

Effect of network quality on internet home complaints, queries, and payments

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Abstract

En el marco de los Internet Service Providers (ISP), la literatura científica presenta modelos de calidad, los cuales se componen de varias dimensiones que influyen en la lealtad de los clientes. La calidad de red es la dimensión más importante de acuerdo a lo indicado por los autores. This study used data from customers whose network quality was upgraded from copper to fiber optic technology between January and April 2019 y se mide el efecto en los reclamos, consultas y en los pagos. Para realizar la prueba de hipótesis se utilizan pruebas no paramétricas, los resultados indican que la mejora de la calidad de red influye en el número de reclamos de manera positiva, reduce la cantidad de reclamos. En lo relativo a las consultas, la mejora de la calidad de red no influye en el número de consultas. La mejora de la calidad de red si influye en el número de pagos anuales y en el valor de los pagos, la mejora de la calidad de red con la tecnología de fibra incrementa el número de pagos anuales de los clientes y el valor de los mismos.

Keywords:

Network quality, telecommunications, complaints, late payments, Internet home

1. Introduction

Studies relating to Internet service quality indicate that there are factors that positively influence customer satisfaction and loyalty [1]. Service quality is an essential differentiator in a competitive business environment [2, 3]. If service quality improves, then customer retention and loyalty improve [4].

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In the field of quality models, the literature indicates that quality dimensions influence cognitive (i.e., value) and affective (i.e., trust and commitment) evaluation, which positively precede customer loyalty [5, 6]. An Internet Service Provider (ISP) quality of service model is composed of the following dimensions [5]:

1. Network Quality
2. Customer service and technical support
3. Information quality
4. Security and privacy

As researchers, ISP professionals, and stakeholders, you understand that network quality is a pivotal factor in the overall service quality of an ISP. Therefore, it is of utmost importance for us to delve into this factor and its effects. In this study, we aim to enhance the network quality of a specific customer group and gauge the impact on complaints, inquiries, and payments for the service. The network quality improvement will be implemented by transitioning customers from copper to fiber optic technology. The measurements will be conducted over a year of copper technology usage and another year with fiber optic technology, providing a comprehensive understanding of the changes.

No similar studies in the literature analyze the impact of network quality and socio-economic level on the number of complaints, queries, number of payments, and value of payment. The following research questions have been posed in this study:

- Q1. Does a specific type of network quality improvement, such as increased bandwidth or reduced latency, influence the number of complaints?
- Q3. Does the improvement of network quality influence the number of inquiries?
- Q5. Does the improvement of network quality influence the number of payments?
- Q7. Does improvement in network quality influence the value of payments?

This paper is organized as follows: Section 2 reviews the work done in the area and motivates the study. Section 3 poses the research questions and explains the procedure used to conduct the study. Section 5 presents the results of the study. Sections 6 and 6 present the discussion and conclusions, respectively.

2. Literature review

2.1. Network Quality

Quality of service positively influences customers' affective and cognitive evaluations, including customer satisfaction, trust, commitment, and customer value [6].

At the ISP level, several studies have been conducted on network quality and quality of service. The study [5] is an online survey of the company's customers, indicates that quality significantly influences customer trust. In [7] determines the effects of quality on customer loyalty. The authors in [1] conduct a quantitative study applying a questionnaire to obtain a service quality model. In [8], authors uses a survey to study service quality and its influence on the behavioral intention to change Internet service providers.

Other studies propose to relate service quality to customer satisfaction through the number of complaints. In [9], authors explore service quality measurement and propose a performance index to indicate customer satisfaction based on the proportion of complaints. In [10], the authors indicate that through the number of customer complaints, service quality can be tracked based on the theory to assist company management in the timely monitoring customer satisfaction; the author has developed a service quality model to monitor service quality.

The quality of service model of an ISP has the following dimensions: **network quality**, customer service, information quality, and security and privacy [5]. Quality studies that have been conducted indicate that network quality is one of the most important dimensions influencing service quality and customer loyalty.

Network quality refers to the quality and strength of the network signal, number of errors, downloading and uploading speed, number of outages, and number of service failures. System response time is another characteristic [11] of network quality. Speed and reliability are important characteristics of Internet service [12] that are related to network quality. In the telecommunications industry, network quality and call quality are key factors for customer satisfaction [13].

In our study, we have proposed to use a case study to evaluate the effects of network quality improvement on the number of complaints, inquiries, and payments made by customers of the Internet home service. In the literature, we have not found a similar study that focuses solely on network quality and its effects.

2.2. Telecommunications complaints and queries

Customers complain when they receive poor services; their behaviors have two ways of expressing it: negative word of mouth and complaining to the company [14]. The most valued reason for complaining to a telecommunications company in order of importance is seeking corrective action, explanations, repair, seeking an apology, expressing emotion or anger [15]. It also indicates that the reasons for not complaining are when it is too late to complain when there is a perception that nothing will be done about the problem, and when there is a fear of complaining.

The company must be aware of the importance of service recovery in resolving these problems [16]. The ability to handle customer questions, concerns, complaints and frustrations is essential to the customer's perception of service quality [17]. Proper complaint handling by the company could be an opportunity to improve customer satisfaction and the company's profitability [18].

The study [10] indicates that through the number of customer complaints the service quality can be monitored based on the theory to assist company management in the timely monitoring of customer satisfaction. The study has developed a service quality model to comprehensively monitor service quality.

While we have, on the one hand, indications of the effects of increased network quality on customer loyalty, the scientific literature does not indicate the effect of network quality improvements on the number of complaints and enquiries.

2.3. Payments

In telecommunications, when providers offer multiple classes of service they can raise more revenue than with a single class of service, the diversity of ISP service plans is conducive to higher revenues. ISPs price their services differentially based on their [19] characteristics.

As the relationship continues, existing customers' spending increases over time, and they also no longer care as they become price insensitive. Customers in long-term relationships will pay more and act as the service provider's promoters, which eventually leads to lower new customer acquisition costs and higher retention [20].

Most customers pay their bills on time, but some forget to do so or intentionally do not pay on time. ISPs strive to increase their customer base and improve their performance. However, they have to deal with late payments by some customers. Late payments can be attributed to fraud, regular delays, or other special reasons [21]. Late payments, although not fraudulent behavior, see reductions in cash flow and increase and d costs for debt collection [22].

Customer on-time or late payment could be influenced by improved network quality. ISPs issue monthly bills, collect payments, and apply service cuts to non-paying customers if the customer does not pay. This study will analyze the effect of increased network quality on the number of annual payments and the value collected.

3. Methodology

This study was conducted using data on complaints, payments, and customer queries about Internet home services for an ISP company in Ecuador from 2018 to 2020. The customers whose data have been used in this study will also be referred to as subjects.

A group of customers whose network quality was upgraded between January and April 2019 was selected and upgraded from copper to fiber optic technology. The measurements were carried out for one year, in which customers used copper technology, and then for one year, in which they used fiber technology.

The month-year and the total number of customers whose network quality was improved (1,998 customers) are shown in the Table 3.

Month	Number of customers
January-2019	557
February-2019	490
March-2019	548
April-2019	403
TOTAL	1,998

Table 1: Number of customers per month whose network quality was improved

Table 3 presents the period in which the number of complaints, inquiries, and payments from customers whose technology was upgraded was recorded from January to April 2019.

Month	Period with Copper Net		Period with Fiber Net	
	Start date	End date	Start date	End date
January-2019	January-2018	December-2018	February-2019	January-2020
February-2019	February-2018	January-2019	March-2019	February-2020
March-2019	March-2018	February-2019	April-2019	March-2020
April-2019	April-2018	March-2019	May-2019	April-2020

Table 2: Periods of data collection for analysis

Studies reported in the scientific literature on Internet home service usually use the online survey method to measure customer satisfaction [23, 24, 25, 26]. In this study, we compare customers with different technologies and customers of different socio-economic statuses with respect to complaints, queries, number of payments, and value of payments.

Based on the research questions, we have the following hypotheses to test:

Q1. Does the improvement of network quality influence the number of complaints?

- H10 (Null hypothesis): There is no difference in the effects of network quality on the number of complaints.
- H11 (Alternative hypothesis 1): There is a difference between the effects of network quality on several complaints. The number of complaints produced with the copper connection is higher than those produced with an optical fiber connection.
- H12 (Alternative hypothesis 2): There is a difference between the effects of network quality on several complaints. The number of complaints produced with a copper connection is lower than those produced with an optical fiber connection.

Q3. Does the improvement of network quality influence the number of consultations?

- H30 (Null hypothesis): There is no difference in the effects of network quality on number of questions.
- H31 (Alternative hypothesis 1): There is a difference between the effects of network quality on number of questions. The number of questions produced with cooper connection is higher than the number of questions produced with optical fiber connection.
- H32 (Alternative hypothesis 2): There is a difference between the effects of network quality on number of questions. The number of questions produced with cooper connection is lower than the number of questions produced with optical fiber connection.

Q5. Does the improvement of network quality influence the number of payments?

- H50 (Null hypothesis): There is no difference in the effects of network quality on number of payments.
- H51 (Alternative hypothesis 1): There is a difference between the effects of network quality on number of payments. The number of payments realized with cooper connection is higher than the number of payments realized with optical fiber connection.
- H52 (Alternative hypothesis 2): There is a difference between the effects of network quality on number of payments. The number of payments realized with cooper connection is lower than the number of payments realized with optical fiber connection.

Q7. Does improved network quality influence the value of payments?

- H70 (Null hypothesis): There is no difference in the effects of network quality on value of payments.
- H71 (Alternative hypothesis 1): There is a difference between the effects of network quality on value of payments. The value of payments realized with cooper connection is higher than the value of payments realized with optical fiber connection.
- H72 (Alternative hypothesis 2): There is a difference between the effects of network quality on value of payments. The value of payments realized with cooper connection is lower than value of payments realized with optical fiber connection.

The results of the data analyses and hypothesis testing are presented below.

4. Results

4.1. *Impact of network quality improvement on the number of complaints*

This study's subjects have made 3,315 claims with copper technology and 2,527 with fibre optic technology.

4.1.1. Influence of technology on the number of complaints

Table 4.1.1 presents the descriptive statistical values for the number of fiber optic and copper complaints. The average number of complaints during a year of service for a copper customer (1.07) is higher than for fiber (0.82).

	Cooper Net	Optical Fiber Net
Mean	1.07	0.82
Standard Deviation	1.94	1.43
Median	0	0
Minimum	0	0
Maximum	18	16

Table 3: Average number of claims per technology

To comprehensively understand research question Q1, a one-factor hypothesis test with two within-subject treatments will be rigorously conducted. This is crucial as it takes into account that each subject has experienced both technologies, thereby providing a robust analysis.

To determine the normality of the data, the Kolmogorov-Smirnov and Shirnov Kolmogorov-Smirnov and Shapiro-Wilk test, the statistical significance value is 0.000, so there is no normality of the data. Therefore, a non-parametric hypothesis test will be applied.

The result of the Wilcoxon test has given a statistical significance value of 0.000; this indicates that there is evidence to reject the null hypothesis H10; therefore, the alternative hypothesis H11 is accepted; the number of claims with copper technology is higher than the number of claims with fiber optic connection. Therefore, technology influences the number of complaints; improving network quality by switching from copper to fiber reduces customer complaints by 24

4.2. Impact on the number of consultations

The study subjects made 245 consultations with copper and 276 with fiber net.

4.2.1. Influence of technology on the number of consultations

Table 4.2.1 presents the statistical values on the number of queries per technology. The average number of queries during a year of service of a customer on copper (0.12) is lower than on fiber (0.14).

	Cooper Net	Optical fiber Net
Mean	0.12	0.14
Standard deviation	0.42	0.47
Median	0	0
Minimum	0	0
Maximum	8	6

Table 4: Number of consultations per technology

In order to answer research question Q3, a one-factor hypothesis test with two treatments within subjects will be performed since the subject has applied both treatments (copper and fiber optics).

To determine the normality of the data, the Kolmogorov-Smirnov and Shapiro-Wilk test has been applied; the statistical significance value is 0.000; therefore, there is no normality of the data; therefore, a non-parametric hypothesis test will be applied.

The Wilcoxon test for related measures was conducted, and a statistical significance value of 0.132 was obtained. This result, indicating a lack of evidence to reject the null hypothesis H30, is significant as it suggests that network quality does not significantly influence Internet customer queries.

4.3. Impact on number of payments

En este estudio se tiene 23.074 pagos con cooper net y 23.426 con fibra óptica.

4.3.1. Influence of technology on the number of payments

Table 5 shows the descriptive statistical values for the monthly payments for fiber and copper. The average number of payments during a year of service of a customer in copper (11.97) is lower than in fiber (12.15).

Table 5: Number of payments within a year

	Cooper Net	Optical Fiber Net
Mean	11.97	12.15
Standard Deviation	3.41	3.02
Median	12	12
Minimum	1	1
Maximum	54	64

Hypothesis testing will be performed with a two-factor within-subjects treatment to answer research question Q5. Customers have made one year of payments with the copper technology service and one year with the fiber optic technology.

Our commitment to thorough data analysis led us to apply the Kolmogorov-Smirnov and Shapiro-Wilk tests to determine the normality of the data. With a

statistical significance value of 0.000, it became clear that the data did not follow a normal distribution, necessitating the use of a non-parametric hypothesis test.

The results of the Wilcoxon test for repeated measures have a statistical significance value of 0.034; this indicates evidence to reject the null hypothesis H50 and accept the alternative hypothesis H52. The number of payments made with copper is less than those made with fiber. It can be affirmed that the improvement of network quality influences the number of payments, the mean value of fiber payments has increased, and the variance concerning copper has been reduced.

4.4. Impact on the value raised

En este estudio se tiene un valor recaudado de 560.715 dollars con cooper net y 608.828 dollars con fibra óptica.

4.4.1. Influence of technology on value raised

Table 5 shows the descriptive statistical values for fiber and copper's total annual payment value. The average number of payments during a year of service for a customer on copper (291.00) is lower than on fiber (315.88).

Table 6: Annual technology revenue

	Cooper Net	Optical fiber Net
Mean	291.00	315.88
Standar Deviation	103.44	102.22
Median	289.13	320.07
Minimum	1	17
Maximum	1,315.00	1,511.00

To answer our research question Q7, which focuses on the impact of different network technologies on customer payments, a hypothesis test will be performed with one factor and two treatments within the subjects. This is because the customers in this study have used both technologies. To determine the normality of the data, the Kolmogorov-Smirnov and Shapiro-Wilk test has been applied. The statistical significance value is 0.000, indicating that the data is abnormal, and a non-parametric hypothesis test will be applied.

The Wilcoxon test has been applied; the statistical significance value is 0.000; this indicates that there is sufficient evidence to reject the null hypothesis H70; therefore, the alternative hypothesis H72 is accepted, the value of payments with the copper connection is lower than the value of payments with the fiber optic connection. It can be stated that the type of network technology influences the value collected.

5. Discussion

It is not recommended to treat all customers equally in terms of methods to increase customer loyalty [27]. Therefore, it is necessary to know about

customer behavior. Additionally, the population under study is stratified by socio-economic level, which is why this little-studied variable has also been addressed.

Regarding improving network quality, this study has shown that improving network quality reduces the number of complaints and increases the value of payments and the number of payments; having fewer complaints allows us to build customer loyalty, reduce operating costs, and improve the company's cash flow. Improving network quality does not influence the number of consultations, possibly related to other social and educational factors, but not to technology.

Although network quality appears to be significantly important in determining the quality of service, it is suggested that companies should not only work on this factor but also consider customer care to increase satisfaction and quality of service [28].

6. Conclusions

We concluded that improving network quality through the change from copper to fiber optic technology positively influences the number of complaints. The improved technology reduces the number of customer complaints by 24%.

Improved network quality does not influence the number of customer queries; even if the technology improves, customers will ask about password changes and other queries related to ICT usage.

Improved network quality does influence the number of payments during a service year; improved network quality with fiber technology increases the number of customer payments.

Improved network quality influences the value of payments in a year, and fiber optic increases the total value of the annual payment. It is known that the value of the minimum fiber optic plan is slightly higher than that of copper (1.50 usd. higher), which would be the main reason for the behavior noted above. Although the value of the service is higher, customers who receive better service concerning the network continue to be payers.

This study has reaffirmed some of the benefits of improving the network quality aspect of ISP companies, which could be extrapolated to the use of communication technologies in general.

7. Future Work

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