Infrastructure Sharing and Remedies in Next Generation Cellular Networks

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Summary
Pakistan is one of Asia's growing telecommunication cellular market, with about 64.05 million subscribers hosting by more than 40,000 Base Transceiver Stations are predominantly based in metropolitan areas. Both mobile operators are undertaking mostly on the development of new BTS without taking into account the existing infrastructure, as a result of the rising amount of customers, which leads to over-spreading of masts, environmental defacing and excessive environmental pollution in the same site BTS are being powered by diesel generators. It is crucial for Pakistan's telecommunications regulatory body, such as PTA, to increase network connectivity, stability, network expansion, customer satisfaction, and resilience, the principles of spectrum sharing and location co-location sharing across all cellular network providers must be introduced. The paper argues that resource sharing and co-location sharing will help to reduce operating costs, call tariffs and the spreading of environmental pollution.

Keywords:
Base Transceiver Station (BTS), Cellular infrastructure, Active and Passive sharing

1. Introduction

The introduction of 4G technologies is changing the wireless networking environment, although at an early stage. More importantly, in the next 5 years, a somewhat 11-fold increase in worldwide mobile data is expected, exceeding 15.9 additional bytes every month by 2018[1], forcing cellular network providers to expand their service networks to improve network capacity and fulfill such immediate traffic demands[2]. As a result of increased energy usage as well as the expense for stakeholders, the exponential expansion of cellular networks is becoming a major problem for society. The broad usage of information and communications technologies (ICT) along with a wide variety of technologies contributes to 5.7 percent of the global energy use as well as 1.8 percent of global carbon dioxide emissions[1], resulting in power costs for telecom operators of around $10 billion[3].

A compelling viable choice for telecom operators to reduce the capital and operating costs associated with the implementation and operation of wireless networks has also been identified as the distribution of network resources. Compelled by regulations enabling providers to install the antennas on the very same BTS, such a new approach encourages a collaborative plan that enables network operators to collectively use the resources to meet their shared goal of providing customer support whilst pursuing efficiency and energy savings[4] .

Although the sharing of cellular infrastructure as a principle is well known in the USA, EU countries there is no study of the environmental and socially profitable model in Pakistan. However, this paper provides a survey of a particular area to evaluate the amount of diesel consumption, the existence of different operator BTS nearby 100m, and suggesting a way to resolve issues of environmental pollution and power shortage in Pakistan through the regulation of PTA.

A: Aims and Objectives

This unique analysis aims to reduce the atmosphere and land congestion since the expected number of cell towers in Pakistan is around 42,000, but we have not yet implemented 5G, however, if 5G is implemented in Pakistan, the number of cell towers would be far higher than 42,000. The said objective is accomplished by the specific goals listed:

- For connectivity, a working model for infrastructure sharing between numerous cellular operators is proposed.
- Initial supportive evidence is given that, if correctly applied, the network service is not significantly disrupted during site colocation.
- Regression analysis is used to analyze the quantity of BTS diesel usage and CO_2 emissions in Pakistan.

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B: Motivation

Reduction of environmental damage, emissions of CO_2 and interference, an excessive amount of antennas, particularly in heavily populated areas that pose a life and property hazard.
Reducing spending on operations and resources

- Cost/ OPEX saving by the use of a single energy resource for leasing, diesel, and industrial power savings.
- Tariff call o Call
- Decreased number of positions and installation of masts
- Shortened period for site selection for potential entrants

Simple access to strategically relevant locations whereby room for new sites is restricted
Land saving of 5G connectivity for the next decade.

C: Challenges

- The question of which venue, BTS, and mast top pick for both the colocation host(s).
- Inconsistency of services and systems used by other operators
- Usage for some operators with poor systems/subpar quality while others have better systems and would thus be not able to share.
- Monopolistic activity by major players creates an anti-competitive environment embraced by prominent teams throughout the telecom industry that creates barriers for new competitors.
- Insufficient efficiency/colocation of microwave links adds uncertainty to the design and consistency of microwave links.

2. Literature review

A: Effects of subscriber growth

For professional and economic development, phones, as well as other ICT devices, are important networking resources. The growing demand for telecommunications networks has led to an improvement in communications networks, like antennas and network facilities, that is needed to ensure adequate connectivity, wireless coverage, and accessibility with minimal service quality[5].

To handle the volume of data and also the performance of communications, heavily populated cities need more wireless infrastructure. This contributes to a need for the building of additional antennas since there is a limit on the number of communication equipment that each tower may hold[6]. The social and economic advantages of modern telecommunications can be achieved by the development of the infrastructure needed, like base station systems that are essential for message acquisition.

B: BTS infrastructure sharing

Infrastructure co-sharing may be defined as the shared usage of mobile network infrastructure by upwards of a single mobile operator via an arrangement to determine contractual and technological terms and conditions. Masts, Base Station facility, Bandwidth, and other services provide wireless networks. To minimize their maintenance costs, phone companies can turn from rivals to business associates as per the specifications of connectivity[7]. The investigator recommended that all fixed and mobile providers must bring infrastructure management into consideration as a method of cutting operational and capital costs. It is therefore important to focus more attention on imagination and innovation for consumer services.

C: Model of infrastructure sharing

Technically the model of Cellular infrastructure sharing is divided into two parts as shown in fig.1.

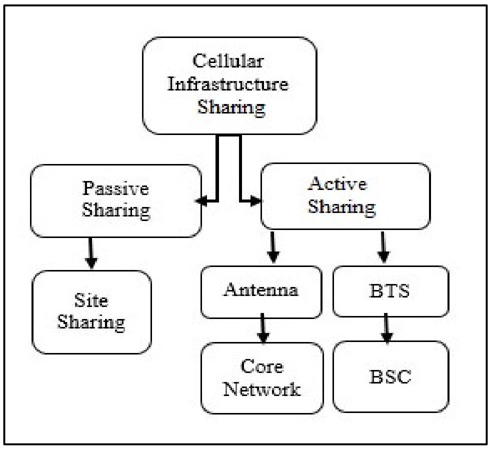

Fig.1 Model of Cellular Infrastructure Sharing

C: Considering the passive sharing

The telecommunication cellular industry is reducing the incomes due to high competition, the mobile service providers are looking for new solutions to cut off the costs. In the beginning, the infrastructure sharing can be used to create a good coverage rapidly for a longer-term and to build a more cost-effective single BTS with different operators in rural areas as per cases of low traffic demand[8]. Sharing arrangements between vendors can offer savings by bringing the resources together to succeed in more productivity. Infrastructure sharing would not only mean rapid implementation but also save the cost of millions of dollars for new and current telecom companies[9].

The sharing of Telecommunication infrastructure can be divided into four ways. First, the business, which describes the contractual companies involved in the agreement. Second is the geography, which specifies the footprint area of each service provider. The third is a technology that describes the technical approach and the fourth is the processing method which specifies the Services and should be exchanged[10]. The technological solution preferred for the distribution of resources is then related to the business model, regional concern, and modeling approach, as well as the choice of a particular provider, which will reduce the ability to make rational choices for other aspects.

D: Passive sharing technical constraints:

- Operators should evaluate the restrictions throughout the context of BTS sharing:
- Electromagnetic efficiency, site area, 2G-3G template blankets configuration can be shared by eligible sites.
- Configuration of hardware on the community site includes connectivity, protection, and BTS implementation plan technology.
- Upkeep, operating equipment, and communication interface guiding.

E: Active Sharing

Active service networking involves sharing a digital network, like a radio interface, comprising of transmitters, BTS, backhaul connections, routers, and central networks, including the functionality of databases[11]. This form of distribution has been further categorized into MORAN (Multi-Operator Radio Access Network), whereby cognitive radio services and licensed bandwidth are exchanged by each phone company. The cost saving is greater than the passive sharing but it is complex to operate and maintain the strategic distinction between all mobile operators therefore it has not been so popular for the core network[12].

E: Research Scope:

Infrastructure sharing is essential for cellular networks specifically in Pakistan, where the electricity shortage is a national concern of the country although the different advantages are associated with operators' challenge of network traffic, diesel consumption and environmental pollutions can easily be resolved. Furthermore, since infrastructure sharing is complex to implement, it requires additional skills with existing resources[13] .
To consider the co-sharing of infrastructure in a business context require statistical objectives along with the cash flow and return on assets. Currently, there is no study of BTS sharing in Pakistan so the operators and PTA are completely unaware of the challenges moreover report of mast congestion could not be carried out in Pakistan therefore it is necessary to have a proper review to develop any relevant standards to regulate co-sharing of sites by multiple operators[14]. Moreover, if mobile service providers can minimize the costs of expanding services to remote areas by sharing the BTS, regulators would have a greater opportunity of achieving all the policy goals of Pakistan telecommunication cellular services. The next part of the paper methodology addresses the research work by the survey existing infrastructure where multiple vendors BTS are nearby each other as shown in figure.2.

Fig.2. Two BTS operators on the same location

3. Methodology

This study has been carried out to examine the amount processing of telecommunications, which is usually targeted at four Pakistani telecom companies. It is possible to define the reason for the choice of such a target group and the position of the data centers and assume the possibility of all users in Qasimabad that use the same site. The methodology contains the four phases to analyze the most popular mobile service providers in Pakistan, namely Jazz, Telenor, Ufone, and Zong, it will suggest the pros and cons of infrastructure sharing.

A: Drive Test Survey with signal strength

A test drive survey was conducted with the addition of a literature review in a specific 10 km area of Pakistan’s city Qasimabad to collect detail information such as energy usage, mast detection, and the existing scale of co-location sharing facilities. A simulation software TEMS investigation was used to identify the coverage area and signal strength both in unshared infrastructure. A test drive of multiple cellular service providers was successfully conducted which includes vehicle, TEMS, GPS, and laptop. Pakistan's most commonly known mobile service providers are Jazz, Telenor, Ufone, and Zong.

As given in figure.3 of Jazz mobile service provider represents the best signal strength from -10 to -70 dBm with a sampling of 26397 in green color, better signal strength from -70 to 80 dBm with a sampling of 7900 in light green color and normal strength is from -80 to -90 dBm with a sampling of 2152 in yellow color.

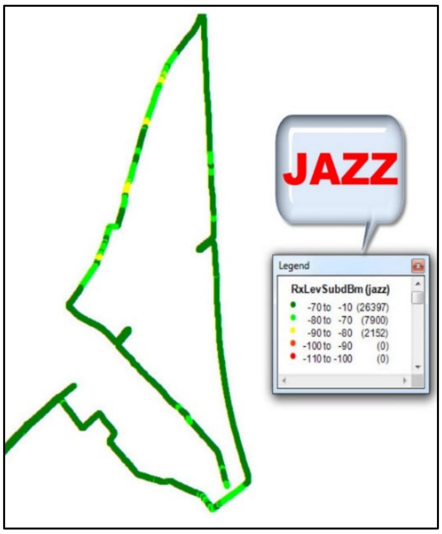

Fig. 3. Drive test of Mobilink Jazz

As given in figure.4 of Telenor mobile service provider represents the best signal strength from -10 to -70 dBm with a sampling of 26964 in green color, better signal strength from -70 to 80 dBm with a sampling of 7128 in light green color and normal strength is from -80 to -90 dBm with a sampling of 832 in yellow color.

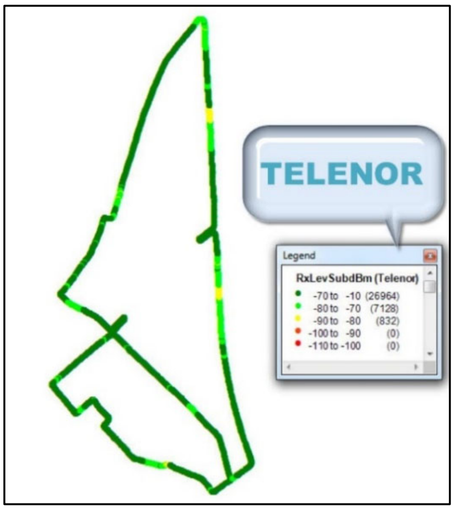

Fig. 4. Drive test of Ufone

As given in figure.5 of Ufone mobile service provider represents the best signal strength from -10 to -70 dBm with a sampling of 24238 in green color, better signal strength from -70 to 80 dBm with a sampling of 10183 in light green color and normal strength is from -80 to -90 dBm with a sampling of 1230 in yellow color.

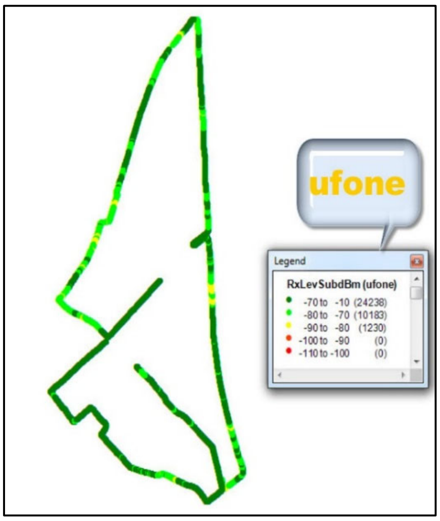

Fig. 5. Drive test of Ufone

As given in figure.6 of Zong mobile service provider represents the best signal strength from -10 to -70 dBm with a sampling of 20022 in green color, better signal strength from -70 to 80 dBm with a sampling of 2250 in light green color and normal strength is from -80 to -90 dBm with a sampling of 185 in yellow color.

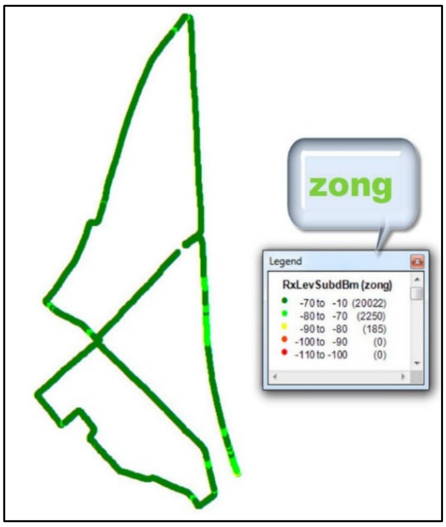

Fig. 6 Drive test of Zong

Overall as per comparison of mobile operators, the best signal strength was found in Zong mobile service with a maximum number of samplings in Qasimabad mostly the site's area is green.

B: BTS coverage area at the same site

As given in figure.7 of Qasimabad BTS view where two BTS of different operators are closed to each other with a distance of 40 meters in the figure.8 two BTS have a distance of 60 meters and in the figure.9 two BTS have a distance of 70 meters

Fig.7. Two BTS nearby 40 meters

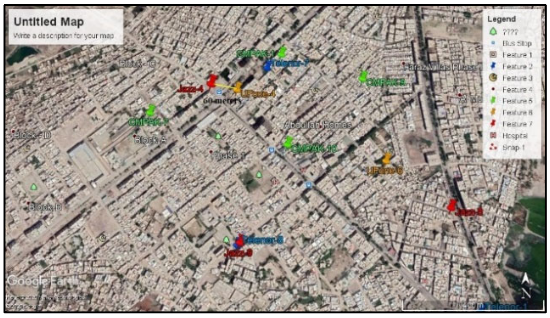

Fig.8. Two BTS nearby 60 meters

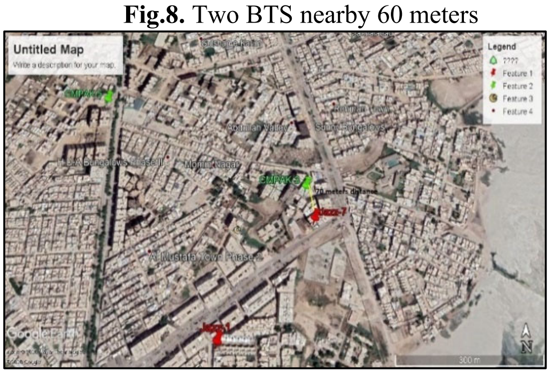

Fig.9. Two BTS nearby 70 meters

C: Cost of BTS installation

The cost of BTS installation varies depending on the manufacturer and mobile operators. The complete BTS installation average cost is around 20 to 50 thousand dollars, 25 thousand dollars for device and equipment, and 5 thousand dollars for connectivity with a core. The comparison of BTS construction cost with different countries is given in table.1[5].

Table 1: Estimated BTS construction cost

BTS	USA	South America	Africa	Asia
Construction cost	0.22M to 0.275M dollar	0.125M to 0.150M dollar	0.15M to 0.175M dollar	0.3M to 0.5M dollar

D: Backup Generators

Most of the base stations in Pakistan are commonly using diesel generator due to untrustworthy and fewer power supplies as shown in figure.10. In the case of load shading of electricity, Mobile service operators produce their source of electricity by utilizing diesel generators continuously. In the said area of drive survey, various vendor's sites were visited to recognize the presence and usage of diesel generators (DGs). Normally the power shortage time in Pakistan is a maximum of 8 hours where the full load of 24KW/30kVA DG consumes 57.6 liters per day but in typical weather conditions it needs to provide power 24/7, the situation goes worse and the fuel consumption reaches 172.8 liters per day. Most of the operator's sites have no backup generators due to the high cost of fuel such as Zong has no backup generators in its different sites as given in table 4.

Fig.10 Diesel Generators

By getting all the information and data from the targeted site and selected vendors, tables 2, 3, 4 and 5 were generated to depict easier and convenient information. All the tables show the Site name, size, and area of the site, whether it possesses a Diesel Generator or no and the period for which it keeps on running every day. The final element is the fuel consumption and burning of one litre fuel emits 2.68kg of CO_2 [15] which is very important to be taken under consideration and requires to be reduced by a greater amount of cost with feasibility of environment .

Table 2: Jazz site DG running hours

Site Name	Longitude	Latitude	DG Status	DG running hour/ day	Fuel/day	CO_2 emission
JAZZ-BTS -1	68.3418	25.4018	Yes	6 hours	36 litres	96.48 kg
JAZZ-BTS -2	68.33972	25.41146	Yes	7 hours	42 litres	112.56 kg
JAZZ-BTS -3	68.33678	25.39826	Yes	6 hours	36 litres	96.48 kg
JAZZ-BTS -4	68.3328	25.3956	Yes	8 hours	48 litres	128.64 kg
JAZZ-BTS -5	68.33654	25.40286	Yes	7 hours	42 litres	112.56 kg
JAZZ-BTS -6	68.3338	25.3869	Yes	6 hours	36 litres	96.48 kg
JAZZ-BTS -7	68.34388	25.40404	Yes	7 hours	42 litres	112.56 kg
JAZZ-BTS -8	68.33997	25.39211	Yes	6 hours	36 litres	96.48 kg
JAZZ-BTS -9	68.3338	25.3912	Yes	8 hours	48 litres	128.64 kg

Table 3.Telenor site DG running hours

Site Name	Longitude	Latitude	DG Status	DG running hour/ day	Fuel/day	CO_2 emission
TELENOR-BTS-1	25.3895	68.34051	Yes	6 hours	36 litres	96.48 kg
TELENOR-BTS-2	25.4001	68.33688	Yes	6 hours and 30 mintues	39 litres	104.52 kg
TELENOR-BTS-3	25.3988	68.345	Yes	8 hours	48 litres	128.64 kg
TELENOR-BTS-4	25.3842	68.32651	Yes	6 hours and 30 mintues	39 litres	104.52 kg
TELENOR-BTS-5	25.3961	68.33455	Yes	6 hours	36 litres	96.48 kg
TELENOR-BTS-6	25.3911	68.33372	Yes	7 hours	42 litres	112.56 kg
TELENOR-BTS-7	25.3897	68.32699	Yes	6 hours	36 litres	96.48 kg
TELENOR-BTS-8	25.4088	68.33629	Yes	6 hours	36 litres	96.48 kg
TELENOR-BTS-9	25.3846	68.32076	Yes	5 hours	30 litres	80.4 kg

Table 4. Ufone site DG running hours

Site Name	Longitude	Latitude	DG Status	DG running hour/ day	Fuel/day	CO_2 emission
UFONE-BTS-1	25.38669	68.33467	Yes	8 hours	48 litres	128.64 kg
UFONE-BTS-2	25.39856	68.33714	Yes	8 hours	48 litres	128.64 kg
UFONE-BTS-3	25.38544	68.32630	Yes	6 hours 15 minutes	45 litres	120.6 kg
UFONE-BTS-4	25.39545	68.33362	Yes	7 hours	42 litres	112.56 kg
UFONE-BTS-5	25.40087	68.33630	Yes	5 hours	30 litres	80.4 kg
UFONE-BTS-6	25.39339	68.33815	Yes	5 hours	30 litres	80.4 kg
UFONE-BTS-7	25.42850	68.34054	Yes	6 hours	36 litres	96.48 kg

Table 5. Zong site DG running hours

Site Name	Longitude	Latitude	DG Status	DG running hour/ day	Fuel/day	CO_2 emission
ZONG-BTS-1	68.335	25.3965	Yes	4 hours	24 litres	64.32 kg
ZONG-BTS-2	68.3226	25.3828	Yes	8 hours	48 litres	128.64 kg
ZONG-BTS-3	68.3437	25.4047	NA	NA	NA	NA
ZONG-BTS-4	68.3215	25.3887	NA	NA	NA	NA
ZONG-BTS-5	68.3387	25.4068	NA	NA	NA	NA
ZONG-BTS-6	68.3428	25.4004	NA	NA	NA	NA
ZONG-BTS-7	68.331	25.3948	Yes	6 hours	36 litres	96.48 kg
ZONG-BTS-8	68.3355	25.4184	NA	NA	NA	NA
ZONG-BTS-9	68.3376	25.3958	NA	NA	NA	NA
ZONG-BTS-10	68.3352	25.3938	Yes	4 hours	24 litres	64.32 kg
ZONG-BTS-11	68.3253	25.3915	Yes	4 hours	24 litres	64.32 kg
ZONG-BTS-12	68.3344	25.3993	NA	NA	NA	NA

4. Policy of Infrastructure sharing by different countries:

Infrastructure sharing policy between mobile network competitors is normally an effective way to reduce unnecessary construction and wastage of infrastructure resources. The operator of the current and next-generation networks such as 4G and 5G can focus on their business and end-user quality of mobile services by removing the responsibility of maintenance and power back of current infrastructure[16]. The government of China-proposed and directed the establishment of China Tower, a joint telecommunications infrastructure venture, in 2014. Now the business survey of China indicates the development of joint venture is supposed to benefit: three telecommunication companies of China have reduced the construction of 10 thousand BTS while saving those millions of square meter area and billions of investment in one year.

Although sharing of resources is not completely a new concept in the telecommunication industry, for example, two UK mobile operators, Vodafone and Telefonica agreed on sharing the BTS, mast, and cellular equipment in 2012. In the same year SingTel-Optus and Vodafone Hutchison Australia, two Australian mobile service operators, decided to share their respective towers by further upgrading and extending their existing networks individually[17]. However, the ideal goodwill is not possible without any proper business model that regulates the operational decision made by all competitors.

5. Recommendation

Sharing technology may be a move towards standardizing existing systems like 2G or 3G networks. Such existing systems are now streamlined by many mobile providers, given the declining revenues of 2G/3G networks as well as the improved frequency efficiency of the next networks (4G and 5G). It is very demanding to finally close the legacy system. However, the Pakistan Telecommunication Authority (PTA) can regulate a policy to decrease the electricity and infrastructure cost for all mobile operators it will save the national revenue as well as environmental pollutions. The above survey explored the drawbacks of just not sharing telecommunications networks, which implies that the investment and operational costs of separate companies in Pakistan can be minimized. The research strongly backed the proposed work in literature reviews that, with the deal to divide the Telecom BTS network with the other telecom carriers, technicians will make saving between 30 and 40 percent from both their CAPEX and OPEX spending. As Findings, the paper presented data that concerned the loss of network efficiency refers to the utilization of telecommunications sites, which would not have been as important as significant network failure problems which would be handled easily by synchronizing site management and assuming responsibility for other party's flawed solution from each organization. It has demonstrated that by embracing infrastructure sharing in their very own manner, providers can achieve a larger strategic edge by wider reach in easier and cheaper forms of market strategies.

6. Conclusion

To control phone companies in Pakistan, there is a need to establish a mobile telecommunication service sharing regulation. A combined arrangement on infrastructure sharing and expansion is the only practical means of achieving effective and quicker network penetration, which would bring the greatest advantages to the different stakeholders in the telecommunications industry. Network infrastructure does have the ability, as shown by the above research, to help increase the level of service provided by mobile networks and minimize CO_2 emissions by reducing fuel consumption. Sharing operational costs will help minimize the capital and operational expenses of mobile phone operators. In certain cases, it's been shown that the volume of Carbon emission could be minimized by reducing energy consumption, but it is still important to consider other contributing factors. It will also serve to even provide improved systems and network expansion in densely populated urban areas, especially in circumstances in which it is not possible to acquire new sites, and also to reduce the challenges and costs associated with multi existing networks by encouraging sharing. While most network operators are conservative in terms of competitiveness and disruption, if they have been properly regulated, they will improve service profitability and efficiency. Future research should carry out precise research and case studies but will focus on the creation of tools for strategic planning to facilitate the customers.

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