Perceived Value and Adoption Intention for 5G Services in India

Moderating Effect of Environmental Awareness

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Abstract: Acknowledgment of the significance of environmental factors in technology adoption is widespread. However, empirical investigations into how environmental awareness influences the interconnection between perceived value and adoption intention for 5G services are notably lacking. This study investigates how perceived value shapes consumers' 5G adoption intentions and how environmental awareness moderates the relationship between perceived value and adoption intention, employing the Value Adoption Model (VAM). Survey items on perceived value, adoption intention, and environmental awareness, drawn from existing literature on consumer value and information systems, were employed to gather data. An online questionnaire was completed by 530 participants from India. The collected data was processed using PLS-SEM. The findings indicate that perceived usefulness and enjoyment are key drivers of adoption, while perceived costs show mixed effects. Notably, technical issues do not negatively impact perceived values, but perceived fees negatively affect the perceived value of 5G services. Overall, perceived value significantly influences 5G adoption intention, with environmental awareness mediating this relationship. The findings offer valuable guidance to 5G service providers in emerging markets and provide policymakers with insights into the interplay of cost-benefits and environmental considerations in 5G service adoption.

Keywords: 5G service, perceived value, adoption intention, environmental awareness, India.

Introduction

Rapid technological development has consistently reshaped the way individuals communicate, access information, and interact with the world. Over time, mobile technology has revolutionised business and consumer experiences. The current 4th generation (4G) may

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fall short in meeting consumer demands for data rate, delay, and network capacity. Unlike previous shifts, the transition to fifth generation (5G) is transformative, offering a twenty times faster data rate, ten times shorter latency, and three times better spectral efficiency (Hutajulu *et al.*, 2020; Agiwal *et al.*, 2021; Erunkulu *et al.*, 2021). The emergence of 5G technology has captured significant attention globally, with both industry and academia focusing on its potential to revolutionise connectivity and usher in a new era of innovative applications. Predictions suggest that 5G services will greatly enhance consumer experiences by delivering superior connectivity, speed, and efficiency (Xie *et al.*, 2023). Considering its significance in the realm of information technology, the introduction of 5G advancements is anticipated to further expand the mobile communication sector (Oinas-Kukkonen *et al.*, 2021; Huseien & Shah, 2022; Ramezanpour *et al.*, 2023). Notably, it has been observed that, in just a few years, 5G data consumption has increased by 1.7 to 2.7 times more than that of 4G in six key 5G-enabled countries (South Korea, Japan, Germany, USA, UK, and Australia) (Open Signal, 2020). Projections also indicate that the global 5G market is on track to reach a substantial $8.46 billion by 2028 (Research and Markets, 2023). The impact of this technology is far-reaching, with expectations of contributing nearly $1 trillion to the global economy by 2030, with its benefits extending across all industries.

India stands at the forefront of technological progress, with notable achievements in the adoption and deployment of 5G technology. Demonstrating a strong commitment to this endeavour, the Indian Government has embarked on an aggressive drive to develop and implement 5G technology across the nation, positioning India as one of the world's most extensive and rapidly expanding 5G markets (KPMG, 2022). The Prime Minister of India launched 5G services on October 1, 2022, and, in a mere eight months following the launch, an impressive 200,000 sites have been established, covering 700 districts. Notably, 5G network coverage now spans all 28 states and 8 union territories (special administrative regions in India), marking one of the most expedited 5G rollouts globally (India, 2023). India's rapid economic growth and its well-established digital infrastructure have laid a robust foundation for the widespread adoption of 5G technology. Recognizing 5G as a pivotal driver of India's economic progress and technological industry development, the Indian Government has set ambitious goals for breakthroughs in 5G mobile communication technology. India, with the world's second-largest mobile Internet consumer base, views 5G as a transformative tool in its digital transformation journey (KPMG, 2022). Deloitte's report suggests that the contribution of 5G services to India's GDP could potentially reach a significant $450 billion by 2040 (Deloitte, 2023).

Consumers in India are displaying a strong appetite for cutting-edge technology and mobile connectivity. A significant portion of the population seeks faster Internet, improved data

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services, and enhanced consumer experiences (Hutajulu *et al.*, 2020; Gupta *et al.*, 2022; Meet *et al.*, 2022). Responding to this escalating consumer demand, telecommunications companies are increasingly motivated to invest in 5G networks (Gupta, 2024; Sargam *et al.*, 2023). The efficient deployment of 5G in India holds the potential to boost telecommunications service providers' average revenue per consumer and restore profitability, which has been notably impacted by intense competition in recent times. India, with 1,145.45 million mobile consumers (TRAI, 2022), represents a vast opportunity for 5G and is actively improving its digital competitiveness by embracing new technologies (Mittal *et al.*, 2013; Gupta, 2024). Additionally, 5G services have a potential to create a wide range of applications with substantial social and economic ramifications in India (TRAI, 2019).

Our research identifies several critical research gaps in the current literature on 5G adoption in India. Firstly, there is a lack of focus on consumer perceptions and behaviours specific to 5G adoption. Secondly, while perceived value is acknowledged in marketing and technology literature, its application to 5G adoption remains underexplored. Thirdly, the role of environmental awareness in influencing 5G adoption intentions has been largely overlooked.

In light of identified gaps, this study aims to explore: How do perceived benefits and costs interact to influence the perceived value of 5G services, and what role does environmental awareness play as a moderator in this dynamic? To achieve this, the primary objective is to investigate the impact of perceived benefits and costs on the perceived value of 5G services, while considering the moderating influence of environmental awareness. Perceived benefits refer to the assessments of the advantages or positive outcomes that individuals anticipate gaining from adopting a product or service. Perceived costs encompass the sacrifices that consumers associate with adopting a product or service. Perceived value represents the trade-off between the perceived benefits and costs incurred (Zeithaml, 1988). Environmental awareness refers to an individual's consciousness and concern about the environmental impact of their choices (Kala & Chaubey, 2023).

The sub-objectives include: (a) examining how perceived benefits influence value perception; (b) assessing the impact of perceived costs; (c) understanding how perceived value influences adoption intentions; and (d) exploring the moderating effect of environmental awareness. We propose and empirically examine the Value Adoption Model (VAM) for 5G services, incorporating insights from technology adoption and value-related literature. This framework offers a fresh perspective on understanding consumer adoption of mobile technology.

Through this exploration, our study provides valuable insights into the factors shaping consumer behaviour in the context of adopting new technology. These insights can inform telecommunications companies' marketing strategies, pricing models, and service offerings,

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ultimately leading to increased adoption rates and higher revenue per consumer. Additionally, our findings can guide policymakers in designing regulations to promote efficient deployment of 5G networks and maximise societal benefits. By introducing and empirically testing the VAM for 5G services, our study contributes to enriching existing theoretical frameworks and stimulates further research in technology adoption and consumer behaviour.

This paper is organised into five main sections. Initially, the introduction sets the stage by providing background information and the motivation behind the research. Following that, the second section explores existing literature and formulates hypotheses based on the review. The third section elucidates the research methodology in detail. Moving forward, the fourth section presents the findings through statistical analysis. Subsequently, the discussion section interprets the significant results and their justifications. Finally, the last section outlines the study's implications, draws conclusions, and suggests avenues for future research.

Literature Review and Hypotheses Development

Value Adoption Model (VAM)

The concept of consumer value has been identified as a significant determinant of consumer behaviour, including for first and repeat purchases, within the academic domains of marketing, e-commerce, and information systems literature (Sheth *et al.*, 1991; Sweeney & Soutar, 2001; Kim *et al.*, 2007; Kim *et al.*, 2017; Lee *et al.*, 2019; Shah *et al.*, 2021; Mathavan *et al.*, 2024). When engaging in decision-making processes, consumers often assess the value of each available alternative by considering the associated benefits and costs. Consumers strive to optimise the value they derive from their interactions with companies across different stages of consumption (Lee *et al.*, 2019; Sirdeshmukh *et al.*, 2002). Consumer value refers to the difference between prospective consumers' evaluation of all benefits and costs of the offering and perceived alternatives (Zeithaml, 1988). Considering this, VAM was considered appropriate to examine consumer intention to adopt 5G. Kim *et al.* (2007) proposed the VAM, asserting that an individual's technology adoption intention is the cognitive evaluation of perceived value based on the perceived cost-benefit analysis. Integrating the Technology Acceptance Model (TAM) with Perceived Value from Davis (1989) and Zeithaml (1988), VAM provides a comprehensive assessment of factors impacting technology adoption. In the context of 5G adoption, positive and negative effects align with the perceived benefit and cost antecedents in the VAM. Hence, this study investigates the 5G adoption intention, considering not only the traditional technology viewpoint but also the consumers' standpoint.

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Perceived Benefits

The perceived benefits of a new product or technology refer to the advantages or positive outcomes that individuals or organizations anticipate when they decide to embrace and use a novel product or technological solution. It has been observed that consumers evaluate and purchase products for their utilitarian and hedonic benefits (Babin *et al.* 1994; Kim *et al.* 2007). For this reason, akin to Kim *et al.* (2007), we adopted usefulness and enjoyment as the benefit elements of perceived value.

Perceived Usefulness (PU)

PU is the extent to which an individual believes that using a specific technology would improve work efficiency (Davis, 1989; Venkatesh *et al.*, 2012). PU is widely recognised as a crucial predictor of new technology adoption across various contexts (Meet *et al.*, 2022; Hooda *et al.*, 2023; Hujran *et al.*, 2023; Kala & Chaubey, 2023). In the context of 5G services, we believe that consumers will derive value from 5G services in terms of faster data speeds, enhanced connectivity, low latency, and better experience with new technology-based services (Liao *et al.*, 2007; Lu *et al.* 2009; Shah *et al.*, 2021). Recent studies in the context of 5G services by Ke *et al.* (2022), Mustafa *et al.* (2022) and Sargam *et al.* (2023) also recommended that functionality and perceived usefulness are the major drivers of adoption of this advanced Internet service. Based on the above findings, consumers will display a higher inclination to utilise such services upon recognizing the performance advantages offered by 5G services. Thus, we posit:

H1: Perceived usefulness is positively associated with the perceived value.

Perceived Enjoyment (PE)

PE reflects the pleasure derived from using technology, irrespective of expected performance outcomes (Davis, Bagozzi, & Warshaw, 1989). Consumers experiencing joy are more likely to adopt and extensively use a technology (Davis, Bagozzi, & Warshaw, 1989). Despite its potential for performance improvement, individuals may use technology primarily for entertainment (McLean *et al.*, 2020). Evidence suggests that PE significantly predicts consumer adoption, satisfaction, and continuance intention in technological contexts (Davis *et al.*, 1992; Lin *et al.*, 2017; Oghuma *et al.*, 2016; Ashfaq *et al.*, 2020). In the case of 5G, beyond business and productivity, it serves as a source of entertainment for consumers, offering activities like online gaming, social networking, and high-quality online media. Shah *et al.* (2021) found that fun and entertainment aspects of 5G positively impact consumers' attitudes toward employing specific technologies. Thus, we propose that:

H2: Perceived enjoyment is positively associated with the perceived value.

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Perceived Costs

Perceived costs can be categorised into monetary and non-monetary costs (Zeithaml, 1988). Monetary cost comprises the actual cost of the product, while non-monetary costs involve factors such as time, effort, unsatisfactory spending, and psychological apprehension with product usage (Kim *et al.*, 2007). The adoption of products featuring innovative technologies introduces inherent risks and potential for exaggerated claims, impacting the perceived value by the consumer (Chen & Dubinsky, 2003). Consequently, building on previous research (Kim *et al.*, 2007; Kim *et al.*, 2017; Lau *et al.*, 2019), we specifically consider the technical aspects and perceived fees associated with 5G as integral components of the overall cost.

Technical Issues

The technical issues of the system encompass all non-monetary costs, gauging how well the technical features and functions align with the consumer's physical and mental needs (Kim *et al.*, 2007; Lau *et al.*, 2019). Regarding 5G services, these technical needs include user-friendliness, service reliability, connectivity, efficiency, security, and ease of use. Previous studies highlight the significant negative impact of technical issues on mobile Internet adoption (Kim *et al.*, 2007), Internet-protocol television (Lin *et al.*, 2012), and Internet-of-Things smart home services (Kim *et al.*, 2017) through perceived value. These studies have mentioned that consumers often find highly technical features or interfaces intimidating, leading to doubts about the technology's overall value. Technical complexity may also demand significant time and effort to learn and adapt, while compatibility issues with existing systems can limit utility and interoperability. Hence, we posit:

H3: Technical issues are negatively associated with perceived value.

Perceived Fee

Perceived fee indicates the monetary costs of a product or service. Venkatesh *et al.* (2012) proposed perceived fees as a predictor of technology usage intention, emphasizing consumers' cognitive evaluation of the trade-off between monetary costs and perceived benefits in using technology. It is acknowledged that perceived fee directly impacts perceived value (Zeithaml, 1988; Kim *et al.*, 2007). In this study, as defined by Kim *et al.* (2007), perceived fee represents the consumer's belief in the costliness of using 5G services. In the realm of 5G services, consumers anticipate additional costs for acquiring 5G-enabled smartphones (Hsu & Lin, 2018; Mathavan *et al.*, 2024). Existing research consistently highlights an inverse association between perceived fee or price and value (Kim *et al.*, 2007; Wang *et al.*, 2013; Shah *et al.*, 2021; Mustafa *et al.*, 2022), although Mathavan *et al.* (2024) discovered contrasting results in the context of fitness-wearable devices. Hence, our proposition is:

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H4: Perceived fee is negatively associated with perceived value.

Perceived Value

Perceived value is the consumer's holistic evaluation of a product, considering both its benefits and the costs required for acquisition and use (Zeithaml, 1988). In this study, perceived value specifically refers to consumers' subjective evaluation of the worthiness of 5G services. Recognizing the subjectivity of perceived value across consumers, objects, times, and circumstances (Zhu *et al.*, 2010), various authors (Sheth *et al.*, 1991; Sweeney & Soutar, 2001; Petrick, 2002; Sánchez *et al.*, 2006) have developed measurement scales to examine and validate its dimensions from the perspectives of benefits and costs. Kim *et al.* (2007) introduced the VAM to elucidate individual acceptance of technological innovations. They utilised benefits (usefulness and enjoyment) and sacrifices (technical issues and perceived fee) to articulate the perceived value of mobile Internet (m-Internet). In the context of 5G services, consumers view the experience as valuable if the benefits outweigh both monetary and non-monetary sacrifices (Hsu and Lin, 2018; Kim *et al.*, 2007; Chong *et al.*, 2010; Shah *et al.*, 2021; Mathavan *et al.*, 2024). A heightened perception of value is likely to result in a more favourable adoption decision, consistent with findings in information technology innovation (Turel *et al.*, 2010; Yu *et al.*, 2017; Kim *et al.*, 2017; Kala & Chaubey, 2023). This relationship is hypothesised to extend to the adoption of 5G services. Therefore, we propose:

H5: Perceived value positively affects 5G adoption intention.

Environmental Awareness

As society becomes more aware of environmental issues and the need for sustainable practices, individuals are increasingly considering the environmental implications of their choices (Zahedi *et al.*, 2019; Kala & Chaubey, 2024), including adopting new technologies like 5G services (Russell, 2018). Environmental awareness encompasses a broad understanding of environmental issues, covering perspectives, concerns, and sensitivities. It includes ideas and attitudes aimed at problem-solving, along with strategies for managing and enhancing the relationship between the environment and people to improve overall environmental quality (Wang *et al.*, 2016; Shah *et al.*, 2021). In simpler terms, it represents an individual's overall comprehension of environmental issues and plays a crucial role in their transition from existing behaviour to more environmentally friendly practices (Wang *et al.*, 2016). Environmental awareness can influence the perception of the benefits that 5G can bring to sustainability efforts. For instance, 5G enables advancements in various sectors, such as smart cities, transportation, education, and agriculture. These advancements can reduce greenhouse gas emissions, optimise resource utilization, enhance perceived learning, and improve

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environmental monitoring (Maeng *et al.*, 2020; Shah *et al.*, 2021). Highlighting these green applications can positively impact the intention to use 5G, particularly among environmentally conscious individuals. An extended model from Chen & Tung (2014) supports the idea that environmental considerations play a positive role in shaping attitudes and behaviours. Building on previous research, we propose the following hypothesis:

H6. Environmental awareness moderates the relationship between perceived value and 5G adoption intention.

Drawing from the literature, we propose a framework (Figure 1) along with six hypotheses, explaining the corresponding relationships among the study constructs.

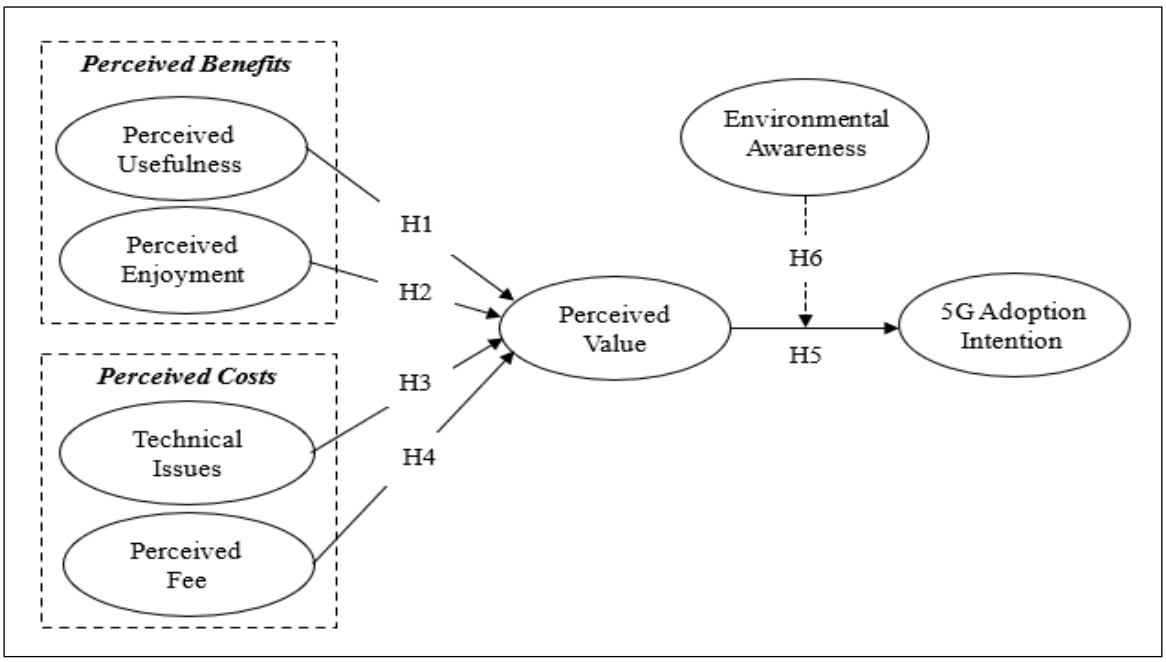

Figure 1. Conceptual Framework

Research Methodology

This study employed a descriptive research approach and used primary data for analysis. The target population of the study was young Indian consumers in urban areas. The reasons for selecting this cohort for the study were: (a) they prefer new technologies faster and recommend new technologies to others; and (b) they are tech-savvy, always active on smartphones, and prefer Internet-based services for everything.

We used a questionnaire to examine consumers' intention towards 5G services adoption. The questionnaire had three sections (section A – Internet usage behaviour and awareness of 5G services; section B - items of study constructs; and section C – demographic information). We adopted established scales to construct the questionnaire (see the Appendix). To achieve the objectives of the study, all items measuring constructs were adapted from existing literature. We relied on multiple sources to measure the constructs. Specifically, six items adopted from

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Davis *et al.* (1989) and Kim *et al.* (2007) were used to measure the 'perceived usefulness' construct. 'Perceived enjoyment' was measured using three items adopted from Agarwal & Karahanna (2000). To measure the 'technical issues' construct, five items were taken from DeLone & McLean (1992) and Kim *et al.* (2007). The 'perceived fee' was assessed using five items drawn from the works of Voss et al. (1998), Kim *et al.* (2007), and Hsu & Lin (2018). Four items adopted from Kim *et al.* (2007) and Shah *et al.* (2021) were used to measure the 'perceived value' construct. The scale of Kala & Chaubey (2023) was used to measure 'adoption intention'. 'Environmental awareness' was assessed using five items sourced from Zahedi *et al.* (2019) and Shah *et al.* (2021). We modified certain statements to enhance content validity and align with the research objectives (Figure 2).

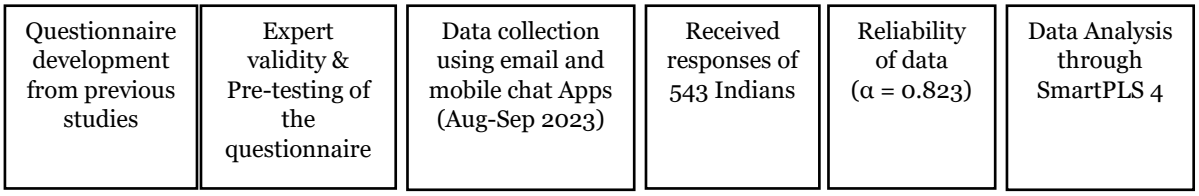

Figure 2. Research Methodology Flowchart

Participants provided their responses on a five-point Likert scale (1 - strongly disagree; 5 - strongly agree). The language of the questionnaire was English. Four experts (one marketing professor, one information systems professor, and two consumers) assessed and validated the questionnaire for content validity. A pretest involving 20 participants over one week found no readability concerns. Data were collected between August and September 2023, spanning a period of six weeks. Purposive and snowball sampling techniques were used to collect the data. These methods were deemed appropriate as the study focused on individuals who may use 5G services, and the respondents were selected based on their knowledge or potential to use. Prospective respondents (approximately 1000 respondents) were invited to participate in the study through email and mobile chat applications (Facebook Messenger and WhatsApp). They were also requested to forward the questionnaire to others who may have used or may use 5G services.

We received 543 responses, and, after eliminating 13 incomplete responses, 530 responses were utilised. The questionnaire showed strong reliability, demonstrating a Cronbach's alpha value of 0.823, significantly surpassing the accepted threshold of 0.70. The data was then analyzed using SmartPLS 4. SmartPLS is a leading tool in structural equation modelling (SEM). It leverages the Partial Least Squares algorithm, making it particularly suitable for quantitative research. PLS-SEM may be preferred over Covariance-based Structural Equation Modelling (CB-SEM) due to its versatility in analyzing complex models with smaller sample sizes and non-Normal data. It requires fewer distributional and measurement model assumptions, making it more flexible and applicable in diverse research contexts. Its ability to

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include both exogenous and endogenous variables without strict causal assumptions provides greater model flexibility. The decision to utilise PLS-SEM was driven by its compatibility with the research objectives, robust bootstrapping for inference, adept handling of both formative and reflective constructs, and a user-friendly interface (Kala *et al.*, 2024).

Common Method Bias (CMB)

CMB refers to a systematic error that arises in research when the same method or source is used to collect data for multiple variables (independent and dependent) in a study. CMB in survey research poses risks of inflated relationships between variables, reduced validity, misinterpretation of results, impaired generalizability, and difficulty in addressing confounding variables, compromising the accuracy and validity of study findings and hindering effective data interpretation.

To address the risk of CMB, the sequence of items was thoroughly mixed during data collection. Two separate tests were carried out to detect any potential bias. Firstly, we conducted Harman's single-factor test, which indicated no CMB, as the variance explained by the single component (approximately 30.15) remained below the 50% threshold (Harman, 1976). Second, we used the approach by Kock (2015), which states that the presence of CMB is indicated by Variance Inflation Factor (VIF) values ≥ 3.3. VIF is a measure used to assess multicollinearity among latent variables or constructs in a model. Multicollinearity occurs when independent variables are highly correlated with each other. All the VIFs were within the 3.3 threshold (Table 2). These results suggest that CMB is not likely to be a major problem.

Findings

Table 1. Demographic Profile (N=530)

Characteristics		Frequency	%
Age (in Years)	<=20	87	16.42
	21-30	271	51.13
	31-40	172	32.45
Gender	Male	313	59.06
	Female	217	40.94
Education	Graduate	187	35.28
	Postgraduate	141	26.61
	Professional	202	38.11
Occupation	Student	215	40.57
	Self-Employed	92	17.36
	Salaried	193	36.41
	Housewife	30	5.66
Monthly Income (in INR)	< 25000	57	10.76
	25001-50000	80	15.09
	50001-100000	162	30.57
	> 100000	231	43.58

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The demographic information of the respondents shows that 51.13% of them were in the age group of 21-30, 59.06% were males, 38.11% were professionals, 40.57% were students, and 43.58% were monthly income earners of more than INR 100000. Table 1 summarises the respondents' demographic information.

Measurement model

We choose both the measurement model and the structural model to assess the validity and reliability of measurement instruments and examine the relationships between latent constructs, respectively, to test hypotheses and gain insights into the proposed theoretical framework. Cronbach's alpha, composite reliability (CR), and convergent validity were assessed to check the reliability and validity of the model. Cronbach's alpha values (0.773 to 0.940) indicated satisfactory internal consistency. CR surpassed the 0.70 threshold for all constructs. Convergent validity (which indicates that the items within a scale are measuring the same construct), confirmed by Average Variance Extracted (AVE) values (0.597 to 0.795), demonstrated suitable correlations among construct items, with factor loadings exceeding 0.60, establishing convergent validity (Hair *et al.*, 2017) (Table 2).

Table 2. Measurements

Constructs and Items	Mean	SD	α	CR	AVE	VIF
Perceived Usefulness			0.940	0.953	0.775	1.170
PU1	3.78	0.926				
PU2	3.71	0.971				
PU3	3.64	1.035				
PU4	3.69	1.031				
PU5	3.81	0.890				
PU6	3.92	0.807				
Perceived Enjoyment			0.848	0.900	0.752	1.011
PE1	4.18	0.604				
PE2	4.00	0.754				
PE3	4.31	0.579				
Technical Issues			0.931	0.949	0.788	1.062
TN1	3.86	0.946				
TN2	3.94	0.955				
TN3	3.83	1.059				
TN4	3.62	1.041				
TN5	3.75	1.055				
Perceived Fee			0.915	0.938	0.754	1.136
PF1	2.93	0.683				
PF2	2.91	0.577				
PF3	2.92	0.698				
PF4	2.90	0.605				
PF5	2.90	0.686				
Perceived Value			0.773	0.854	0.597	1.376
PV1	3.77	0.552				
PV2	3.09	0.551				
PV3	3.79	0.534				
PV4	3.77	0.538				

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Constructs and Items	Mean	SD	α	CR	AVE	VIF
Adoption Intention			0.863	0.918	0.790	
AI1	3.43	0.314				
AI2	3.53	0.224				
AI3	3.62	0.222				
Environmental Awareness			0.934	0.951	0.795	1.318
EA1	3.09	0.546				
EA2	3.55	0.540				
EA3	3.42	0.491				
EA4	3.67	0.615				
EA5	3.25	0.542				

Discriminant validity ensures that different constructs are adequately distinguished from each other. It was measured using the Heterotrait-Monotrait ratio (HTMT) matrix, with values below 0.90 indicating success (Henseler *et al.*, 2015). HTMT calculates the ratio of correlations between constructs (heterotrait correlations) to correlations within constructs (monotrait correlations). It helps researchers assess the distinctiveness of constructs in PLS-SEM models, ensuring that each construct measures a unique concept. All values were below the cutoff, confirming the model's discriminant validity. The Fornell-Larcker criterion, where square roots of AVE values exceeded correlations between constructs and their indicators, further supported satisfactory discriminant validity. Overall, the proposed model exhibits robust justifications, successfully establishing discriminant validity (Table 3).

Table 3. Discriminant validity

Constructs	AI	PE	EA	PF	PV	TN	PU
AI	**0.889**	0.125	0.638	0.133	0.450	0.213	0.170
PE	0.111	**0.867**	0.074	0.115	0.160	0.107	0.078
EA	0.590	0.055	**0.892**	0.360	0.598	0.221	0.515
PF	-0.074	0.090	0.332	**0.868**	0.488	0.153	0.351
PV	0.313	0.087	-0.490	-0.415	**0.773**	0.618	0.790
TN	0.183	-0.059	-0.211	-0.141	0.528	**0.888**	0.244
PU	0.101	-0.067	-0.477	-0.333	0.672	0.229	**0.880**

*Fornell–Larcker criterion (below the main diagonal) and Heterotrait–Monotrait Ratio (HTMT) (above the main diagonal). Main diagonal: in bold, square root of the AVE.

Structural model and hypotheses testing

To assess the fitness of structural relationships in the model, VIF, coefficient of determination (R^2), and standardised path coefficients were evaluated. VIF values, addressing multicollinearity, ranged from 1 to 1.581, all within a satisfactory range of 1.0-5.0. The R^2 values were 0.657 and 0.833, respectively, indicating satisfactory variance. Additionally, all standardised path coefficients were statistically significant at the 0.01 level. Overall, these findings support the fitness of the structural model (Hair *et al.*, 2017) (Figure 3).

Table 4 displays hypothesis test results. Perceived usefulness positively influenced 5G perceived value (β=0.527, p=0.000), supporting H1. Perceived enjoyment (β=0.163, p=0.005) positively affected perceived value, confirming H2. Surprisingly, technical issues (β=0.389,

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p=0.000) positively impacted 5G perceived value, leading to H3 rejection. Conversely, perceived fee (β= -0.199, p=0.000) negatively influenced perceived value, supporting H4. Perceived value (β=0.771, p=0.000) significantly and positively influenced adoption intention, confirming H5 (Figure 3).

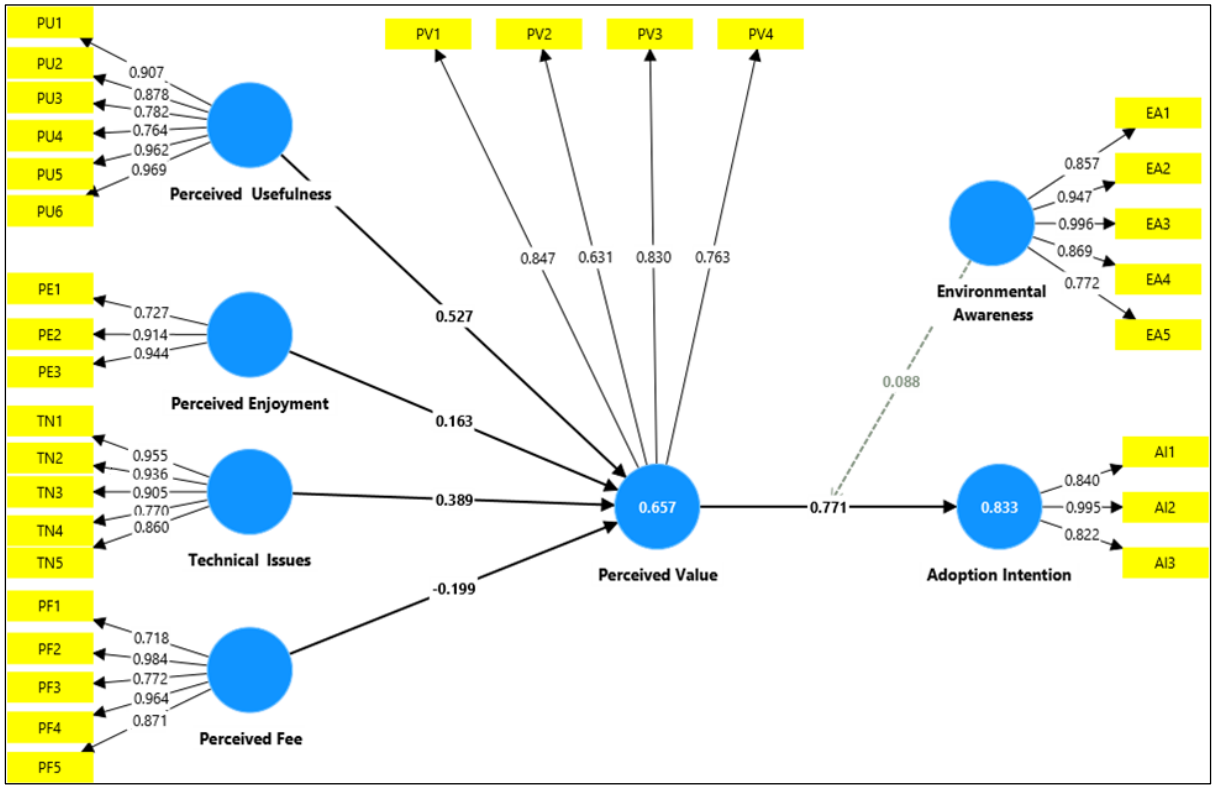

Figure 3. Structural Model

Table 4. Path Coefficients

Hypothesised Path	Path Coefficient (β)	Standard Deviation	T-statistic	P-value
PU -> PV	0.527	0.026	20.665	0.000
PE -> PV	0.163	0.058	2.825	0.005
TN -> PV	0.389	0.028	13.969	0.000
PF -> PV	-0.199	0.026	7.531	0.000
PV -> AI	0.771	0.033	23.034	0.000
EA × PV -> AI	0.088	0.020	4.445	0.000

Moderation analysis

Examining the moderation effect of environmental awareness on perceived value and adoption intention, a significant moderation effect was found (β=0.088, p=0.000). The analysis unfolded in two steps. Initially, the influence of environmental awareness on adoption intention yielded an R^2 of 0.657. Upon introducing the moderator variable, Environmental Awareness, the R^2 increased to 0.833. The resulting F^2 (effect-size) was 0.045, indicating a small moderation effect as per Cohen's criteria. Calculating the Q^2 (predictive relevance) produced a value above zero, signifying the model's predictive relevance. In conclusion,

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environmental awareness moderates the relationship between perceived value and adoption intention, providing support for hypothesis H6.

Discussion

Analyzing the acceptance of 5G services among young Indian consumers through the lens of perceived benefits and costs is crucial for comprehending the broader societal, economic, and technological ramifications of this transformative technology. It can inform business strategies, policy decisions, and innovation, ultimately shaping the future of communication and connectivity in India. Understanding consumer perceptions of 5G services can provide insights into their adoption behaviour. Factors such as pricing, quality of service, and perceived value can influence consumer choices, helping businesses refine their marketing and pricing strategies.

This study examined a research model, drawing from prior research, to explore factors influencing consumers' intention to adopt 5G services in India using VAM. Six hypotheses were formulated and tested with PLS-Structural Equation Modelling to achieve research objectives. The data, measurement model, and structural model demonstrated a satisfactory fit, with significant reliability observed across all constructs.

In alignment with the VAM hypotheses, the findings of this study indicate that individuals attributing perceived benefits, which subsequently contribute to perceived values, significantly influence adoption intentions. Regarding perceived costs, mixed results were observed regarding consumer adoption of 5G. Furthermore, perceived benefits exert a greater influence on perceived value compared to perceived costs. These results are consistent with earlier studies by Chong *et al.* (2010) and Shah *et al.* (2021), which also found that costs do not significantly impact the adoption decision.

The findings show that perceived usefulness plays a decisive role in forming high perceived values of 5G services, because it directly relates to the tangible benefits and advantages that consumers experience. 5G services, with their significantly higher data speeds, lower latency, and greater capacity, provide consumers with the ability to access and utilise a wide range of applications and services more efficiently. The faster and more reliable connectivity enables quicker downloads, smoother video conferencing, faster loading times for web content, and convenience in remote working for professionals. These improvements in productivity contribute to the perceived usefulness of 5G services. When consumers perceive that 5G technology is genuinely useful in improving their lives, work, and entertainment, it contributes to a stronger overall positive evaluation of the service, leading to a higher perceived value. These findings are consistent with earlier research conducted by Shah *et al.* (2021), Ke *et al.* (2022), Mustafa *et al.* (2022) and Sargam *et al.* (2023).

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Perceived enjoyment also influences the perceived value of 5G services. The functional features of 5G services can have a positive impact on consumers' daily lives, from improved entertainment experiences to more efficient work and communication. In alignment with the previous works (Shah *et al.*, 2021, Maeng *et al.*, 2020; Oinas-Kukkonen *et al.*, 2021; Mustafa *et al.*, 2022), the findings show that potential consumers intend to use 5G services for both utilitarian and hedonic purposes.

Surprisingly, the study discovered a positive impact of technical issues on the intention of Indians to adopt 5G services. The reasons for contradictory findings can be justified by the nature of consumers and digital ecosystem provided by the Indian Government. Many Indians are tech-savvy, and they are generally quick to adapt to new technologies. Younger generations tend to be more willing to embrace emerging technologies. They are familiar with smartphones, apps, and the basics of mobile networks, which can make the transition to 5G smoother. They are often more willing to explore and experiment with the capabilities of 5G services. These results attest to the findings of Meet *et al.* (2022), Shah *et al.* (2021), Ke *et al.* (2022) and Mustafa *et al.* (2022).

Consistent with the findings of Kim *et al.* (2007), Wang *et al.* (2013), Hsu & Lin (2018), Shah *et al.* (2021) and Mustafa *et al.* (2022), this study found the significant and negative impact of perceived fees on 5G adoption intention. With any new technology, there can be uncertainty about the long-term benefits and whether the investment will pay off. People have several legitimate concerns and worries regarding the high fees and operating costs associated with 5G services (Shah *et al.*, 2021). The apprehensions about high fees and operating costs associated with 5G adoption stem from a combination of financial concerns, uncertainty, and the perceived need for new devices (such as 5G-compatible smartphones) and plans.

Finally, the study revealed that environmental awareness moderates (small moderation effect) the relationship between perceived value and the intention to adopt 5G. It suggests that environmental awareness may influence how individuals perceive the value of adopting 5G technology. If individuals perceive that 5G adoption aligns with their environmental values (e.g., through energy efficiency, reduced carbon footprint, or sustainable practices), they may be more inclined to adopt the technology. As 5G technology is associated with advances and potential changes in energy consumption, waste management, and electronic waste, environmentally conscious individuals might weigh these factors more heavily in their decision-making process. Moreover, various reports have mentioned that 5G networks are designed to be more energy efficient. They can reduce carbon emissions through decreased travel needs, facilitate the development of smart infrastructure, and stimulate innovation in various sectors. In doing so, 5G will enable more efficient resource management, lower energy

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consumption, and improve overall environmental sustainability (Russell, 2018; Hutajulu *et al.*, 2020; Maeng *et al.*, 2020).

Theoretical implications

The study significantly contributes to the theoretical understanding of 5G adoption by delving into consumers' intentions to adopt 5G services. This expansion of the existing literature is crucial, as it goes beyond the application of 5G in the digital landscape and smart infrastructure, focusing instead on the consumers themselves and their adoption behaviours. The inclusion of the 'environmental awareness' construct in the model represents a noteworthy theoretical advancement. By incorporating environmental awareness, the study recognises the importance of contextual factors beyond traditional technological features. This integration reflects a more holistic approach to understanding the motivations behind 5G adoption, acknowledging the role of consumers' environmental consciousness. The study introduces a nuanced perspective by demonstrating how environmental awareness moderates the relationships between perceived value and intentions to adopt 5G services. This finding augments the literature by emphasizing the influence of environmental considerations on the perceived value and subsequent adoption intentions of consumers regarding 5G services. This theoretical insight suggests that consumers' environmental awareness plays a pivotal role in shaping their attitudes toward 5G adoption.

This study contributes to the growing body of knowledge on 5G services, particularly focusing on tech-savvy young consumers. By exploring the adoption intentions of this demographic, the research sheds light on the preferences and perspectives of a key target audience for 5G services. Moreover, providing consumer perspectives from a benefit-cost angle adds theoretical depth, especially in the context of 5G being in its nascent stage in India and globally.

Social implications

Examining the factors influencing perceived value and adoption intention of 5G services and the moderating role of environmental awareness carries significant societal implications. This research empowers consumers to make more informed decisions about their technological choices. Increased awareness of the environmental implications of 5G adoption may lead to more environmentally conscious consumer behaviours and encourage the development of sustainable technology solutions. Policymakers can use the findings to inform regulatory decisions and initiatives related to 5G adoption. By understanding the interplay between various variables, policymakers can develop policies that incentivise sustainable and equitable

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access to 5G services while mitigating potential negative impacts on consumers and the environment.

Managerial implications

The study's implications extend to academics, policymakers, and 5G service providers. With perceived usefulness exerting the most significant influence on perceived value, providers should emphasise the practical benefits and utility of 5G in their marketing and promotional efforts. Showcasing how 5G meets specific needs and enhances consumer experiences is crucial. The study demonstrates that, when consumers perceive the technology as user-friendly and see positive returns, the likelihood of adoption and subsequent usage increases.

Acknowledging the significant impact of Perceived Enjoyment on perceived value, marketers should incorporate elements that enhance the overall enjoyment of using 5G services. This could include promoting entertainment features, user-friendly interfaces, and other aspects that enhance the overall consumer experience. The unexpected positive effect of technical issues on perceived value suggests that highlighting the advanced technical features, even if considered as cost factors, can contribute positively to how consumers perceive the value of 5G services. Service providers should communicate the technological advances, innovations, and ease of use that set their 5G offerings apart.

Recognizing the negative impact of perceived fees on perceived value, 5G providers should consider transparent and competitive pricing models. They should clearly communicate the value proposition and justify any associated costs to alleviate concerns about perceived fees.

Since environmental awareness moderates the relationship between perceived value and adoption intention, educational campaigns should be designed to inform consumers about the environmental aspects of 5G technology. Highlighting eco-friendly features, energy-efficiency, smart infrastructure to reduce carbon emissions, and development of innovative sustainable solutions using 5G technology can enhance the overall appeal. Regarding e-waste caused by 5G, service providers along with handset manufacturers can design a recycling program responsibly. By offering consumers convenient options for recycling their old devices and network equipment, organizations (service providers and manufacturers) can reduce the volume of e-waste ending up in landfills and consequently encourage consumers to adopt 5G responsibly.

Given the dynamic nature of technology adoption, both 5G service providers and policymakers should engage in continuous market research to stay informed about evolving consumer preferences, concerns, and technological advances. The collaboration between 5G service

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providers, handset manufacturers, and government can result in a sustainable and eco-friendly 5G ecosystem.

The research findings offer valuable managerial implications for academics. By integrating these findings into academic programs, educators can provide students with a comprehensive understanding of consumer behaviour dynamics, the process of technological adoption, and the significance of environmental awareness in influencing consumer preferences.

Conclusion

This study examines the intricate interplay between perceived benefits and costs in shaping consumers' perceptions of the value associated with 5G services, with a particular emphasis on the moderating role of environmental awareness. The findings of this research highlight the significance of perceived usefulness, perceived enjoyment, technical issues, and perceived fee in shaping consumers' perceptions of the value associated with 5G services.

Furthermore, the inclusion of environmental awareness as a moderating factor adds a crucial dimension to our understanding of 5G adoption. The study demonstrates the moderation effect of environmental awareness on the relationship between perceived value and adoption intention. This highlights the importance of considering consumers' environmental consciousness in the context of emerging technologies, suggesting that environmental factors can influence the adoption decision-making process.

For companies aiming to encourage 5G adoption, this study emphasises promoting the practical benefits of the technology, addressing technical features transparently, and offering competitive and transparent pricing models. In the Indian context, where 5G is still in its nascent stages, this research provides timely and relevant insights for both industry practitioners and policymakers. As the technology landscape evolves, understanding consumer preferences, addressing concerns, and incorporating sustainable practices will be crucial for the successful adoption of 5G services in India.

Limitations and future directions

The study has some limitations along with a few recommendations for future research. Firstly, the study's exclusive focus on India warrants caution in generalizing findings to other contexts. Secondly, for a more comprehensive understanding of 5G adoption, future research should incorporate demographic factors. We suggest conducting segmentation analysis to identify distinct consumer segments with varying adoption intentions and factors influencing their decisions. Understanding the diverse needs and preferences within the Indian consumer base can guide targeted marketing strategies and service offerings. Thirdly, the sample size of 530 participants may restrict generalizability. Future research should use larger samples for robust

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results. Next, as digital ecosystem laws evolve, it is suggested that future studies examine how regulatory and environmental changes affect individuals' behavioural intentions. We suggest conducting longitudinal studies to track changes in 5G adoption intentions over time. This would provide a more dynamic perspective on how consumer perceptions and intentions evolve as 5G technology becomes more widespread and matures in the Indian market. Lastly, we also recommend cross-cultural comparative studies to investigate how cultural, technological, and infrastructural factors may interact with perceived value and environmental awareness in shaping adoption intentions, providing a more global perspective on 5G adoption.

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Appendix: Measurement Items

Constructs and Items
Perceived Usefulness
PU1: 5G will enable me to accomplish tasks more quickly.
PU2: 5G will enhance my task effectiveness.
PU3: 5G will make it easier to do my task like remote work and online learning.
PU4: 5G will significantly improve my overall connectivity experience.
PU5: 5G will save me time and effort in performing tasks.
PU6: The features and capabilities of 5G will make it a valuable addition to my daily life.
Perceived Enjoyment
PE1: I find using 5G networks and services will be highly enjoyable.
PE2: The fast download and streaming speeds of 5G will make my online activities more enjoyable.
PE3: The enhanced quality and reliability of 5G will make my digital interactions more enjoyable.
Technical Issues
TN1: It is easy to use 5G. (reversed)
TN2: 5G can be connected instantly.
TN3: 5G will take a short time to respond.
TN4: It is easy to get 5G to do what I want it to do.
TN5: The system of 5G will be reliable.
Perceived Fee
PF1: The fee that I have to pay for the use of 5G will be too high.
PF2: The fee that I have to pay for the use of 5G will be reasonable. (reversed)
PF3: I am pleased with the fee that I must pay for the use of 5G. (reversed)
PF4: I am worried about the operating cost associated with 5G technology adoption.
PF5: Switching to 5G technology would require substantial financial investments.
Perceived Value
PV1: Compared to the costs I need to pay, the use of 5G will offer value for money.
PV2: Taking all the pros and cons into consideration, the use of 5G is beneficial to me.
PV3: Despite my unfamiliarity with 5G, the use of 5G is worthwhile for me.
PV4: Overall, the use of 5G will deliver me good value.
Adoption Intention
AI1: I plan to upgrade to 5G services in the near future.
AI2: I am actively researching and staying informed about the benefits and implications of 5G technology.
AI3: I am eager to experience the enhanced speed and connectivity that 5G services promise to deliver.
Environmental Awareness
EA1: I consider the potential environmental impact of my actions when making my decisions.
EA2: I would like to describe myself as environmentally responsible.
EA3: I am worried about wasting and destroying the earth's resources.
EA4: Even if I feel inconvenient, I would like to take more environmentally friendly actions.
EA5: I am very knowledgeable about 5G radiation and its related environmental issues.

The notation "(reversed)" indicates that the scoring of the item is reversed. This means that higher scores on the original scale correspond to lower scores on the revised scale, and vice versa. It ensures that respondents are answering questions consistently throughout the questionnaire.

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