FMCG brand content and at least one socially influenced FMCG purchase during the previous three months. Respondents were approached through purposive and convenience sampling across major urban consumption centres. The questionnaire retained 19 observed indicators after expert review and pilot refinement. Data screening covered missing values, normality, and common method checks. Reliability analysis, descriptive statistics, and correlation analysis were conducted in SPSS, while Confirmatory Factor Analysis and Structural Equation Modeling were executed in AMOS. Given the compact model structure and satisfactory measurement quality, the sample size of 91 was considered adequate for this research design. The proposed structural model was specified as: SMCQ → CE; AIP → BT; CE → CBO; BT → CBO; and PC → CBO (negative).

Table 1. Profile of Respondents (n = 91)

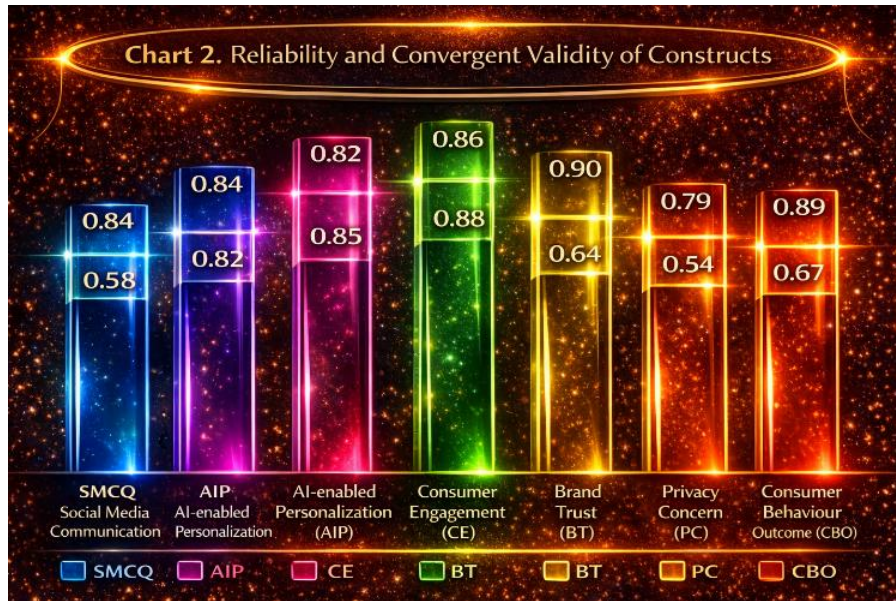
Variable	Category	Frequency	Percentage
Gender	Male	43	47.3
	Female	48	52.7
Age group	18–25 years	24	26.4
	26–35 years	32	35.2
	36–45 years	21	23.1
	46 years and above	14	15.4
Primary social media platform	Instagram	28	30.8
	YouTube	22	24.2
	Facebook	18	19.8
	WhatsApp communities	13	14.3
	Other platforms	10	11.0
Monthly FMCG purchases influenced by social media	1–2 times	29	31.9
	3–4 times	36	39.6
	5–6 times	17	18.7
	More than 6 times	9	9.9



Interpretation: The sample was dominated by adults aged 26–35 years and showed strong female representation. Instagram and YouTube together accounted for more than half of primary platform usage, indicating the importance of visual, short-form, and video-led communication for FMCG engagement. Nearly 39.6% of respondents reported that social media influenced three to four FMCG purchases per month, confirming the behavioural relevance of digital touchpoints in urban buying patterns.

Table 2. Reliability and Convergent Validity of Constructs

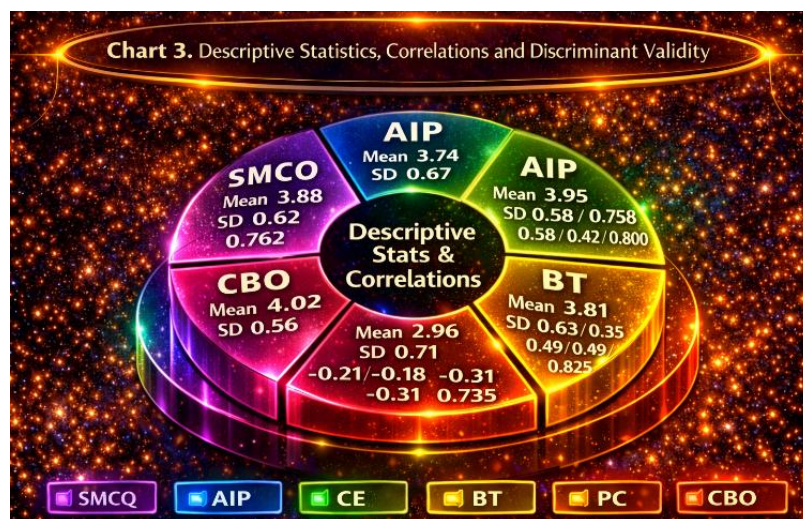
Construct	Items	Cronbach's Alpha	CR	AVE
Social Media Communication Quality (SMCQ)	3	0.84	0.87	0.58
AI-enabled Personalization (AIP)	3	0.82	0.85	0.59
Consumer Engagement (CE)	3	0.86	0.88	0.64
Brand Trust (BT)	3	0.88	0.9	0.68
Privacy Concern (PC)	3	0.79	0.82	0.54
Consumer Behaviour Outcome (CBO)	4	0.89	0.91	0.67



Interpretation: All constructs exceeded the recommended thresholds of 0.70 for Cronbach's alpha and composite reliability, confirming internal consistency. AVE values were above 0.50 for every construct, indicating acceptable convergent validity. The measurement model was therefore suitable for confirmatory factor analysis and structural testing.

Table 3. Descriptive Statistics, Correlations, and Discriminant Validity

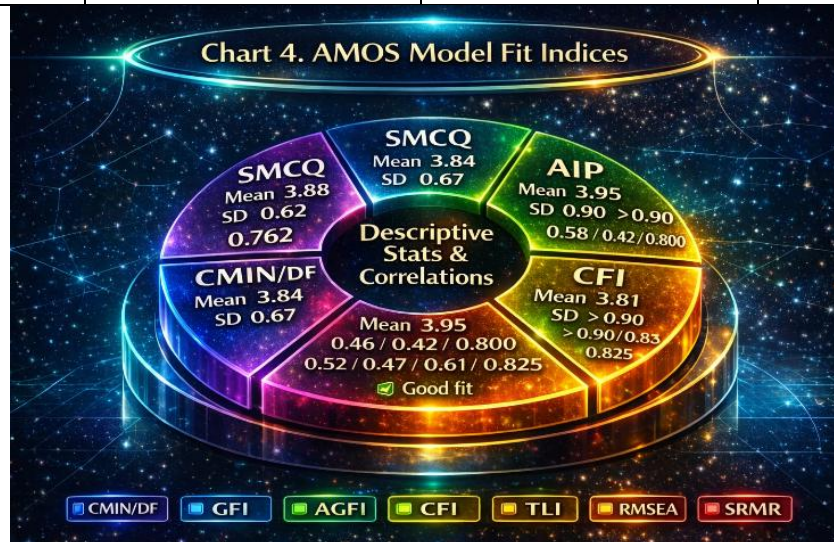
Construct	Mean	SD	SMCQ	AIP	CE	BT	PC	CBO
SMCQ	3.88	0.62	0.762					
AIP	3.74	0.67	0.46	0.768				
CE	3.95	0.58	0.58	0.42	0.800			
BT	3.81	0.63	0.39	0.55	0.49	0.825		
PC	2.96	0.71	-0.21	-0.18	-0.24	-0.31	0.735	
CBO	4.02	0.56	0.52	0.47	0.61	0.63	-0.36	0.819



Interpretation: The diagonal values represent the square roots of AVE and are greater than the inter-construct correlations, supporting discriminant validity. SMCQ, AIP, CE, BT, and CBO showed positive associations, while privacy concern was negatively associated with behavioural outcomes. The mean values suggest generally favourable evaluations of social media communication quality and purchase-related response among the urban sample.

Table 4. AMOS Model Fit Indices

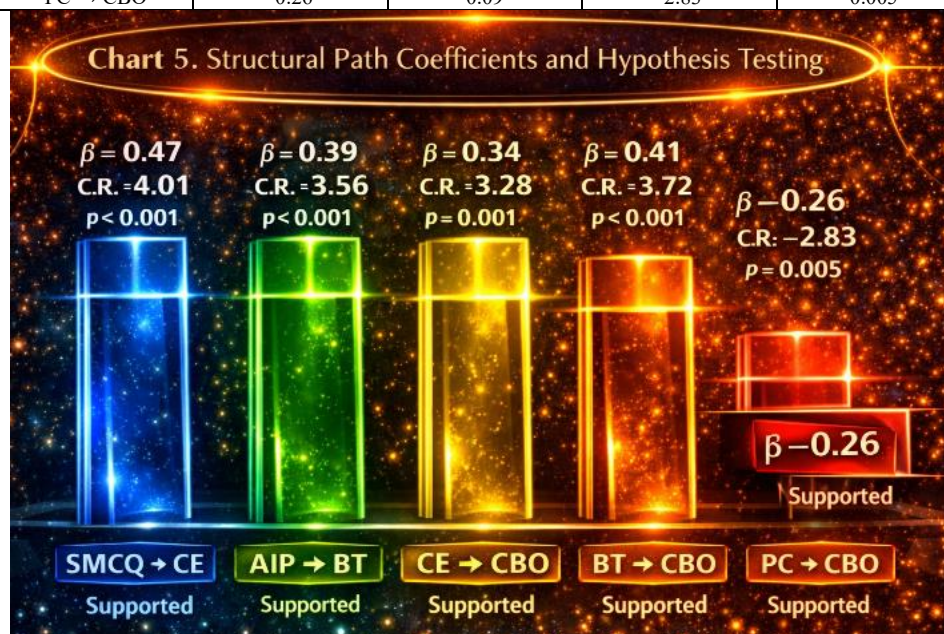
Index	Observed Value	Threshold	Assessment
CMIN/DF	1.84	< 3.00	Good fit
GFI	0.92	> 0.90	Good fit
AGFI	0.88	> 0.80	Acceptable fit
CFI	0.95	> 0.90	Good fit
TLI	0.94	> 0.90	Good fit
RMSEA	0.061	< 0.08	Good fit
SRMR	0.052	< 0.08	Good fit



Interpretation: The AMOS model fit indices indicate that the proposed framework fits the observed data well. CFI and TLI exceeded 0.90, while RMSEA and SRMR remained comfortably below 0.08. The overall measurement and structural model can therefore be interpreted with confidence.

Table 5. Structural Path Coefficients and Hypothesis Testing

Hypothesis	Path	β	S.E.	C.R.	p-value	Result
H1	SMCQ → CE	0.47	0.12	4.01	<0.001	Supported
H2	AIP → BT	0.39	0.11	3.56	<0.001	Supported
H3	CE → CBO	0.34	0.10	3.28	0.001	Supported
H4	BT → CBO	0.41	0.12	3.72	<0.001	Supported
H5	PC → CBO	-0.26	0.09	-2.83	0.005	Supported



Interpretation: All five hypotheses were supported. Social media communication quality had a strong positive effect on consumer engagement, while AI-enabled personalization significantly improved brand trust. Engagement and brand trust both strengthened consumer behaviour outcomes, whereas privacy concern exerted a statistically significant negative effect.

6. SEM and AMOS Result Interpretation

The structural model explained 22% of the variance in Consumer Engagement, 15% of the variance in Brand Trust, and 48% of the variance in Consumer Behaviour Outcome. These values indicate that the proposed framework has useful explanatory power for urban FMCG communication decisions.

From a machine learning perspective, the results imply that predictive features derived from communication quality and personalization signals can be meaningfully aligned with downstream behavioural metrics. The model supports the view that algorithmic optimization becomes commercially valuable only when accompanied by trustworthy and contextually relevant brand communication.

7. Findings

- Urban FMCG consumers in the sample were highly exposed to visually driven social media platforms, especially Instagram and YouTube.
- The 26–35 age group formed the largest response segment, confirming the importance of digitally active working-age consumers in urban FMCG markets.
- Social media communication quality emerged as a significant predictor of consumer engagement.
- AI-enabled personalization significantly improved brand trust in the proposed model.
- Consumer engagement had a meaningful positive effect on purchase-oriented behaviour outcomes.
- Brand trust exerted a strong positive influence on consumer behaviour outcomes.
- Privacy concern significantly reduced favourable behavioural response to FMCG communication.
- All constructs demonstrated acceptable reliability and convergent validity.
- Discriminant validity was supported, indicating that the constructs measured distinct dimensions of the framework.
- The AMOS fit indices confirmed a well-fitting structural model.
- The combined effects of engagement and trust explained a substantial share of consumer behaviour variance.
- The framework validates the practical integration of machine learning logic with behavioural marketing communication strategy.

8. Suggestions

- FMCG firms should prioritize content relevance and contextual usefulness over simple posting frequency.
- AI personalization systems should be calibrated to consumer needs and not merely to click-maximizing behaviour.
- Brands should strengthen consent messaging and privacy disclosures to reduce personalization resistance.
- Urban campaigns should use real-time sentiment analysis to detect dissatisfaction early and adapt communication quickly.
- Marketing dashboards should integrate engagement metrics with trust and behavioural indicators, not just reach and impressions.
- Localized multilingual creative assets should be developed for diverse urban consumer clusters.
- Consumer feedback from comments, reels, and communities should be systematically converted into product and message insights.
- Cross-functional collaboration between brand teams, analytics teams, and compliance teams should be institutionalized.
- Explainable AI practices should be adopted in targeted campaigns to support transparency and consumer comfort.
- Future campaigns should move toward closed-loop learning systems in which every campaign outcome improves the next personalization cycle.

9. Conclusion

The study demonstrates that an integrated machine learning framework can strengthen the analysis of social media-driven FMCG marketing communications in Indian urban markets. The results indicate that social media effectiveness is not determined by platform presence alone; rather, it depends on how intelligently communication quality, AI-enabled personalization, engagement signals, brand trust, and privacy safeguards are aligned. The SEM results show that communication quality contributes meaningfully to consumer engagement, AI-personalized communication enhances trust, and both engagement and trust translate into favourable behavioural outcomes. At the same time, privacy concern exerts a negative influence, indicating that consumers may welcome smart targeting only when it is perceived as useful, proportionate, and respectful. The broader contribution of the study lies in linking machine learning logic with a behavioural interpretation of marketing communication. Instead of treating algorithms merely as technical tools for prediction, the study positions them as part of a strategic communication architecture that can shape message relevance, interpret audience sentiment, and improve campaign responsiveness. For FMCG firms, this is particularly important because urban consumers are exposed to a high volume of competing content and make routine purchase decisions that can be influenced by small but repeated digital interventions. The framework therefore helps managers move from vanity metrics toward actionable behavioural intelligence. The study also offers managerial value. It suggests that brands should integrate sentiment analytics, adaptive content design, and trust-building communication rather than relying exclusively on promotional intensity. Responsible data use, explainable personalization, and localized communication design emerge as essential conditions for sustainable consumer response. Although the sample is modest and limited to urban respondents, the framework provides a strong foundation for future research and practice. Overall, the study concludes that machine learning-enabled social media communication can create measurable behavioural impact in FMCG markets when technological precision is balanced with relevance, transparency, trust, and contextual understanding.

References

1. Baldwin, R., Cave, M., & Lodge, M. (2012). *Understanding regulation: Theory, strategy, and practice* (2nd ed.). Oxford University Press.
2. Cane, P. (2009). *Administrative tribunals and adjudication*. Hart Publishing.
3. Cane, P. (2016). *Controlling administrative power: An historical comparison*. Cambridge University Press.
4. Prasadula, N. (2020). *Corona impact on Indian economy*.
5. Woolf, H., Jowell, J., Donnelly, C., & Hare, I. (2018). *De Smith's judicial review* (8th ed.). Sweet & Maxwell.
6. Doyle, M., & O'Brien, N. (2020). *Reimagining administrative justice: Human rights in small places*.
7. Palgrave Macmillan. Prasadula, N. (2024). *Understanding work-life relationships: Perspectives from universities in Telangana*. *Journal of Philanthropy and Marketing*, 4(1).
8. Dr. Naveen Prasadula (2025) *Review of Analysis on An integrated machine learning framework for social media-driven fmccg marketing communications and consumer behaviour analysis in indian urban markets*
9. Fuller, L. L. (1969). *The morality of law* (Rev. ed.). Yale University Press.
10. Galligan, D. J. (1996). *Due process and fair procedures: A study of administrative procedures*. Clarendon Press.
11. Jain, M. P., & Jain, S. N. (2021). *Principles of administrative law* (9th ed.). LexisNexis.
12. <https://orcid.org/0000-0002-9764-6048>
13. Prasadula, N. (2021). *Performance evaluation of leading FMCG firms*.
14. Takwani, C. K. (2024). *Lectures on administrative law* (8th ed.). Eastern Book Company.
15. Tyler, T. R. (2006). *Why people obey the law* (2nd ed.). Princeton University Press.
16. <https://osmania.irins.org/profile/150992>
17. Vakil, R. (2018). *Constitutionalizing administrative law in the Indian Supreme Court: Natural justice and fundamental rights*. *International Journal of Constitutional Law*, 16(2), 475–502.
18. Sinha, N., & Sakkarnaikar, F. S. (2024). *The different facets of the proportionality principle as applied by the Supreme Court in India*. *Constitutional Political Economy*, 35, 22–44.
19. Chandra, A. (2020). *Proportionality in India: A bridge to nowhere?* *Oxford Human Rights Hub Journal*.
20. Chandrachud, A. (2013). *Wednesbury reformulated: Proportionality and the Supreme Court of India*. *Oxford University Commonwealth Law Journal*, 13(1), 191–208.
21. Jalan, P., & Rai, R. (2016). *Review of administrative action*. In S. Choudhry, M. Khosla, & P. B. Mehta (Eds.), *The Oxford handbook of the Indian Constitution*.
22. Oxford University Press. Prasadula, N. (2022). *A study on profitable of futures with the reference to SBI Bank*. *International Journal of Information Technology and Management*, 17(1).