

Weighted Least Squares Regression on User perception on Internet services by Internet Service Providers (ISP)

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Abstract

This study investigates the relationship between user perception and the perceived quality of Internet Service Providers (ISPs) using Weighted Least Squares Regression (WLS). With the rapid advancement of digital technologies and the increasing importance of internet services, understanding customer satisfaction and its determinants is crucial for ISPs. The research employs a quantitative approach, collecting data from 181 students at Kwame Nkrumah University of Science and Technology (KNUST) through a structured questionnaire. The study examines how speed, reliability, and customer assistance influence user perception and, consequently, the overall evaluation of ISP services.

The findings reveal that user perception, weighted by user ratings, has a substantial and statistically significant impact on the perceived quality of ISPs. The high R-Square value (0.807) and significant F- and t-values confirm that user perception is a substantial predictor of ISP service evaluations. Descriptive statistics indicate that respondents generally have a favorable opinion of ISPs, though there is variability in individual assessments. The study also highlights the importance of demographic factors such as gender, age, and educational qualification in shaping user perception, while the profession was insignificant.

Theoretical implications support models like SERVQUAL, emphasising the centrality of customer perception in service evaluation. The study suggests that ISPs should invest in customer care, quality improvements, and data-driven decision-making to enhance customer satisfaction and loyalty. Socially, the findings underscore the importance of reliable internet access for digital inclusion, particularly in underserved populations. The study concludes with recommendations for future research, including using longitudinal data and machine learning techniques to explore user perception and satisfaction with ISPs further.

Keywords: *Weighted Least Squares Regression, User Perception, Internet Service Providers (ISPs), Customer Satisfaction, Service Quality, Digital Inclusion, Task-Technology Fit (TTF), Quantitative Research, Telecommunications, Customer Feedback, Speed, Reliability, Customer Assistance, Demographic Factors, SERVQUAL Model, Data-Driven Decision-Making.*

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1.0 INTRODUCTION

Beginning in the late 20th century and continuing to the present, the digital era is defined by the rapid advancement of digital technology (Imamov & Semenikhina, 2021). The digital age has changed how people live, work, and communicate; thus, ushering us to society 5.0 – super bright technological innovations and development (Roblek et al., 2020). With an emphasis on cyber-physical systems, IoT, iOS, 5G, and Industrial Internet, the fourth industrial revolution is changing the Internet technology landscape. It raises the value of data for businesses and changes the network mentality from connections to creativity on Gen X, Y and Z (Wang & Gao, 2020; Turkson et al.n.d). Learning and communication have been completely transformed by the internet, creating the "gig economy" and changing social media interactions (Kraus et al., 2023). Over 570 million Africans were internet users in 2022, with Nigeria having the highest number. Improved telecom infrastructure and rising mobile device usage are to blame for this expansion, which has led to a spike in internet connections (Nwaobi, 2024). Digital services and activities, such as social networking, online shopping, and mobile payments, have become increasingly popular, according to Owusu, et al., (2022).

The internet is expected to expand and become more accessible with the advent of 5G and quantum computing due to numerous investments in artificial intelligence, robotics, etc (Dhanabalan & Sathish, 2018). It will become more interconnected, enabling faster data transfer and sharing, and becoming more private and safer. The internet's popularity is increasing due to its interconnected services and global reach. Customer satisfaction in online service providers is influenced by service quality, cost, and technical support (Buhajoti, 2019). Customers desire fast, stable connections without interruptions or downtime. They expect good value for their money and feel dissatisfied if they are paying too much or not getting desired services. Additionally, customers want reliable and knowledgeable providers to be sure they receive the services they need (Boamah, 2020).

According to Bhanye et al., (2023), Africa's online social networking users reached 380 million in 2022, with North Africa having the highest penetration. The COVID-19 pandemic and increased home delivery demand have driven growth in the e-commerce and fintech sectors. However, gender disparities persist, and Africa's internet and telecommunications infrastructure remains underdeveloped due to funding issues. In 2022, 380 million Africans were using online social networking, with North Africa having the most significant penetration. The COVID-19 pandemic and rising desire for home delivery have fueled the expansion of the fintech and e-commerce industries. However, because of financial constraints, Africa's internet and telecommunications infrastructure is still underdeveloped, and gender gaps still exist (Nyirenda-Jere & Biru, 2015; Mishi & Anakpo, 2022).

Internet service providers (ISPs) might lose business due to increased competition, particularly with fiber-optic internet and 5G technologies (Sacco, 2020). ISPs struggle to compete, leading to financial losses. Customers switch providers due to reluctance to upgrade networks, and concerns about data safety and confidentiality. Many ISPs fall short in meeting these requirements (Major, 2021). Sluggish internet speeds can hinder basic tasks like streaming, downloading files, and browsing. Customers may experience website loading delays, wait times, technical difficulties, and poor return on investment due to insufficient data caps, hidden fees, poor customer service, and inadequate technical support (Phokeer, 2021).

Due to data restrictions on broadband plans, the lack of transparency in pricing, and the inability to access specific web material, many consumers have voiced their displeasure with ISPs (Nerjaku & Spaho, 2021). Research examining and quantifying how user perceptions affect the perceived effectiveness and caliber of Internet service providers (ISPs) employing the weighted

least squares approach is scarce. It specifically aims to determine the degree to which user feedback—represented in weighted perceptions—can reliably forecast the total service rating of ISPs. This study seeks to demonstrate the relationship between user perception and ISP service evaluation, delving into speed, reliability, customer assistance, and specific aspects of ISP services that influence perception.

On the other hand, investors, regulatory agencies, ISPs, and consumers must understand the elements that influence customer satisfaction with ISPs (Shokoohyar et al., 2021). These elements aid in pinpointing regions in need of development, boosting customer satisfaction, and assessing an ISP's feasibility as an investment choice. To boost customer loyalty and pinpoint development opportunities, businesses must optimise their service offerings (Alifah & Windasari, n.d.). Telecommunication firms must be aware of these elements to develop campaigns that connect with consumers and raise satisfaction levels (Sharma, 2021).

2.0 MATERIALS AND METHOD

According to Bhanye et al., (2023), Africa's online social networking users reached 380 million in 2022, with North Africa having the highest penetration. The COVID-19 pandemic and increased home delivery demand have driven growth in the e-commerce and fintech sectors. However, gender disparities persist, and Africa's internet and telecommunications infrastructure remains underdeveloped due to funding issues. In 2022, 380 million Africans were using online social networking, with North Africa having the most significant penetration. The COVID-19 pandemic and rising desire for home delivery have fueled the expansion of the fintech and e-commerce industries. However, because of financial constraints, Africa's internet and telecommunications infrastructure is still underdeveloped, and gender gaps still exist (Nyirenda-Jere & Biru, 2015; Mishi & Anakpo, 2022).

2.1 Underpinning Theory

21.1. Task Technology Fit theory (TTF model)

According to the TTF model, people will only embrace technology if it is practical and enhances their ability to complete tasks. Task characteristics, technological characteristics, TTF, and utilisation are all included in the TTF model (Wu & Chen, 2017). "The actions carried out by individuals in turning inputs into outputs" is how task characteristics are defined. The task technology-fit is "the degree to which a technology assists an individual in carrying out his/her tasks." In contrast, the technology characteristics pertain to "the technology used by individuals to perform their tasks" (Saputra et al., 2018).

According to the Task-Technology Fit (TTF) principle, how well technology supports human tasks significantly impacts user performance and happiness. According to TTF, consumers are more likely to express pleasure and improved performance when internet services meet their needs (such as speed, dependability, and accessibility) in how they view the services offered by ISPs. According to TTF, consumers will be more satisfied if an ISP's internet services satisfy their unique requirements, such as offering steady speeds for streaming, gaming, or remote work.

Users who are happy with the service view it as dependable and worthwhile, which enhances their opinion of the ISP. TTF further emphasises that when the technology offered meets the user's needs, the user performs better. Regarding ISP services, consumers' capacity to finish jobs effectively increases with dependable connection and sufficient speed. This performance increase further supports positive opinions of the ISP. By customising their offerings to meet the unique requirements of their clientele, ISPs can take advantage of TTF principles and raise customer happiness and perceived performance. Internet service providers can increase their competitive edge and customer loyalty by guaranteeing high-quality service that satisfies users' task demands.

Authors like Lin et al. (2020) employed the task-technology fit model for social media marketing in the tourism and hospitality industry. Rzepka et al. (2022) drew on the Task-technology fit model to examine the fit between conversational agents' interaction modalities and information search tasks—voice assistant vs. Chatbot. Saputra et al. (2018) employed the UTUAT and (TTF) for mobile app browser acceptance by Generation Y.

2.2 Empirics

Saranya & Chinnadorai (2014) found that respondents chose packages with speeds between 51B mbps and 1 mbps and were well-informed about internet service providers thanks to posters, leaflets, and banners. Between Ts, they used their existing service provider for % to 1B months. 500 and Ts. 1000 per month, and did not move to another service. Furthermore, Nyika & Mphokhethwa (2023) found that better infrastructure, reasonably priced internet packages, multilingual websites, and open security measures are essential to increase trust in online transactions. It suggests multilingual support, cybersecurity, digital customer service, culturally appropriate advertising, and customised internet bundles.

Mare (2020) investigates the reasons and methods by which private telecom companies in a militaristic authoritarian state carry out government directives to block Internet access. The author discovered that between 2016 and 2019, Zimbabwe's government expanded its arsenal of authoritarian measures to include state-ordered Internet shutdowns, which had a detrimental effect on telecom companies' capacity to remain financially viable. The study highlights the significance of considering sociopolitical and economic factors by examining how private telecom businesses respond to government mandates. It suggests that operators abide by government orders in part to fulfill licensing criteria because they are worried about political harassment and arbitrary incarceration.

3.0 RESEARCH METHODS

The research philosophy of pragmatism is in line with the study. Practical results rather than theoretical distinctions pique the interest of pragmatics (Ormerod, 2021). This takes a philosophical stance as the pragmatic researcher can select the processes, methods, and techniques that best serve the study's objectives (Sultana, 2020). Additionally, the study employed a quantitative research methodology focusing on the relationship between user perception and ISP service evaluation, delving into speed, reliability, customer assistance, and specific aspects of ISP services that influence perception.

According to Mohajan (2020), quantitative research focuses on deduction, confirmation, theories/hypotheses, explanations, predictions, standardised data collection, and statistical analysis. The research employed a cross-sectional approach to gather data, whereby information was acquired from participants—students from KNUST—using a structured questionnaire survey. A typical questionnaire consists of two parts.

Part 1 addressed the respondents' demographic information, which is necessary to confirm the data's accuracy. Conversely, Part 2 examines the relationship between user perception and ISP service evaluation, delving into speed, reliability, and customer assistance - specific ISP services influence perception. A Likert item on a scale of 1 to 5 (strongly disagree to agree strongly) was used to develop this section of the questionnaire, allowing researchers to assess the degree of agreement with the numerous factors under investigation as described in other studies (León-Mantero et al., 2020). The respondents were purposively selected and the target group consisted of students from year 1 to year 4.

The researcher applied the Cochran (1997) formula ($n = 1 + N(e)^2$) for sample size calculations in the case of an infinite population. The study's population was 400 respondents, with a 95% confidence level, a maximum variability, and a 5% margin of error and per the formula, the sample size. The responses were 181 out of 200. It is also important to remember that the primary justification for using the purposive sample approach was the requirement that respondents had in-depth knowledge of and have utilised any of the developing technologies before administering a questionnaire. Based on this, the questionnaires were partly self-administered over three weeks using in-person meetings and an online platform (Google forms).

4.0 DATA ANALYSIS AND DISCUSSION

The data collected were analysed using descriptive statistical techniques using the Statistical Package for Social Sciences software version 26. Table 5 describes the personal factors, p values, and their significance in user perception. The table shows that the hypothesis is accepted as "Not Significant" (in one case) and rejected as "Significant" in the remaining four cases. It is concluded that, except for profession, all other personal factors considered for the study significantly influenced the user perception.

Table 1 - Chi-Square values – Personal factors and User perception (USERint)

Personal Factors	Chi-square value	P-value (≤ 0.05)	Significant/Not significant
Gender	41.849	0.000	Significant
Age	156.375	0.000	Significant
Educational Qualification	197.366	0.00	Significant
Profession	9.831	1.000	Not significant

Source: Primary data using SPSS

Table 6 describes the personal factors, p values, and their significance in user perception. It is found from the Table that the hypothesis is accepted "Not Significant (in one case and the remaining four cases, the hypotheses are rejected "Significant (It is concluded that except profession, all other personal factors considered for the study exercised significant influence on the Internet service providers (INTs).

Table 2 - Chi-Square values – Personal factors and Internet service providers (INTs)

Personal Factors	Chi-square value	P-value (≤ 0.05)	Significant/Not significant
Gender	51.273	0.000	Significant
Age	88.200	0.000	Significant
Educational Qualification	81.651	0.000	Significant
Profession	24.175	0.977	Not significant

Source: Primary data using SPSS

4.1 Descriptive statistics

Table 3 descriptive statistics for Internet service providers (INTs) and user perception (USERINT) shed light on the variability and central tendency of respondents' assessments of ISP services. Assuming the score scale accepts values that indicate adequate performance, the average rating of 38.14 for Internet service providers (INTs) indicates that respondents gave ISP services a relatively high rating. The average weighted perception score, or user perception (USERintn0), is

39.14. It is marginally higher than the ISP rating (INTs), indicating that respondents generally have a more favorable opinion of ISPs than they do of their service ratings.

The Internet service providers' (INTs') 4.58 standard deviation indicated moderate variance around the mean. This implies that although the majority of respondents' assessments are almost average, there are some variations in each ISP's assessment. The slightly more significant standard deviation (5.30) for user impression scores implies a broader range of responses. This would suggest that user opinions varied more widely, which might reflect variations in personal experiences or ISP service expectations. The close means for both variables show that user perception and ISP assessments generally agree. The preceding regression findings showing user perception significantly impacts ISP evaluations are supported by this alignment. ISPs can use these averages and variations to gauge overall customer satisfaction and identify possible areas for development. In order to connect customer experience with perception, ISPs may need to close the gap between perceived expectations and actual service quality, as indicated by the modest discrepancy in means.

Table 3

Descriptive Statistics			
	N	Mean	Std. Deviation
INTs	181	38.1389	4.57924
USERintn	181	39.1444	5.29585

Using a Weighted Least Squares Regression (WLS) model, Table 4 evaluates the link between Internet Service Providers (ISP) services as the dependent variable and user perception (USERintn) as a weighting variable. The correlation coefficient, or $R = 0.899$, indicates how strongly the predictor (ISP services) and the outcome variable (user perception, weighted by USERintn) are linearly related. An influential positive association is indicated by a R of 0.899. 0.807 is R Square (R^2): According to the R^2 value, this model accounts for 80.7% of the variation in how users view ISP services. This high value indicates a robust model fit and demonstrates that ISP services adequately explain user impression as weighted by the variable USERintn.

Adjusted $R^2 = 0.806$: To account for the number of predictors, Adjusted R^2 slightly modifies R^2 . Given that it is around R^2 , the model is resilient and has good population generalisation. The standard error represents the average difference between the observed and model-predicted values, which is 11.98333. While consistent with common prediction mistakes in behavioral and perception studies, this moderate standard error suggests some variability that the model may not entirely capture.

According to the R Square Change and F Change values, the correlation between ISP services and user impression is statistically substantial ($p < 0.001$). The overall significance of the model is demonstrated by the F Change of 746.490, which offers compelling proof that the ISP services variable significantly predicts changes in user perception. The model's residuals (errors) are evaluated for independence using the Durbin-Watson statistic, which is 1.878. A number near 2 indicates that the residuals have little to no autocorrelation, confirming the validity of the model's assumptions.

Table 4

Model Summary^{b,c}

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.899 ^a	.807	.806	11.98333	.807	746.490	1	178	.000	1.878
a. Predictors: (Constant), Unstandardized Residual										
b. Dependent Variable: INTs										
c. Weighted Least Squares Regression - Weighted by USERintn										

The significance of the Weighted Least Squares Regression model used to comprehend the association between Internet Service Provider services (dependent variable: INTs) and user perception (weighted by USERintn) is detailed in Table 5, which also displays the ANOVA table. According to the ANOVA results, the regression model is highly significant ($p < 0.001$), indicating that user perception, weighted by USERintn significantly influences the perception of ISP services (INTs). The strength of this link is shown by the strong F-statistic (746.490). This indicates that the model is a powerful tool for forecasting the relationship between user ratings (USERintn) and their assessment of ISP service quality (INTs), since it successfully captures and explains the variability in users' impressions of ISPs.

Table 5

ANOVA^{a,b}						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	107196.184	1	107196.184	746.490	.000 ^c
	Residual	25560.837	178	143.600		
	Total	132757.021	179			
a. Dependent Variable: INTs						
b. Weighted Least Squares Regression - Weighted by USERintn						
c. Predictors: (Constant), Unstandardized Residual						

The Weighted Least Squares Regression model demonstrates a strong, statistically significant relationship between the unstandardised residuals (weighted by USERintn) and the perception of ISP services (INTs); the high t-value (27.322, $p < 0.001$) and the standardised Beta (0.899) highlight the significant influence of the predictor on ISP perception; the collinearity statistics reassure us that multicollinearity is not a problem, confirming the robustness and reliability of this model; the narrow confidence interval further bolsters our confidence in these findings, showing that user perceptions are a significant and accurate predictor of ISP service ratings.

Table 6

Coefficients^{a,b}							
Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	Correlations	Collinearity Statistics

	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	38.287	.143		268.194	.000	38.006	38.569				
	Unstandardized Residual	1.000	.037	.899	27.322	.000	.928	1.072	.899	.899	.899	1.000
a. Dependent Variable: INTs												
b. Weighted Least Squares Regression - Weighted by USERIntn												

5.0 CONCLUSION

With the cross tabulations, the study found that, except for profession, all other personal factors considered exercised significant influence on the user perception (USERIntn), and the Internet service providers (INTs). Based on the weighted least squares regression analysis, the analysis indicates that user perceptions, as weighted by user ratings, have a substantial and statistically significant impact on the perceived quality of Internet Service Providers (ISPs). The high R-Square value and significant F- and t-values confirm that user perception substantially predicts how ISP services are evaluated. This conclusion highlights the importance of customer perception in shaping the reputation and perceived effectiveness of ISPs.

5.1 Theoretical, Managerial, and Social Implications

The findings contribute to the growing literature on service quality assessment and customer perception in the telecommunications and internet services industry. The study supports theoretical models that place customer perception at the center of service evaluation, such as the SERVQUAL model. It aligns with theories suggesting customer perceptions significantly influence service quality assessment and satisfaction. This study adds a quantitative dimension to theories on perception by demonstrating the importance of weighting customer feedback. Weighting perceptions can more accurately reflect how various user experiences contribute to overall satisfaction and service quality evaluations.

Moreover, the study's findings highlight the value of customer satisfaction in internet service, particularly given the centrality of internet access in social and economic life. ISPs can use these insights to improve service delivery, which, in turn, benefits society by supporting access to reliable internet—a critical factor in digital communication, education, work, and social engagement. By understanding customer perceptions' weight on service evaluation, ISPs may become more responsive to customer needs, fostering a culture of customer empowerment and active feedback. Thus, insights from this study can contribute to policy and practices aimed at digital inclusion, where reliable internet services are increasingly considered essential for all societal sectors, especially underserved populations.

ISPs should invest in customer care, prompt issue response, and quality enhancements because customer perception has a significant impact. Programs for improving the customer experience can lower attrition, boost customer loyalty, and raise satisfaction. Managers that use data-driven decision-making should make use of weighted customer feedback. This method allows for service enhancements focused on actual user demands and experiences, improving offers based on facts rather than conjecture. To monitor shifts in perception over time, ISPs should think about establishing formal customer feedback loops and regularly collecting weighted data. Managers can react proactively by using this feedback to track the effects of service enhancements or modifications. ISPs can set themselves apart in a crowded market by focusing on user pleasure as a competitive advantage. They can draw in and keep a loyal customer base by projecting an image of customer-centricity.

5.2 Limitations and future research directions

Although this study offers insightful information, some limitations suggest areas that warrant more investigation. A cross-sectional dataset, which records user perception at a particular moment in time, is used in this study. Finally, possible moderating factors like service type and regional variations were not taken into consideration in this investigation. Future research could look into how various internet service types (such as home broadband versus mobile data) might affect perception differently. Longitudinal data may be used in future studies to track how attitudes evolve over time in response to market shifts or service quality improvements. The researcher makes the case that more research on how users perceive and are satisfied with internet service providers can apply a machine learning technique.

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