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Network Utilization and Pricing: Evidence from India's Telecommunications Sector

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Abstract

The paper aims to analyse the difference between peak-hour and non-peak hours network traffic of a telecom service provider Aircel in the selected regions of India and to examine the price sensitivity of the network traffic. We observe that the traffic is sensitive to any change in the price. There is an increase in the usage of the network during the off-peak hours if there is a price discount. We also observe that it is possible to transfer some part of the peak – hour traffic to non-peak hours if the policy of differential pricing is implemented. Transferring some traffic from peak-hour to the off-peak hour may reduce the amount of equipment required to service the incoming calls for the operators and, also improve the quality of service provided to the subscribers. On the basis of this experiment, we recommend that TRAI can make traffic distribution relatively uniform by adopting the policy of dual pricing.

1.Introduction

In India, the telecommunications service industry has experienced spectacular growth as a result; it has become the second largest network in the world, next only to China. Tele-density measured by the number of telephones per 100 people, increased to 88.81percent in November, 2019 from less than 1 percent during the early 1990s [1]. As a result of various policy measures since 1994, the telecommunications industry of India was transformed from public-sector – led monopoly to a highly competitive industry with the entry of several private sector and foreign multinational companies. There are 22 telecom circles in India, and each telecom circle had 6 to 7 operators providing similar services. However, there has been a consolidation in the market structure after the entry of Reliance Jio in the year 2016. The number of operators has declined from 13 to 7 between 2013-14 and 2018-19. Out of these 7 operators, the share of three operators, namely Bharti Airtel, Vodaphone, and Reliance Jio, collectively is almost 88 percent out of the total mobile subscriber base of this industry. Consequently, the degree of market concentration measured by Herfindhal – Hirschman index (HHI) has increased from 1465.65 in 2013-14 to 2697.56 in 2018-19 [2]. Average Revenue Per Subscriber (APRU) declined steadily from Rs.1319 in 1999 to Rs.205 in 2009, and then to Rs.74.8 in 2019[3]. The decline in APRU has resulted in a significant increase in the number of mobile subscribers from 3.58 million in 2000 to 1.18 billion as of August 31, 2021.

The entry of private players and foreign multinationals necessitated the existence of an independent regulator in the sector; therefore, the Telecom Regulatory Authority of India (TRAI) was established in 1997 to regulate telecom services, to protect the interests of service providers, and consumers and for fixation of tariffs. The tariff regulation was initiated with the notification of the Telecommunication Tariff Order 1999 (TTO 1999) for the telecommunication services in India. TRAI reviewed cellular mobile tariff in the year 2002, and it observed that a stage had been reached when market forces could effectively regulate cellular tariff. So, TRAI decided to forbear the tariffs for cellular mobile services except for (i) Rural fixed line services; (ii) National roaming services ; and (iii) Leased circuits. TRAI followed the policy of "regulatory forbearance" as price regulation was not necessary since the markets were functioning in a competitive manner. Regulatory forbearance does not imply "deregulation" , it indicates enforcing regulation when it is needed (TRAI, 2012).

TRAI monitors the performance of telecom operators on the basis of certain key performance indicators (KPIs) such as network availability, connection establishment (accessibility), connection maintenance (retainability), connections with good voice quality, inter-connectivity, down-link and up-link packet drop rates, metering and billing credibility, response time to the customer for assistance and termination or closure of service. The benchmark is specified for each KPI, and the operators are penalized for non-compliance (TRAI, 2017).

A telecom network carries different types of traffic like voice, real-time data (video call), non real-time data (mail, text), streaming data (movie download) etc., throughout the day. It is likely that there is a variation of traffic within a day and also between days. The maximum traffic observed in an hour in a day is called busy hour traffic. If a network is capable of handing the busy hour traffic (carrying maximum traffic of the day) then it will be able to handle traffic throughout the day; otherwise some of the traffic is lost during the busy hour. The capability of the network to handle the busy hour traffic (voice) is reflected in terms of grade of service. Acceptable grade of service indicated as P.02 (P stands for probability of a call being lost for the capacity issue). It implies that only 2% of calls can be lost, assuming that blocked calls simply go away without waiting. This KPI (Key Performance Indicator) is closely monitored by the regulator TRAI. While designing the network capacity, telecom service operators consider factors like projected traffic, traffic type, available technology, regulatory guidelines, etc. The variation of traffic makes telecom network utilisation non-uniform, maximum utilization during the busy hours, and less utilization during non-peak hours. The information about the network utilization of an operator can be obtained from the data of its Operating Support System (OSS) [5]. OSS is a system where all traffic statistics, alarms and other parameters are recorded, and network performance is monitored. When analysed for an appropriate time period (commonly one business cycle) OSS data trend gives insight into network utilization (both for peak and non-peak hours) of a telecom service provider.

There is a possibility, the network capacity deployed to handle the busy hour traffic (peak traffic intensity) remains underutilized in non-busy hours. The nature of the network traffic is such that it is a perishable inventory, and can not be stored for future use. The objective of this paper is to analyse the difference between peak-hour and non-peak hours network traffic of a telecom service provider Aircel in the selected regions of India and also to examine the price sensitivity of the network traffic [6]. Pricing as a tool for improving network utilization has not been explored so far in India. The phenomenon of peak load is found in situations where

product and service are not storable or storage cost is very high. We come across such situations in power, telecom, aviation, and other sectors when there is the peak demand in a certain duration, and there is off-peak demand. A peak load problem is said to exist if the quantity demanded in two periods is different at that same price (Steiner, 1957). If the price charged at peak load period is different (always greater than non-peak period) than the other period, it is termed as peak load pricing strategy.

The study is divided into the following sections: Section 2 contains a brief review of existing studies on pricing in the telecom sector. Section 3 outlines the methodology adopted for the study. The main findings from the empirical analysis are presented in Section 4, and Section 5 concludes the paper.

2.Literature review

Vannucci et al (2003) analysed the effect of price on dial-up internet traffic based on data collected from residential subscribers in South Africa who were making use of cheaper off-peak rates for dial –up internet service outside business hours. It was found that the traffic intensity was highly dependent on the call tariff. It was observed that the system of two-step tariff changes, with the initial tariff decrease being larger than the second, had resulted in the lowest traffic intensity, translating into equipment savings due to the lower traffic and operational savings due to the lower aggregate bandwidth demand. Garbacz and Thompson (2007) observed that price elasticities are very large for mobile services in developing countries. After analysing the impact of price reduction on the usage of telecom network in the Korean mobile service sector, Cha et al. (2008) recommended a market-segment based price reduction strategy to minimize losses. Michalakelis et al (2010) showed with the help of "diffusion-price" model that pricing policy was able to make the diffusion of ADSL (Asymmetric Digital Subscriber Line) technology to diverge substantially.

Naldi and Pacifici (2010) discussed the pricing strategy based on a fee and a consumption-based rate (with a free traffic level included in the bundle). The service provider may adjust its offer after the customer's initial rejection by increasing the amount of free traffic. This analysis is then extended to the case of simultaneous updating of both the free traffic amount and the unit price. The study was carried out in the context of consumer customer churn in the telecommunication sector.

The OECD Report (2013) on Communications Outlook acknowledged the existence of segments of price-sensitive customers and the operators using third-degree price discrimination

during the period of monopoly days. The report also mentions that pricing can be a tool allowing users to self-govern usage, thereby ensuring efficient use of networks. Intensive users of over-the-top (OTT) services (i.e., from third-party providers over the internet) may place a heavy load on their networks, requiring increased levels of investment in the network. This report mentions the possibility of pricing as a tool used by an operator for efficient network usage.

Stork and Gillwald (2014) dealt with the link between mobile termination rate reductions and retail prices in South Africa, Namibia, and Kenya. Regulators reduced termination costs towards cost-efficient operators [7]. In all these countries, there was significant growth in the market. However, only in the case of South Africa there was no reduction by smaller operators in tariff in the first termination cost reduction (cost benefit not passed to the retail case) however, it was reduced in the second termination cost reduction. This study contrasted with the available literature that termination charges and mobile retail prices are interlinked [8].

We could not find any study on pricing as a policy tool for the telecom regulator to improve utilization of network capacity in the context of Indian telecom sector. This paper will fulfill this gap in the existing literature.

3.Methodology

In this paper, we have analysed the pattern of hourly traffic data for Mumbai and Punjab circles of the telecom service operator Aircel. We have measured network usage during busy hours (i.e., peak-hour) and off-peak hours (care has been taken so that there are no events and incidents so that there is no abnormal increase in the usage of data during the study period). We have conducted Tukey's test to examine whether the busy hour traffic is significantly different from non-busy hour traffic. The test statistic is given as :

$$q_s = \frac{y_A - y_B}{SE}$$

Where, Y_A is larger of the two means and Y_B is smaller of the two means and SE is the standard error of the sum of the means.

We have also examined whether the traffic is sensitive to price. For this, we have conducted an experiment in which free talk time (of value Rs.5) was added to the recharge voucher of the denomination Rs.70 with the condition that the additional talk time can be used in non-busy hours only[9]. We have analysed the changes in the talk-time due to this price incentive.

4. Results

Table 1 (in Appendix) shows the hourly traffic pattern (measured in erlangs) for the subscribers of Aircel in Mumbai [10] from May 23, 2017 to June 03, 2017. It can be observed from the Table that on average, the traffic was at its peak at 20:00 hour (more than 40,000 erlangs) every day, and the traffic was minimal at 5:00 hour. The maximum voice traffic was 44919.35 erlangs on May 28, 2017 (Sunday) at 20:00 hour, and the minimum was 1329.34 erlangs on May 23, 2017 (Tuesday) at 4:00 hour. The network had a designed capacity of 81000 erlangs. So, the capacity utilization on average varied from as low as 3.01 percent during the off-peak hour (i.e., at 5:00 hour) to 52.01 percent during the peak hour (i.e., at 20:00 hour). It can be observed from Figure 1 (in Appendix) that the mean traffic was the lowest at 5:00 hour, then it started rising till 13:00 hour then it continued to fall till 16:00 hour, and it again showed a rising trend reaching the maximum value at 20:00 hour followed by a declining trend. The pattern of the mean traffic resembles like M-curve. The results of Tukey's test show that there exists a significant difference at 1 percent level in average traffic between the peak hour (i.e., 20:00 hour) and off-peak hours during the study period (Table 2).

The voice traffic data collected from Aircel for Punjab [11] circle also showed similar patten (Table 3). In the case of Punjab, the average traffic was minimum at 4:00 hour and the maximum at 21:00 hour. The results of Tukey's test show that there was a significant difference at 1 percent level between average traffic of the peak hour (i.e., 21: 00 hour) and non-peak hours (Table 4). However, the difference in average traffic between 20:00 hour and 21:00 hour was not statistically significant. In this case also, the pattern of the hourly average traffic resembles like M- curve (Figure 2). In the case of Punjab, the voice traffic was minimum at 278.47 erlangs at 3:00 hour on 07 Jun, 2017 (Wednesday) and the maximum at 10539 erlangs on 11 Jun, 2017 (Sunday) at 21:00 hour. The designed capacity of the network was 46000 erlangs. So, the capacity utilization on average varied from as low as 0.76 percent at 4:00 hour to 21.80 percent at 21:00 hour during May 30 – June 11, 2017 (Table 3). So, a large part of the capacity remained unutilized for a considerable time period every day. So, there is a scope for implementing dual pricing – a lower price for off- peak period and a higher price for the peak period. If subscribers are price sensitive then it is possible to divert some portion of peak -hour traffic to off-peak hours. We have therefore, conducted an experiment to test the price sensitivity of telecom subscribers.

Telecom service companies in India provide both pre-paid and post-paid recharge services. Pre-paid recharge vouchers with different denominations and talk-time are sold in the market. If free talk – time is added to a specific denomination, and it is observed that subscribers are now purchasing pre-paid recharge vouchers with that specific denomination much more than before, then it can be concluded that subscribers are price-sensitive. In Table 5a, sales records of prepaid recharge vouchers of different denominations of Aircel company are provided across Pan India from 15th to 19th October, 2016 (i.e., 5 days). The first column of the Table shows different denominations in Maximum Retail Price (MRP) for prepaid recharge vouchers. MRP is inclusive of Service Tax (column 2) and the processing fee (column 3). Talk time available to each customer for a specific denomination is shown in column 4. Pre-paid recharge vouchers with denominations of Rs.150 and Rs.220 included additional talk time (column 5). Column 6 shows the sales of recharge vouchers during 5 days (i.e., during October 15-19, 2016), and the total talk time for each denomination of the recharge voucher is shown in column 7. It can be observed from Table 5a that the talk time available for each recharge voucher was almost equal to the MRP net of Service tax and processing fee (i.e., column 4 = Column1 – Column 2-Column 3) except in situations when MRPs were Rs.150 and Rs.220. If a customer purchased a recharge voucher for Rs.150, she got a talk time of 150 minutes instead of 130 minutes (since Rs. 20 was paid as the Service tax out of MRP of Rs.150). This might be interpreted as the customer was getting an extra talk time of 20 minutes. Similarly, if a customer purchased the recharge voucher by paying MRP of Rs.220, then she got an additional talk time of 29 minutes. Now, to analyse the price sensitiveness of the customers, it is shown in Table 5b that an additional talk time of 14 minutes was made available with respect to the recharge voucher with denomination Rs.70 from October 25 to 29, 2016 (i.e., 5 days). The additional talk time could be used during non-busy hours only. It can be observed from column 6 of Tables 5(a) and 5(b) that the sale of recharge vouchers with the denomination of Rs.70 increased from 13272 during 15-19 October, 2016 to 36975 during 25-29 October, 2016 i.e., by 178.59 percent. The total talk time also increased from 768051 minutes to 2773125 minutes (i.e., by 261.06 per cent) due to the additional talk time allotted to the recharge voucher of Rs.70 (column8, Table 5(b)). So, there was a considerable transfer of traffic from the peak period to off-peak period as the additional talk time could be used during non-busy hours only.

Tables 6(a) and 6(b) show hourly traffic during pre-incentive and post-intensive periods respectively. The additional talk time was provided for 5 days. So, if a customer purchased recharge voucher of denomination Rs.70 on October 29, 2016, she could use it till November 02, 2016. So, the traffic data are reported for nine days i.e., from October 25 to November 02,

2016 in Table 6(b). A comparison of traffic for 9 days between 15-23 October, 2016 (i.e., pre-incentive period) and October 25 – November 02, 2016 (i.e., post-incentive period) is shown in Figure 3. It is observed that the average traffic movement was more stable in the post-incentive period compared to pre-incentive period. Table 6(a) shows that in the pre-incentive period (i.e., from 15th to 23rd October, 2016), the average minimum traffic (i.e., 33.11 erlangs at 3:00 hour) was 18.68 percent of the maximum traffic (i.e.,177.20 erlangs at 20:00 hour). In the post – incentive period, the average minimum traffic (i.e., 64.24 erlangs at 3:00 hour) was 65.13 percent of the maximum traffic (i.e.,98.63 at 20:00 hour) (Table 6(b)). So, it was possible to transfer traffic from peak-period to non-peak period by providing price-incentive.

While there was a considerable increase in the total talk time for the recharge vouchers with the denomination of Rs.70, the sale of recharge vouchers declined for all other denominations except for Rs.60 and Rs.150. In the case of Rs.60, the increase in the sale of recharge vouchers was marginal (i.e., by less than 1 percent). Although recharge vouchers with denominations Rs.150 and Rs.220 offered additional talk time, the sale of recharge vouchers with the denomination of Rs.150 increased by 4.24 percent, whereas sales declined for Rs.220. The sale of recharge vouchers with a denomination of Rs.150 increased since, apart from offering extra talk time, such vouchers also included an additional feature of 7 days extended validity. As a result, some customers preferred to purchase recharge vouchers with the denomination of Rs.150 instead of Rs.220.

It is therefore observed that the traffic is sensitive to any change in the price. There is an increase in the usage of the network during the off-peak hours if there is a price discount. This caused a shift in traffic from the peak hour to the off-peak hours. On the basis of this experiment, we recommend that TRAI can make traffic distribution relatively uniform by adopting the policy of dual pricing. At present, TRAI does not have any KPI for monitoring network utilization. It believes that market competition will ensure optimum utilization of the network resources. However, the market structure is becoming oligopolistic in nature with three major players, namely R-Jio, Airtel and Vodaphone. In such a situation, TRAI should play a more proactive role by fixing a lower tariff during off-peak hours in order to smoothen out the traffic intensity imbalance.

5.Conclusion

Network capacity deployed to handle the busy hour traffic (peak traffic intensity) is underutilized in non-busy hours. It is perishable inventory, and once the capacity of network is lost, it cannot be recovered, nor can it be stored for the future. The Indian Telecom operators

never used price discrimination and revenue management with the objective of network utilization. TRAI has laid its own KPIs for network quality performance, efficiency, service offered, and complaint resolution. It has taken a stand of forbearance on the tariff front, assuming that market competition will drive the correct price. In India, operators/service providers deploy excess network resources (very high) to avoid the TRAI imposed penalty (i.e., the penalty for not complying KPIs). In this paper, it is found that it is possible to transfer some part of the peak – hour traffic to non-peak hours if the policy of differential pricing is implemented as customers in India are quite price sensitive. So, there is a possibility for diverting traffic from peak-hour to off-peak hours by fixing a lower tariff on the network traffic during off-peak hours. Transferring some traffic from peak-hour to the off-peak hour will reduce the amount of equipment required to service the incoming calls for the operators and, also improve the quality of service provided to the subscribers. The policy of dual pricing is likely to ensure more uniform usage of the network resources.

Notes

[1] Urban tele-density is 156.82 percent and rural tele-density is 56.71 percent. Annual Report 2019–2020, Department of Telecommunications (DOT), Ministry of Communication and Information Technology, Government of India, New Delhi.

[2] The Herfindahl-Hirschman Index (HHI) measures market concentration and is a metric used to determine market competitiveness. Annual Report, TRAI, 2018-19.

[3]Market Study on the Telecom Sector in India – Key Findings and Observations by Competition Commission of India, 2021.

[4] https://www.trai.gov.in/sites/default/files/PR_No.45of2021_0.pdf

[5]The Operating Support System (OSS) is part of the operating system where all important operational data are captured and stored for a certain period, and customized reports are generated.

[6] Aircel, an Indian mobile network operator, used to provide voice , 2G, and 3G data services. It was a market leader (more than 60 percent market share) in Tamil Nadu , and a major player in Odisha, Assam, and North-East telecom circles. Aircel started incurring losses after the entry of R-Jio in the market. At the end of December 2017, Aircel accumulated a debt of around ₹16,000 crore (US$2.3 billion). Aircel filed for bankruptcy in March,2018.

[7] Termination rate is charged by one operator whose network is utilized by the second operator for terminating its traffic on the first operator. It could be either because the called/terminating subscriber is on the second operator, or the first operator needs a transit path to reach the called/terminating subscriber on its network.

[8] Mobile retail price includes terminating charges plus operational charges plus a mark-up.

[9] Additional talk time was for outgoing calls since incoming calls are free in India.

[10] India has a federal structure with 28 states (i.e., provinces) and 8 union territories. Mumbai is the capital city in the Indian state of Maharashtra. Mumbai is the commercial capital of India, with a population of roughly 20 million.

[11] Punjab is one of the states in India. The estimated population of Punjab is 30.49 million.

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APPENDIX

Table 1: Day-wise Traffic (in Erlangs) - Aircel (Mumbai)

Time(Hrs)	May 23, 2017	May 24, 2017	May 25,2017	May 26, 2017	May 27,2017	May 28,2017	May 29,2017	May 30,2017	May 31,2017	June 01,2017	June 02,2017	June 03,2017	Average	Capacity Utilization (%)
0	12375.46	11965.58	12261.32	12183.3	12387.73	11922.79	11792.78	11950	12551.48	11728.93	12344.03	12296.32	12146.64	14.99585185
1	6678.39	6256.93	6443.95	6186.11	6657.2	6579.54	6364.41	6330.26	6857.8	6434.11	6822.48	7020.02	6550.93	8.087567901
2	3423.54	3365.78	3460.11	3377.94	3507.28	5108.31	4553.39	4509.91	4663.97	4391.08	4509.64	4756.23	4135.6	5.105679012
3	1922.1	1802.54	1844.16	1904.25	1983.81	5364.95	4208.99	4103.06	4134.93	3961.68	3963.79	4195.59	3282.48	4.052444444
4	1329.34	1356.52	1365.69	1334.81	1351.03	4564.91	3710.22	3470.02	3530.33	3481.68	3537.48	3563.94	2716.33	3.353493827
5	1701.11	1760.79	1748.84	1692.84	1668.56	2874.93	2880.41	2885.96	2964.68	2879.46	3004.2	3229.56	2440.94	3.013506173
6	4468.3	4511.08	4449.51	4287.83	4321.67	4432.47	4520.47	4645.28	4619.39	4621.81	4810.06	4720.3	4534.01	5.59754321
7	10397.98	10167.48	10133.91	9893.12	9845.05	8835.96	9454.43	9591.91	9411.2	9230.06	9625.5	8872.85	9621.62	11.87854321
8	17591.18	17472.4	17543.77	16994.05	16959.88	14753.03	15983.98	16337.33	16146.98	15717.52	16097.45	14716.52	16359.51	20.19692593
9	22878.91	23236.69	23319.67	22641.62	22633.86	19908.65	21571.99	22012.29	21175.11	20672.84	21323.66	19321.33	21724.72	26.82064198
10	26788.68	26499.13	26800.89	26448.86	26171.37	23455.77	25515.06	25796.96	25132.08	24996.19	25115.58	22671.94	25449.38	31.41898765
11	29035.64	28277.67	29038.51	28665.42	27948.08	26097.33	28267.58	28153.35	27915.35	27516.24	27130.78	25574.17	27801.68	34.32306173
12	29297.88	28767.72	29257.71	28097.97	27620.52	27270.39	28715.95	28934.61	28693.7	27642.67	27906.19	26887.36	28257.72	34.88607407
13	31334.41	31365.25	31700.16	27433.97	29477.24	27224.73	34142.94	30411.42	30515.76	26826.89	29988.27	27467.99	29824.08	36.81985185
14	29436.28	29475.25	29665.2	28117.51	27710.14	26239.22	31034.18	28691.23	28521.33	28172.03	28034.21	26614.05	28475.88	35.15540741
15	25408.72	25065.03	25483.97	25966.24	24553.27	24003.33	26785.79	25293.76	24789.62	26115.86	24683.91	23701.9	25154.28	31.05466667
16	24681.02	24597.93	24869.12	25343.17	23827.51	23424.42	25341.97	24465.01	24243.92	25787.32	24173.76	23214.3	24497.45	30.24376543
17	25716.11	25919.54	26214.9	26604.1	25341.87	24214.89	26079.32	25121.89	25646.99	26703.17	25159.9	23088.91	25484.3	31.46209877
18	28708.16	28680.78	29063.41	29467.92	28368.67	26092.38	27350.08	27028.83	27231.53	27748.56	26881.42	25666.92	27690.72	34.18607407
19	34233.46	34201.62	34271.44	34788.47	34942.26	30140.91	31410.41	30911.91	30712.64	30775.42	30508.86	27543.89	32036.77	39.5515679
20	40334.56	40232.02	40409.75	40738.04	41350.24	44919.35	43842.47	43158.57	42835.84	42964.65	42016.55	42732.71	42127.9	52.00975309
21	39581.94	39868.61	40159.93	39734.93	38727.84	40197.72	40046.35	39988.34	39618.37	39502.72	38343.25	41124.9	39741.24	49.06325926
22	32294.64	32678.22	32587.48	32139.7	32148.19	32781.8	32719.36	33189.49	32106.87	32792.94	31421.52	33706.34	32547.21	40.18174074
23	21475.55	21796.86	21657.6	21287.47	21943.05	21937.97	21561.34	22485.42	21176.98	22095.45	21611.86	22925.51	21829.59	26.95011111

Table 2 : Tukey's Test Results on Mean Difference of hourly traffic (Aircel-Mumbai)

(I) Treatment	(J)	Mean Difference (I-J)	Std. Error	Sig.
20.00hr.	0 hr.	29981.25250*	458.11165	.000
	1 hr.	35576.96250*	458.11165	.000
	2 hr.	37992.29750*	458.11165	.000
	3 hr.	38845.40833*	458.11165	.000
	4 hr.	39411.56500*	458.11165	.000
	5 hr.	39686.95083*	458.11165	.000
	6 hr.	37593.88167*	458.11165	.000
	7 hr.	32506.27500*	458.11165	.000
	8 hr.	25768.38833*	458.11165	.000
	9 hr.	20403.17750*	458.11165	.000
	10 hr.	16678.52000*	458.11165	.000
	11 hr.	14326.21917*	458.11165	.000
	12 hr.	13870.17333*	458.11165	.000
	13 hr.	12303.81000*	458.11165	.000
	14 hr.	13652.01000*	458.11165	.000
	15 hr.	16973.61250*	458.11165	.000
	16 hr.	17630.44167*	458.11165	.000
	17 hr.	16643.59667*	458.11165	.000
	18 hr.	14437.17417*	458.11165	.000
	19 hr.	10091.12167*	458.11165	.000
	21 hr.	2386.65417*	458.11165	.000
	22 hr.	9580.68333*	458.11165	.000
	23 hr.	20298.30750*	458.11165	.000

*indicates statistically significant at 1 percent level

Table 3: Day-wise Traffic (in Erlangs) - Aircel (Punjab)

Time(hrs)	May 30, 2017	May 31, 2017	June 01,2017	June 02, 2017	June 03,2017	June 04,2017	June 05, 2017	June 06, 2017	June 07,2017	June 08, 2017	June 09, 2017	June 10,2017	June 11, 2017	Average	Capacity Utilization (%)
0	1906.55	1796.31	1841.69	1973.58	1898.2	2067.19	1709.36	1604.1	1639.19	2005.21	1780.8	1948.71	1746.98	1839.84	3.998652174
1	1024.82	925.83	936.97	951.64	929.41	1006.72	866.62	831.49	683.34	978.07	833.67	950.23	814.56	902.57	1.962108696
2	532.36	450.53	509.02	502.99	520.64	633.62	429.87	479.92	375.62	512.72	457.25	557.96	455.64	493.7	1.07326087
3	395.75	350.75	395.14	411.64	398.25	436.97	337.7	353.52	278.47	354.29	326.83	367.5	372.79	367.66	0.79926087
4	382.84	294.82	366.99	360.96	407.11	429.06	332.47	324	296.15	332.64	317.13	360.78	373.72	352.2	0.765652174
5	819.68	759.19	794.3	815.3	885.27	1012.78	818.64	802.4	564.96	785.38	738.89	826.87	773.15	799.75	1.738586957
6	2329.82	2109.9	2306.35	2441.84	2440.88	2569.8	2293.9	2215.82	1544.86	2343.49	2196.53	2371.54	2154.69	2255.34	4.902913043
7	4566.19	3915.87	4525.13	4617.61	4549.8	4497.46	4266.48	4351.85	3483.2	4498.64	4220.21	4496.25	4105.06	4314.9	9.380217391
8	6053.64	5676.67	5946.39	5967.3	5948.45	5736.79	5755.21	5743.75	5018.84	5776.54	5634.61	5721.6	5530.46	5731.56	12.45991304
9	6905.75	6946.63	6687.18	6807.52	6704.55	6366.03	6453.12	6566.31	6297.32	6359.46	6140.56	6114.63	6272.59	6509.2	14.15043478
10	7614.58	7552.98	7493.47	7497.22	7377.3	7003.06	7315.7	7221.35	7064.02	7127.49	7135.69	6590.6	7168.13	7243.2	15.74608696
11	7878.93	7752.76	7831.92	7775.33	7548.54	7492.72	7755.91	7485.56	7365.25	7388.74	7316.64	7175.89	7400.72	7551.45	16.41619565
12	7288.09	7449.27	7560.73	7391.22	7355.28	7006.2	7431.34	7066.74	7193.63	7231.48	7153.68	7011.1	7121.52	7250.79	15.76258696
13	7934.24	8063.26	8301.59	8002.25	8219.21	6811.04	7989.53	7646.16	8053.71	8015.57	7829.91	7863.59	7152.64	7837.13	17.03723913
14	7097.14	7169.65	6995.68	7030.05	6760.66	6307.15	6837.64	6423.48	7106.7	7014.72	7000.15	6726.53	6482.74	6842.48	14.87495652
15	6528.33	6714.1	6482.09	6395.99	6134.73	5893.96	6301.84	5947.46	6497.73	6310.49	6411.07	5997.05	6151.1	6289.68	13.67321739
16	6778.68	6859.35	6754.08	6992.19	6743.68	6281.08	6598.97	6415.63	6604.07	6605.92	6675.82	6427.55	6694.36	6648.57	14.45341304
17	7352.63	7585.27	7515.21	7287.97	7130.64	6833.45	7145.56	7096.44	7098.38	6890.13	7094.59	6794.34	6744.38	7120.69	15.47976087
18	7889.42	7952.46	7867.71	7148.11	6989.77	7165.96	7757.08	7153.39	7474.15	7463.77	7705.86	7730.22	7385.59	7514.11	16.33502174
19	8499.52	8201.02	8087.79	8205.62	7905.14	7651.28	7943.46	7804.85	7813.94	7951.23	7941.22	8010.31	7983.76	7999.16	17.38947826
20	10278.75	10189.43	9930.39	9968.86	9705.5	10145.2	9628.87	9652.62	9629.88	9750.99	9896.91	9684	10233.11	9899.58	21.52082609
21	10309.84	10079.62	10350.01	10210.09	10130.14	10159.51	9510.06	9578.3	9823.5	9906.34	10239.09	9575.25	10539	10031.6	21.80782609
22	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	7263.75	15.79076087
23	3830.87	4072.8	4047.9	3985.08	3927.63	3750.55	3399.87	3371.19	4080.25	3887.72	4221.44	3650.58	4134.3	3873.86	8.421434783

Source : Aircel

Table 4: Tukey's Test Results on Mean Difference of hourly traffic (Aircel-Punjab)

(I) Hour	(J) Hour	Mean Difference (I-J)	Std. Error	Sig.
21.00	.00	8191.76000*	92.55807	.000
	1.00	9129.02923*	92.55807	.000
	2.00	9537.89308*	92.55807	.000
	3.00	9663.93462*	92.55807	.000
	4.00	9679.39077*	92.55807	.000
	5.00	9231.84154*	92.55807	.000
	6.00	7776.25615*	92.55807	.000
	7.00	5716.69231*	92.55807	.000
	8.00	4300.03846*	92.55807	.000
	9.00	3522.23846*	92.55807	.000
	10.00	2788.39692*	92.55807	.000
	11.00	2480.14154*	92.55807	.000
	12.00	2780.80538*	92.55807	.000
	13.00	2194.46538*	92.55807	.000
	14.00	3189.11231*	92.55807	.000
	15.00	3741.90846*	92.55807	.000
	16.00	3383.02846*	92.55807	.000
	17.00	2910.90462*	92.55807	.000
	18.00	2517.48154*	92.55807	.000
	19.00	2032.43154*	92.55807	.000
	20.00	132.01846	92.55807	.999
	22.00	2767.84615*	92.55807	.000
	23.00	6157.73615*	92.55807	.000

*indicates statistically significant at 1 percent level

Table 5(a): Sale of Recharge Vouchers from October 15 to October 19, 2016

MRP	Service Tax	Processing Fee	Talk Time	Additional Talk Time	Sale of Recharge Vouchers (5 days)	Total Talk Time
Rupees	Rupees	Rupees	Minutes	Minutes	Number	Minutes
1	2	3	4	5	6	7
10.08	1	1.01	7.76	0	292220	2267627
20	3	2	15.39	0	154492	2377632
30	4	3	23.09	0	133737	3087987
40	5	3	31.78	0	18538	589138
50	7	3	40.48	0	173473	7022187
60	8	3	49.17	0	20594	1012607
70	9	3	57.87	0	13272	768051
100	13	3	83.96	0	28218	2369183
150	20	0	150	20	48011	7201650
200	26	3	170.91	0	635	108528
220	29	0	220	29	2208	485760

Notes :
i) Column 4 = Column 1 - Column 2 - Column 4 except when MRPs are Rs.150 and Rs.220. Customers were given additional talk time of 20 minutes and
ii) Column 5 shows that customers were given additional talk time of 20 minutes and 29 minutes if they purchased recharge vouchers with MRPs of Rs.150 and Rs.220 respectively.
iii) Column 7 = Column 4 x Column 6

Source : Aircel

Table 5(b): Price Sensitivity of Traffic during 25 - 29 October, 2016

MRP	Service Tax	Processing Fee	Talk Time	Additional Talk Time	Sale of Recharge Vouchers (5 days)	Total Talk Time	Change in the Talk Time
Rupees	Rupees	Rupees	Minutes	Minutes	Number	Minutes	(Percent)
1	2	3	4	5	6	7	8
10.08	1	1.01	7.76	0	273513	2122461	-6.4
20	3	2	15.39	0	143134	2202832	-7.35
30	4	3	23.09	0	125361	2894585	-6.26
40	5	3	31.78	0	16611	527898	-10.39
50	7	3	40.48	0	168417	6817520	-2.91
60	8	3	49.17	0	20714	1018507	0.58
70	9	3	75	14	36975	2773125	261.06
100	13	3	83.96	0	27770	2331569	-1.59
150	20	0	150	20	50046	7506900	4.24
200	26	3	170.91	0	621	106135	-2.2
220	29	0	220	29	1981	435820	-10.28

Notes:

i) Column 4 = Column 1 - Column 2 - Column 4 except when MRPs are Rs.150, Rs.220 and Rs.70. Additional talk time of 14 minutes was made available with respect to the recharge voucher with denomination of Rs.70.
ii) Column 7 = Column 4 x Column 6
iii)Column 8 = Percentage change between Column7 and Column 7 of Figure 5(a)

Source : Aircel

Table 6(a): Day-wise Traffic (in Erlangs) - Aircel during 15-23 October, 2016

Time (hrs)	Oct 15, 2016	Oct 16, 2016	Oct 17, 2016	Oct 18, 2016	Oct 19, 2016	Oct 20, 2016	Oct 21, 2016	Oct 22, 2016	Oct 23, 2016	Average
0	66.74	65	65.39	66.45	66.74	67.15	66.61	66.58	65.24	66.21
1	56.73	55.25	55.58	56.49	56.73	57.08	56.62	56.59	55.46	56.28
2	48.22	46.96	47.24	48.01	48.22	48.52	48.13	48.10	47.14	47.84
3	33.37	32.5	32.69	33.23	33.37	33.58	33.31	33.29	32.62	33.11
4	80.34	73.01	68.49	71.48	85.59	83.18	80.66	81.50	80.33	78.28
5	99.09	90.04	84.47	88.15	105.56	102.58	99.47	100.51	99.07	96.55
6	109.8	99.77	93.603	97.68	116.973	113.67	110.23	111.38	109.78	106.99
7	109.48	100.43	94.59	98.76	117.25	114.03	111.90	112.24	110.03	107.63
8	108.96	101.66	94.55	98.97	117.89	113.87	111.52	113.67	110.87	108.00
9	109.8	100.77	96.41	99.64	120.48	115.95	113.54	114.72	111.97	109.25
10	153.65	146.52	147.39	153	153.00	153.00	153.00	153.00	153.00	151.73
11	161.74	155.87	156.8	161.05	158.34	161.03	161.44	157.95	153.12	158.59
12	163.35	158.99	159.94	165.88	164.67	165.87	169.51	162.69	154.66	162.84
13	164.99	162.17	163.14	170.86	171.26	170.84	177.99	167.57	156.20	167.22
14	163.35	160.58	164.74	169.20	169.61	169.18	174.60	167.57	157.75	166.29
15	155.19	150.94	154.85	160.74	157.74	159.03	165.87	155.84	145.13	156.15
16	156.72	147.98	151.82	159.12	148.73	151.37	156.43	149.83	142.28	151.59
17	161.74	155.87	156.8	161.05	158.34	161.03	161.44	157.95	153.12	158.59
18	164.97	157.43	161.51	167.49	159.92	161.03	164.67	161.11	154.66	161.42
19	166.62	160.58	164.74	172.52	166.32	165.87	172.90	165.94	162.35	166.43
20	173.85	174.55	175.59	178.45	179.22	180.33	178.88	178.78	175.2	177.20
21	170.25	165.82	166.81	169.53	170.26	171.31	169.94	169.84	166.44	168.91
22	136.2	132.66	133.45	135.62	136.21	137.05	135.95	135.87	133.15	135.13
23	95.34	92.86	93.41	94.94	95.35	95.94	95.16	95.11	93.21	94.59

Table 6(b): Day-wise Traffic (in Erlangs) - Aircel during October 25- November02, 2016

Time (hrs)	Oct 25, 2016	Oct 26, 2016	Oct 27, 2016	Oct 28, 2016	Oct 29, 2016	Oct 30, 2016	Oct 31, 2016	Nov 01, 2016	Nov 02, 2016	Average
0	71.91	69.77	72.36	71.18	70.75	73.66	73.99	73.38	71.88	72.10
1	71.19	69.07	71.64	70.47	70.04	72.92	73.25	72.65	71.16	71.38
2	70.48	68.38	70.92	69.76	69.34	72.19	72.52	71.92	70.45	70.66
3	64.07	62.16	64.48	63.42	63.04	65.63	65.93	65.38	64.05	64.24
4	83.29	80.81	83.82	82.45	81.95	85.32	85.71	85.00	83.26	83.51
5	89.70	87.03	90.27	88.79	88.25	91.88	92.30	91.53	89.67	89.94
6	88.42	88.23	91.34	87.52	90.37	92.77	90.98	92.23	88.38	90.03
7	89.22	88.87	91.67	88.32	90.59	92.98	91.73	93.34	88.28	90.56
8	89.30	89.11	92.25	88.40	91.27	93.70	91.89	93.15	89.27	90.93
9	89.30	90.46	93.12	89.28	86.71	95.57	94.65	95.02	80.34	90.49
10	90.67	89.47	90.89	89.98	88.54	92.97	92.49	93.89	85.98	90.54
11	90.25	88.22	90.33	90.17	89.78	90.79	93.70	89.56	81.95	89.42
12	90.36	82.05	89.22	89.27	90.44	89.9	92.77	88.87	81.13	88.22
13	91.55	81.22	90.43	91.23	90.87	90.56	92.67	90.87	84.56	89.33
14	92.21	80.98	91.22	91.87	91.22	88.77	92.89	91.22	88.89	89.92
15	92.33	86.44	92.21	92.55	90.05	89.35	94.76	89.87	90.04	90.84
16	92.87	85.66	94.98	92.96	90.87	89.97	96.98	90.22	93.62	92.01
17	92.65	89.78	96.05	94.48	92.34	90.33	98.67	92.87	95.41	93.62
18	95.51	91.22	97.02	95.43	87.34	90.94	99.21	93.33	96.37	94.04
19	98.05	93.55	98.00	96.40	91.94	95.72	100.21	95.33	97.35	96.28
20	98.37	95.44	98.99	97.37	96.78	100.76	101.22	100.38	98.33	98.63
21	93.45	90.67	94.04	92.50	91.94	95.72	96.16	95.36	93.41	93.70
22	88.78	86.13	89.34	87.88	87.34	90.94	91.35	90.59	88.74	89.01
23	79.90	77.52	80.40	79.09	78.61	81.84	82.22	81.53	79.87	80.11

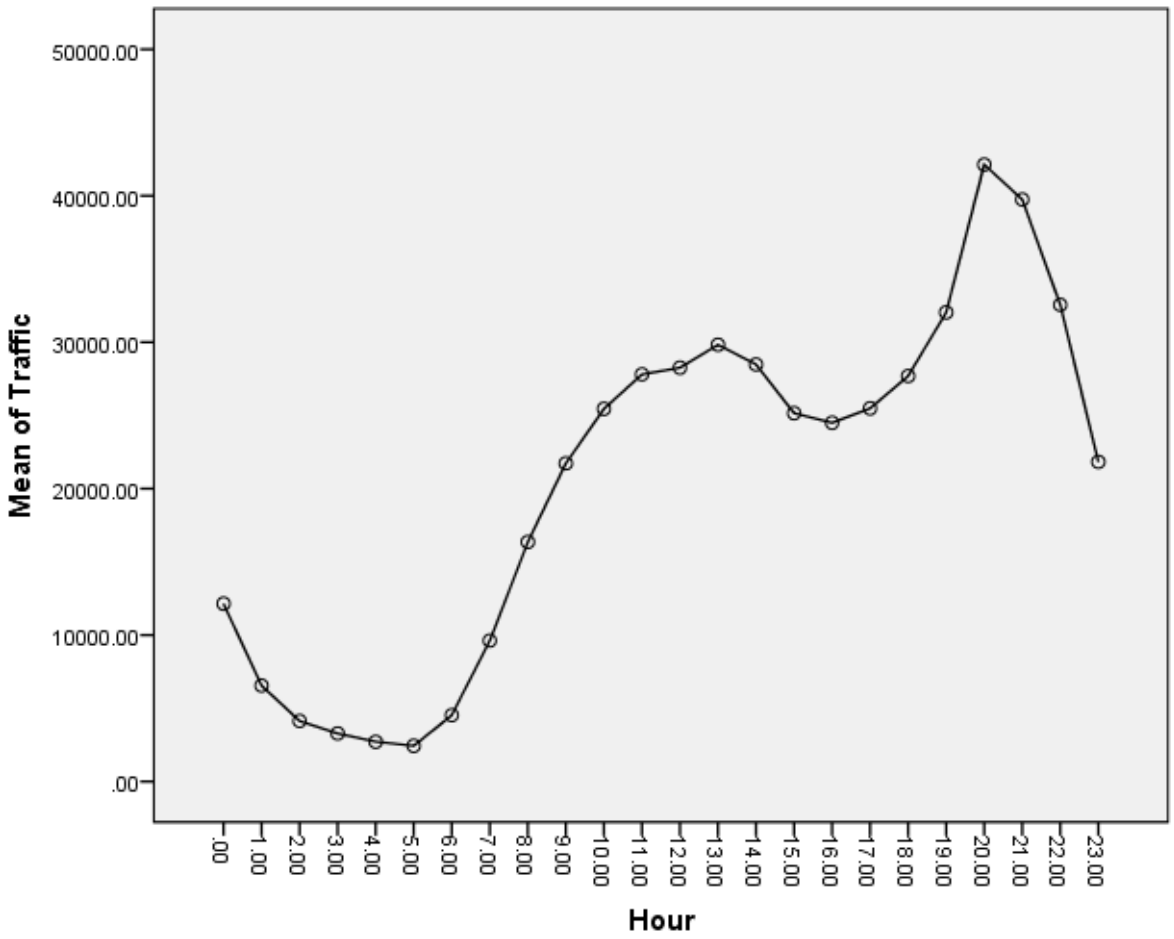

Figure 1: Hourly Mean Traffic (in Erlangs) – Aircel (Mumbai)

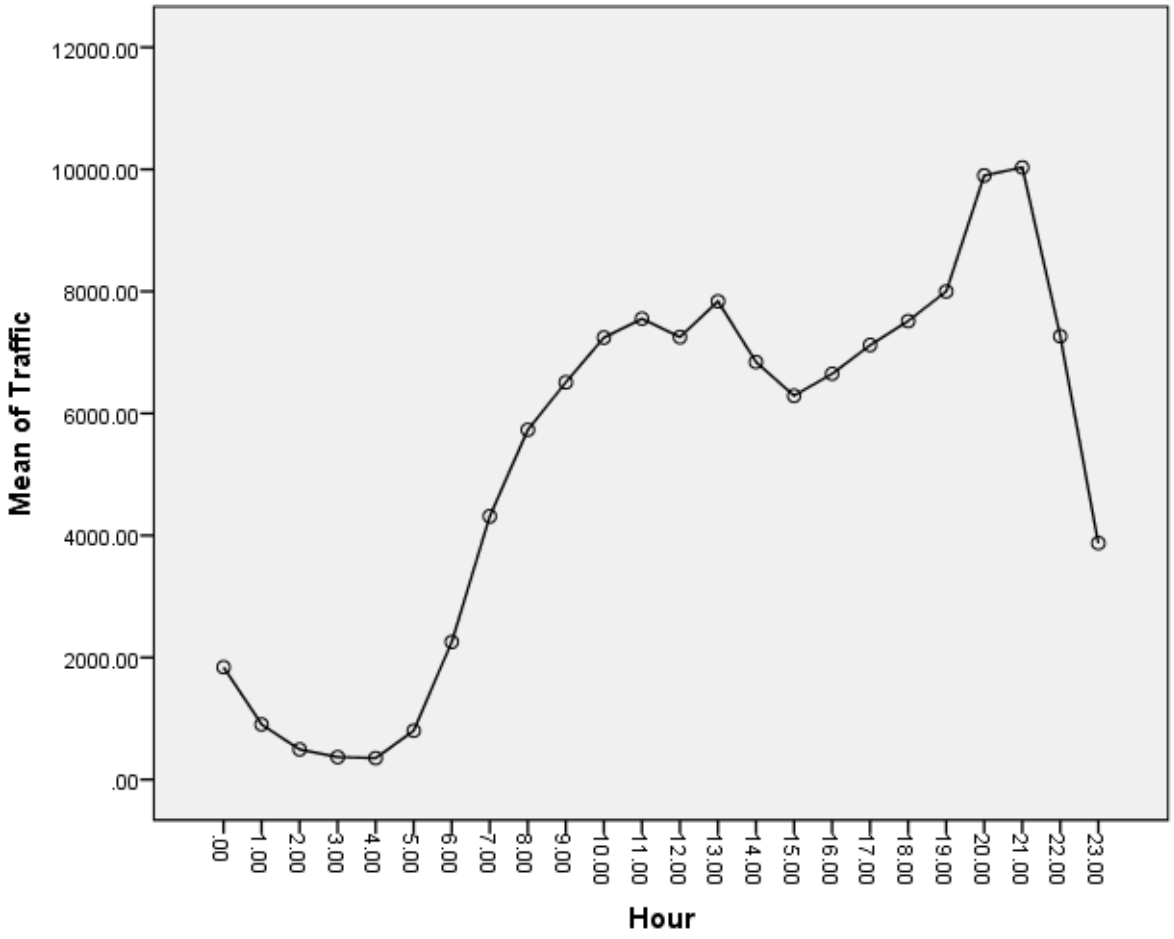

Figure 2: Hourly Mean Traffic (in Erlangs) – Aircel (Punjab)