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Mobile communication (2G, 3G and 4G) and future interest of 5G in Pakistan: a review

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ABSTRACT

The use of mobile communication is growing radically with every passing year. The new reality is the fifth generation (5G) of mobile communication technology. 5G requires expensive infrastructural adjustment and upgradation. Currently, Pakistan has one of the most significant numbers of biometrically verified mobile users. However, at the same time, the country lags incredibly in the field of mobile internet adoption, with just half of the mobile device owners avail broadband subscription. It is a viable market with a large segment yet to be tapped. With the advancing progression in Pakistan towards the internet of things (IoT) connectivity, i.e., solar-powered home solutions, smart city projects, and on-board diagnostics (OBD), the urgency for speed, bandwidth and reliability are on the rise. In this paper, Pakistan's prevalent mobile communication networks, i.e., second, third and fourth generation (2G, 3G and 4G), were analyzed and examined in light of the country's demographics and challenges. The future of 5G in Pakistan was also discussed. The study revealed that non-infrastructural barriers influence the low adoption rate, which is the main reason behind the spectrum utilization gap, i.e., the use of 3G, and the 4G spectrum is minimal.

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1. INTRODUCTION

Every year the use of mobile communication rises dramatically. It has become essential and even commodities everywhere [1]. The year 1895 laid the foundation for mobile communication. It has evolved vastly over time since then [2]. A wireless networking technology, i.e. complex spectrum connectivity, gives unlicensed users a remarkable ability to make use of frequency bands opportunistically [3]. Mobile communication is leading the current century with unmatched aggressive growth [4]. To accumulate this massively rising data and provide similar service quality to all users, higher bandwidth utilization, reliability, and higher connectivity are required [5]. Spectrum crisis and high energy consumption are the main challenges for 4G. Mobile networking technology's latest development is the fifth generation (5G) [6] which is expected to deal with all the expected growing demands. Researchers anticipate the deployment of 5G networks beyond 2020 [7]. Embracement of 5G networking is supposed to address the currently faced problems adequately [8]. However, with all these pressing expectations, it requires extensive infrastructural

modifications [9] and up-grading the current infrastructure, requiring extensive costs. A significant paradigm shift is vital in this regard [9].

In Pakistan, telephone density (teledensity) is as high as 74% [10]. It is around 96% in urban areas and 32% in suburban and rural areas [11]. It means that there are over 150 million biometrically verified mobile users in the country. Pakistan arrived late in this field but since the licensing and adoption of 3G/4G in 2014 [12]. However, wireless broadband penetration is merely 27.2% [10] as connectivity and reliability are overwhelming issues, even in urban areas [13]. Barriers like affordability [11], unemployment [14], and illiteracy [15] remain the core issues for adoption despite the coverage opportunities. 5G will surely add its bit to all these barriers. It was anticipated that by 2019, 3G/4G would capture 58% of the mobile market, overtaking the 2G subscriptions [12] however, 2G still dominates 59% of the market whereas 3G, and 4G only has 27 % and 14% market share respectively [16]. The long-term solution for improving latency is to boost peering locally and with regional internet service providers (ISPs) [17]. To enhance the communication capacity, 5G may utilize the spectrum in millimetre-wave (mm-Wave) bands [18] that will require real disruption in both system architecture and component design [19].

IoT is another pressing challenge [20]. In recent years, the Internet has been linked with everyday devices through the internet of things (IoT) [21]. IoT devices contain everyday objects, which communicate with each other to make life simpler for human beings [22]. IoT devices are increasingly used to produce vast amounts of data [23]. 5G networks will substantially develop the current IoT systems [24]. Edge computing has taken over cloud computing [25]. Ensuring appropriate requirements before deploying machine-type communications (MTC) applications can help scientists achieve Globally connected things [26].

Several studies have investigated the use, utility, and benefits of 5G, but surprisingly very few investigated the need and interest of 5G in any region or country. In this paper, the need and interest of elevating to 5G were discussed in the context of Pakistan's mobile communication usage demographics. Previous studies associated with Pakistan have failed to demonstrate any significant contribution in this context.

The paper is organized as followed. Section 2 contains the currently available technologies, giving a brief discussion of current generations' technology, standards, and frameworks. Section 3 describes the limited use of currently prevailing technologies in terms of Pakistani demographics. Section 4 discusses the future interest of 5G in Pakistan, and lastly, the paper's conclusion is presented in Section 5.

2. CURRENTLY AVAILABLE TECHNOLOGY

In Pakistan, second, third and fourth generations (2G, 3G and 4G), wireless network networks run simultaneously. Trials for 5G wireless networking have already begun. In the early 2000s, the telecom sector's deregulation happened, which boosted the industry and market competitiveness, notably [27].

2.1. Second generation (2G)

Pakistan adopted the 2G in early 2000 when transmission of data, along with voice, was first accomplished through global system for mobile (GSM) networks [28]. After deregulation of the industry in 2003-04, the two multinational telecom companies telenor and warid started operations in 2005 [27]. General packet radio services (GPRS) followed as an advanced version. The 2G umbrella grew when the enhanced data GSM environment (EDGE, 2.75G) was introduced [29]. The problem of secure data transmission in 2G networks was achieved through digital encryption [30].

2.2. Third generation (3G)

Pakistan auctioned 3G spectrum in 2014, where different telecom operators were issued 2x10 MHz and 2xMHz licensees from the 2100 MHz band [31]. This generation addressed the various issues and shortcomings in previous generations [32]. As a critical variant, HSDPA (3.5G) enhanced the speed and data transmissions of the downlink data streams. Another option is HSUPA (3.75G) which improves the rate of uplink data streams.

2.3. Fourth generation (4G)

Pakistan auctioned 4G spectrum in 2014 and 2016. Only ZONG (Telecom operator) won the 4G license in the 1800 MHz band in the first auction. In 2016, new licenses were auctioned by Pakistan telecommunication authority (PTA). Telenor was the sole winner with a 10MHz block [33]. In 4G, few modifications were introduced as compared to its predecessors [34]. The two commercially used and implemented 4G networks are cell WiMAX standard and long-term evolution (LTE) [35]-[37]. 4G paved the way for achieving high speed and real-time data streaming. 4G systems introduced MIMO technology. With this technology, users can have services that were previously impossible to experience [38].

2.4. Fifth generation (5G)

5G networking is supposed to address the currently faced problems adequately [8]. 5G mobile network technology triggers very high bandwidth usage for mobile users who never experienced such valuable technology. Networks using 5G will expand the current IoT and encourage cellular operations [24]. 5G technology comes with combinations of enhanced services and a wide range of connectivity [39]. Wireless technology's fifth-generation would be complete, tackling all urgent problems and have zero drawbacks [40]. However, with all these expectations, the adoption of 5G concepts requires quite a few infrastructural modifications [41] and up-gradation, which will come with significant expenses. Table 1 shows the comparison and differences among 3G, 4G and 5G networks in Pakistan [42]-[43].

Table 1. Comparison and differences among 3G, 4G, AND 5G networks

Technology/ Feature	2G	3G	4G	5G
Date of Introduction	2003	2014	2014-16	2019-(trials)
Data Bandwidth	14.4kbps	2Mbps	2Mbps – 1Gbps	2Mbps – 1Gbps
Frequency	800 to 1800 MHz	1.8 to 2.5 GHz	2-8 GHz	3-300GHz
Standards	GSM, GPRS, EDGE	WCDMA, UMTS, CDMA2000, TD-SCDMA	All-access convergence including OFDMA, LTE, WiMAX, MC-CDMA Network-LMPS	CDMA, BDMA, and WWWW (Worldwide Wireless Web), 5G NR
Multiple Access	FDMA, TDMA	CDMA	CDMA	CDMA and BDMA
Core Network	PSTN	packet network	All IP network	Flatter IP network and 5G network interfacing (5G-NI)

3. LIMITED USE OF 2G, 3G AND 4G IN PAKISTAN

In Pakistan, teledensity is as high as 76.377% (Dec 2019) [44]. Still, wireless broadband penetration is currently only at 39.98% [10], [45]. That is equal to more than 169 million smartphone users, about 85 million 3G/4G customers, 3 million local fixed subscribers and about 87 million broadbands subscribers [45]. According to the investment board (BOI), in the last ten years, Pakistan has attained over $5.7 billion in foreign investment in IT and telecommunications [46]. Although the number of broadband subscribers has exponentially increased since its launch in 2014, [47], adoption has been held back by non-infrastructural barriers [48], i.e. low smartphone adoption rate. Figure 1 [16, 47] compares mobile internet subscribers covered but not using the internet and users not included [16].

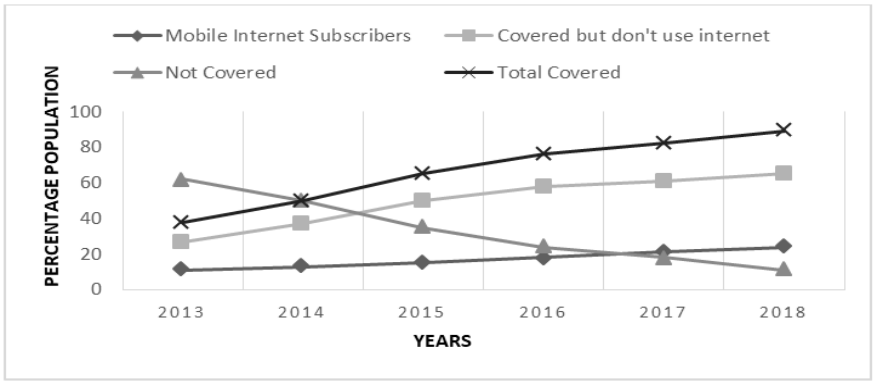

Figure. 1 Mobile broadband network coverage

The trends reveal that in the last five years between 2013 and 2018, wireless broadband coverage has dramatically improved from 38% to nearly 90%. However, there is a significant gap between users and coverage, i.e., 50% of mobile users do not use mobile broadband even though the service is available. Only around 85 million users adopt mobile broadband technology. Similarly, the smartphone adoption rate is 37% in Pakistan, compared to 48% in South Asia [16]. A large proportion of the subscribers (59%) [45] avail themselves of 2G services. Percentages of connections (excluding cellular IoT) are illustrated in Figure 2 [16], [45].

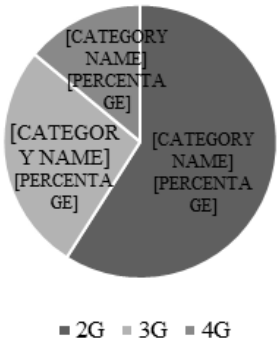

Figure 2. Percentage of connections (2G, 3G, 4G)

However, mobile broadband's adoption rate over fixed broadband has substantially increased from 1.3 million to 87 million over the last few years [45]. Conversely, fixed broadband usage showed a dip from 3.8 million to 2.2 million over the same period [48]. Broadband users are illustrated in Figure 3 [16, 47].

Shortly, IoT will integrate into a variety of intelligent objects. IoT, as the hub between different technologies, will also allow various applications to make the intelligent decision [49]. At present, Pakistan's IoT applications have emerged in many applications. For example, solar home solutions make rural households off-grid power electronics, OBDs and IoT solutions integrated with vehicle and motorcycle insurances products to mitigate theft services [50]. A significant noticeable rise in the last two years from 400,000 to 662,000 connections [16] proves that IoT has a bright future in Pakistan. The rising will hugely depend on grasped intentions and ease of use of the IoT [50]. Figure 4 [16] illustrates the number of IoT cellular connections in Pakistan.

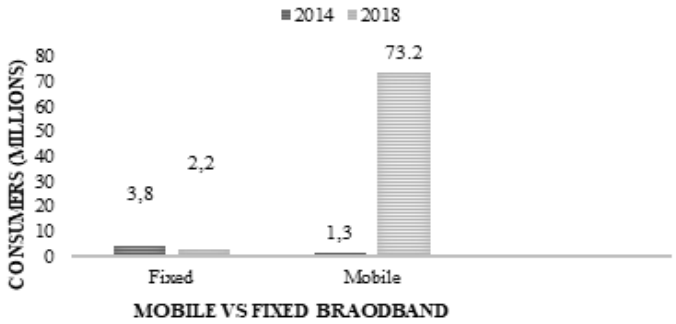

Figure 3. Fixed vs mobile broadband users in millions

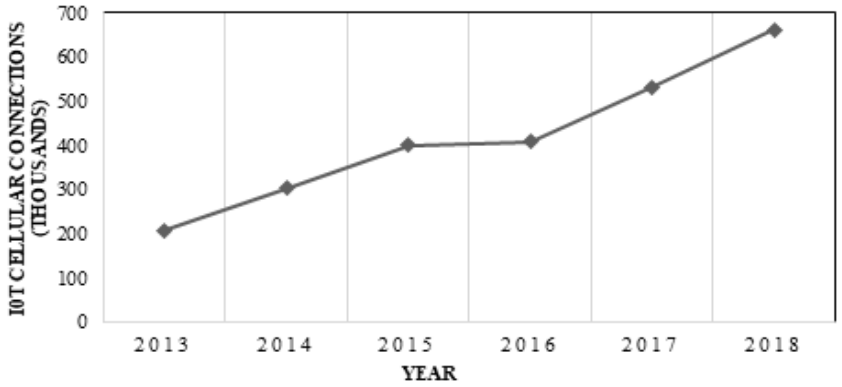

Figure 4. IoT Cellular connections in thousands

4. FUTURE INTEREST OF 5G IN PAKISTAN

Pakistan introduced 3G and 4G cellular technologies in 2014. As depicted in Figure 3, 59% of the total teledensity in Pakistan has not moved on from 2G connectivity. Only 27% of users have shifted to 3G technology, and a mere 14% of subscribers have adopted 4G technology [16]. The extrapolated percentages of the population for mobile broadband network coverage (2017-22) are calculated using MATLAB. These are illustrated in Figure 5.

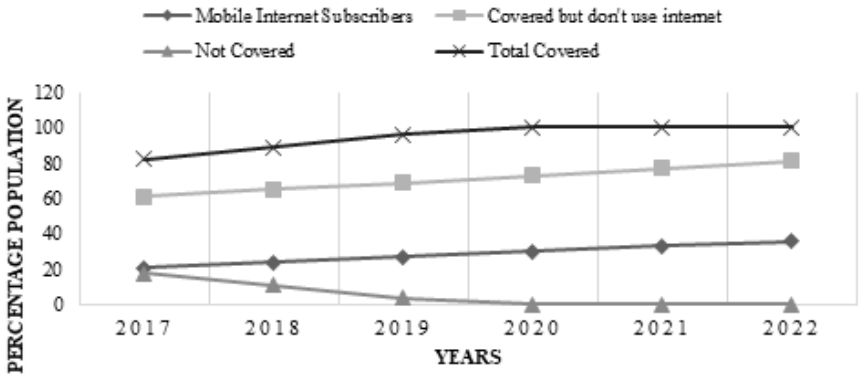

Figure 5. Extrapolated results for mobile broadband network coverage

These deduced results show that mobile broadband network coverage will reach 100% by next year. Still, it is worth noting that projections for mobile internet subscribers are only around 36%. It means that a substantial proportion of 64% of the population will not use the internet regardless of coverage and spectrum availability. Despite over 9 million devices through local manufacturers since 2016 [16], the smartphone adoption rate is one of the lowest in the region. Pakistan will have around 146 million smartphone connections by 2025, lagging in the 8th position, while Indonesia, India, and China will be the smartphone superpowers over the same period [51]. Mobile internet subscribers in Pakistan are crouched, which profoundly questions the need for elevation to the fifth generation (5G) of mobile communication technology. Mobile penetration was incredibly enriched. After the launch of e-broadband in 2014, its penetration is incredibly rich and dramatically increased over the past few years. Based on the previous data, the MATLAB extrapolation tool was used to extrapolate the results, as shown in Figure 6.

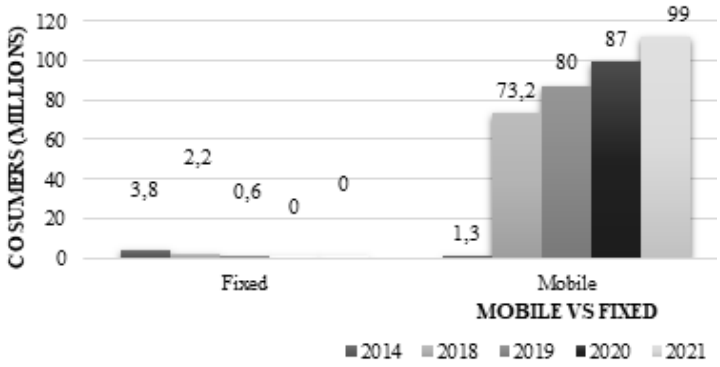

Figure 6. Foresee results for fixed vs mobile broadband users in Millions

The forecasted results and trends over the last two years imply that growth is reducing. The current reach is 87 million [45], and the estimated reach for mobile broadband users is 100 million by 2021, which is again not an encouraging figure for the adoption rate of mobile broadband. By 2025, smart cities in Pakistan will improve citizens' access to facilities such as smart energy, telemedicine, e-government, digital libraries and e-banking [12]. MATLAB extrapolation tool was used to extrapolate future trends for IoT mobile

connections. Figure 7 illustrates the results, which are encouraging but are not satisfying enough for the embracement of 5G.

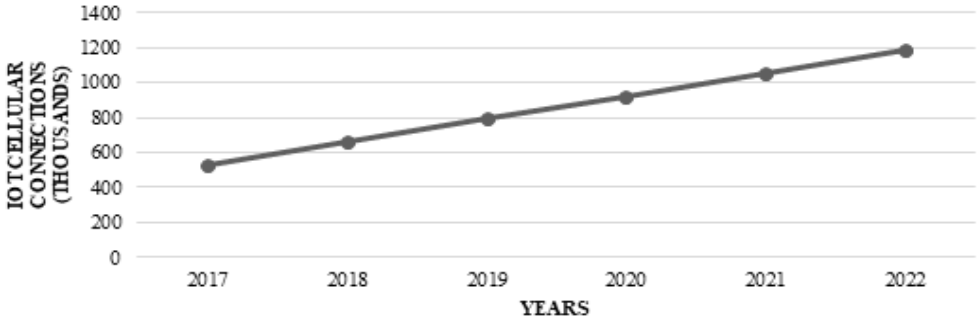

Figure 7. IoT Cellular connections in thousands (predictions)

Currently, there are over 9.1 billion IoT connections worldwide, and 16 billion additional links are expected by 2025, making it a significant number of 25.2 billion. Smart buildings, consumer electronics, and smart homes are the key growth verticals in today's age [51]. The time has come for Pakistan to be on-board with these trends.

5. CONCLUSION

In this paper, the prevalence of 2G, 3G, and 4G mobile communication scenarios in the demographics and challenges faced in Pakistan were studied and reviewed. In Pakistan, the adoption rate for switching to 3G,4G is not encouraging. 2G networks still hold 59% of the total subscribers. The smartphone adoption rate is also low despite the introduction of local manufacturing and mobile devices' production. Pakistan is likely to miss the chance of being the smartphone superpower like China, India, and Indonesia are all set to meet their set targets by 2025. Also, an essential aspect of 5G mobile communication technology is cellular IoT connections. Current numbers and future extrapolations are also not promising. They need to rise exponentially to fill the spectrum. The study revealed that non-infrastructural barriers influence the low adoption rate, which is the main reason behind the spectrum utilization gap, i.e., the use of 3G, and the 4G spectrum is minimal. Lacking behind in literacy and shortage of jobs are the main contributor to such trends. It is favourable to fill up the spectrum utilization gap before elevation to 5G, which may be considered a fancier operation. The government can Introduce the time-bound frameworks for gap filling, consumer readiness, infrastructural adjustments, and up-gradation. The proposed exercise will facilitate the elevation to the 5G of mobile communication technology at the right time. 7In the future, both qualitative and quantitative studies can be carried out to get a deeper pulse of reasons behind non-infrastructural barriers. Studies can also dig deeper into the proposed frameworks for gap filling, consumer readiness, infrastructural adjustments, and up-gradation.

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