

Increment of Mobile Subscriber in India : Gompertz Curve

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Abstract -In India mobile phone was introduced around 1995-1996. In the starting years, it was not so common among people. But as time moves it becomes a necessary component of people's lives. Now everyone can do their work within a few minutes by using mobile phones. This is the reason of mobile phone growth. In this research work we will ascertain the pattern of mobile subscriber with respect to population, as population increases the subscriber is also increased. To determine the growth of the user it uses Gompertz curve that indicates the shape and growth of mobile subscriber with respect to time here we encounter the upper limit of the curve that is used to fit the data to the model and the model suggests the development of mobile subscriber in near future This work will extrapolate the mobile phone subscriber in the future as well as find out the trend of future subscribers.

Keywords-Mobile phone, Gompertz curve, Population density of mobile subscriber, Population of India, Diffusion of Mobile Phone.

I. INTRODUCTION

In 21st century mobile phone becomes a necessary component of people's lives. Its approach isn't limited only for communication, but it replaced desktop to pocket PC. Now it is like global address. Where the people living in the different state county city and even in the same city can connect communicates and share data easily and as considerably they can finish their internet related work like banking, electronic mails, booking and shopping etc. A decade back when mobile phones were not so common. The device was very expensive and communication cost was also high for the user, but from the last few year use of mobile phone increased and their cost becomes decrease considerably and this factor helped a lot to make them available for a common man. Mobile phones are now inexpensive, easy to apply, and comfortable and equipped with almost every latest feature we want which will update the user with daily life. As well as the growth of functionality and flexibility in cost is increased the Growth of mobile phone subscribers is also increased and its usage is Expanding rapidly throughout the India. The design of mobile phone is becoming easier. The shape and size of mobile phone is reducing. Now a days people also use smart watches which give them similar functionality like a mobile phone. in today's world the approach of mobile not limited upto making phone calls only technologically advanced smart phone sets are capable storing data, holding images, e-

commerce, video calling and can even provide access to email and internet, to mention just a few of the available choices. The latest developments in mobile communication include, smart watches, notebook, tablet PCs. Mobile phones also storage of data on cloud. The mobile phone also offers immediate help in Emergencies big and little. [1]

II. LITERATURE REVIEW

Christian M. Dippon 2012, define necessity and penetration rate of 3G service in India, Mexico and Thailand by using the Gompertz curve model. [4]

Different research shows that the mobile phone is not used only for oral communication, but it reaches the different application upper limit as per the report of IBA-FICCI-BCG, Mobile Banking is the second largest growing service in acquiring new customers. [2]

Anabela Botelho, Ligia Costa Pinto (2004). The research shows that the pattern of diffusion of mobile phone in Portugal is S shaped and with a logistic function. It is found European union have mobile phone penetration rate 50 per 100 subscribers, 38 in Belgium and 60 in on Finland .They use the Gompertz curve model. [3].

Ahmad, M. I., Alsaadi, M. K, Almamri 2014, applied four models (logistic model, Gompertz model, Growth curve model and autoregressive AR (1) model) for studying and comparing diffusion of mobile telephony in mobile. At the end of their analysis they found that the Gompertz model adequately describes the path of mobile telephony diffusion Oman. [5]

Christos Michalakelis, Dimitris Varoutas, Thomas Sphicopoulos 2008, examines and presents the diffusion rate of mobile telephony subscriptions in Greece by using Bass model, Gompertz model, Fisher-Pry model and Logistic models. they found that Gompertz model fit adequately in data which will help in forecasting the values. [6]

Sanjay Kumar Singh (2008), estimate future trend and analyze the pattern and rate of adoption of mobile phone in India. Research uses S-shaped curve model and Gompertz curve model. Paper compares the diffusion rate of mobile phone in India with different saturation level. It concluded that Gompertz curve fits more adequately in the previous data set. [7]

Ruchita Gupta, Karuna Jain (2012) state and investigates the social, technological, economic and political factors that have influenced the diffusion process of mobile phone, especially the diffusion speed and concluded that Gompertz curve fits best in curves. [8]

III. DATA

The first cellular technology adopted in India in 1995. In 1995, the first mobile telephone service began operating in metro cities of India, after the telecom sector was opened up by the Government for private investment, as a part of Privatization and Globalization policy. A year later, the services spread towards the rest of the geographical areas of India. During the initial five to six years, the average growth of mobile phone subscribers was very late; primarily the cost of mobile phone was very high and airtime charges of the service providers were also high. The New Telecom Policy in 1999, In India, the mobile phone service operators use the GSM (global system for mobile communications) and CDMA (code-division multiple access) technologies. Approximately 75 percent of the mobile phone users under GSM technology with the 900 MHz band, but, recently, the providers operate in the 1800 MHz band, as well (TRAI Annual Report, 2006-07). Till March 31, 2014, India had 904.52 million mobile telephone subscribers (TRAI annual report). [1] [11] [12]

For empirical analysis, we divided the data into two periods - estimated period 1995 to 2014 and forecasting period. The data were collected from website the World Bank. The annual data on mobile subscribers per 100 people (mobile density). India is a developing country and adopted mobile telephony in 1995, and hence the study period is limited. The availability of 20 observations is considered to fit the curve for estimation of diffusion models perform well. In the first step, nonlinear diffusion models are transformed into their linear form for estimating initial parameter. Estimation of initial parameter is based on transformation formula. The estimated parameters are substituted into the Gompertz curve model. In second step substitute the value of t in model for forecasting the values.

Table I: Number of mobile subscribers in India.

Year	Mobile cellular subscription per year
1995	76680
1996	327967
1997	881839
1998	1195400
1999	1884311
2000	3577095
2001	6540000
2002	13000000
2003	33690000
2004	52220000

2005	90140000
2006	166050000
2007	233620000
2008	346890000
2009	525090000
2010	752190000
2011	893862478
2012	864720917
2013	886304245
2014	960579472

*Source website of the World Bank [9]

IV. MODEL FOR GROWTH OF SUBSCRIBER

This paper defines the growth of mobile phone subscribers in India using Gompertz curve. The model followed curve when the density of mobile subscriber reaches 100% in India. The model is based on Gompertz curve distribution to extrapolate and forecast the mobile phone subscriber. According to Gompertz curve y be the mobile phone subscription density over population of India. L is the upper limit of mobile phone subscribers, e the base of natural logarithms, b and k are coefficient for fitting the curve to a set of data , historical data is used to fit the model

$$y = Le^{-be^{-kt}}$$

Where upper limit of the growth curve is reflected by L, the Gompertz curve transformation formula

$$Y = \ln \left[\ln \frac{L}{y} \right] = \ln b - kt$$

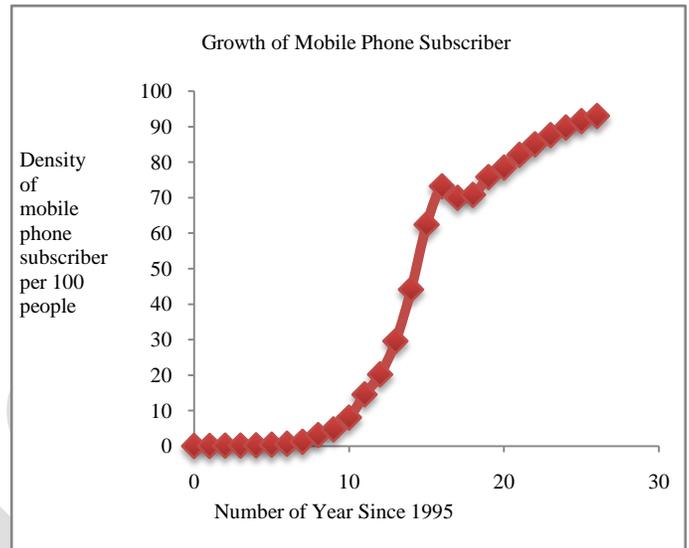
Table II- Mobile Phone Subscribers and Population in India

Year	Mobilecellular subscription per year	Population total	Density of totalmobilesubscriberper 100people (y)
1995	76680	955804355	0.008022562
1996	327967	973147577	0.033701672
1997	881839	990460131	0.089033266
1998	1195400	1007746556	0.118621095
1999	1884311	1025014711	0.183832581
2000	3577095	1042261758	0.343205051
2001	6540000	1059500888	0.617271781
2002	13000000	1076705723	1.207386542
2003	33690000	1093786762	3.080125045
2004	52220000	1110626108	4.701852372
2005	90140000	1127143548	7.997206759

2006	166050000	1143289350	14.52388234
2007	233620000	1159095250	20.15537550
2008	346890000	1174662334	29.53103968
2009	525090000	1190138069	44.12009108
2010	752190000	1205624648	62.39006487
2011	893862478	1221156319	73.19803895
2012	864720917	1236686732	69.92238977
2013	886304245	1252139596	70.78318167
2014	960579472	1267401849	75.79123170

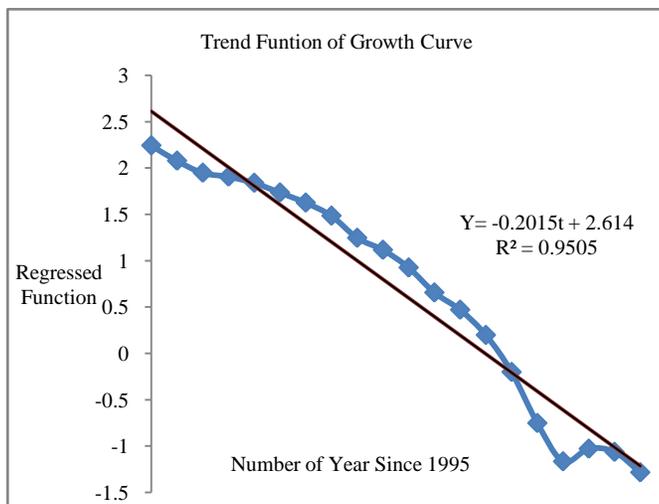
2017	22	85.02814576
2018	23	87.58248474
2019	24	89.72756988
2020	25	91.52015765

Fig. 2 Forecasting of Mobile Phone Subscribers in India



*Source website of the World bank [9][10]

Fig. 1 Fitting of Regressed Function



L	100
Ln(b)	2.614
b	13.6536
k	0.2015

The data is regressed to find out the trend equation and the other values shown in table. When the curve reaches its upper limit and data is fitted to the model it gives the value of coefficient b and k. The transformation variables are a linear function of time t. They can be substituted back into the Gompertz curve formula. The formula can be extrapolating the future value of time by substituting appropriate values of t.

$$y = 100e^{-13.6536e^{-0.2015t}}$$

Year	Number of year since 1995 (t)	Density of total mobile subscriber per 100 people (Y)
2015	20	78.45203169
2016	21	82.00466380

V. CONCLUSION

In this paper, the growth of the mobile phone in India has been analysed using Gompertz curve models. The result shows that the Gompertz curve adequately describes the path of mobile phone subscription in India. It is found that there are 71 mobile phone users per 100 persons in India at the end of year 2013–2014 from the historical data. The number of mobile phones will surpass the number of people in the country by 2024–2025. As shown earlier Gompertz curve considers 100 as its upper limit of the subscription.

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