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Effect of the Human Development Index on Mobile Telephony Diffusion: Evidence from SAARC Member Countries*

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Abstract

Purpose - The propose of this study is to examine the effect of human development index on mobile telephony diffusion.
Design/methodology/approach - This study fits the modidensity of South Asian Association for Regional Cooperation (SAARC) member countries with an econometric Gompertz growth model. The diffusion factors, including the human development index (HDI), gross domestic product (nominal) per capita, fixed-line telephony subscription, and population data of each member country from 2005 to 2018 are considered for the empirical experiment. Furthermore, the mobidensity of randomly sampled countries with very high human development scores (the Republic of Korea, Switzerland and Norway) and high development scores (Brazil and Costa Rica) have been examined with the same process as SAARC members.
Findings - We have found a positive but insignificant relationship between the HDI value and mobile telephony diffusion in Afghanistan, Bangladesh, Bhutan, India, and Pakistan; a positive and statistically significant relationship at a 99% confidence level in SriLanka; and a negative and insignificant relationship in the Maldives and Nepal. HDI has both positive and negative effects on mobile telephony diffusion, with the nature of effect depending on the profiles of each country. HDI is a diffusion determinant of mobile telephony only for the high human development country groups.
Research implications or Originality - This study provides a reference for policymakers, telecommunication stakeholders, and future researchers to design the telecommunication policies and strategies.

Keywords: Keywords: Mobile Telephony, Human Development Index, Diffusion Determinants, SAARC
JEL Classifications: C5, D8, L8, M3, O4

Ⅰ. Introduction

The human development index (HDI) measures key dimensions of human development and provides a good understanding of the socio-economic level of a country. Compiled by the United Nations (UN), the HDI covers 189 countries, and tracks four principal areas of interest: expected years of schooling, mean years of schooling, life expectancy at birth, and national per capita income. The HDI classification and its corresponding cutoff points are as follows: less than 0.550 for low, 0.55—0.699 for medium, 0.700—0.799 for high, and greater than 0.800 for

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very high countries(UNDP, 2018).

Information and communication technologies (ICTs) influence the human development index (Pedro, 2019), and mobile telephony, being a critical element of the ICT indicators (ITU, 2017), plays a crucial role in the measurement of HDI (Zhang and Danish, 2019). The social entrepreneur and Nobel Prize winner Muhammad Yunus said, "The quickest way to get out of poverty right now is to have one mobile telephone." (Yunus and Narula, 2011). The number of mobile phone users has been rapidly growing of late. By 2025, the number of unique mobile subscribers is expected to reach 5.9 billion, which is equivalent to 71% of the world's population (GSMA, 2018). The adoption of mobile technology has played a significant role in boosting the economic growth and total factor productivity (TFP) of countries (Deloitte et al., 2012). However, our literature review revealed that previous studies have not considered the effect of HDI on mobile telephony diffusion.

Thus, this study tries to empirically analyze the effect of HDI in addition to nominal gross domestic product (GDP) per capita, population, and number of fixed telephone subscribers, on mobile telephone diffusion in the South Asian Association for Regional Cooperation (SAARC) member countries. SAARC is an organization of eight South Asian countries—Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka—established on December 8, 1985 with multiple objectives, such as to promote people's welfare and improve their quality of life, accelerate economic growth, promote and strengthen collective self-reliance, and strengthen cooperation with other developing countries (Arjun, 2016). SAARC member countries have diverse identities in terms of HDI, area, population, GDP, and geographic location. The HDI ranges from low to high with Afghanistan at the lower end, and Sri Lanka and the Maldives at the higher end (UNDP, 2018). Considering the area, India is the seventh-largest country in the world, while the Maldives the smallest country in Asia (CIA, 2018). As regards the geographic location, Nepal, Bhutan, and Afghanistan are landlocked; the Maldives and Sri Lanka are islands; and India, Pakistan, and Bangladesh are connected by both ocean and land. An initial examination of the sample of SAARC member countries was conducted, as we assume that this regional study can be representative of the global level for understanding the effect of HDI on mobidensity.

The rest of the study is structured as follows. In Section II, the literature on mobile telephony diffusion and its determinants has been summarized. Section III illustrates the methodology and data used in current study. The empirical model to analyze mobile telephony and diffusion determinants is described in Section IV. Section V explains the empirical analysis and findings of the study. It starts with estimating the Gompertz growth parameters and analyzes the diffusion determinants in SAARC. Furthermore, we compare two high HDI and three very high HDI group countries. We finally examine the demand forecast of mobidensity in SAARC members using the Gompertz parameters for the period 2019 to 2025. Section VI concludes the study, presenting the research limitations, policy implications, and prospective work.

II. Literature Survey

Previous studies have established that socioeconomic inequality within and between developing and developed nations plays a pivotal role in the affordability of ICTs (Choudrie and Dwivedi, 2006; Grosso, 2006). Most studies have suggested that ICT accessibility is significantly

Table 1. Some Recent Studies on Mobile Telephony Diffusion and Their Features

Study	Location	Period	Study model(s)	Driving factors examined	Factor significance
Hwang et al. (2009)	Vietnam	1995-2006	Bass, Gompertz, and Logistic*	Fixed-line telephones	Significant
				Herfindahl index	Significant
				Price control	Insignificant
				Data used	Significant
Baláž and Williams (2012)	The Czech and Slovak Republics	1948-2009	Lotka-Volterra (LV)	Fixed-line telephones	Significant
				GDP per capita	Significant
Avila et al. (2018)	Guatemala	1990-2013	Logistic*, Gompertz, and Bass. LV for the competition effect	Fixed-line telephones	Significant
				Investment in telecommunications	Significant
				Number of operators	Significant
				GDP per capita	Insignificant
Sultanov et al. (2016)	Kazakhstan	1994-2013	Bass, Gompertz*, and Logistic	Fixed-line telephones	Significant
				Population	significant
				GDP per capita	Insignificant
				Interconnection tariff	Insignificant
				Liberalization of the telephone market	Insignificant
Honoré (2019)	Cameroon	2000-2016	Gompertz and Logistic*	Fixed-line telephones	Significant
				Number of operators	Significant
				GDP per capita	Significant
				SMS application	Significant
				Mobile banking application	Insignificant
Gupta and Jain (2012)	India	1998-2008	Gompertz*, Logistic, and Bass	Fixed-line telephones	Significant
				Calling party pays	Significant
				Tariff	Significant

*The best-fitting diffusion model

related to the distribution of income (Ali et al., 2019; Hilbert, 2010; Prieger, 2015). Affordability predicts the level of mobile telephony penetration(Barrantes and Galperin,2008), which is often used as a key indicator of ICT development.

Digital mobile telephony networks were introduced around the world in the early 1990s (Gruber, 2001; Asif, 2018), and there exists significant research explaining mobile telephony and the determinants of its diffusion. Recently, the application of diffusion models to country-level mobile telephony as well as diffusion determinants have been extensively studied (Avila et al., 2018; Botelho and Pinto, 2004; Chu et al., 2009; Frank, 2004; Gamboa and Otero, 2009; Gupta and Jain, 2012; Honoré, 2019; Hwang et al., 2009; Lee and Cho, 2007; Liu et al., 2012; Michalakelis et al., 2008; Singh, 2008; Sultanov et al., 2016). Some studies have attempted to analyze the growth of mobile telephony in groups of organizations and countries with an international scope (Aker and Mbiti, 2010; Balá and Williams, 2012; Castells et al., 2007; Dekimpe et al., 1998; Gruber, 2001; Gruber and Verboven, 2001; Kim, 2012; Massini, 2004; Sundqvist et al., 2005). These studies address the status of technological levels and the economic development of various nations.

The models employed, the factors influencing diffusion, and their significance, as reported in some representative studies on mobile telephony penetration, have been presented in Table 1. The conventional models used to analyze mobile telephony diffusion are as follows: Bass, Gompertz, logistic, and Lotka-Volterra. Previous studies that examined fixed-line telephones, the Herfindahl index, price control mechanisms, investments in telecommunications, number of operators, population, interconnection tariffs, and linearization of telephony markets were considered to identify the determinants of telephony diffusion. The HDI provides an explicit, qualified evaluation of health, safety, and education policy, and it facilitates the comparison of progress of nations over time (Lind, 2019). We found a gap that this important measure has not been studied for analyzing the determinants of telephony diffusion. Consistent with previous studies, the current research aims to evaluate the effect of HDI on the penetration of mobile telephony using evidence from SAARC member countries.

III. Methodology and Data Description

India is a SAARC member and was a better fit with the Gompertz growth model than Bass and logistic model on mobile penetration (Gupta and Jain, 2012; Singh, 2008). There are significant studies on wireless mobile telephony diffusion that observed a better fit with the Gompertz model (as Gupta and Jain, 2012; Michalakelis et al., 2008; Singh, 2008; Sultanov et al., 2016; Wu and Chu, 2010; Yamakawa et al., 2013). Building on these studies, we use the Gompertz model to analyze the diffusion of mobile telephony in all the SAARC member countries. Because of its significance for mobidensity in all SAARC member countries, the Gompertz diffusion driving speed (b) is considered for examining the diffusion determinants.

There is a wide range of tools and methods used to analyze innovation adoption determinants, such as exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and the correlation coefficient test (Gautam and Shrestha, 2018; Kim and Kim, 2012; Singh et al., 2014). In this study, we adopt Gompertz model parameters that are estimated from the nonlinear least square (NLS) tool in R, while the determinants are examined with the generalized linear regression model (GLM) using Gompertz time-varying diffusion speed (b) as in equation (5).

Based on the previous studies, we examined the GDP, fixed-line telephony penetration, population, and HDI (the overall country status determinant) to analyze the diffusion determinants of mobidensity among the eight members of the SAARC. Owing to issues regarding the availability of data on all factors before 2005, the current research utilized mobidensity and other empirical data from 2005 to 2018. The GDP and population statistics were obtained from the World Bank (World Bank, 2019), mobidensity and fixed-line telephone subscribers per 100 inhabitants from ITU ICT statistics (ITU, 2019a), and HDI data from the UNDP Human Development Report (UNDP, 2019). The mobidensity of all member countries are based on sales of subscriber identification module (SIM) cards. The mobile telephony penetration in SAARC member countries is presented in Figure 1. This shows that mobile telephony penetration is lowest in Afghanistan and highest in the Maldives. Nepal has a unique mobidensity growth pattern, which is increasing continuously and following Sri Lanka.

In the present scenario, the mobidensity of the Maldives, Sri Lanka and Nepal are above, and the rest of the countries are below, the benchmark value of 120 subscribers per 100 inhabitants established by the ITU (ITU, 2019b). Figure 2 presents the HDI values of SAARC member countries, a numerically small digit that determines the national status. It is observed that Sri Lanka is in the high human development group throughout our study period, and Maldives, since 2014; Afghanistan is in the low human development group, with other member countries being in the medium human development group from 2005 to 2018.

Figure 1. Mobidensity of SAARC Member Countries from 2005 to 2018

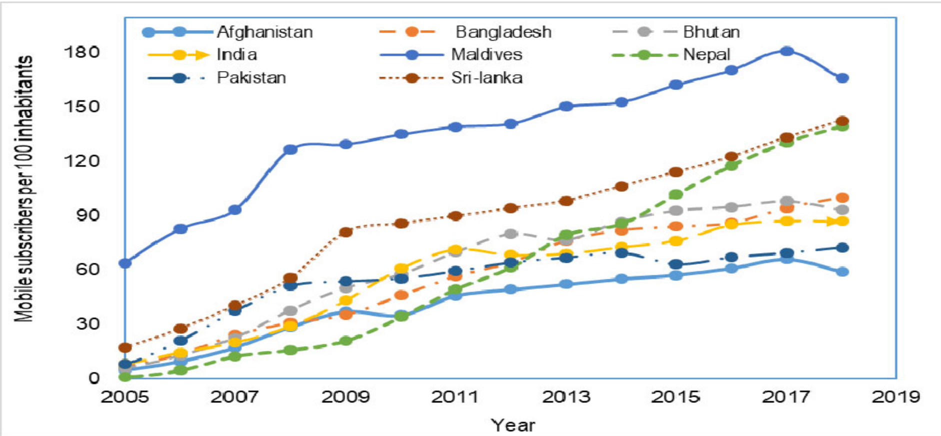
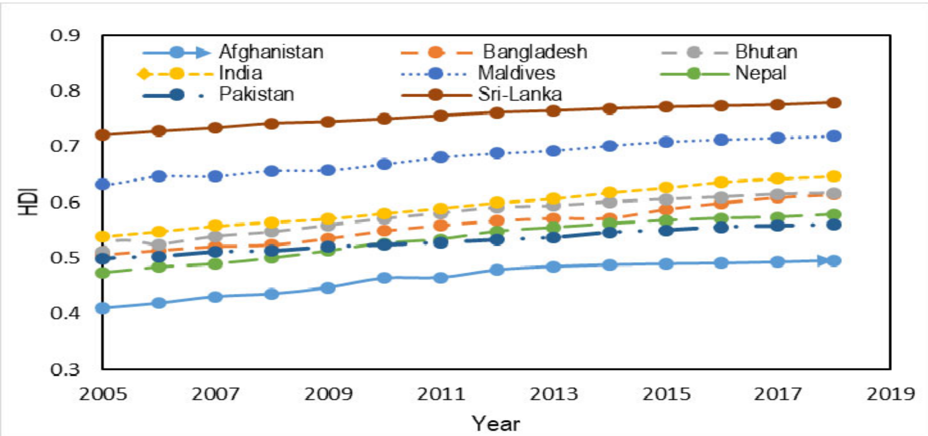


Figure 2. HDI of SAARC Member Countries from 2005 to 2018



IV. Empirical Model

Innovation diffusion typically follows a sigmoid or an S-shaped curve (Botelho and Pinto, 2004). The fundamental diffusion model can be expressed mathematically as:

$$\frac{dF(t)}{dt} = b(t)(M - F(t) = f(t) \tag{1}$$

where, $\frac{dF(t)}{dt}$ is the rate of diffusion at time t, $b(t)$ is the growth coefficient, M is the potential mobidensity and $F(t)$ are the adopters at time t with boundary condition $F(t=t_0) = F_0$ (Mahajan and Peterson, 1985).

The Gompertz model was developed in the early 1800s. It has been used in different studies, such as those on animal population, cotton hypocotyl elongation, disease progression, economy, and cancer modeling (Sabzpoushan, 2020). In telecommunication, Chow (1967) applied the Gompertz model to analyze computer demand in the United States and found a better fit than other models as a vital reference for analyzing the growth of telecommunication services (Wu and Chu, 2010). This S-shaped growth pattern considered in the Gompertz model is as follows (Chow, 1967):

$$\frac{dF(t)}{dt} = bF(t)(\ln(M) - \ln(F(t))) \tag{2}$$

The general solution of equation (2) is written as:

$$f(t) = Me^{-ae^{-bt}} \tag{3}$$

where, $f(t)$ is the rate of diffusion at time t, the asymptote M refers to the potential mobidensity, a is the timing and location coefficient, growth coefficient b is the intrinsic diffusion speed, and e is an Euler's number (e=2.7182…). The diffusion speed b in our study is assumed to be a function of GDP, population, fixed line telephony, and HDI, and can be expressed as below:

$$\text{Diffusion speed } (b) = f(\text{GDP, Population, Fixed-line, HDI}) \tag{4}$$

In order to analyze the determinants of diffusion speed, we performed a linear regression model with the following formula:

$$b(t) = \beta_0 + \beta_1 \cdot \text{GDP}(t) + \beta_2 \cdot \ln \text{Pop}(t) + \beta_3 \cdot \text{Fix-line}(t) + \beta_4 \cdot \text{HDI}(t) \tag{5}$$

Because of the higher digits, the population is considered in the logarithmic scale. To obtain the annual values of the driving speed parameter $b(t)$, we used the discrete form of the Gompertz model (Massini, 2004; Sultanov et al., 2016), that has been mathematically represented in equation (6).

$$b(t) = \frac{F(t) - F(t-1)}{F(t-1)(\ln(M) - \ln(F(t-1)))} \tag{6}$$

where potential mobidensity (M) is estimated from equation (3).

V. Analysis and Findings

Gompertz growth parameters are estimated with the present trend of mobidensity diffusion. The significance of their diffusion determinants with HDI and other factors such as GDP, fixed-line telephony and population, and mobidensity forecasting of individual SAARC member countries are analyzed in the following sub-sections.

1. Estimation of Gompertz Growth Parameter

Since the 1990s, digital mobile networks have been adopted all over the world (Gruber, 2001; Asif, 2018). The main objective of this current study is to analyze the effect of HDI in mobile telephony adoption in SAARC member countries. We examined open-source data for mobidensity and other empirical data from 2005 to 2018. The details of the estimated Gompertz parameters using the NLS tool in R are presented in Table 2.

Table 2 shows that the Gompertz model has a significant fit (with a 99.9% confidence level) on the mobidensity of all SAARC member countries. This model can be used as a reference model to examine the determinants of diffusion speed and to forecast the penetration rate of mobile telephony in these countries. With the Gompertz fit, it is seen that potential mobidensity is the highest in Nepal (209.7), while the lowest is in Afghanistan (64.28). The residual standard error can be used to judge a model's goodness of fit to the diffusion pattern (Gupta and Jain, 2012; Sultanov et al., 2016). This indicates that the Gompertz model has a better fit on the historical data of Nepal (2.509) than for other SAARC member countries. It is also seen that the potential mobidensities with the Gompertz model in Afghanistan, Bangladesh, Bhutan, India, and Pakistan, are below the mobidensity standard value (120) as defined by ITU (ITU, 2019b).

Table 2. Estimation of Gompertz Parameters

Model	Parameters	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Gompertz Model	*M*	64.28***	114.05***	99.54***	87.16***	176.6***	209.7***	67.86***	149.31***
	a	3.34***	3.28***	4.02***	4.04***	1.24***	5.48***	3.31***	2.38***
	b	0.32***	0.22***	0.34***	0.37***	0.25***	0.19***	0.54***	0.22***
	Residual standard error	2.824	2.57	2.798	4.741	7.6	2.509	3.268	7.335

*** significant at the 0.001 level

2. Analysis of the Effect of HDI on Mobidensity

The diffusion speed of mobile telephony in a nation is influenced by social change-related external factors as key determinants (Chu et al., 2009; Frank, 2004; Gruber, 2001; Gupta and Jain, 2012 Honoré, 2019; Sultanov et al., 2016; Yamakawa et al., 2013). This study has examined HDI and three other factors—GDP, population, and fixed-line telephone subscribers per 100 inhabitants—to analyze the diffusion determinants as in equation (5). The generalized linear regression coefficients (β_i) of each factor (i) on mobile telephony diffusion speed using the generalized linear model (GLM) fuction in R are summarized in Table 3.

From the regression analysis, it can be seen that all factors except HDI have a negative effect on the mobile telephony diffusion rate in Afghanistan, but GDP is a significant determinant with a 90% confidence level. In Bangladesh, the intercept, GDP and population are significant, with a 90% confidence level, but the population has a negative effect on the diffusion rate. Sri Lanka is a country where only fixed-line telephony diffusion is insignificant and has a negative impact on mobile telephony; and the other factors are statistically significant. The intercept, GDP, and population play a decisive role and are significant with a 99.9% confidence level, and HDI is significant with a 99% confidence level. While HDI plays a decisive role in mobile telephony diffusion for all countries except the Maldives and Nepal, it is significant only in the case of Sri Lanka. The regression model tha we have proposed had a better fit for Bangladesh because of the least null deviance value (0.22) among SAARC members.

Table 3. Results of the Regression Analysis

Parameters		Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Generalized regression coefficient of factors of driving speed (b) with 13 degrees of freedom	β_0	-20.39	169.8 ·	707.3 ·	756.73	-122.9*	0.62	1304	-197***
	GDP	-0.015·	7.37 E-4 ·	1.12 E-5	0.004 ·	7.69 E-4	-2.56 E-4	0.01	-5.6E-4***
	In (Pop.)	-0.56	-9.13 ·	-53.76 ·	-37.54	10.05	1.31 E-09	-74.69	11.19***
	Fix	-2.58	1.5 E-02	-1.31	0.74	2.30	-0.08	-0.06	-9.9 E-4
	HDI	83.08	2.8	36.8	38.75	-26.04	-0.02	200.55	14.2**
	Null deviance	14.17	0.22	11.57	5.09	9.58	0.39	24.994	0.32

***, **,*, and · are significant at the 0.001,0.01,0.05 and 0.1 levels, respectively

3. Comparison of High and Very High HDI Group Countries

We randomly selected three countries from the very high HDI group (Norway, Switzerland, and South Korea) and two from the high HDI group (Brazil and Costa Rica), from outside the SAARC region, to observe the effect of HDI on the diffusion of mobile telephony. We found that the HDI is a significant determinant of mobile telephony diffusion in the high HDI group countries. The estimated Gompertz growth parameters and the mobile telephony diffusion determinants examined, as in the previous section, are presented in Table 4.

Table 4 shows that the Gompertz potential mobidensities of all countries are highly significant with a 99.9% confidence level. The regression intercept, population, and HDI are significant diffusion determinants for Brazil; intercept, GDP, population and HDI for Costa Rica; intercept and population for Norway; and none of the factors we examined are significant diffusion determinants for Switzerland and South Korea. The negative effect of HDI on mobile telephony diffusion in Brazil and Costa Rica, which has not been discussed in this study, is to be further investigated.

Table 4. Parameter Comparison of High and Very High HDI Group Countries

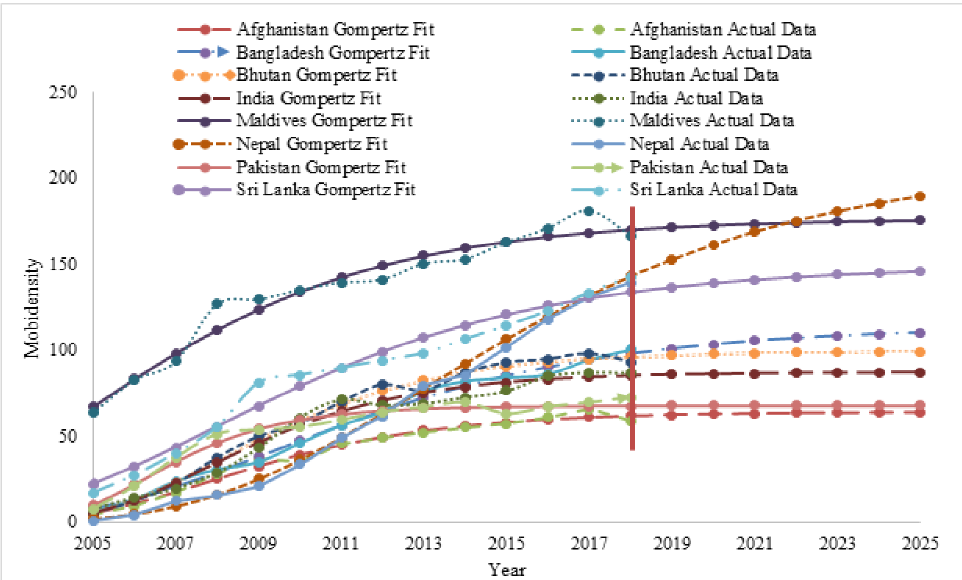
Parameters		Brazil	Costa Rica	Norway	Switzerland	South Korea
Gompertz Model	*M*	123.05***	223***	111.4***	134.7***	183.68***
	a	1.84*	3.68***	0.17	0.56***	0.89***
	b	0.4*	0.21***	0.61	0.34***	0.062**
Generalized regression coefficient of factors of driving speed (b) with 13 degrees of freedom	β_0	-5.38 E3*	205.4*	-1.13 E4 ˙	851.4	4.51
	GDP	-5.78 E-4	6.17 E-4**	-2.03 E-4	4.42 E-5	2.76 E-6
	Ln (Pop.)	296.8*	-11.8*	71.4 ˙	-62.6	-0.28
	Fix	1.83	0.018	2.92	8.24 E-4	-3.17 E-3
	HDI	-445*	-39.6*	183	150.2	0.61

***, **,*, and ˙ are significant at the 0.001,0.01,0.05 and 0.1 levels, respectively

4. Forecasting Mobidensity of SAARC Members

In this section, we attempt to forecast the mobidensity of SAARC member countries by 2025 using the Gompertz growth model discussed in the previous section. The predicted mobidensity using Gompertz growth diffusion parameters from 2005 to 2025, and actual mobidensity of SAARC members are plotted in Figure 3. Mobile telephony penetration will be highest in Nepal (189.48 subscribers per 100 inhabitants) and lowest in Afghanistan (64.02 subscribers per 100 inhabitants) by 2025.

Figure 3. Actual and Predicted Mobidensity



VI. Conclusion and Implications

We have analyzed the diffusion of mobile telephony in South Asian Association for Regional Cooperation (SAARC) member countries using an econometric Gompertz growth model, and examined the effect of HDI, gross domestic product (nominal) (GDP) per capita, fixed-line telephony subscription, and population of each member country based on previous studies.

In this study, we have used mobidensity, HDI, GDP, fixed-line telephone subscribers (per 100 inhabitants), and population data from 2005 to 2018. The Gompertz growth diffusion parameters are estimated using the NLS tool and factors influencing diffusion are examined with the GLM tool in R. The NLS analysis performed that the Gompertz model found the significant at 99.9% confidence interval. In reference to a study by Gupta and Jain (2012) on mobile telephony diffusion in India and our significant results with the Gompertz growth model, we have adopted Gompertz model throughout the study without examining other econometric diffusion models, such as Bass and logistic models.

The current study is mainly focused on examining the effect of HDI on mobidensity diffusion. Our regression results with Gompertz diffusion speed (b) in equations 5 and 6 reveal a positive but insignificant relationship of HDI with mobile telephony diffusion in Afghanistan, Bangladesh, Bhutan, India, and Pakistan, while it is positive and significant at a 99% confidence level in Sri Lanka; the Maldives and Nepal exhibit a negative and insignificant relationship of HDI and mobidensity. Thus, we conclude that HDI is not the determinant of mobile telephony diffusion for all countries. HDI and mobile telephony diffusion may have both positive and negative relationships, and it depends on the profiles of the individual countries.

Sri Lanka transitioned from the medium HDI group of countries and joined the high HDI group in 2003, while the Maldives joined in 2014 (UNDP, 2018). Based on the analysis on the SAARC countries and the other randomly selected five countries from the high and very high HDI group (Table4), this study suggests that HDI is a determinant of mobile telephony diffusion for those countries that belong to the high HDI groups throughout the study period. Our analysis will provide a future reference for research on mobile telephony penetration in the global scenario.

Telecommunication companies and policymakers can use the findings of this research as supporting data to establish mobile service strategies and sustainable telecommunication industry policies for scarce spectrum and resource management, in the SAARC member countries. Moreover, understanding mobidensity based on the analysis in this paper helps to set future investments in next-generation technology and services in the SAARC region. The Gompertz growth model used in this study is highly significant, with a 99.9% confidence level for all SAARC member countries; policymakers can adopt this model to forecast the demand for mobile telephony.

Table 2 shows that SAARC members except for the Maldives, Sri Lanka, and Nepal have a potential mobidensity which is lower than the ITU-benchmarked value of 120 (ITU, 2019b), given the present mobidensity pattern. It is suggested that telecommunication policymakers should try to maintain the global standard and provide quality telecommunication services in the SAARC region.

However, there are some limitations to this study. First, the mobidensity determinants of all member countries are based on sales of SIM cards. The real adoption of the mobile telephone is not to be evaluated based on this study. Second, because of data availability, we have analyzed the factors with 14 sample sizes and got the significance of HDI only in the case of Sri Lanka, and high human developed group countries. The statistical significance depends on the sample size (Lin et al., 2013). Thus, the use of a small sample size in our analysis is also a limitation of this study. Third, there are various determinants of diffusion (Kalba, 2008 Liu et al., 2012; Malhotra et al., 2014; Zhang, 2017), but we used just four factors, which were found to be insignificant in the case of the Maldives, Nepal, and Pakistan. The detailed diffusion factors including geographic and timing variables are to be considered in the analysis for diffusion determinants, as these are missing in the present study.

This paper illustrates guidelines for future studies for a better understanding of mobile telephony diffusion and the effect of HDI for mobile telephony in the SAARC region. Future research can also compare other diffusion models, such as Bass, Logistic, Lotka-Volterra, Probit, and autoregressive integrated moving average (ARIMA), and forecast mobidensity using the best-fitted model. There are various factors driving mobile telephony adoption, which vary for each member country. Diffusion patterns, factors driving diffusion, and analysis of their significance regarding mobile telephony can also be a future avenue of research. Higher mobidensity than the ITU-benchmarked statistics (ITU, 2019b), in countries with low population and high dependence on tourism, that can also be the cause of an inflow of foreign travelers should be investigated and validated. The effect of HDI on mobile telephony diffusion in high and very high HDI group countries can also be considered for further validation of current research. From the historical data, we can see that the Maldives went from a medium to a high HDI group country in 2014. Analyzing the effects of mobile telephony diffusion can be a stream of the next research. Therefore, there is a lot of scope to conduct future studies in this cluster.

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