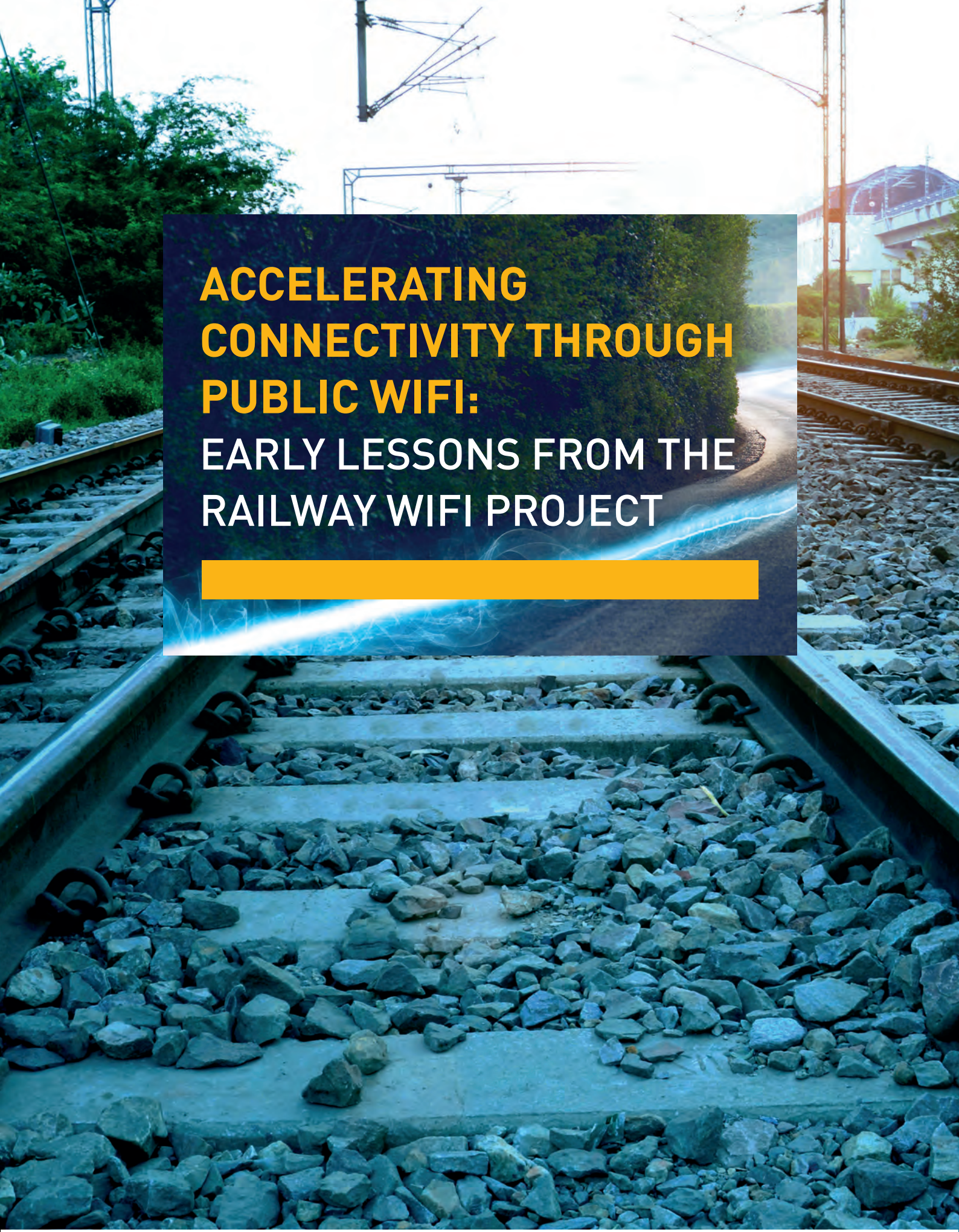

ACCELERATING CONNECTIVITY THROUGH PUBLIC WIFI:

EARLY LESSONS FROM THE RAILWAY WIFI PROJECT

analysys mason

Google Station

Contents

Analysys Mason Limited
North West Wing, Bush House
Aldwych
London WC2B 4PJ
UK
Tel: +44 (0)20 7395 9000
london@analysysmason.com
www.analysysmason.com
Registered in England No. 5177472

Analysys Mason India Private Limited
1st Floor, Tower 'C', Building No. 10
DLF Cyber City, Phase II
Gurgaon 122002
Haryana
India
Tel: +91 124 4501860
newdelhi@analysysmason.com
www.analysysmason.com

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The analysis contained in this document is the sole responsibility of Analysys Mason and does not necessarily reflect the views of Google or other contributors to the research.

We would like to thank the many industry experts whom we interviewed for the purposes of writing this report. Appreciation is due to over 20 industry experts in various facets of the ecosystem including policy makers, service and content providers and industry associations for their time and valuable inputs during our research.

The authors would like to extend wholehearted thanks to the Google Station and RailWire teams and executives who took the time to provide valuable inputs and to review this report.

1 Executive summary

With over 316 million active mobile broadband users in the country at the end of 2017 compared to 200 million the year before, India has made rapid strides in growing its base of internet users. Faster 3G and 4G rollouts, service take-up and broadband-friendly use cases have also driven the time spent online and the volumes of data consumed by the average internet user. Despite this growth, mobile broadband penetration in India (31% at the end of 2017) still lags developed markets by a wide margin, and remains at the low end of large emerging markets.

The market has evolved rapidly in 2017, in particular with the entry of Reliance Jio in the market with highly competitive 4G offers. In parallel and beyond 4G networks, significant projects are helping create significant resurgence in interest for public Wi-Fi as a mechanism to broaden broadband coverage and improve affordability of broadband services in India.

Railtel has been playing a key role in a number of initiatives to improve connectivity throughout India: it is operating over 47 000km of fibre optics throughout the county, plays a role in BharatNet and the National Knowledge Network, has initiative connectivity initiatives for far-flung areas such as North-Eastern states, and is offering broadband using fibre to the home, whilst exploring new services such as content delivery networks, data centres and the Internet of Things.

A major example is the partnership between Railtel, Indian Railways and Google, to offer public Wi-Fi in train stations. The project is covering 400 stations as of June 2018 (about 7.6 million monthly active Wi-Fi users). Other large scale public Wi-Fi rollouts are also under way, with Jio reportedly operating around 80 000 public Wi-Fi access points as of mid-2017 with more to come.

The scale of the Google / Railtel project makes it a fascinating proof of concept, demonstrating that fast and affordable public Wi-Fi can succeed in bringing more people online. This report aims to test this hypothesis, through a detailed assessment of data available about the project, assess the impact of public Wi-Fi on the broader connectivity ecosystem (including consumers, wireless ISPs, TSPs and government) as well as identify best practices for deployment of public Wi-Fi in India.

The widespread availability of fast, unconstrained and free Wi-Fi in 400 stations[1] shows the scale of the latent demand for broadband in India. A typical user consumes over 300MB in 30 minutes (roughly 50% of what a Jio 4G user consumed in a full day when it was offering data for free, and close to what they appear to be consuming now), and research has found that 1.5% of daily users on average are first-time internet users.

This latent demand presents a strong opportunity for the wider connectivity ecosystem. Wi-Fi ISPs have a clear addressable market, although their economic equation can be difficult (see below). Even if the Google / Railtel / Indian Railways project represented as much as 60% of the public Wi-Fi footprint nationwide, there would still be a large opportunity for wireless ISPs. Furthermore, they

[1] As of June 2018

could benefit from the R&D efforts expanded as part of the project, for example through the Google Station Wi-Fi product.

TSPs, in particular mobile operators, can more directly monetise this demand: 20% of Wi-Fi users are willing to pay more for better mobile broadband (outside train stations) as a result of experiencing a real fast broadband service on Wi-Fi. An additional 14% of the users are willing to upgrade their existing smartphones after experiencing high-speed Wi-Fi. This means that around 100 million people are willing to spend an additional USD2 to 3 billion per year on handsets and cellular mobile broadband services as a result of experiencing fast broadband on public Wi-Fi.

The business case for many WISPs is difficult, because of the current common practice whereby they must shoulder all the costs of deploying and operating the public Wi-Fi hotspots. Venue owners also typically demand a revenue share with a minimum guarantee, even though monetising demand is not straightforward. "Sachet" pricing and increasing penetration of electronic payment systems are improving the situation, but WISPs are struggling to build sustainable business cases.

Venues are increasingly subscribing to the idea of public Wi-Fi on their premises can benefit their broader business, thanks to large scale, high profile public Wi-Fi deployments such as the Google / Railtel / Indian Railway partnership, and indeed the prevalence of free Wi-Fi in venues such as Starbucks India (provided by Tata). They look at Wi-Fi as an incentive for their own customers to come and spend time in their shops, stations or coffee shop, and to improve their customers' experience. This increases their footfall, brand image and potentially revenue.

Proliferation of public Wi-Fi can therefore provide a significant boost to the government's Digital Ambition ambitions – ubiquitous connectivity, digital inclusion and enabling infrastructure. In addition, productivity improvements from high speed Wi-Fi for the overall economy can also translate into tangible benefits to GDP. By 2019, a successful public Wi-Fi market in India could see over 600 million people experiencing a public Wi-Fi service. For this to become a reality, over 3 million access points must be rolled out throughout the country, including in tier 3 cities and villages. Most of them will need to be connected through high-speed fibre optic links to ensure a high quality of service, comparable with what Google and Railtel already offer today.

This is a real challenge, and regulatory and policy support by TRAI and DOT is essential to facilitate the proliferation of public Wi-Fi. TRAI supported many positive initiatives in its recent consultative process, in line with the wishes expressed by all the participants in the ecosystem that we have interviewed:

- The costs of deploying public Wi-Fi hotspots need to be managed. This implies that more spectrum should be available for Wi-Fi, that rights of way be obtainable in straightforward and low cost manner, that active sharing of Wi-Fi infrastructure be allowed, that Wi-Fi aggregator hub based model be encouraged and that issues around authentication, licensing and payments be resolved.

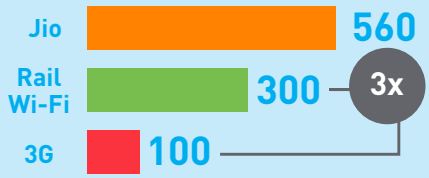
- It also requires that venue owners shouldering some of the costs, as in the case of the Google/Railtel and Starbucks deployments – these high-profile rollouts have the potential to demonstrate the value of Wi-Fi for venue owners.

- Mobile operators should also use Wi-Fi to offload excess data traffic from cellular networks, with some of the cost saving potentially reinvested in more public Wi-Fi coverage. Further, deployment of advanced technologies such as Hotspot 2.0 for ensuring interoperable roaming between cellular and Wi-Fi can also be helpful, which can enable Wireless ISPs to act as neutral third-parties offering multiple operator-specific SSIDs to telecom operators over a common infrastructure, minimizing duplication of investments, obviating the need for overbuilding of backhaul and access points, and ensuring level playing-field between operators

ACCELERATING CONNECTIVITY THROUGH PUBLIC WI-FI

Impact on Internet Users 'inside' Stations

MB PER USER PER DAY



% USER TIME IN STATION SPENT ON WI-FI

68% All users

50% First-time users

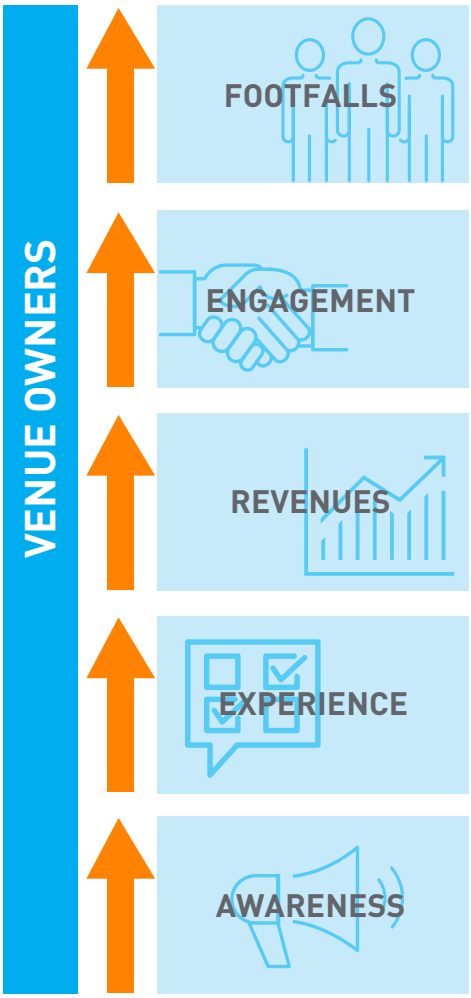
% USERS IN STATIONS OPTING FOR USE-CASES

76% Social networking

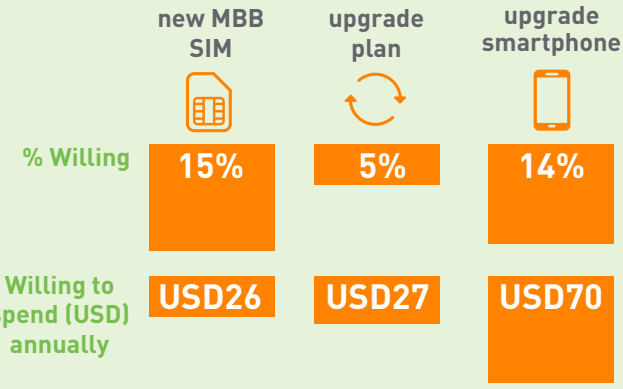
75% Productivity

35% Video / rich media

Impact on WISPs and Venue Owners



Impact on Internet Users 'outside' Stations



Impact on Handset Manufacturer Revenues

By 2019, **over 100m users** will spend an extra **~USD3 billion** annually on MBB and handsets because of their experience of high-speed public Wi-Fi

Broader Impacts of Public Wi-Fi on Economy, Productivity and Government

1 INCREASED PRODUCTIVITY
Evolved use cases of internet usage e.g. video

2 HIGHER GROSS DOMESTIC PRODUCT
India's GDP could increase by over USD20 billion cumulatively between 2017-19

3 DIGITAL INDIA GOALS
7 of 9 pillars directly addressed

2 Context and objectives of this report

The Government of India has embarked on a very ambitious programme of economic and social transformation, of which the Internet is an essential enabler. Through the Digital India campaign, the Government of India seeks to improve digital infrastructure, increase Internet connectivity and make digital services available to the population electronically, also gains relevance in this context. Large scale initiatives such as ubiquitous fibre connectivity through BharatNet, demonetisation of currency notes and push towards digital payments, and e-governance delivery through the CSC and digital village model are expected to receive a fillip through increasing broadband connectivity and will in turn also help in increasing Internet penetration across the country.[2]

With increasing availability of affordable smartphones, wider 3G and 4G network coverage by Telecom Service Providers (TSPs or Telcos), cheaper data plans, and a proactive interest by TRAI and the government through their policy framework, Mobile Broadband[3] (MBB) penetration[4] in India has increased rapidly in the past few years to reach 31% by 2017 as shown in Figure 2.1. The commercial launch of Reliance Jio's 4G network in 2016 and its expansion in 2017 has also accelerated the adoption of 4G in the country, both through aggressive marketing and by driving other Telcos to rollout their 4G networks at an increased pace.

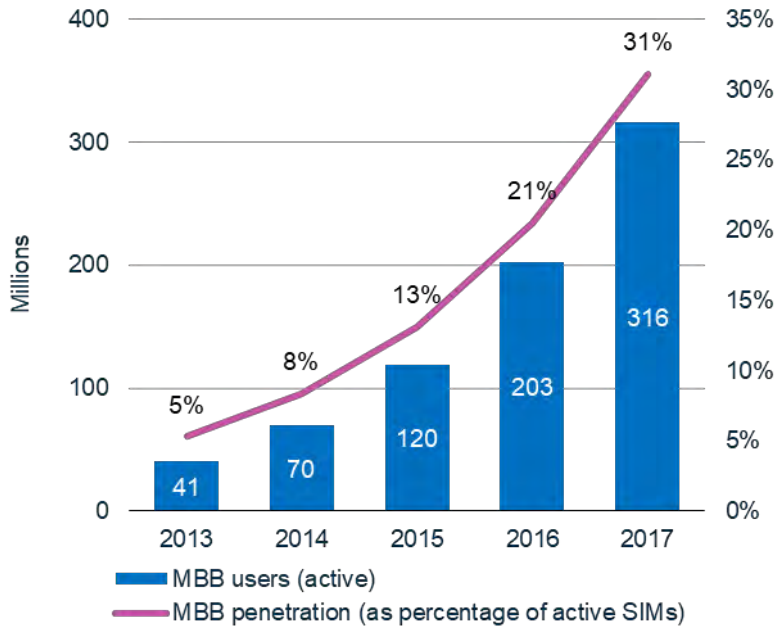


Figure 2.1: Penetration of mobile broadband in India [Source: TRAI, Analysys Mason, 2018]

In addition to a growing broadband user base, usage patterns for data services are also changing rapidly, driven by faster mobile data through 3G and 4G data networks.

2 Section 4.4 talks further about the digital enablement of government's Digital India and related objectives.

3 Refers to cellular data connections of download speed greater than or equal to 512Kbps as defined by TRAI

4 Refers to mobile broadband SIMs as percentage of active SIMs

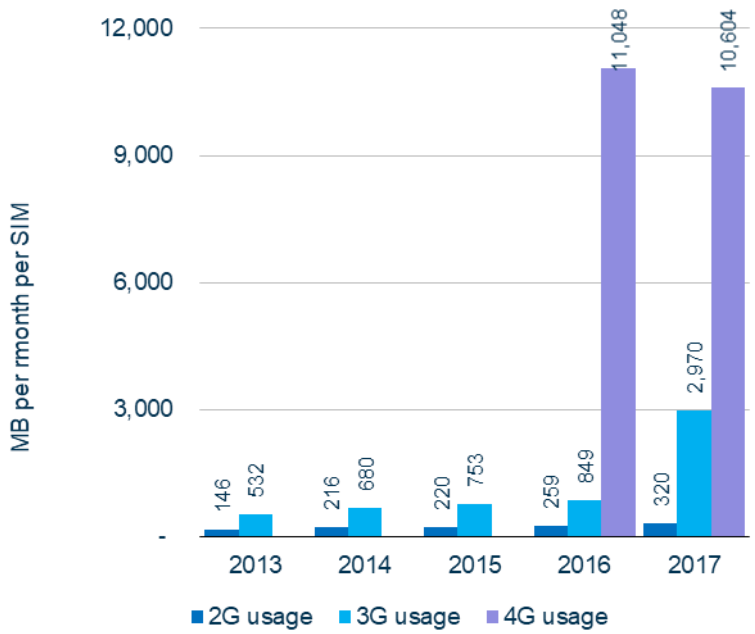


Figure 2.2: Data usage of Internet users across technologies in India [Source: Nokia Mobile Broadband Index, Analysys Mason, 2018]

Although India's MBB penetration has witnessed an impressive growth over the last couple of years, it is significantly lower than many of the developing markets as shown in Figure 2.3. Affordability of handsets and data plans continue to be some of the key barriers preventing further adoption of MBB (and even of basic mobile Internet), especially in rural areas.

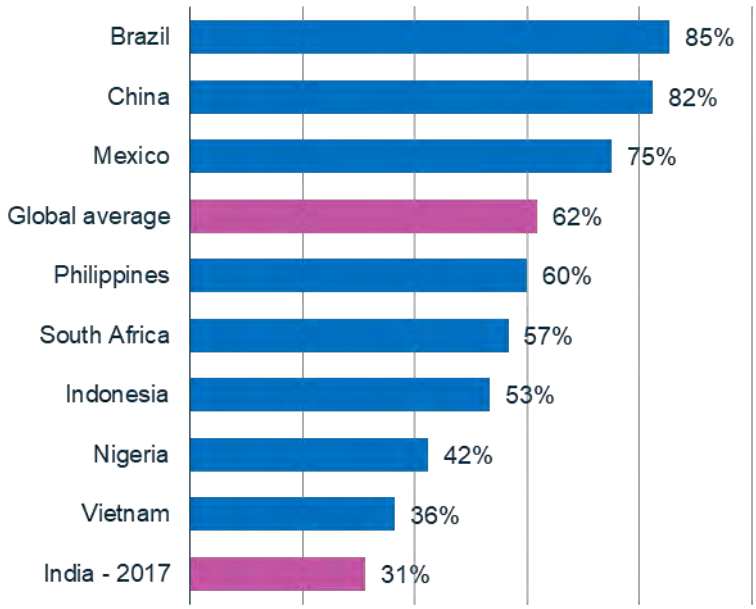


Figure 2.3: MBB penetration by country December 2017 [Source: GSMA Intelligence, Analysys Mason, 2018]

In this context, further proliferation of public Wi-Fi has been recognised as an important step in improving adoption of broadband connectivity in India. Providing access to Wi-Fi could be an economical and rapid way of connecting the unconnected throughout the country, especially given the unfeasible business case of rolling out expensive traditional cellular infrastructure in rural areas, plagued with a lower willingness to pay and revenue potential.

Wi-Fi networks operate on unlicensed spectrum (unlike cellular data networks which operate on licensed spectrum), and offer a relatively low-cost option for Telcos to alleviate network capacity congestion observed in areas of high density. Globally, Telcos have been increasingly deploying and integrating Wi-Fi solutions as add-ons to their cellular networks, using technologies such as Passpoint and Hotspot 2.0 for example. According to iPass's Wi-Fi Growth Map, India currently has just ~36 000 commercial hotspots, compared to emerging markets such as China (more than 6.1 million), Indonesia (more than 165 000) and Mexico (more than 165 000), reflecting a significant scope for further deployment of Wi-Fi access points across the country.

Several initiatives and partnerships have been undertaken to promote the deployment of Wi-Fi in India to bring Internet to the unconnected. One such project, with a high profile due to its scope and geographic breadth, is the partnership between Indian Railways (venue and infrastructure provider), Railtel (backhaul connectivity provider) and Google India (last mile access, technology solution and implementation service provider). It aims to provide free high-speed Wi-Fi connectivity to passengers at over 400 railway stations across the length and breadth of the country. As of June 2018, 400 stations are covered by the project, with an estimated 7.6 million monthly active users including rail travellers, merchants and other users of train stations such as porters. The Wi-Fi project is one amongst many connectivity initiatives implemented by Railtel to help push India's connectivity frontiers through multitude of access and connectivity technologies, as shown in the breakout box 'Railtel: taking a multitudinous approach to broadening India's connectivity infrastructure'[5].

This report considers the Railtel/Google high-speed public Wi-Fi project as a model initiative for propagating Wi-Fi connectivity and aims to highlight the impact it creates on stakeholders across the entire ecosystem including Internet users, Wi-Fi based Internet Service Providers (WISPs)[6], venue owners, telecom operators, handset manufacturers, and the government. A thorough evaluation of a project with a scale of the Railtel/Google Wi-Fi partnership could provide a strong foundation towards the identification of best practices of public Wi-Fi deployment, and hence could drive the implementation of other models across the country.

5 For more details, see: https://www.railtelindia.com/images/pdf/Corporate_Presentation.pdf; and http://www.ncr.indianrailways.gov.in/uploads/files/1476946039487-Railtelpresentation260416.pdf

6 Refers to service providers offering internet access using Wi-Fi as the last-mile access technology

Railtel: taking a multitudinous approach to broadening India's connectivity infrastructure

Formed in the year 2000, Railtel is a leading public-sector Telecom Service Provider under the Ministry of Railways. It is one of the largest telecom infrastructure provider in India, with carrier neutral offerings to Telcos, Government Departments, Enterprises, Banks and Educational Institutions. It also has exclusive Right of Way (RoW) along Indian Railway tracks connecting over 7000 stations criss-crossing the country. Utilizing an extensive fibre network encompassing 47 000km of fibre optics routes and 4500 point of presence stations, Railtel has aimed at expanding digital connectivity through multiple connectivity technologies.

- **National Knowledge Network**: a key government connectivity project envisaging linking Indian universities, centres of higher learning and research with a Pan India high-bandwidth network. Railtel is one of the implementation partners of this connectivity project.
- **Connectivity in Far-Flung North East**: The North Easter states of India remain digitally under-served due to supply side constraints such as tough geography and terrain. Railtel is currently laying optical fibre infrastructure across 6 North East states to bring them into the national connectivity fold.
- **BharatNet**: Out of the 250 000 gram panchayats (GPs) to be connected in India's leading BharatNet program, Railtel has been tasked with connecting 36 000 GPs spanning 11 states and union territories with high speed fibre based backhaul network.
- **Railwire Home Broadband**: riding on its nationwide fibre infrastructure Railtel has also launched a Pan India home broadband network for retail subscribers. With more than 100 000 subscribers in states such as Karnataka, Tamil Nadu, Kerala, UP, Haryana, Maharashtra, and Gujarat, the service offers high-speed bandwidth for IPTV, video on demand, HD video and Web2.0.
- **Railway Digital Network**: A mass advertising platform comprising of 100 000 networked screens across 2000 railway stations in India, RDN gives Indian Railways the ability to offer infotainment services to its passengers, vendors and merchants on a real time basis. Key real-time statistics and public announcements such as train schedules, weather, utilities, health are facilitated along with capturing public feedback through social network integration
- **New Data Services**: In addition to the above, Railtel is leveraging new data services such as content delivery networks, data centres, cloud computing, security and surveillance and internet of things to further expand the connectivity frontiers across the country.
- **Railtel/Google Wi-Fi project**: to connect 400 Railway Stations in the country is a concrete step by one of India's largest PSU telecom infrastructure providers to leverage the potential of public Wi-Fi for broadening digital penetration in the country. The high-speed Wi-Fi network with uncapped bandwidth of 1 Gbit/s per station provides path-breaking digital experience to existing and new users alike routinely marred with sluggish bandwidth and patch network coverage.

The remainder of this report is laid out according to the structure depicted in Figure 2.4. Railtel/Google high-speed Wi-Fi project forms the key model project and the focus of this study, which is the centrepiece of the broader Public Wi-Fi scenario in India. This has direct implications on Wi-Fi ecosystem in the country, and indirect implications on the broader connectivity ecosystem, along with government, GDP and productivity.

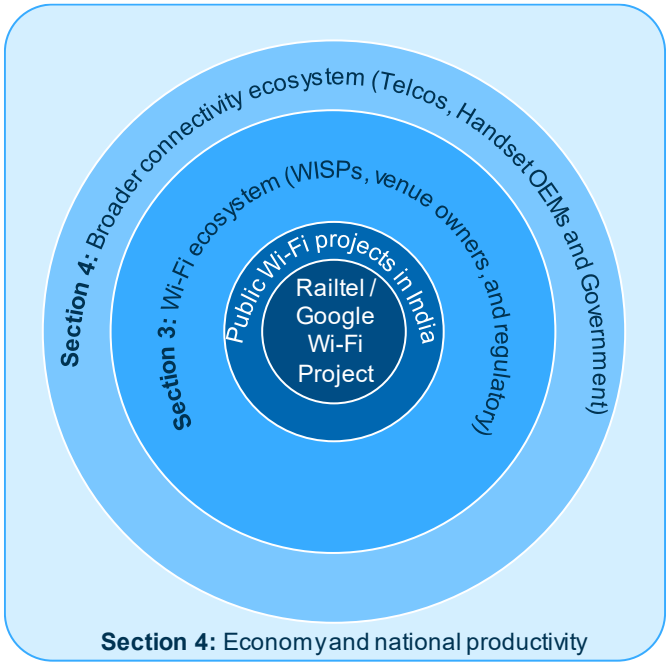


Figure 2.4: Impact generated by public Wi-Fi deployed captured through various sections of this report [Source: Analysys Mason, 2018]

- Section 3 focusses on the Railtel/Google high-speed public Wi-Fi project, and covers its *direct* impact on stakeholders including Internet users in railway stations, Wi-Fi ISPs, venue owners such as Railways and others, and Wi-Fi policy scenario.
- Section 4 provides an informed view of the *indirect or wider* impact of Railtel/Google project on stakeholders including Internet users outside railway stations, Telcos, handset manufacturers and the government.
- Section 5 concludes the key messages from this report and brings into focus the next steps from the perspective of proliferation of public Wi-Fi in India.

The report also includes several annexes containing supplementary material.

3 The Railtel / Google partnership: a proof of concept for the Indian Public Wi-Fi ecosystem

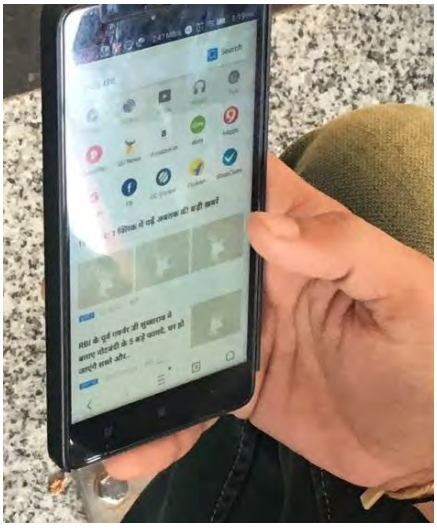
This section of the report focuses on a systematic analysis of the key ecosystem benefits of high-impact public Wi-Fi projects, from the focal standpoint of the Railtel/Google high-speed public Wi-Fi project. We conduct a thorough evaluation of this model project to understand its impact on relevant direct stakeholders such as Internet users of the public Wi-Fi project, other Wi-Fi focussed ISPs, other venue owners like Indian Railways and the Wi-Fi regulatory scenario.

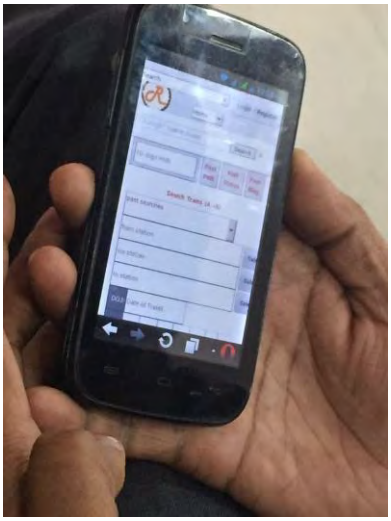
3.1 Internet users within public Wi-Fi ecosystem

Unconstrained access to the Internet through broadband public Wi-Fi shows significant pent-up demand for connectivity throughout India

The Railtel/Google high-speed public Wi-Fi project also gains relevance in light of the Wireless Broadband Alliance's 2016 City Public Wi-Fi survey[7], where 50% of the respondents believed Train Stations to be the most popular venue type expected to witness the fastest traffic growth in coming years. The Railtel/Google project has now achieved its ambition to cover 400 stations as of June 2018. The positive impact of the project in terms of user footprint and quantum nature of Internet usage underlines its significant potential to act as an enabler of digital revolution in India. Detailed data collected from system dashboards and primary surveys across multiple railway stations, paints a very encouraging picture of the unfulfilled demand for broadband data amongst India's grassroots.

Figure 3.1: Pictorial evidence, from primary surveys, of users accessing high speed broadband through Railtel/Google Wi-Fi [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]





7 http://www.wballiance.com/wp-content/uploads/2016/12/Industry-Survey-results-2016.pdf

Usage statistics show significant pent up demand for connectivity, amongst train commuters in stations covered by the Railtel / Google project who have used the service. With unconstrained, free high-speed Wi-Fi connectivity, an average user consumes over 300MB in an average 30-minute data session. This is much higher than what we observe on an average 3G connection in the country currently, around 100MB per user per day. Another proof-of-concept on how unrestrained high-speed internet could influence data usage patterns is demonstrated through the case of Reliance Jio, where it has been observed that an average active Reliance Jio user (estimated based on publicly available data[8]) consumed an 560MB of data per day when their services were not monetised. This heavy usage is clear testimony of the significant demand potential that lies dormant in India, and which can be activated through deployment of ubiquitous Wi-Fi networks in the country. It is also important to note that the usage of over 300MB using Railtel/Google high-speed Wi-Fi is just for a 30-minute session, compared to the usage of 560MB for a Reliance Jio user for an entire day.

Figure 3.2 below compares usage on Wi-Fi in stations covered by the Railtel/Google partnership, with that of an average user of paid 3G services, and further with that of a data user on the Reliance Jio network.

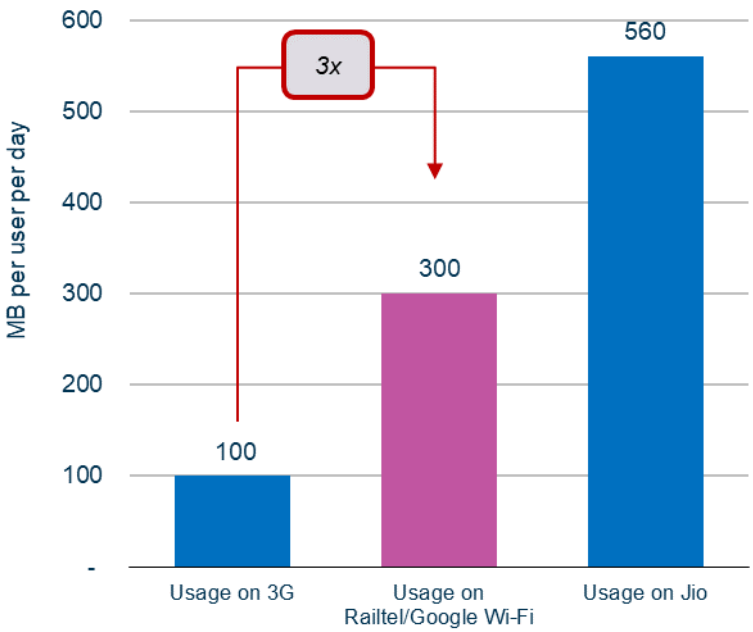


Figure 3.2: Internet usage on unfettered fast Wi-Fi compared to Jio and 3G users in India [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

Users are also increasingly using their time at stations more productively with the availability of high-speed complimentary Wi-Fi. Given that prolonged train delays are not uncommon in India,[9] enforced waiting can now be used productively on the Internet. This leads to better customer satisfaction and brand management for Indian Railways.

8 http://telecom.economictimes.indiatimes.com/news/thanks-to-reliance-jio-india-becomes-top-mobile-data-user/57269548; http://telecom.economictimes.indiatimes.com/news/with-83mn-customers-jio-set-to-break-even-on-ebitda/58001479; http://www.trai.gov.in/sites/default/files/Press_Release_34_Eng_28_04_2017.pdf

9 http://www.hindustantimes.com/india-news/check-train-delays-or-face-action-railway-minister-suresh-prabhu-warns-officials/story-4EBKFHelWFY7pasuAleQWM.html

Rail Wi-Fi: Enhancing passenger experience and leading to better brand engagement

One of the opportunities that could be unlocked by Indian Railways to foster passenger engagement is through the usage of online apps for booking rail tickets. Railway station counters are currently the predominant means for booking rail tickets, particularly in rural areas. Rail Wi-Fi offers passengers the flexibility to book their travel tickets by themselves online, without having the need to invest their time in long queues. This can be seen from the case of an employee working at a cement plant as an excavator operator. While he was on his way to Batargarh, he was informed by his supervisor to take a train to Raigarh from Batargarh. Unfortunately, he did not have sufficient cash to book a ticket after reaching Batargarh. He also noticed that the queue for booking tickets at the station counter was very long, and he would not be able to book his ticket on time to catch the train. He quickly connected to the Wi-Fi network and checked the availability of trains from Batargarh to Raigarh, and booked his ticket online. The availability of Wi-Fi has helped him to effectively improvise his travel schedule.

Data and research (e.g. data shown in Figure 3.3) suggests that there is ample appetite for Internet data usage amongst passengers with almost 70% of the station time being spent on Wi-Fi. More encouragingly even first time Internet users,[10] who experience Internet for the first time even through the Railtel/Google high-speed public Wi-Fi project, spend as much as 50% of their in-station time on Wi-Fi. While the overall average user base for the Railtel/Google high-speed public Wi-Fi project spend close to 25 minutes on Wi-Fi, first-time users spend close to 17 minutes on Wi-Fi.

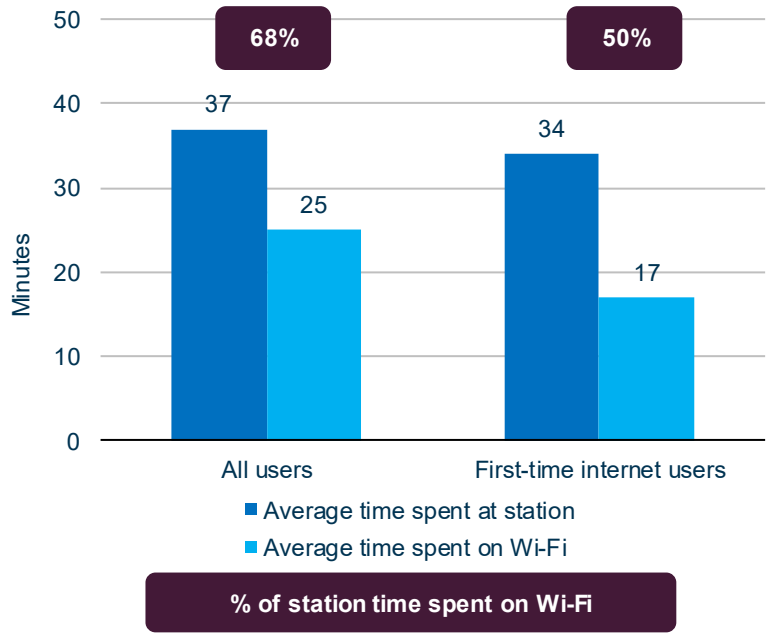


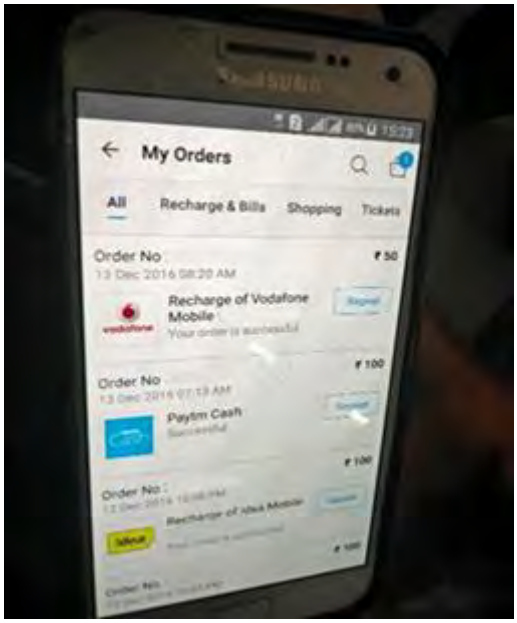
Figure 3.3: Users' time spent at the railway station and accessing Wi-Fi [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

10 Defined as smartphone users who never experienced Internet before accessing it for the first time through the Railtel/Google free public Wi-Fi project

With unconstrained access to the Internet, users are migrating to more evolved and productivity-enhancing use cases

Empirical research[11] has linked high speed broadband access with increased productivity and key socio-economic benefits such as increased business efficiency, better access to healthcare and education, and environmental benefits due to more efficient energy consumption. Research from international markets[12] also suggests that high speed broadband drives adoption of evolved Internet use-cases such as commerce, travel, financial services and online work collaboration.

Figure 3.4: Pictorial evidence demonstrating how Railtel/Google high-speed Wi-Fi is being used towards productive use-cases [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]



This is corroborated with key findings from Railtel/Google Wi-Fi users' usage patterns. As depicted in Figure 3.5, surveyed users were inclined towards evolved use-cases such as online shopping, e-banking, news and textual browsing and utility transactions such as ticket booking. While social networking ranked the highest amongst usage patterns, evolved-activity usage trends were almost equally popular.

11 A 2013 study by Ericsson, Arthur D. Little and Chalmers University of Technology titled 'Socioeconomic Effects of Broadband Speed' using empirical data from 33 OECD member countries inferred that doubling broadband speeds can add 0.3 percentage points to GDP growth

12 Research commissioned by the Australian Government Department of Broadband, Communications and the Digital Economy - https://www2.deloitte.com/au/en/pages/economics/articles/benefits-high-speed-broadband-australian-households.html

Figure 3.5: Evolving Internet usage habits[13] through unconstrained high speed Wi-Fi in India [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

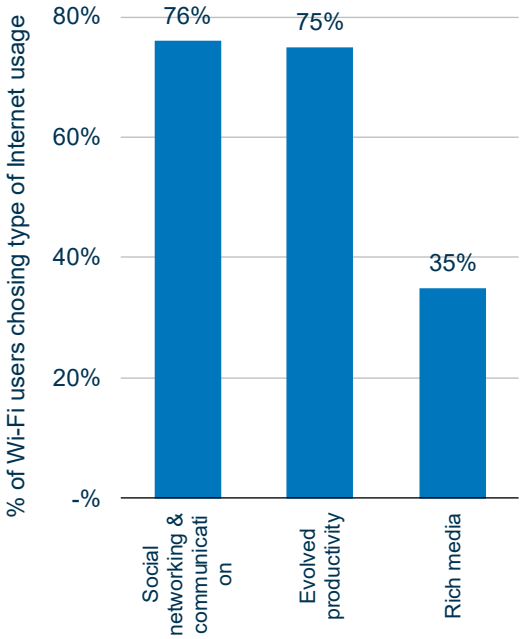
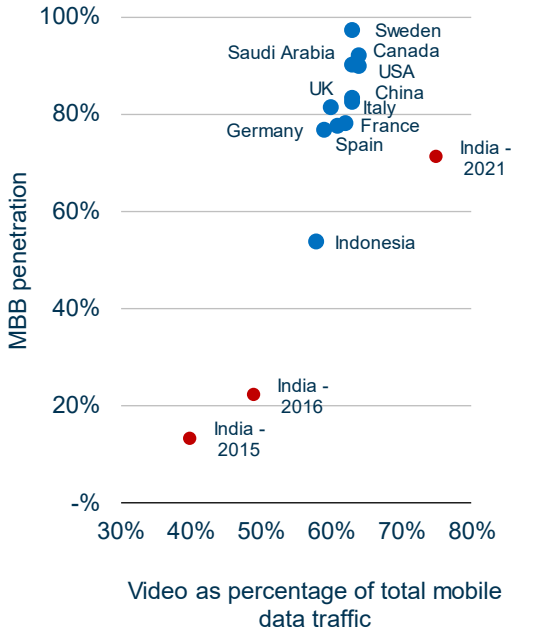


Figure 3.6: Share of video within overall mobile data traffic [Source: Cisco Visual Networking Index, 2017 and Analysys Mason, 2018]



Further, services focussed on rich media (predominantly video and graphics based) have also proven very popular with Wi-Fi users in train stations. This interest in rich media does not necessarily support productivity improvements of course, but help engage more and more people with the Internet. However, video-based rich media use cases are relevant in the context of the government's Digital India initiative including universal digital inclusiveness. Evidence from ongoing connectivity projects in India, as shown in the breakout box 'Potential of video and rich applications to foster online engagement and improve accessibility', depict the benefits of video and rich media applications in expanding outreach and accessibility in rural areas (due to high levels of illiteracy). The widespread availability of newer use cases for fast broadband such as video content through platforms and channels like YouTube, Hotstar, Netflix and Amazon Prime is also helping increase the consumption of data and such projects would enable India to achieve a higher MBB penetration, and reach levels similar to global benchmarks as shown in Figure 3.6.

13 Social networking: Facebook, Twitter, WhatsApp, Viber and other similar apps; Evolved productivity: Email, information search, online shopping, online banking, news and article browsing, e-ticketing, online navigation, downloading apps; Rich media: Online videos (streaming and downloading), online songs, online games, photo sharing, video calling

Potential of video and rich applications to foster online engagement and improve accessibility

The Ashwini project, is a rural connectivity project launched by a non-profit organization called the Byrraju Foundation, aims to provide broadband access to a collection of villages in the West Godavari district of Andhra Pradesh India. Access to Wi-Fi is provided to villages through a microwave backhaul relay from a fibre POP at a central village (which acts as a hub). The project relies heavily on interactive video applications such as e-education, e-healthcare and e-farming. The reliance on video gains significance in light of the illiteracy (inability to benefit from text based Internet use cases) of rural population. With e-governance delivery as its central focus, Project Ashwini leverages a Wi-Fi based model to drive forward the Digital India ambitions of the central and state governments such as digital inclusion and electronic delivery of services.

Key services include:

- Online education: video education classes on subjects such as English, Mathematics and Sciences
- Online health training: video based sessions and survey camps providing health information
- Agricultural information: video agricultural training and education for rural farmers in the villages

In addition to quantitative surveys, discussions with users of Railtel/Google Wi-Fi helped identify key productivity benefits experienced by users daily, driven by free high-speed Wi-Fi. Based on these discussions we have distilled fundamental productivity dimensions, illustrated in Figure 3.7, which can be unlocked by high speed public Wi-Fi.

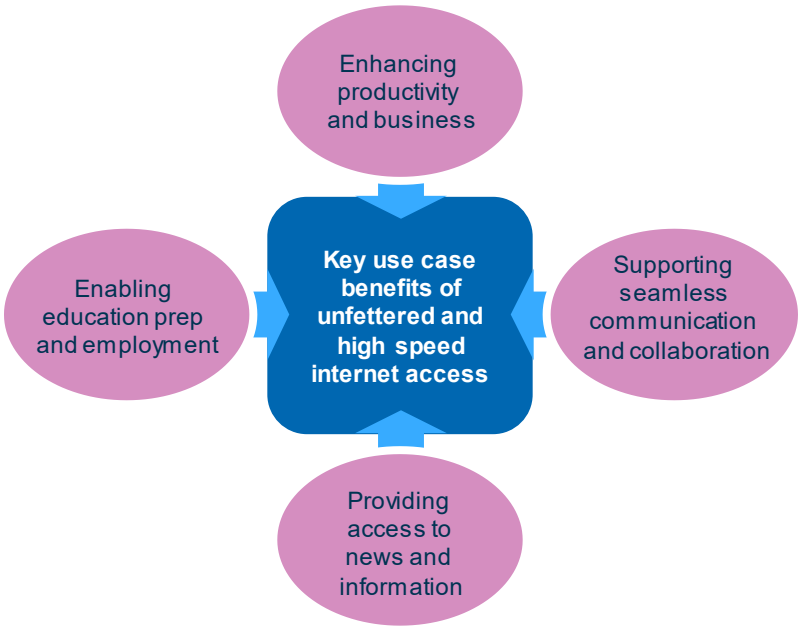


Figure 3.7: Productivity dimensions unlocked with high speed public Wi-Fi, observed in discussions with Railtel/Google Wi-Fi users [Source: Analysys Mason,2018]

These productivity dimensions are supported by discussions with actual users who have experienced productivity improvements in their daily life with the availability of free, unlimited access to fast broadband in Railway Stations. This was evident in the case of an Accountancy teacher, interviewed by IPSOS in Indore station, who was able to improve his productivity through online lecture preparation, grading and evaluation which was made possible by Railtel/Google high-speed Wi-Fi.

These dimensions are discussed in detail in the Figure 3.8 below, while detailed user discussions are presented in the breakout box 'Illustrative user stories: Rail Wi-Fi driving passenger productivity'.

Figure 3.8: Use case examples from the Railtel/Google high-speed public Wi-Fi project user survey [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

Productivity Type	Benefit	User Examples from Railtel/Google Free Wi-Fi Project
Enhancing productivity and business	*Enable users in better management of their livelihood, business and employment*	▪ Availability of free Wi-Fi on railway stations during business travel enable an Accounting teacher to improve his productivity, remain plugged into his work seamlessly without undue disruptions, and allow him greater time with his family
Supporting seamless communication and collaboration	*Promotes free flow of communication and collaboration among Internet users*	▪ Unfettered Wi-Fi enabled a 23 year old salesperson travelling on his first professional assignment to access and reply to his business-related e-mails on the go, without disrupting his work flow and productivity
Providing access to news and information	*Offers unfettered access to the information economy*	▪ Fast broadband through Wi-Fi enables a traveller from Punjab to Mumbai, an avid follower of news, to remain plugged into the information highway despite loss of normal cellular range during his train travels
Enabling education preparation and employment	*Enhances productivity of students and employment seekers*	▪ The Railways public Wi-Fi network, enabled a group of college students to access e-mails, complete several job applications and browse online resources to help in interview preparation, without putting more strain on their limited monthly budgets

The availability of high speed broadband in the form of free Wi-Fi not only has implications at a micro user level, but also at a macro level of an economy's GDP. These implications and the quantitative link between public Wi-Fi access and GDP of an economy and GDP per capita are discussed in greater detail later in the report in Section 4.4.

Illustrative user stories: Rail Wi-Fi driving passenger productivity

Enhancing productivity and business: An Accountancy teacher who travels daily from his home in Indore to his work place in Ujjain was interviewed for this study. His key challenges include insufficient time to prepare assignments and lecture notes, along with scarce family time on account of the travel-intensive in nature of his job. This implied unproductivity with delayed assignments and student grading. With the availability of free Wi-Fi in railway stations through the Railtel/Google project, he is now able to access his coaching centre's website to grade his students' assignments and browse through online resources to help prepare for his lectures more efficiently. This has further resulted in him being able to spend a greater amount of time with his family after returning from work.

Supporting seamless communication and collaboration: A 23-year-old sales person, travelling on his first professional work assignment, was interviewed. While he had access to a basic smartphone, purchased on the insistence of his manager to e-mail daily sales reports, being a first-time smartphone user, he maintained an economical and low quota mobile data plan. On a work-related assignment, his manager asked him to reply to an e-mail immediately, but with an exhausted data plan his options were limited. The availability of free public Wi-Fi on the railway station enabled him to access and reply to his business-related e-mails on time, without disrupting his work flow and productivity.

Providing access to news and information: This was evident in the case of a passenger traveling from Punjab to Mumbai, an avid follower of news, was also interviewed as part of this report. Given the inconsistent 2G and 3G mobile Internet connectivity, he could not always browse news websites seamlessly. Poor network quality resulting in longer webpage loading times and subsequent loss of interest were found to be some of his key challenges. The availability of public Wi-Fi at New Delhi railway station during his transit now enables him to quickly access relevant news articles on his mobile phone, pointing to the potential of Wi-Fi as a tool to increase user satisfaction, and to make users more informative and productive.

Enabling education preparation and employment: A group of college students were interviewed at an Indian Railways station during the process of publishing this report. They were applying to jobs through their campus recruitment channel. This time critical function required seamless cellular connectivity, since campus recruitment representatives communicated primarily through e-mails the availability of new job opportunities, dates of future interviews, resources for interview preparation, and other helpful career related information. Given their limited budget, few students were unable to maintain cellular data packages and consequently lost out. However, the Indian Railways public Wi-Fi network, enabled them to access e-mails, complete several job applications and browse online resources to help in interview preparation, without putting more strain on their limited monthly budgets.

3.2 Wi-Fi based Internet Service Providers (WISPs)

Wi-Fi based ISPs are benefitting from high-impact Wi-Fi connectivity projects rolled out in India such as the Railtel/Google high-speed Wi-Fi project

The Railtel/Google partnership is one high-profile example of a large-scale public Wi-Fi deployment. Concurrently, many Wi-Fi ISPs (WISPs) have been developing different business models to further the rollout and adoption of public Wi-Fi around the country as a means to increase broadband penetration. As a result, there is a concurrent spread of Public Wi-Fi operators in the country. Further, these WISPs are deploying varied business models driving at the same objective that the Railtel/Google high-speed public Wi-Fi project has been originally working towards – increasing broadband penetration in the country.

Based on industry discussions, initiatives such as the Railtel/Google project have had several key impacts and benefits on the Wi-Fi ISP ecosystem in India:

- **Marketing and end-user education:** high-profile Wi-Fi projects in India such as The Railtel/Google high-speed public Wi-Fi project have generated significant user interest and awareness regarding the potential of both broadband and that of Wi-Fi as an enabling tool. Wi-Fi focussed ISPs given their relatively smaller size and limited marketing budgets (many WISPs are focussed on rural areas in India where monetisation is challenging), the visibility created by large Wi-Fi projects is beneficial in propagating the Wi-Fi model amongst Indian, particularly first time, Internet users
- **Furthering Digital India objectives:** among the many objectives of Digital India two key Internet connectivity related pillars include broadband highways and public Internet access programme. High-visibility Wi-Fi projects act as viable proofs of concept for propagating Internet connectivity in a rapid, efficient and economical manner. For instance: few of the anchor clients for Bluetown include state governments and local political administrators offering Internet connectivity to their local constituencies, villages, schools, colleges, hospitals and tourist places
- **Spearheading positive regulatory changes:** the positive industry voice and discussion around needed regulatory reforms such as delicensing Wi-Fi spectrum, ecosystem collaboration, among others have received a significant fillip through the nationwide awareness created around Public Wi-Fi by high-visibility projects. These regulatory changes required to enable public Wi-Fi in India are discussed in greater detail in Section 3.4 of the report

Despite challenges such as monetisation, ISPs are increasingly realising the importance of high speed Wi-Fi as a potent means of last mile connectivity across India

Wi-Fi networks, deployed over unlicensed interference-prone spectrum and with shorter coverage radius, have traditionally not been considered the technology of choice by most operators. However, evidence from deployments by WISPs in India suggests judicious models have emerged which ensure a feasible business case. Two salient features emerge:

- Topography agnostic deployments: Breaking conventional rationale about rural deployments being economically unsustainable, rural focussed WISPs such as Bluetown and Air Jaldi have deployed sustainable networks in villages through value engineered networks and varied business models. On the other hand, urban focussed WISPs such as Ozone Networks have focussed on building strong venue partnerships to grow a sustainable deployment footprint

- Business models: Rural focussed WISPs have mainly relied upon the anchor customer model, where network deployment is centred around assured revenues from an institutional customer, while capturing additional demand from retail and footfall traffic. Urban WISPs on the other hand have relied upon venue owner partnerships and revenue share agreements

Key Wi-Fi based ISPs such as Bluetown, Air Jaldi and Ozone Networks which have played an important role in expanding Public Wi-Fi in India have been discussed in greater detail in the breakout box 'Wi-Fi Internet Service Providers (WISPs): Overview and Business Models'.

Monetisation of a public Wi-Fi service is essential to ensure self-sufficiency and adequate service quality which can sustain user interest and experience. Given the low ARPU levels in India (ARPU[14] in USD PPP[15]: India – 8, UK – 25, France – 25, USA – 41), it is not surprising for WISPs to witness challenging business cases in deploying sustainable Wi-Fi networks. Although primary survey of Railtel/Google high-speed Wi-Fi users indicates emerging user willingness to take positive actions supporting monetisation, as has been depicted graphically in Figure 3.9.

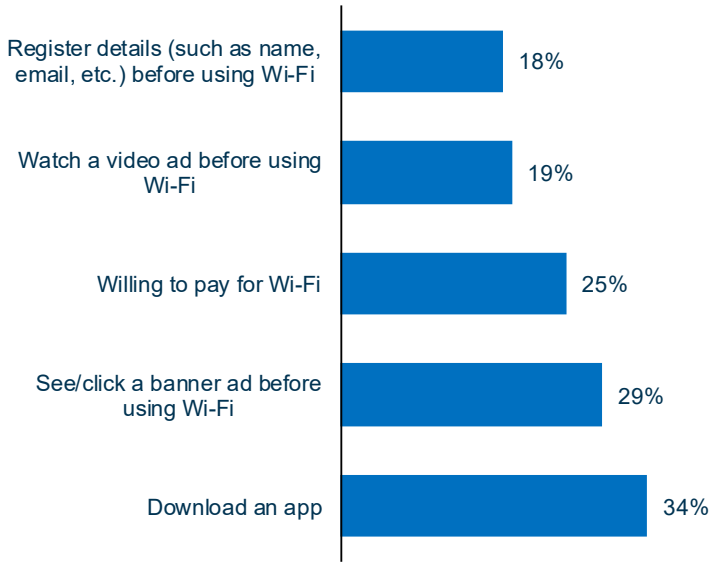


Figure 3.9: Percentage users willing to perform the corresponding activity while accessing Wi-Fi [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

Only a quarter of those interviewed, expressed a willing to pay for Wi-Fi services, reflecting that a relatively minor proportion of users are willing to increase their share of wallet for Internet services at adequate speeds. Further, around 30% users are willing to click on a banner advertisement, and

14 From GSMA Intelligence, corresponds to December, 2016

15 Refers to Purchasing Power Parity as reported by World Bank

about 20% users are willing to watch a video before logging into the Wi-Fi service which could be used by advertisers to gain from ad-revenues resulting from users clicks and views.

In terms of willingness to pay, the survey revealed that 40% users were willing to pay INR5 for half hour of Wi-Fi usage as shown in Figure 3.10. As per TRAI's consultation paper on the proliferation of public Wi-Fi in India,[16] the cost of providing Wi-Fi is INR0.02 per MB of data. Given that an average Railtel/Google Wi-Fi user consumes just over 300MB of data per session, the resulting cost per half hour of Wi-Fi delivery is ca. INR6. As seen in Figure 3.10, faced with a purchase decision, the ideal price point for one-thirds of users who are aware of the Railtel/Google Wi-Fi is higher than INR6, the break-even point for providing Wi-Fi services. Consequently, a positive business case of Wi-Fi deployment (cost less than ideal price point) can be theoretically ensured.

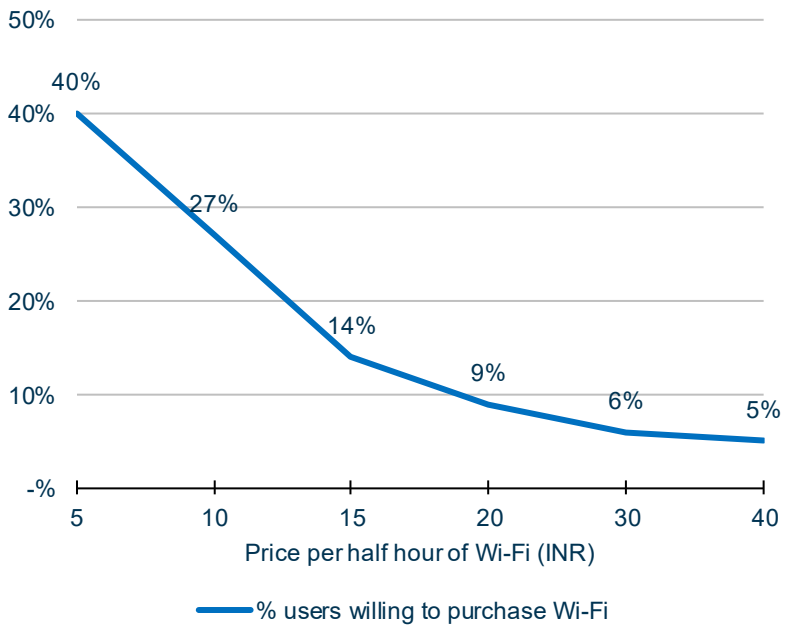


Figure 3.10: Users' willingness to pay for Wi-Fi services as observed from the Railtel/Google high-speed public Wi-Fi project [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

In the recent past, WISPs have been expanding their scale across the country. Air Jaldi, for instance, partnered with Facebook in its Express Wi-Fi initiative, to provide an affordable Wi-Fi solution offering Internet access to villages in Uttarakhand. Bluetown is increasing its reach through innovative partnerships with anchor users such as state governments.

Wi-Fi as a Service is another deployment model whereby a managed Wi-Fi network is rolled-out by the WISP and enterprises (including SMEs and start-ups) with limited capex resources can lease Wi-Fi connectivity through unique SSIDs.

Other players such as Google are productising their services through means which are in coherence with the suggested PDOA model[17] by TRAI. These means include monetisation through advertisements, pre-deployment support (site selection and Radio Frequency design), and post-

16 TRAI Consultation Paper on Proliferation of Broadband through Public Wi-Fi Networks, 13th July 2016

17 TRAI Recommendations on Proliferation of Broadband through Public Wi-Fi Networks, 9th March 2017

deployment support (using analytics and dashboards) and can provide a valuable stepping stone for venues or smaller ISPs in the ecosystem.

These efforts notwithstanding, the current Wi-Fi hotspot footprint of these WISPs is estimated to be around 25 000 only. In comparison, an estimated 0.8 million hotspots will be required for India to meet global average benchmarks of 1 hotspot for every 150 people.[18]

The above discussed bottleneck of inadequate monetisation calls for the need to explore additional means for enhancing the growth of public Wi-Fi deployment in India, such as venue owner partnerships. By introducing Wi-Fi in their premises, venue owners can reap multiple benefits such as increased customer satisfaction, better engagement, user stickiness, and higher store visits. These benefits are discussed in greater detail in the next section through the standpoint of Indian Railways and other Indian and International venues. Partnerships between WISPs and venue owners could pave the path to unlocking Wi-Fi deployment at scale in India, by ensuring commercial viability of Wi-Fi deployment for WISPs and venue owners.

18 TRAI Consultation Paper on Proliferation of Broadband through Public Wi-Fi Networks, 13th July 2016

Wi-Fi Internet Service Providers (WISPs): Overview and Business Models

Wi-Fi ISP		Description
Bluetown	*Overview*	• Bluetown is a managed Wi-Fi hotspot service provider offering connectivity through solar powered access points on existing telecom infrastructure • It has partnered with BSNL to expand Internet connectivity in Bihar, Jharkhand, Assam, and Andaman & Nicobar, and gets access to BSNL's tower and backhaul infrastructure for Wi-Fi deployment • BSNL has contracted deployment of ca. 25,000 Wi-Fi hotspots covering ca. 50,000 villages in India. Started in 2016, Bluetown currently has a small footprint of 75 Wi-Fi hotspots. The company plans to cover 2,500 hotspots in 2017 and 25,000 hotspots by 2020
	Business model	• Bluetown has two business models: anchor clients and retail customers – Anchor clients: Partnerships with anchor users such as state governments who fund the deployment of Wi-Fi in exchange for free access Wi-Fi to the public are growing – Retail customers: Village Level Entrepreneurs (VLEs) are entrusted with hotspot maintenance and sale of prepaid data packs priced at ~USD1.5 for 1 GB of data with 28 days' validity. Smaller data sachets are also available • Revenue sharing with BSNL enables commercial viability of the business model
Air Jaldi	*Overview*	• Air Jaldi is a Class A ISP offering Wi-Fi based Internet connectivity in remote rural areas of India such as Kangra Valley, Mandi and Jharkhand. It operates 11 networks in 7 Indian states, a combined coverage area of ~24,000 sq. km. and serves ~70,000 active subscribers • It leases bandwidth from Telcos and creates its own backhaul network, connecting the nearest PoP to its NOC, by deploying solar powered wireless relays mounted on poles. The network is value engineered to keep costs low
	Business model	• Air Jaldi's business model centres around finding an anchor customer who can guarantee a certain minimum threshold usage to make deployment of relays economically viable. Anchor clients include institutional customer such as microfinance institutions, business process outsourcing units (BPOs) and educational institutions • This institutional network enables coverage extension to households, markets and footfall traffic, by installation of hotspots at local retail outlets such as grocery stores. Local ecosystem partners such as grocery store or tea stall owners act as downstream distribution agents and maintenance teams for its networks. Typical data packs are priced at ~USD1.8 for monthly access to 1.5GB of data
Ozone Networks	*Overview*	• Ozone Networks is a neutral Wi-Fi service provider with ca. 6500 private and public hotspots deployed across 23 cities, and has an estimated footfall of 50 million per month on its network • Its deployment strategy is heavily reliant upon partnerships with venues such as coffee shops, restaurants, airports, education establishments, hotels, hospitals and commercial establishments
	Business model	• Unlike other players like Bluetown and Air Jaldi, Ozone focusses more on building partnerships with venues, and has a greater reach in urban areas • One of Ozone's selling points is its location based services, where users' location data is relayed to venue owners through analytics platforms. Venue owners then use this data to promote offers or engage with their end-customers based on their location • Further, Ozone monetises through a freemium model, where Wi-Fi is offered free for a limited duration, post which users are charged a certain fee for using Wi-Fi • Ozone's customised algorithms help it in advertising coupons from its partners, and capture revenues based on the coupons redeemed by the end-customer

3.3 Venue owners

Indian railways has benefitted from increased foot falls for merchants and better customer engagement for its passengers through introduction of high speed Wi-Fi

The introduction of high speed Wi-Fi has benefitted Indian railways in the form of direct benefits for its passengers and indirect benefits for its merchants. Several passengers who were surveyed have reported being better engaged, while several business opportunities have been presented to the merchants operating on railway stations due to the introduction of high speed Wi-Fi.

Figure 3.11: Benefits and use cases of high speed Wi-Fi for Indian Railways as observed in The Railtel/Google high-speed public Wi-Fi project [Source: Analysys Mason,2018]

Better engagement of passengers: Wi-Fi connectivity has enabled passengers to better utilize their idle travel time in productive tasks such as fulfilling unattended chores, and Indian Railways to better engage with their passengers and build a stronger brand image through a complimentary relevant service which benefits its customers in tangible ways. There is a virtuous link between better time utilization (enabled by free high-speed Wi-Fi) and satisfaction derived by passengers, which in turn benefits venue owners (such as airports and railway stations). Not surprisingly, most countries have invested behind Wi-Fi connectivity at airports and train stations (6062 such hotspots in Europe in 2017, with 2010 in North America and 490 in Australia. India still has a long way to go with only 130 comparable Wi-Fi hotspot deployments)[19]. In addition, with the advent of "bring your own device" approaches to IT, many venue owners could see benefits in making a wireless network available to their customers and staff, separately from the network they use for their own business use.

19 https://www.ipass.com/wifi-growth-map/

Illustrative user stories: Rail Wi-Fi driving passenger engagement

Multi-tasking: Rail travel usually provides passengers with a lot of free time which could be spent productively on multiple personal and professional endeavours, given the right enabling tools. Such an instance emerged upon discussions with a passenger from Patna, working in a paper mill in Delhi, who spent frugally on prepaid data plans to ensure sufficient remittance of his income to his family. Traveling to his family home in Patna after 18 months, he aspired to gift his father an appropriate present for his birthday, but due to the hectic nature of his work he had been unable to visit the market. Indian Railways' free Wi-Fi service at the station enabled him to browse multiple e-commerce sites and shortlist an appropriate gift to be delivered to his family home even before his arrival.

Better connectivity: Inability to speak to one's family for a prolonged duration could be an unfortunate societal barrier, especially if resulting from lack of sufficient network coverage and connection quality. Such a case emerged when a migrant worker from Bihar, who was traveling to Rajasthan for work, was interviewed. He hadn't spoken to his family for over 2 weeks due to poor network connectivity in their village. Adequate Internet bandwidth from the public Wi-Fi at Indian Railways accorded him the opportunity to communicate with his wife over a video call (IMO App), when the connection in his village was at last available. The passenger was immensely satisfied with the superior call quality, which he generally never experienced over cellular networks

Better business opportunities for merchants: Wi-Fi connectivity has also resulted in productivity for the merchants of Indian Railways. With more avenues to expand into current or related business areas, or greater general productivity in managing day to day work affairs, merchants operating on Tran Stations are benefitted which in turn benefits Indian Railways through greater stakeholder satisfaction, higher revenues and generally enhanced prosperity.

Figure 3.12: Business opportunities presented to merchants by the Railtel/Google high-speed Wi-Fi project [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

Business impact	User Examples from Project Nilgiri
Expansion of the current business	▪ Access to free Wi-Fi in the railway station enabled a chemist to install Paytm on his phone, and the acceptance of digital payments resulted in the growth of his business
Expansion into new businesses	▪ Access to free Wi-Fi enabled a book-stall owner to expand his business by offering digital payment services such as mobile and DTH recharges
Provision of complimentary services resulting in indirect business growth	▪ Availability of Wi-Fi helped a refreshment-stall merchant to become the go-to person for passengers and porters to receive updates on train schedules. These passengers also ended-up purchasing refreshments from the stall, thereby boosting his business
Increased productivity	▪ Access to real time information on train schedules due to Rail Wi-Fi enabled a porter to reduce his time spent anticipating the arrival of trains, and helped him better plan his day

Illustrative user stories: Rail Wi-Fi driving businesses for merchants

Expansion of the current business: Broadband connectivity through complimentary public Wi-Fi allows merchants to leverage emerging economic and digital trends for the betterment of their business. A shopkeeper operating a chemist shop on a station benefitted from the growing popularity of digital payments by tying up with Paytm. After receiving adequate training, the merchant started accepting digital payments and offering customers the facility to recharge their mobile packs as well. Having gained popular appeal post de-monetisation, digital payments continued to remain relevant for the chemist given the hassle for passengers to arrange petty-change within short transit times. Consequently, the merchant's business has grown significantly post introducing digital payments and as much as 40% of his total transactions are currently through the mobile wallets.

Expansion into new businesses: Many small-time merchants operating on Indian Railways' stations routinely look for ways to extend their business in similar or related areas and augment their incomes. One such merchant who owned a bookstall wanted to expand his business, and provide better means for his daughter's education. However, he couldn't find any opportunities which allowed additional business from the confines of his existing business premises. With the availability of Wi-Fi at the railway station and the Myrecharge App, he started providing mobile and DTH recharge services, along with providing money-transfer facilities through Internet banking. Over time his primary as well as secondary revenue streams improved significantly, since passengers looking for mobile plans recharge or money transfer services also ended up purchasing books from his stall.

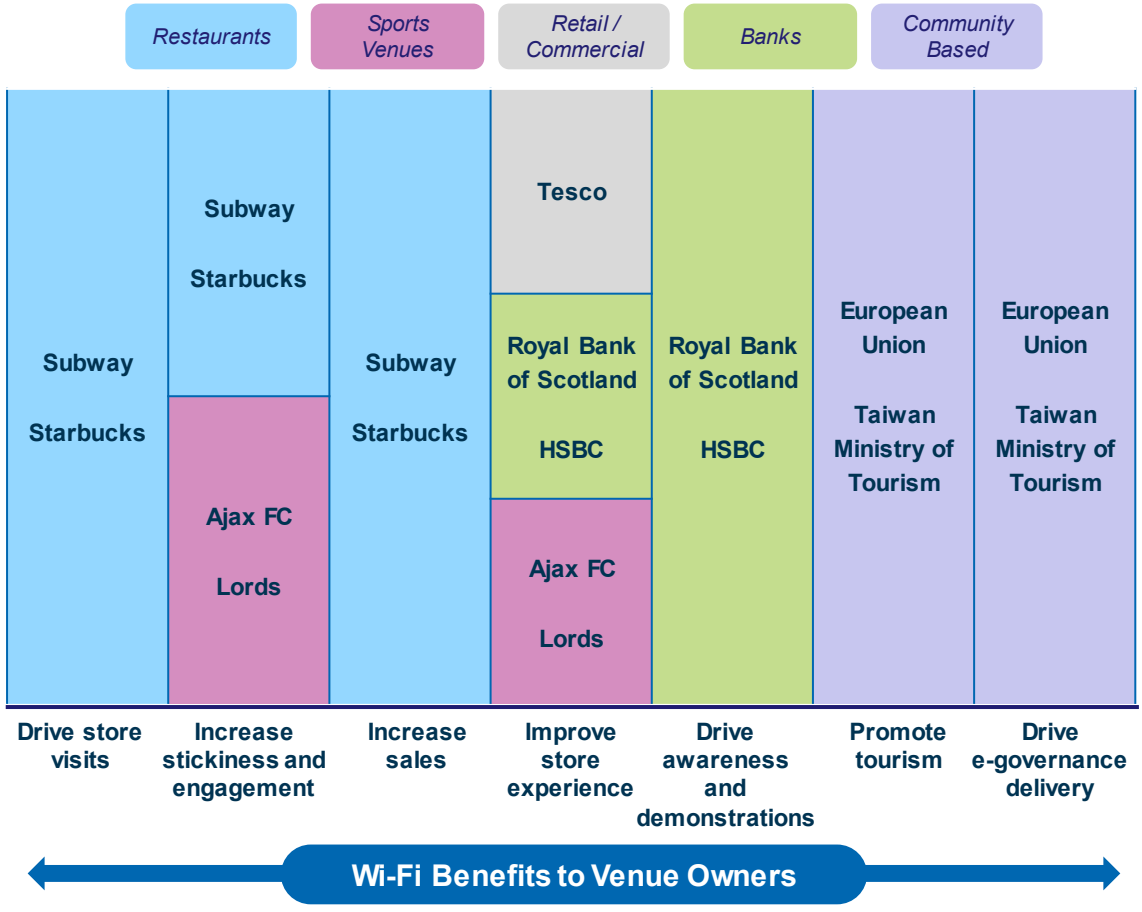
Provision of complimentary services resulting in indirect business growth: Socially well connected merchants, if adequately enabled, can act as change agents for venue owners as was depicted by a refreshment stall owner on an Indian Railways platform. The merchant having recently purchased a smartphone, and gaining access to the railway's Wi-Fi network at station, initiated a regular practice of browsing through websites to remain updated on train schedules. His stall is now heavily frequented by both passengers and porters to receive the latest updates on train schedules. Enquiring passengers also usually also end-up purchasing refreshments from his stall, resulting in significant growth in his business over time.

Increased productivity: Increasing productivity of venue owner's ecosystem stakeholder is another possible benefit of public Wi-Fi. In one of the interviews, a porter mentioned how the availability of Wi-Fi resulted in him being able to better plan his daily schedule. Before the presence of Wi-Fi at the station, he used to wait for long periods of time anticipating the arrival of a train, many a times resulting in him skipping his meals. With the availability of Wi-Fi and a smartphone, the porter has become self-empowered and is now able to regularly check arrival and departure times of trains to support his livelihood, become more productive, and manage his day more efficiently.

Evidence from international markets suggests that varied venue owners have reaped multiple benefits from the introduction of high speed Wi-Fi for their users

Globally, Wi-Fi has been one of the preferred modes of Internet access for over two decades. Wi-Fi deployment has received a proactive push from multiple stakeholders including Internet users, governments, regulators, venue owners and Telcos. Venue owners, in particular, have explored various business models for effective deployment of public Wi-Fi. Several international examples corroborate the benefit of deploying public Wi-Fi as shown in Figure 3.13.

Figure 3.13: Articulated benefits of public Wi-Fi to venue owners from international case studies [Source: Analysys Mason, 2018]



Key benefits accruing to venue owners from Wi-Fi deployments can be broadly bucketed into seven categories. Detailed international case studies of Wi-Fi deployment by venue owners are presented in the breakout box 'International case studies of Wi-Fi deployment by Venues' in Annex B.2.

- **Drive store visits** – free Wi-Fi helps drive customer visits to store, since, ceteris paribus, users prefer stores offering Wi-Fi compared to those that do not
- **Increase stickiness and engagement** – customer loyalty could be increased by bundling exclusive content platforms with products or services (e.g. Starbucks). Wi-Fi could also strategically promote brands on social media through customers' activity (Facebook or Twitter)

- **Increase sales** – free Wi-Fi could be an effective strategy to ensure customers spend more time at the store, and in turn end-up purchasing more products or services (e.g. coffee, beer, food)
- **Improve store experience** – Wi-Fi can help customers make informed purchase decisions through online browsing, price comparisons and product feature demonstrations
- **Drive awareness and demonstrations** – Wi-Fi could be used by stores to educate their customers about their products or services (e.g. banking or investment products)
- **Promote tourism** – Countries, states and cities offering seamless public Wi-Fi are tourist friendly, especially when the tourists cannot speak the local language(s)
- **Drive e-governance delivery** – Wi-Fi could be used to drive services such as e-governance, e-health, and e-farming, by local and central governments

Within India, WISPs and venue owners are engaging in innovative partnerships to maximise the utility from Wi-Fi services. WISPs are supplementing their freemium Wi-Fi services (where users receive free Wi-Fi for a limited time after which they are charged for Wi-Fi usage) with value added services. For instance, WISPs are offering location based services through Wi-Fi and receive a share of revenues from the venue owners. Through these services, customers who visit a venue owner such as a restaurant chain for the first time are required to login to the Wi-Fi service. Customers are automatically connected to the restaurant's Wi-Fi during their subsequent visits. The restaurant can then use the data on customers' location, and send push notifications on their mobile phones to offer free food or beverages, to introduce new offerings specific to the geography, and even to advertise discount coupons from other retailers. In addition, venue owners gain from access to valuable customer data such as their demographics and purchase history, which could be used to effectively market targeted solutions specific to their customers.

The break-out box 'Wi-Fi deployment by Venues in India: The case of Café Coffee Day' elucidates one such case of Wi-Fi roll-out as seen in the case of Café Coffee Day outlets in India.

Other venues such as banks, retail and commercial properties, and airports stand to gain significantly from offering Wi-Fi services to their customers. Some of the examples include:

- Deployment of Wi-Fi inside bank branches could facilitate a mechanism for banks to interact with their customers, educate their customers about their digital products, and hence increase the adoption of digital banking services. International examples as shown in Annex B.2 provide evidence for this hypothesis, and Indian banks such as Axis Bank[20] are increasingly recognising the importance of Wi-Fi by deploying hotspots in their branches.
- Commercial real estate properties housing retail outlets represent another set of venue owners who could deploy Wi-Fi to drive sales by enhancing customers' in-store experience. Access to in-store Wi-Fi helps users to access product information and reviews online, use digital payment

20 http://www.dqindia.com/axis-bank-launches-free-wi-fi-service-across-128-branches/

channels for payment (through wallets such as Paytm in the context of India), and also offers the stores the option to promote their offerings. Adoption of Wi-Fi by premium commercial real estate properties is gaining traction, and examples include Ambience Mall in Delhi, High Street Phoenix Mall in Mumbai, Orion Mall in Bangalore, and Phoenix Market City Mall in Chennai.

- Offering free Wi-Fi at airports could result in benefits accruing from real-time marketing of offers by outlets such as restaurants, retail and duty free shops. Major airports in India in cities such as Delhi, Mumbai and Bangalore offer free Wi-Fi for a limited time, and other airports are releasing RFPs for deploying Wi-Fi services.

Wi-Fi deployment by Venues in India: The case of Café Coffee Day

Café Coffee Day (CCD) is a café chain of over 1500 outlets throughout India. CCD service offering focuses on coffee, food and a comfortable ambience at affordable prices, primarily targeting the younger demographics. CCD offers free Wi-Fi at its outlets, with at-least 10-15 seating capacity (excluding the Express CCD outlets). Customers who place an order at the billing counter are provided with a voucher code for accessing Wi-Fi for up to 30 minutes of usage. Upon the completion of 30 minutes, customers may either opt to place another order for food or beverages, or purchase a Wi-Fi plan separately.

Restricting the availability of free Wi-Fi just to the customers who place an order for food or beverages ensures that CCD selectively entertains the purchase of its products. Besides, CCD is a popular hangout place for the younger demographics, and hence a significant proportion of customers who stay for a longer time eventually place another order, thereby getting access to 30 minutes of free Wi-Fi simultaneously. CCD also stands to benefit from analysing data on customer purchase behaviour, and uses its Wi-Fi login portal as a platform to promote its products and merchandise.

As discussed in Section 3.2, Wi-Fi hotspot deployment in India is challenging because of difficulties in monetisation. Low ARPU levels coupled with low willingness to pay for public Wi-Fi constraints deployments. Venue owners in India are also averse to the idea of sharing infrastructure and roll-out costs. Discussions with WISPs revealed venue owners (in hospitality and travel) pressing for monetary incentives or Minimum Monthly Guarantees (MMGs) for direct revenue to facilitate Wi-Fi partnerships. Other challenges that are faced by WISPs include

1. Bearing the entire upfront capex including the installation of access points and leased line for Wi-Fi deployment
2. Bearing the entire opex including manpower for Wi-Fi deployment

Even in cases of initiatives involving the societal objective of increasing broadband access such as the recently released E-tender for license for providing Wi-Fi at Pune airport, service providers were mandated to pay an MMG of INR 10 000 per month[21], which was further subject to annual

[21] http://www.aai.aero/tenders/WIFI_Oct2016.pdf

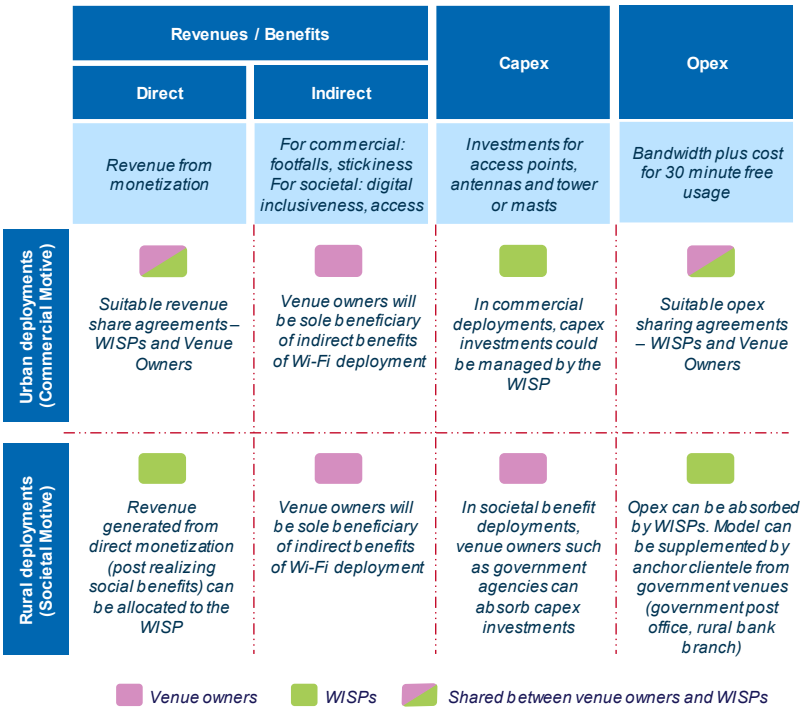
escalation of 10%. Such mandates could make it difficult for a single stakeholder (WISPs) to independently resolve the deployment conundrum.

This inherent tension between offering a low-cost service to end users on the one hand, and economically viable deployments on the other, calls for pragmatic partnerships between WISPs and venue owners. This can enable synergies and economically feasible business models in otherwise unprofitable scenarios. This will enable rapid deployment of Wi-Fi hotspots in the country and unlocking ecosystem benefits for all parties including WISPs, venue owners, Internet users and the government.

- For commercial deployments, direct revenues could be shared by WISPs and venue owners, while indirect revenues or benefits typically accrue to the venues. Further, upfront capex installation could be absorbed by WISPs while operational expenditure could be shared between the two parties
- For deployments with a societal motive, direct benefits could fully be allocated to WISPs while indirect benefits accrue to government venues. For costs, the venues could help subsidize the cost of upfront capex, while WISPs could foot the bill for opex. Government venues could also guarantee connectivity revenues for WISPs from anchor contracts

Figure 3.14 delineates possible partnership models that could be explored by venue owners and WISPs to proportionately split benefits and costs in a profitable yet sustainable manner.

Figure 3.14: Possible partnership models for Wi-Fi deployment between Venue Owners and WISPs [Source: Analysys Mason, 2018][2223]



An example of an innovative model for propagating low-cost edge connectivity is Railtel's 'Railwire Saathi'[24] initiative, presented below, It proposes a sustainable business model for rural Wi-Fi deployments that could serve as a model case study for future projects.

22 Even for most "Societal Motive" deployments capex and opex are being borne by WISPs, as is evident from the example of Pune Airport quoted above

23 Proposed capex investments will only include access point and CPE (Customer Premise Equipment) capex, and assumes that the backhauling fibre link and infrastructure is already present at the venue

24 For more details, see: http://www.hindustantimes.com/india-news/railwire-saathi-wi-fi-kiosks-at-500-remote-railway-stations-for-e-services/story-iNWWkFXcjRdLtdqq1aOxiP.html

Railwire Saathi: a sustainable model for propagating low-cost edge connectivity

Key challenges in bridging India's rural connectivity woes have hitherto included non-availability of reliable and low-cost bandwidth, and lack of well-thought out business models aiding sustainable connectivity investments. Railtel's Railwire Saathi is a rural focussed connectivity project aimed at offering solutions to both of the above connectivity challenges.

Railwire Saathi aims to replicate the Public Call Office (PCO) model for deepening penetration of broadband in India, through the public Wi-Fi model. The project aims at enabling Wi-Fi kiosks, through Railtel's ubiquitous fibre backhaul network, across rural areas and villages to offer digital services such as e-commerce, banking, medicine, education, and a myriad of e-governance services. The project targets rural folks, preferably women, as village level entrepreneurs to drive adoption. Facilitated with training programs (designed by National Skill Development Corporation), certification and business finance these village entrepreneurs will be empowered to operate digital kiosks as means of livelihood and expanding digital connectivity in the country.

Railwire Saathi is expected to be a sustainable model which can help continue the advance of public Wi-Fi connectivity beyond the 400 station footprint of the Railtel/Google Wi-Fi project.

3.4 Regulatory drivers and barriers

Positive regulatory push towards Wi-Fi has laid the initial groundwork for developing the public Wi-Fi ecosystem in India

A positive and pragmatic regulatory framework for the Wi-Fi industry is a must as it ensures that the demand and supply ecosystems are adequately empowered, undue restrictions to innovation are removed while investments and partnerships are encouraged which can further the development of Wi-Fi deployment across the nation. In the last few years, the telecom regulator, in conjunction with the government, has instituted positive policy development towards the deployment of Wi-Fi, and this has been pivotal towards encouraging deployment of Wi-Fi by Telcos and ISP, adoption by Internet users, and fostering partnerships such as The Railtel/Google high-speed public Wi-Fi project.

Key initiatives supported by the regulator, policy makers, government and academics that have contributed to positive developments in the Indian Wi-Fi ecosystem include:

- A nationwide backhaul network capable of supporting broadband speeds at costs that are reasonable in view of the business case, enabling positive returns for relatively rural Wi-Fi deployments with low revenue potential
- Well-articulated policy, clearly attributing accountability within specific government departments for swift allocation of Right of Way and rationalization of ROW costs, thereby helping the business case for Wi-Fi networks currently challenged with low monetisation

- In line with international markets, maintaining key Wi-Fi spectrum in 2.4 and 5GHz unlicensed, to ensure adequate ecosystem development; however further effort is needed in this direction

► *BharatNet: Nation-wide backhaul connectivity platform*

BharatNet is aimed at ensuring fibre deployment across the country to most of the 250,000 Gram Panchayats (while connecting the remainder with microwave radio links and satellite), thereby providing access to broadband even in areas where the private sector would not normally invest for lack of a viable business case. Similar to the availability of fibre backhaul from Railtel being a key enabler of the success of the Railtel/Google high-speed public Wi-Fi project, BharatNet's ubiquitous fibre footprint will be pivotal towards the deployment of similar Wi-Fi based last mile access models expected to be deployed by multiple Wi-Fi based ISPs (WISPs), Common Service Centres (CSC) and Village Level Entrepreneurs (VLEs).

This hypothesis is strongly supported by a commercial analysis of BTS deployment costs in urban versus rural areas, and a further comparison of deployment cost with traditional means (BTS) and Wi-Fi as last mile access. With significantly high cost of deployment in rural areas, telecom operators' BTS deployment business case becomes unfeasible with backhaul being a large chunk of the cost. With BharatNet backhaul availability and innovative last mile access means such as Wi-Fi, the overall deployment cost is brought down significantly ensuring broadband demand is effectively unlocked in the grassroots.

Figure 3.15: Comparative deployment cost of urban and rural sites [Source: Analysys Mason, 2018]

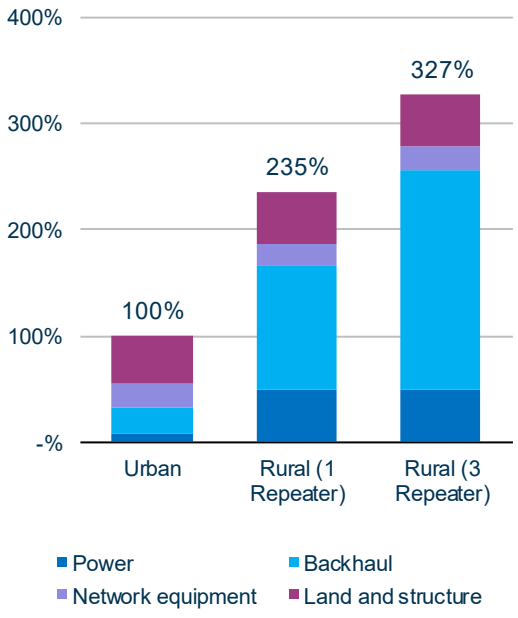
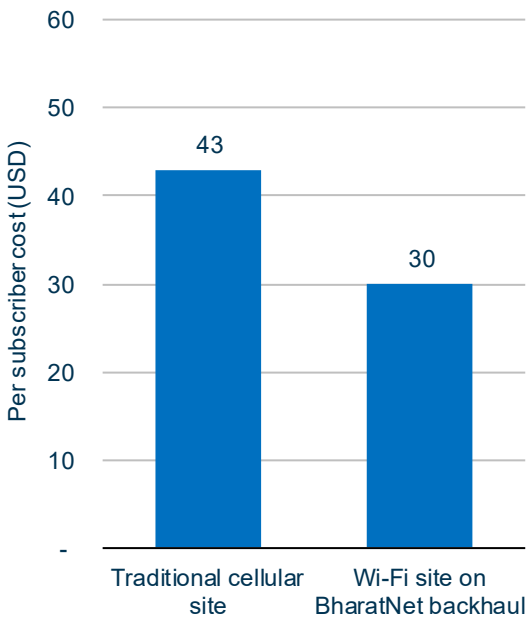


Figure 3.16: Per-subscriber cost of various deployment models [Source: Analysys Mason, 2018]



However key implementation modalities of the BharatNet project need timely execution to ensure the initiative remains timely and meaningful for the ecosystem's development, as is emphasised in the next section.

► *Comprehensive and clearly articulated Right of Way Policy*

Supporting high broadband speeds with ever increasing Internet usage levels, propelled by productivity and rich media use cases, is dependent upon an efficient backhaul network. Backhaul connectivity in India predominantly uses microwave technology, which is constrained by spectrum and has a technological limitation for supporting high throughput levels. Optical fibre is a viable alternative for backhauling higher traffic and throughput levels thereby unlocking true broadband connectivity, but only around 15% of the mobile towers in India currently have optical fibre backhaul.

A key bottleneck for large scale, rapid and economically feasible deployment of fibre backhaul is access to government permissions better known as Right of Way (ROW). ROW clearances in India have been marred with procedural delays, bureaucracy, red tape, fragmented rules and regulations and multiple clearance agencies and unclear accountability. Further when ROW is granted, charges typically tend to be astronomical in many parts of India, varying from a few thousand dollars to upwards of USD200 000 per kilometre (such as in South Mumbai) of fibre depending on the municipal body.

Rationalisation of ROW policies, by the Ministry of Communications through Department of Telecommunications' Indian Telegraph Right of Way Rules 2016, is be an important step in removing this bottleneck. The recently approved Right of Way (RoW) rules are a key enabler for expediting the deployment of underground (optical fibre) and over ground (mobile towers) infrastructure in India. The rationalisation of administrative expenses across the country, development of an electronic application process within one year of the roll-out of ROW rules, single clearance window for application, designation of nodal officers for appropriate authorities and fast-tracking decision on RoW permits to within 60 days after application are expected to facilitate transparent, economical and rapid rollout of fibre backhaul. There rules also indicate rationalization of ROW costs, which would be beneficial for most Wi-Fi focussed deployments in the country as in the current scenario monetisation is relatively challenging (as explained in Section 3.2.)

► *Unlicensed Wi-Fi spectrum*

Free and de-licensed spectrum availability has been a major driver of Wi-Fi take-up across the world, leading to global economies of scale and mass production of Wi-Fi equipment which drove down the cost of Wi-Fi (access points, chipsets) devices thereby reinforcing the virtuous cycle. India has harmonized its Wi-Fi de-licensing policy to global best practices, albeit partially, with TRAI recommending phased de-licensing of key Wi-Fi bands since 2004.

The table shows the current unlicensed spectrum map in India which has been a key driver of public Wi-Fi take up:

Figure 3.17: Assessment of spectrum frequency bands used for deploying Wi-Fi [Source: TRAI Consultation Paper on Proliferation of Broadband through Public Wi-Fi Networks, 2017]

Frequency Range (MHz)	Maximum EIRP[25]	Remarks
2400 – 2483.5	4W	Can be used indoor as well as outdoor
5150 – 5350	200mW	Outdoor use is permitted in 5150 – 5250 MHz range, but it is not license-exempt
5725 – 5875	200mW	Outdoor use is permitted in 5725 – 5825MHz range, but it is not license-exempt
5825 – 5875	4W	Can be used indoor as well as outdoor

Regulators can do more to support public Wi-Fi deployment

Despite the above development in the Indian regulatory space, further positive regulatory changes are needed for the betterment of the Wi-Fi ecosystem. This is due to the rapid pace of Internet usage growth and growing popularity of Wi-Fi (as a viable last mile access solution), as evidenced by the positive impact of the Railtel/Google high-speed public Wi-Fi project and other similar public Wi-Fi initiatives in India. This section highlights such positive regulatory recommendations which are required to unlock the true potential of Wi-Fi in India.

Regulatory intervention in the form of flexible and forward thinking policy reform is much needed to ensure propagation of public Wi-Fi ecosystem in India. Based on discussions with multiple stakeholders in the regulatory, academic and policy regime in India, we have categorized required regulatory reform in the following buckets:

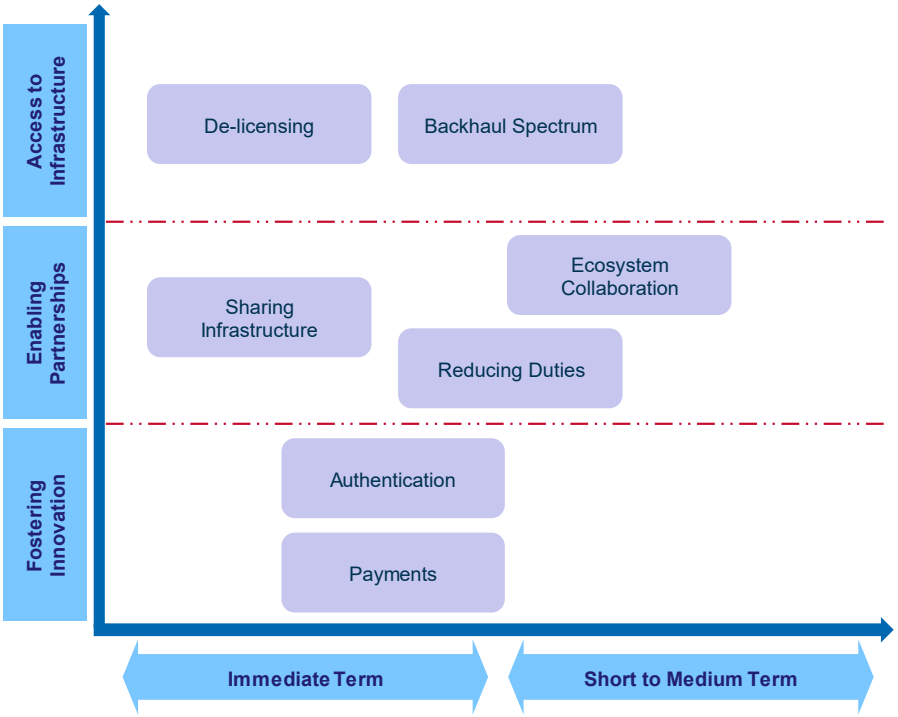
- Access to government infrastructure: such as Wi-Fi and backhaul spectrum
- Enabling partnerships: between Wi-Fi and telecom operators, between government departments and ministries and between various participants in the Wi-Fi delivery ecosystem such as WISP, aggregators, payment and authentication providers, Telcos, etc.
- Fostering innovation: for ensuring development of key enablers of Wi-Fi delivery such as payments and authentication

Further, some of these reforms are critical and long-pending such as de-licensing of Wi-Fi spectrum, while others are quick fixes which can help unlock growth of public Wi-Fi with minimal regulatory and governmental effort. These have been identified as falling under our immediate and short term focus recommendations. On the other hand, some reforms would require intricate thought and coordination between multiple stakeholders and would require a longer time to fruition. These have accordingly been classified as medium term regulatory reform projects. Figure 3.18 provides an overview of the above discussed regulatory reforms, along recommended implementation timelines.

25 Refers to Effective Isotropically Radiated Power, the maximum power that could be radiated from a Wi-Fi access point

Further, it is encouraging to see that the TRAI has already recommended several of these key initiatives to the DoT[26].

Figure 3.18: Recommended regulatory reforms for unlocking Wi-Fi growth in India [Source: Analysys Mason, 2018]



- De-licensing Wi-Fi spectrum and liberalising technical usage: De-licensing spectrum in the 5.1 – 5.3 and 5.7 – 5.8GHz band for outdoor usage will ensure greater availability of Wi-Fi spectrum for traditional offloading in urban area and hotspot deployment in rural areas, and will relieve congestion in the 2.4GHz band. Further removing technical limitations on radiated power will also help in making Wi-Fi deployments commercially viable.

- Making more EHF spectrum available: V-band (60GHz) and E-band (71 – 76GHz and 81 – 86GHz)[27] should be made available to enable backhaul wireless deployment thereby relieving capacity constraints on existing microwave based backhaul links. A de-licensed and a light licensing framework could be explored for these technologies in line with international precedents.

- Sharing of Wi-Fi infrastructure to promote neutral networks: Modification of DOT's current active sharing rules or clarification to explicitly allow sharing of active components between Wi-Fi operators to enable economies of scale and partnership synergies.

- Ecosystem collaboration for Wi-Fi delivery: In line with the recommendations of the regulator, a hub based model for Wi-Fi delivery including upstream bandwidth providers, Wi-Fi

26 TRAI Recommendations on Proliferation of Broadband through Public Wi-Fi Networks, 9th March 2017

27 For more details, see http://www.analysysmason.com/Research/Content/Reports/Spectrum-management-approaches-for-E-BAND-7080GHz-in-selected-markets/

aggregator and downstream Wi-Fi networks will be most suited for India. Light licensing and allowance of outsourcing would be required to enable successful implementation of this model.

- Reducing import duty burden: Rationalization and reduction of duties will be most beneficial to kick starting the next phase of growth in Wi-Fi deployments in the country.

- Robust payments framework: Allowing regulatory freedom to the market to evolve innovative payment solutions such as UPI and wallets, and not mandating any specific platform is required from the regulator. Also, regulations on the usage of specific tools such as Direct Carrier Billing towards inter-operator payments (for services such as Wi-Fi) are not clear, and liberalizing the usage of such platforms will ensure that the micro and digital payments conundrum is effectively addressed.

- Seamless authentication infrastructure: The regulator should allow the market regulatory freedom to weave innovative solutions to seamless authentication. Service providers should be given the flexibility to adopt technologies such as EAP-SIM based authentication which offer users the convenience to login seamlessly while also simultaneously ensuring the necessary compliance for security purposes, instead of being mandated to implement OTP-based authentication. Further from the government side, creation of a unified ecosystem for authentication leveraging Application Program Interfaces (APIs) implemented for e-Know Your Customer (eKYC) can enable rapid Wi-Fi take-up.

Globally, in countries like USA, France and Australia, regulators have implemented robust policies[28] to increase Wi-Fi adoption. Detailed description of these reforms is provided in Annex B.1.

28 Some of these policies include the delicensing of 5GHz frequency bands, a light-licensed framework for E-band, making V-band license exempt, supporting the usage of Direct Carrier Billing (DCB), and promoting the usage of EAP-SIM based authentication for simpler Wi-Fi login

4 Public Wi-Fi in the broader connectivity ecosystem: driving demand, connecting Digital India

This section of the report focuses on a systematic analysis of the key ecosystem benefits accrued to the broader industries of mobile telecoms and handsets. We conduct a thorough evaluation of this model project to understand the impact of the proliferation of public Wi-Fi on the industry revenues, and also highlight the fact that such public Wi-Fi initiatives support the government's thrust towards Digital India initiatives.

4.1 Broadband users beyond the public Wi-Fi footprint

High-speed broadband Internet access with Wi-Fi is stimulating demand for broadband data more broadly in the connectivity ecosystem outside railway stations

The availability of high speed Wi-Fi at stations has revealed significant appetite for data consumption in terms of traffic and time spent by users online, as illustrated in Section 3.1. Further, unfettered fast broadband is also helping migrate usage habits gradually towards more evolved use cases with efficiency and rich media focus.

One of the most significant impacts of the Railtel/Google high-speed Wi-Fi project has been the broader spill-over effect of Wi-Fi availability on user behaviour *outside* railway stations. While increasingly acknowledging the benefits of Internet, surveyed users of Railtel/Google high-speed Wi-Fi indicate willingness to consider broadband positively outside stations as well (either purchasing a new Internet connection by non-users or upgrading usage by existing Internet users).

In rural areas, MBB penetration is significantly lower than average, constrained by supply side issues such as lower MBB network coverage as shown in Figure 4.1 and Figure 4.2. Tier-2 and Tier-3 cities share demographic and socio-political characteristics with rural areas, and users from Tier-2 and Tier-3 railways stations portray a more positive outlook towards the usefulness of the service to access the Internet, compared to users in Metro and Tier-1 railway stations. This further indicates that Tier-2 and Tier-3 areas could witness a significant push in terms of broadband penetration, if the users from these cities are provided with experience to high speed Internet through means such as public Wi-Fi.

Figure 4.1: Share of MBB subscribers split across urban and rural areas [Source: TRAI, Analysys Mason, 2018]

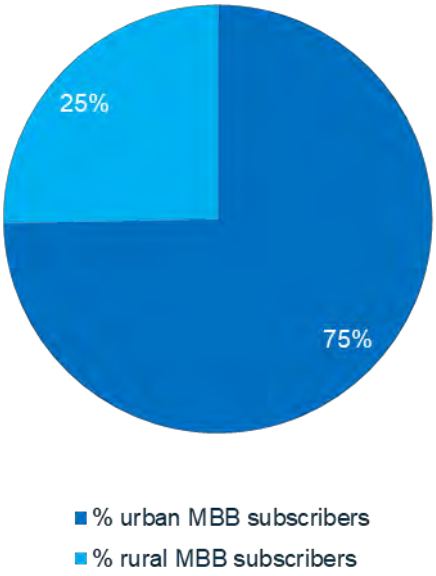
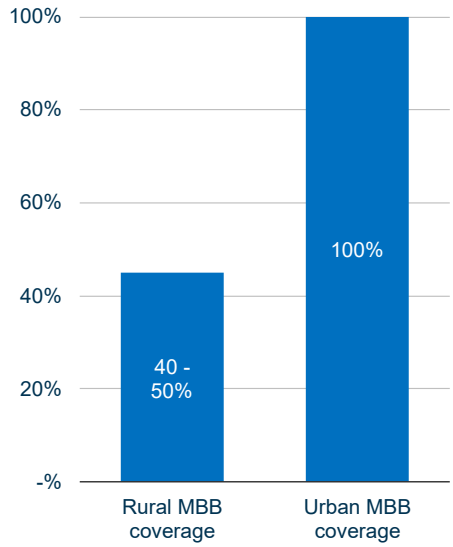


Figure 4.2: Population coverage of MBB networks by leading incumbent operators across urban and rural areas in India [Source: Analysys Mason, 2018]



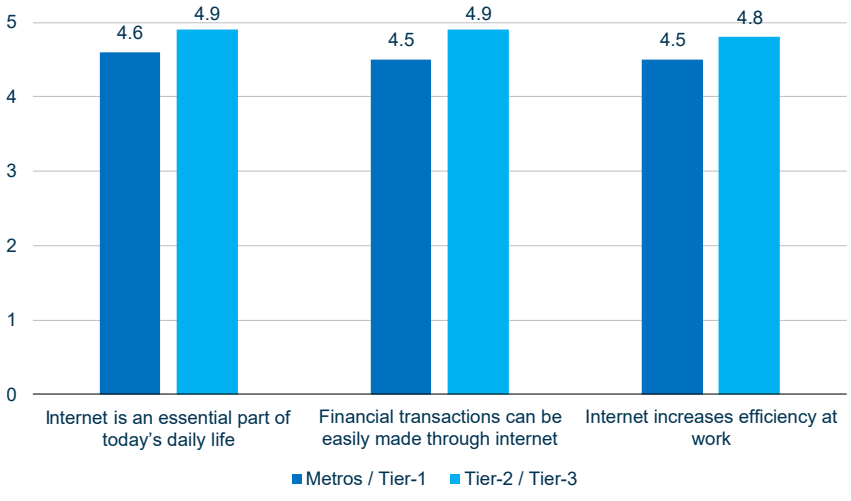


Figure 4.3: Perceptions on the usefulness of Internet across city-tiers [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

Primary survey discussions with users at Railtel/Google in connected railway stations show that many users are keen to use the Internet outside stations because of their experience in the stations. After experiencing free high-speed Wi-Fi, nearly 65% of the surveyed primary users expressed willingness to take positive action to continue experiencing high speed Internet outside stations also. Details around the specific positive actions and analysis supporting our estimates of free high-speed public Wi-Fi's impact on multiple stakeholders is discussed in the next sub-section below.

Having tried unfettered high speed Internet access first hand, users appreciate the value of high speed Wi-Fi and are willing to pay for it outside railway stations

As discussed above, after experiencing high speed Internet through Rail Wi-Fi, 65% of the survey respondents indicated a willingness to take one of the following positive actions required to continue access to high speed Internet outside railway stations:

- Purchase a new mobile broadband connection
- Upgrade their existing mobile broadband connection
- Upgrade their existing smartphone

This is depicted in detail in Figure 4.4 and Figure 4.5 below. Access to high speed Wi-Fi resulted in ca. 15% respondents indicating willingness to purchase a new MBB SIM and ca. 5% respondents indicating willingness to upgrade their current plans to ensure access to faster data speeds, by spending an additional ca. USD2.2 to USD2.3 per month on MBB data. Also, ca. 14% of the respondents expressed a willingness to upgrade their smartphones after experiencing high speed Wi-Fi, with an additional monthly spend of USD5.9 towards upgrading their handset.

Figure 4.4: Percentage of users willing to take an action after experiencing high speed Wi-Fi[29] [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

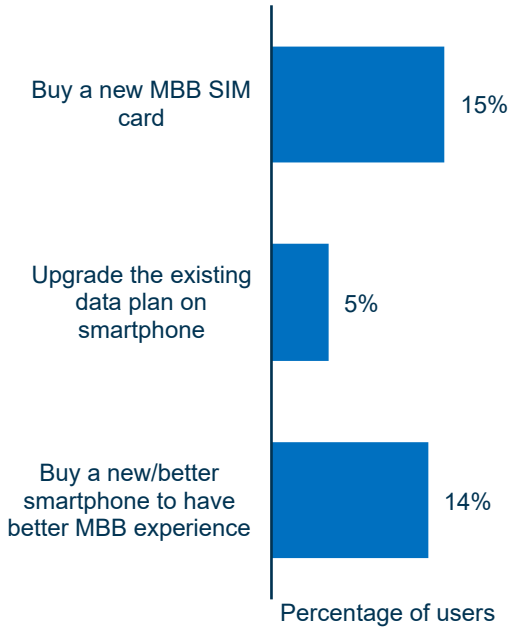
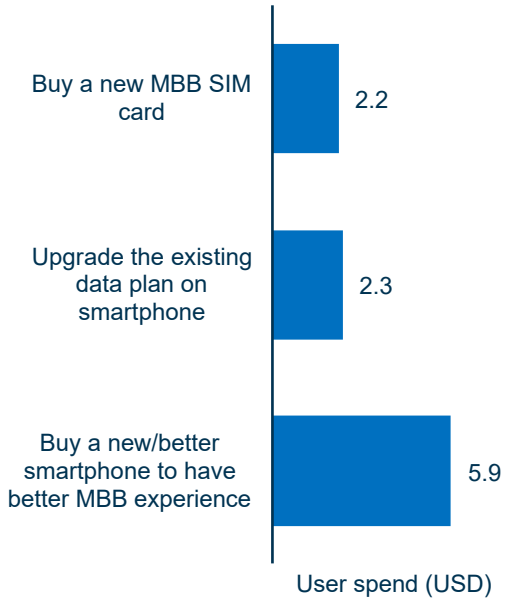


Figure 4.5: Additional monthly willingness to pay after experiencing high speed Wi-Fi[30] [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]



29 In the estimation of users willing to purchase a new MBB connection after using Railtel/Google Wi-Fi, the base included first-time internet users and 2G-only internet users. Further, it has been considered that these data-light users (i.e. first-time internet users and 2G-only users) possess a basic smartphone since they have not possibly experienced high speed internet prior to using Railtel/Google Wi-Fi, and hence constitute the base for the users who are likely to upgrade their smartphones

30 Monthly smartphone prices have been calculated by assuming an average handset replacement life of 24 months

Access to unfettered high speed Wi-Fi broadband is expected to result in tangible business benefits for stakeholders such Telcos and handset manufacturers. Aggregating the entire willingness to pay, on an average, interested Railtel/Google Wi-Fi users are willing to spend an additional amount of USD3.7 per month (from a typical MBB user's current spend per month of USD4.7). The sections below consider impact on various stakeholders separately. Purchase of new broadband connections and upgradation of existing broadband connections are expected to translate in a revenue increment for fixed and mobile network operators. Additionally, smartphone upgradation is likely to result in increased revenues for handset manufacturers. Access to fast public Wi-Fi is also expected to result in a tangible push towards the government's broader objectives related to digital access and inclusiveness, along with productivity improvements for the entire Indian economy.

4.2 Telecom operators

Demand stimulation with free high-speed public Wi-Fi has the potential to increase revenue for other operators by ca. USD3.0 billion cumulatively from 2017 to 2019

The proliferation of public Wi-Fi results in a two-fold impact – addition of new mobile broadband (MBB) users and increase in usage of existing MBB users – on the revenues of the mobile telecom industry as shown in Figure 4.6, as evidenced by the data shown in the previous section.

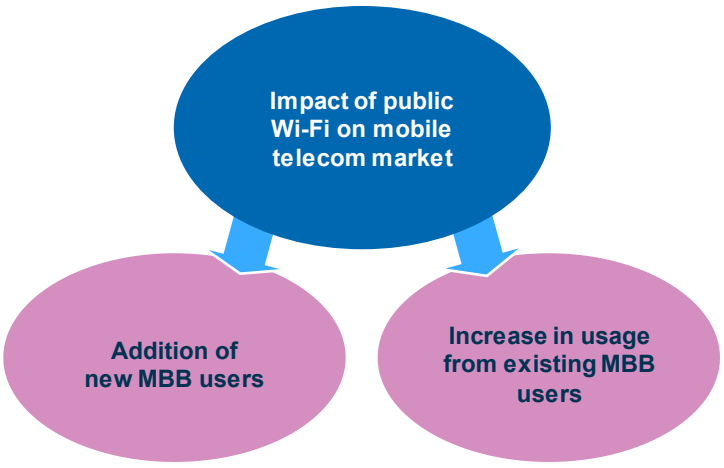


Figure 4.6: Impact of public Wi-Fi on mobile telecom market [Source: Analysys Mason, 2018]

Having experienced high speed Internet through the Railtel/Google high-speed Wi-Fi project, a significant fraction of users was found to be interested in purchasing a new MBB SIM to continue accessing high speed Internet. Besides, users who were already using MBB data have expressed willingness to upgrade their current data plan, since access to high speed Internet enabled these users experience the gamut of use cases offered by high speed Internet.

Primary survey of the Railtel/Google Wi-Fi users offers some quantitative insights into number of first-time Internet users in the surveyed stations over time These are people who, although they use a smartphone, did not identify as Internet users prior to using the Wi-Fi service. Extrapolating these survey results to the entire station base in the Railtel/Google project, and to the broader public Wi-Fi footprint in the county, we estimate that 47 million new Internet users could emerge as a direct

result of large-scale public Wi-Fi projects that are currently under way. Further, an additional 68 million users at a Pan-India level are estimated to upgrade their existing mobile data plans after experiencing high speed Wi-Fi through. The cumulative impact of public Wi-Fi on the Indian mobile telecom market through the addition of new MBB users, and the upgradation of data plans by existing users in the period 2017-19 has been captured in Figure 4.7 and Figure 4.8 respectively.

Figure 4.7: Estimated incremental new MBB users generated due to public Wi-Fi in India [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]

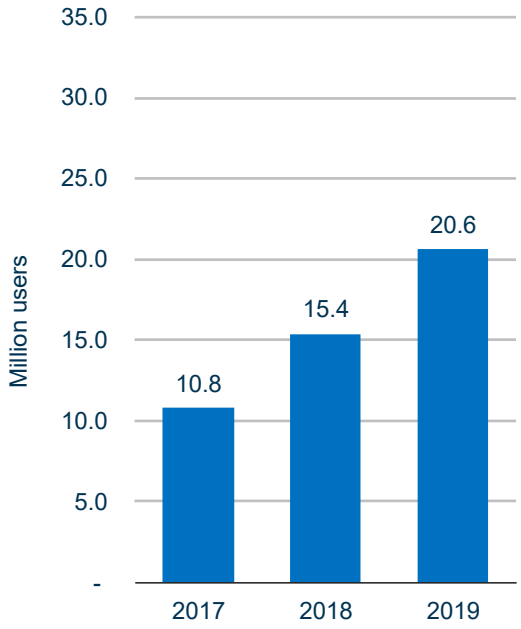
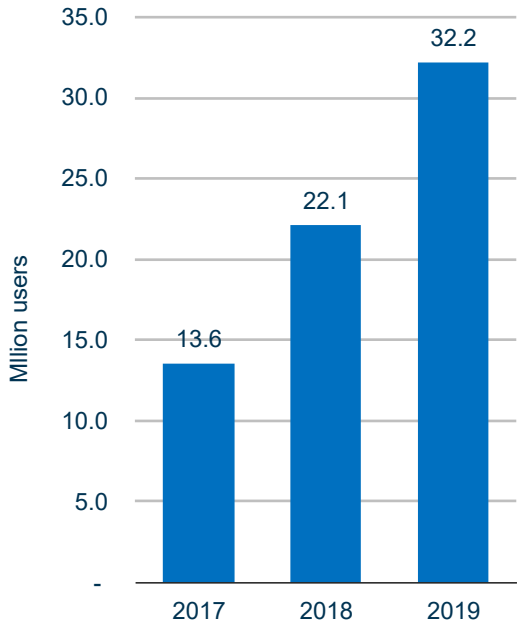


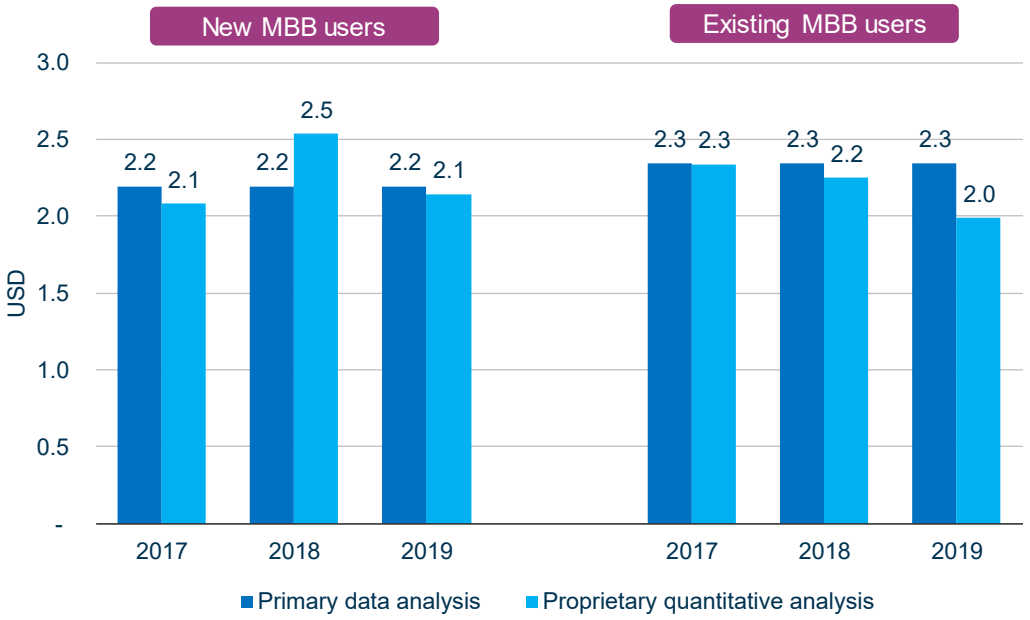
Figure 4.8: Estimated users willing to upgrade data plans due to public Wi-Fi in India [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]



In addition to analysing results from the primary survey of Railtel/Google Wi-Fi users, we have also conducted an independent proprietary quantitative analysis to determine the spend on mobile broadband data by new subscribers and incremental usage spend by existing mobile broadband subscribers. This analysis incorporated population and income distribution, estimated user addition, and affordability levels of various population / user segments.

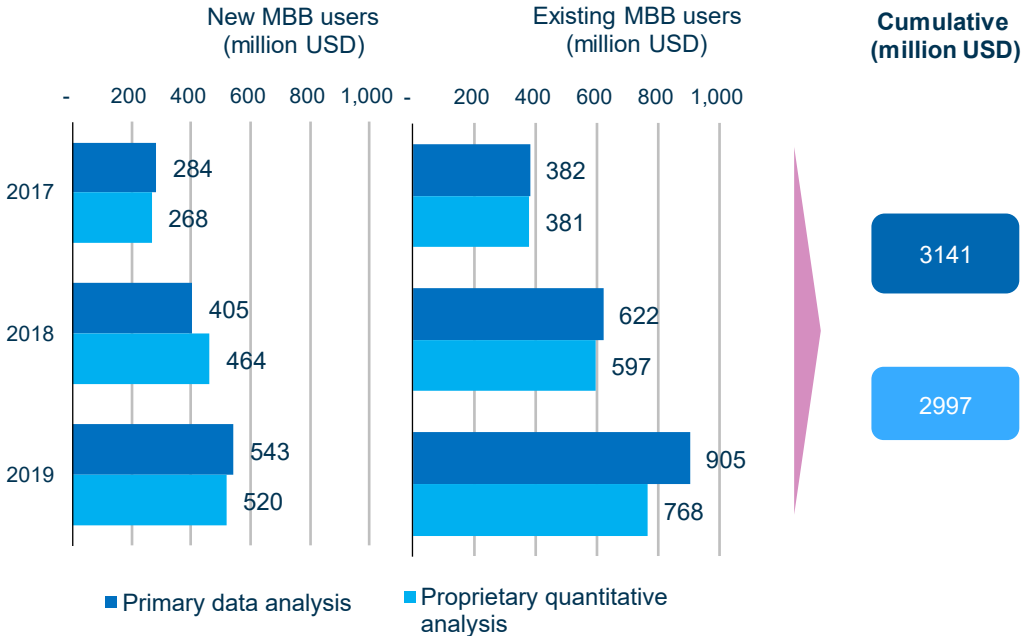
Respondents interested in purchasing a new MBB SIM expressed a willingness to spend an average of ca. USD2.2 additionally on data services. Similarly, respondents interested in upgrading their current data plan have expressed a willingness to spend an average of ca. USD2.3 additionally for usage upgrade. Results from both the methods highlighting the increase in spend by new MBB users and by users upgrading their existing data plans are shown in Figure 4.9.

Figure 4.9: Estimated increase in spend on data by new MBB users and by existing MBB users due to the proliferation of public Wi-Fi in India [Source: Ipsos Connect, 2017 and Analysys Mason, 2018]



Analysis from both these methods indicates that an additional revenue of ca. USD3.0 billion over the period 2017-19 could be generated to the mobile telecom market in India thanks to the dissemination of public Wi-Fi. Further explanation of the analysis is provided in Annex A.4.

Figure 4.10: Estimated additional revenues generated from the addition of new MBB users and the upgrade of existing MBB users due to the proliferation of public Wi-Fi in India [Source: Analysys Mason, 2018]



Evidence from recent market experience suggests that high-speed Wi-Fi and LTE are complementary and can co-exist to the benefit of all stakeholders

With ever increasing mobile data traffic, Telcos globally have been exploring options for enhancing the user experience while controlling costs. Breakout box 'Wi-Fi offload: evidence from international markets' offers evidence of significant reliance by Telcos on Wi-Fi offloading, with the share of offload to public mobile data in developed telecoms markets in North America and Europe being more than 1.5 times that of the offload share in India. Telcos facing the issue of spectrum scarcity, particularly in densely populated areas find Wi-Fi as a convenient option to offload their data traffic. With burgeoning data consumption, it becomes increasingly crucial for Telcos to deploy Wi-Fi offload solutions to ensure decongested networks and better asset utilization.

There is inherent complementarity between Wi-Fi and cellular broadband technologies such as LTE. The following articulated benefits accruing to Telcos from Wi-Fi deployments and Wi-Fi offload provide strong evidence for this complementarity:

- Improve user experience and control subscriber churn: with skyrocketing data usage growth, especially in Metros, telecom networks are increasingly under capacity constraints. This leads to degrading quality of service and users experiencing 2G speeds on 3G/4G connections. This leads to subscriber dissatisfaction and subsequent churning out to competitors. Timely investments in Wi-Fi deployments brings in additional unlicensed spectrum into the equation thereby decongesting networks and allowing better quality of service to MBB subscribers.

- Optimal utilization of spectrum investments: Spectrum investments are sunk costs. However, Telcos can ensure better utilization of these investments through Wi-Fi offload. With a given amount of spectrum, an operator can support significantly additional mobile traffic with the use of unlicensed Wi-Fi spectrum for offloading. This improves the business case for operators as additional subscribers can be supported on existing (and expensive) licensed airwaves.

Evidence from Indian market further suggests Telcos are moving in this direction to benefit from this inherent complementarity in these technologies. For example, Airtel and Vodafone have jointly launched a Wi-Fi based ISP named FireFly Networks. FireFly Networks has partnered with the New Delhi Municipal Corporation (NDMC), and deployed Wi-Fi hotspots across government institutions areas such as district courts, and some of the high-density areas such as Connaught Place and Khan Market. Tata DoCoMo has been similarly offering Wo-Fi services at several airports throughout the country.

However, there are still inherent challenges that prohibit Telcos from fully utilizing the benefits of Wi-Fi as articulated above. Technology enhancements are required for true interoperability and seamless subscriber network switching in the back end. Passpoint and Hotspot 2.0 are needed to ensure true roaming between cellular and Wi-Fi networks. Users frequently face the issue of getting disconnected from public Wi-Fi networks, and the need to reconnect multiple times to Wi-Fi drastically reduces their Wi-Fi experience, even if offered for free. Although ISPs such as Tata

DoCoMo have been proactive in the implementation of EAP-SIM based authentication[31] for seamless login, such services are still to witness a mass-scale rollout throughout the country. Such deployments will ensure that subscribers receive optimal quality of service consistently irrespective of whether they are connected to a cellular or a Wi-Fi network.

Further, as seamless integration between Wi-Fi and cellular networks becomes more widespread, automatic mobile data offload is becoming a viable network management proposition for operators. Indian networks and handsets, telecom operators and cellular subscribers can benefit from this trend through better throughput, higher service quality and higher industry revenues. For instance, telecom operators who opt to commercially leverage Railtel's fibre backhaul through seamless Wi-Fi connectivity can benefit from lower congestion on their spectrum in very high footfall areas (railway stations). This can help reduce investment needs in these areas are increase data revenue through higher usage traditionally marred with congested networks. Subscribers can also benefit from higher throughputs and reliable service levels in dense traffic areas such as Railway Stations.

More generally, there are ecosystem benefits to be reaped from an increase in seamless mobile data offload onto public Wi-Fi networks. Wireless ISPs (WISPs) can offer neutral public Wi-Fi infrastructure to telecom operators, thereby acting as a neutral third-party offering multiple operator-specific SSIDs over a common infrastructure, minimizing duplication of investments, obviating the need for overbuilding of backhaul and access points, and ensuring level playing-field between operators. This can be especially relevant for key venues with dense traffic profiles which may elicit interest from several telecom operators.

31 EAP-SIM based login requires a one-time configuration of a user's handset, through which the user's authentication information is directly captured from his/her SIM card. Once the configuration is completed, the user could directly connect to the Wi-Fi throughout its network in the country without having to enter any login details.

Wi-Fi offload: evidence from international markets

Evidence from international markets indicates a strong demand for public Wi-Fi networks. Developed markets such as USA, UK and France have ca. 30% of their total public data offloaded to public Wi-Fi networks as shown in Figure 4.11.

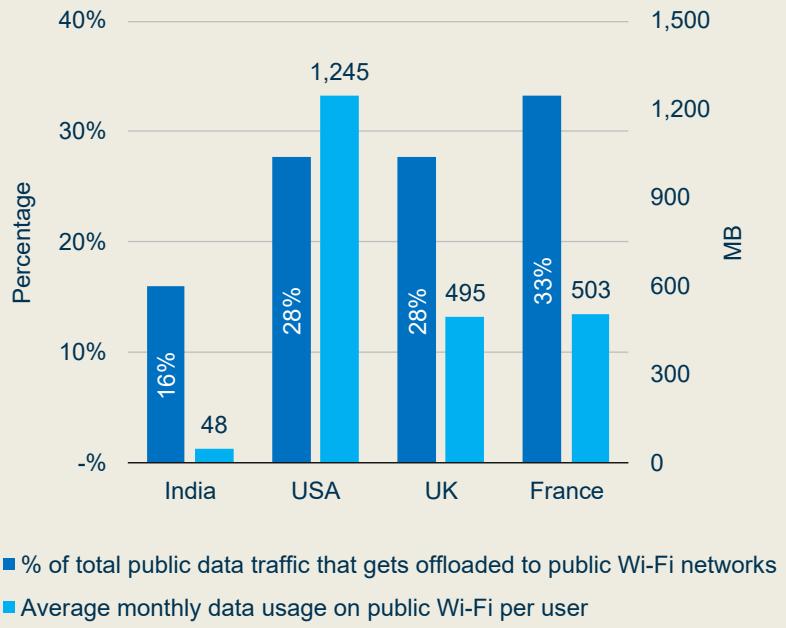


Figure 4.11: Data traffic on handsets offloaded through public Wi-Fi networks [Source: Analysys Mason, 2018]

India currently has just 16% of the total data consumed from public networks (cellular and Wi-Fi) offloaded to public Wi-Fi. Further, India's average public Wi-Fi data consumption of 48MB per data user has a potential to increase significantly to the levels of global benchmarks as shown in Figure 4.11.

Innovative partnerships between venue owners and WISPs (as discussed in Section 3) could foster a holistic Wi-Fi ecosystem resulting in the increase of Wi-Fi uptake. Further, a focus on the implementation of technologies such as Passpoint or Hotspot 2.0 by Telcos could go a long way in ensuring optimal user experience for Wi-Fi, and therefore, having an additional layer of network to supplement their existing 3G and 4G networks.

4.3 Handset manufacturers or OEMs

Smartphone adoption can see a positive impact due to users experiencing the value of high speed broadband through unfettered Wi-Fi

Increase in access to high speed Internet results shifts user perception towards high-spec smartphones capable of offering an enhanced end-user experience on the Internet.

Empirical evidence from primary survey corroborates this hypothesis, with the results reflecting that respondents who have experienced high speed Internet through The Railtel/Google high-speed public Wi-Fi project are interested in upgrading their smartphones. Without experiencing unrestrained access to high speed Internet, before accessing Rail Wi-Fi, data use for these users was primarily restricted to limited use cases, and hence low-end smartphones were sufficient. Access to high speed Internet through The Railtel/Google high-speed public Wi-Fi project enabled them to consider upgrading their smartphones for a richer user experience resulting from:

- Better screen size contributing to the streaming of high quality videos
- Higher resolution cameras leading to better quality of video calls
- Higher storage space and improved processor specifications resulting in access to a wider array of apps

Based on primary survey data on the number of users interested in upgrading their smartphones after having experienced high speed Wi-Fi, and the additional amount they are willing to spend on upgrading their smartphone, we have estimated the impact of high speed Wi-Fi on the handset market revenues over the period 2017-19. To further validate these results and eliminate skewness in the results due to sample bias, we conducted a proprietary analysis on the potential impact of high speed Wi-Fi on handset market revenues. In this proprietary analysis, we have assumed that users with an entry level smartphone would be upgrading to smartphones with prices closer to the average price of a smartphone in India. Findings from both the approaches are shown in Figure 4.12.

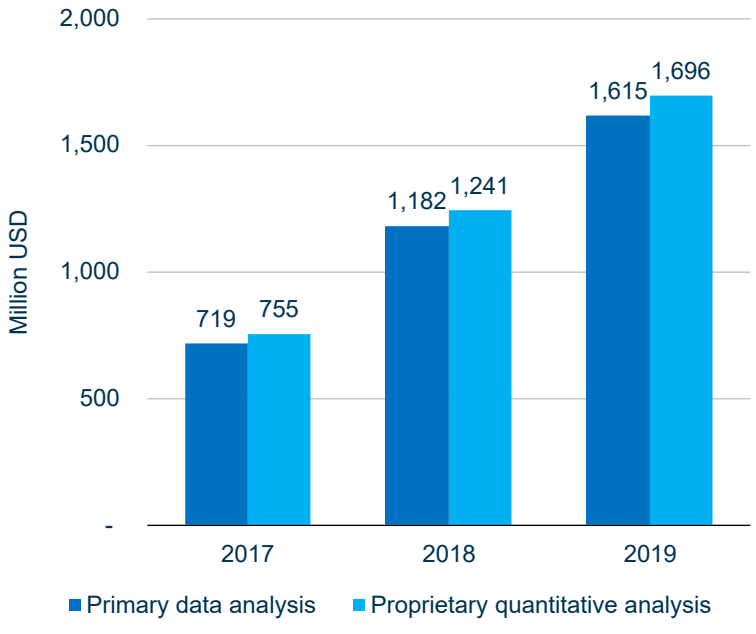


Figure 4.12: Estimated additional revenue for handset manufacturers from smartphone upgrades [Source: Analysys Mason, 2018]

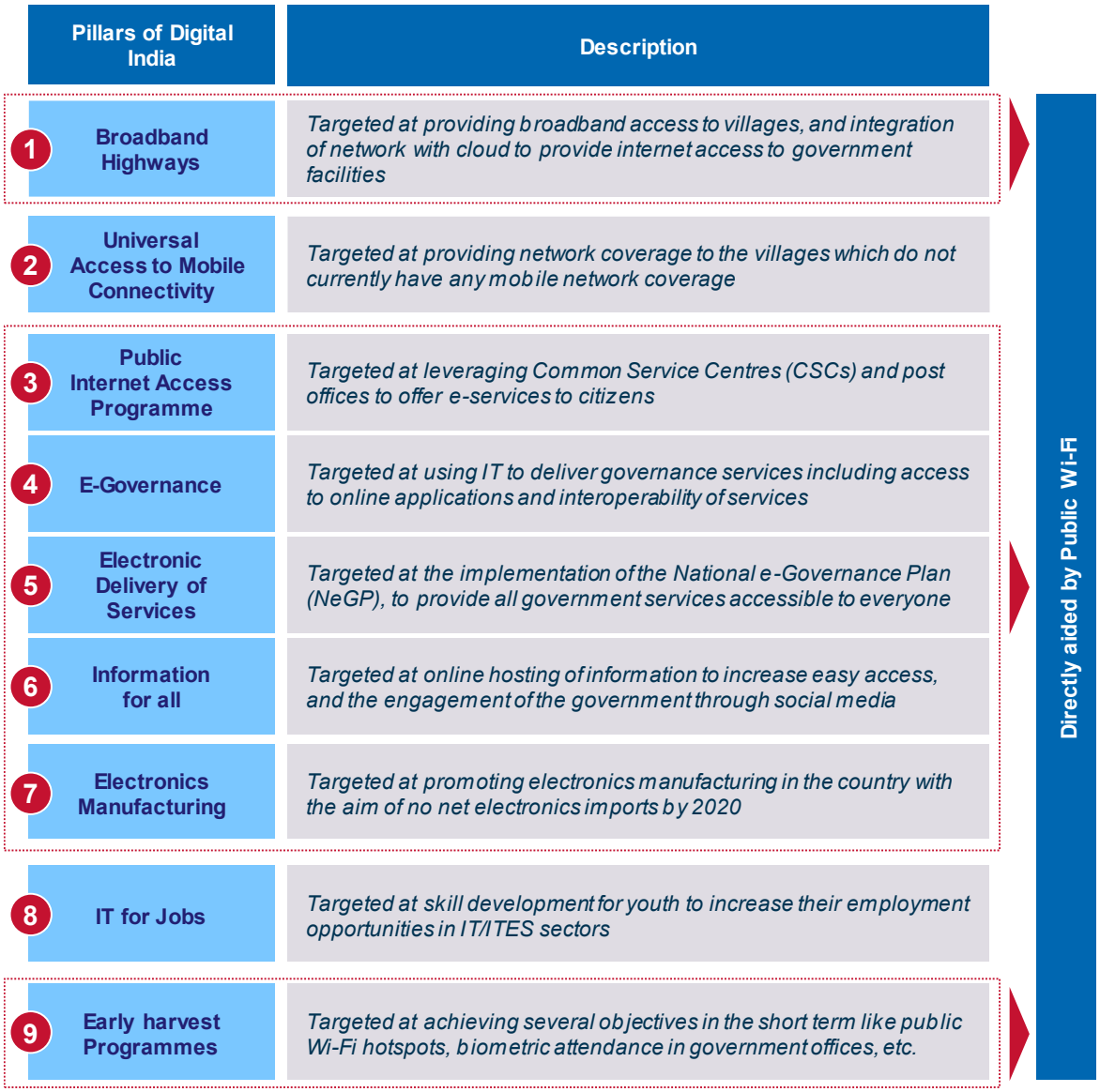
As shown in Figure 4.12, the proliferation of public Wi-Fi could result in an additional revenue of around USD3.5 billion to the handset market over the period 2017-19. Please refer to Annex A.3 for detailed methodologies.

4.4 The Government's broader ambition for Digital India

High speed Wi-Fi directly helps in fulfilling the Government of India's digital objectives

The Digital India initiative is a major focus area for the government of India and will be the drive force behind significant technological and connectivity investments in the country for the foreseeable future. The 9 pillars of the Digital India programme aim to offer digital connectivity universally, lay down robust digital infrastructure, and digitalise delivery of government services to help catapult India into the league of developed nations in the coming years. Public Wi-Fi will be a key enabler of these pillars as laid out in the initiatives. Figure 4.13 depicts the various touchpoints that public Wi-Fi has across the gamut of Digital India. Achievement of six out of the nine pillars is directly or indirectly predicated on the availability of ubiquitous public Wi-Fi networks in the country.

Figure 4.13: Key pillars of Digital India [Source: digitalindia.gov.in, Analysys Mason, 2018]



- Broadband highways: The deployment of Wi-Fi is an extension to the BharatNet project by providing last mile interne access to villages. Deployment of Wi-Fi could be a cheaper option (compared to the deployment of 3G or 4G networks) in places which already have access to backhaul through fibre

- Public Internet access programme: Common Service Centres (CSCs) play a key role in providing Internet access to villages by engaging people at the grass roots level. Wi-Fi hotspots could be conveniently deployed across these CSCs to connect the unconnected. The break-out box 'Wi-Fi as an enabler of Digital India initiatives' illustrates the inter-link between CSCs and public Wi-Fi in a greater detail

- E-governance and Electronic delivery of services: Wi-Fi (even if offered for free for a limited time) could help facilitate citizens gaining access to governance, health, education services, and complete online applications for identification documents such as Aadhaar, Passport, Driver's license, etc.

- Information for all: Wi-Fi could be instrumental in facilitating everyone in the country to access Open Data Platform (Data.gov.in). Citizens' lifestyles could witness a significant increase in productivity if they are provided access to information and documents online through the platform. Further, citizens could get their concerns addressed by the concerned government representatives when engaged through social media platforms

- Electronics manufacturing: Increased demand for Wi-Fi services could propel local manufacturing of network equipment, and therefore, contribute to the Government's target of achieving net zero imports of electronics goods by 2020

- Early harvest programmes: This pillar directly aims to expedite the provision Wi-Fi access to students at universities, and at the deployment of public Wi-Fi hotspots in the country.

Wi-Fi as an enabler of Digital India initiatives

In 2016, the CSC Special Purpose Vehicle (SPV), set with an objective of implementing the CSC scheme, took an initiative to explore various technology solutions focused on developing an affordable yet reliable ICT solution for the rural landscape. The objective was to develop a rural Wi-Fi infrastructure to turn the village into a 'Smart village'. Village level entrepreneurs (VLEs) are entrusted with the task of operating the CSC. These VLEs, are therefore, the critical touchpoints in ensuring digitisation of the village.

The proliferation of public Wi-Fi would be a step in the right direction towards the implementation of CSC SPV's goal of fulfilling the government's social security schemes such as Pradhan Mantri Suraksha Bima Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana and Atal Pension Yojana to provide pension and insurance coverage to economically weaker sections of the society. Moreover, Wi-Fi could be instrumental in the implementation of the National Digital Literacy Programme and the Cyber Gram Yojana across the country. Wi-Fi could also be helpful towards ensuring the success of CSC SPV's partnerships with Sarkari Pariksha.com for using its services was key towards helping rural aspirants prepare for government jobs through mock tests available on the website.

Recognising the importance of Wi-Fi, the CSC SPV received an ISP license and had set up its first Wi-Fi choupal at Gharora village in Faridabad district. CSC turned this village into a hotspot by utilising fibre from the BharatNet project.

Based on research literature, access to high speed broadband (through Wi-Fi) leads to an impact of USD12–56 billion on GDP in 2019 (cumulatively USD21–103 billion in 2017-19)

The relationship between penetration of high speed broadband and growth of GDP in a country is well documented empirically by means of several research reports. The consensus from such reports is that on average a 10% increase in broadband penetration in a country results in ~1% increase in the GDP growth[32] due to the widespread increase in productivity, tools and business ecosystem propagated by high speed broadband.

The Railtel/Google high-speed public Wi-Fi project is a novel initiative aimed at increasing access to high speed broadband through a complimentary Wi-Fi service. The fast-growing footprint of public Wi-Fi projects is estimated to activate ca. 21 million new mobile broadband users in 2019.

We estimate the productivity benefits occurring from the proliferation of public Wi-Fi in India through projects such as the Railtel / Google partnership to be significant in a large economy such as India. Public Wi-Fi is estimated to result in an upliftment of India's GDP by USD11.6 billion in 2019 (ca. USD21 billion cumulatively from 2017-19). This will be translated in the form of greater

32 A state-level study by ICRIER and IAMAI in 2011 estimates an increase of 1.08% in GDP growth rate for a 10% point increase in broadband penetration. While a World Bank study in 2009 estimates a GDP growth impact of 1.21% for developed countries and 1.38% for developing countries for a 10% point increase in broadband penetration.

productivity emerging from enhanced productivity for small and large businesses, educational institutions and government establishments.

The link between broadband and economic productivity has also been explored in a recent report by ICRIER,[33] which established a relationship between internet traffic (mobile and total) and GDP growth. According to the report, a 10% increase in India's mobile internet traffic can potentially deliver a 1.3% increase in India's GDP, whilst an increase of 10% in total internet traffic (mobile + fixed) can lead to additional GDP growth of 3.3%. This approach leads to materially higher estimates of GDP impact, and would result in Public Wi-Fi driving incremental GDP of ca. USD56.4 billion in 2019 (ca. USD103 billion in aggregate over 2017-19).

33 http://icrier.org/pdf/Estimating_eValue_of_Internet%20Based%20Applications.pdf

5 Conclusions and next steps for public Wi-Fi in India

As recognised by all stakeholders, and evidenced by the first data made available by Google for this study on its partnership with Railtel, large scale public Wi-Fi deployment have the potential to have a significant impact on the connectivity ecosystem in India. For users, it offers an open, interoperable access to the Internet, often at limited or no cost to them. For existing connectivity providers, primarily Telecom Service Providers and Internet Service Providers, the incremental demand that can be stimulated through more people experiencing fast Internet access in public Wi-Fi hotspots is a clear revenue opportunity. More sophisticated consumers are also likely to buy more and better devices – as smartphone penetration accelerates over the next few years. Overall, around 100 million Indians are likely to spend up to USD3 billion annually by 2019 on better MBB and smart devices.

In order for these benefits to be realised, however, significant barriers must be surmounted. The main impediments to the more rapid proliferation of public Wi-Fi nationwide have been clearly identified, both by TRAI in its recent consultation, and by the stakeholders across the ecosystem whom we interviewed in the preparation of this report. The lack of supporting infrastructure, including backhaul, and the remaining hurdles in clearing rights of way are being proactively addressed, but much more could be done around spectrum, know-your-customer regulations, payments and partnerships / standards.

Perhaps the biggest barrier, however, remains economic. Despite the potential for Wi-Fi to provide very high-speed Internet access to a vast number of people, its technical characteristics mean that hotpot must be deployed in large numbers: TRAI estimated that around 800 000 hotspots would be needed in India. Currently, this is hampered by the need for WISPs to shoulder the entire cost of the rollout and operation of these hotspots, including in most cases sharing part of the revenue they manage to generate with venue owners. More convenient and streamlined monetisation from end-users is a clear way to improve this business case, but cannot hope to sustain nearly a million commercial hotspots (of which only around 36 000, less than 5%, currently exist). Ultimately, venue owners need to see the benefit to their core business from offering public Wi-Fi, and share the costs, rather than the revenue, of WISPs. Mobile operators can also use Wi-Fi to offload excess data traffic from cellular network, with some of the cost saving potentially reinvested in more public Wi-Fi coverage.

The current large-scale experiment between Railtel and Google, with Indian Railways as the venue owner, offers a high-profile proof of concept, clearly demonstrating the positive impact that public Wi-Fi can have on the public and also on venue owners. More such partnerships will hopefully develop going forward, combining free access for a limited period, subsidised by venue owners and WISPs on the one hand, and monetisation models with very little friction on the other hand.

Ultimately, the research we conducted for this reports shows the potential of this currently niche industry to grow and contributed to the Digital India ambition of the Government.

Annex A Quantitative methodology notes

A.1 Methodology: public Wi-Fi market sizing

Quantitative surveys

Quantitative surveys were conducted by IPSOS in two phases – phase 1 in July 2016, and phase 2 in February 2017. A total of 6 railway stations across cities in India were surveyed during phase 1 – Allahabad, Kalyan, Gorakhpur, Lucknow, Pune and Raipur. A total of 4 railways stations across cities were surveyed in phase 2 – Nagpur, Kacheguda, Cuttack and Mathura. On average, 610 respondents per station were interviewed in phase 1 of the survey, and 650 respondents per station were interviewed during phase 2 of the survey.

Estimating the scale and growth of public Wi-Fi in 2017

As per the recent industry reports[34], Reliance Jio had an estimated footprint of 80 000 public Wi-Fi access points as of mid-2017. The Railtel/Google Wi-Fi project has around 10 000 access points in 400 stations. We estimate an additional 25 000 access points deployed by other service providers such as Ozone, Tata, etc. across the country.

To derive the share of the Railtel/Google Wi-Fi project to the overall public Wi-Fi ecosystem footprint in India in terms of monthly active users (MAU), we have used data from international benchmarks such as Wireless@SG from Singapore[35]. Wireless@SG consisted of an MAU of 2 million users with 10 000 access points, giving an MAU per access point ratio of 200.

Applying the same ratio to the base of Reliance Jio's public Wi-Fi footprint, we derive an MAU of 10 million users for Reliance Jio in mid-2017. Further, an estimated 5 million MAU could be attributed to other public Wi-Fi service providers. With the Railtel/Google Wi-Fi project's MAU of 6.5 million users at the same point in time, its share could be observed to be ca. 30% in mid-2017. Given the rapid development of Jio's Wi-Fi footprint in 2017, we expect that Google's MAU at the end of 2016 (ca. 5 million) were over 50% of the market total, demonstrating a rapid overall growth in the market.[36]

34 http://telecom.economictimes.indiatimes.com/news/mojo-networks-company-behind-reliance-jios-wifi-network-is-now-eyeing-indias-public-wifi-market/59470482

35 https://www.imda.gov.sg/~/media/imda/files/inner/about%20us/newsroom/media%20releases/2014/0328_wirelesssg/wirelesssgfactsheet.pdf?la=en

36 There is of course some degree of overlap between MAUs for different Wi-Fi providers – for the purpose of these estimates we have not explicitly modelled such overlap, but have taken a view as to what it could be going forward

What the public Wi-Fi market could look like in 2019

In 2019, with the implementation of regulatory reforms suggested in Section 3.4 coupled with an increased adoption of public Wi-Fi by venue owners, and an increased focus on Wi-Fi deployment by telecom operators, the public Wi-Fi market could witness a significant expansion in the country.

These changes are expected to result in over 600 million people potentially accessing public Wi-Fi in 2019. Such a large base of public Wi-Fi users must be supported by a commensurate deployment of Wi-Fi access points in the country. Using the benchmark of 200 users per access point observed in Singapore and other markets, we estimate positive market developments could trigger the deployment of up to 3 million access points in the country. Most of these access points will need to be connected through high-speed fibre optic links to ensure a high quality of service, comparable with what Google and Railtel already offer today.

A.2 Methodology: estimation of impact of public Wi-Fi on mobile broadband (MBB) adoption

Primary quantitative surveys were used in quantifying the impact of public Wi-Fi on MBB user penetration. Primary surveys indicated the percentage of users who were interested in purchasing a new mobile broadband SIM (i.e. first-time internet users, and 2G-only internet users) after having experienced high-speed internet at surveyed railways stations. Further, primary surveys also indicated the percentage of users who were interested in upgrading their current MBB plans after having experienced high-speed Wi-Fi.

Estimated additional users impacted by Railtel/Google high-speed Wi-Fi (i.e. first-time MBB users, and upgrade users) were then extrapolated across all 400 stations covered by the initiative. A second set of extrapolation is further conducted to estimate the impact generated by all public Wi-Fi initiatives in the country. To ensure adequate robustness of this analysis, a sensitivity analysis has also been conducted as shown in Annex A.5.

A.3 Methodology: impact quantification on Handset Manufacturing revenues

For the estimation of the impact of public Wi-Fi on the revenues of the handset market, data from primary survey responses and proprietary quantitative analysis were used.

- Primary survey responses indicated that as many as 14% of the users who were using internet for the first time at the railway station or those who were only accessing 2G internet on their smartphone were interested in upgrading their smartphones for better user experience after using Wi-Fi at the station. These users were interested in spending an additional ~USD142 on average towards the upgradation of their smartphone. Further, considering that smartphones are replaced by users after ca. 2 years on average, we have calculated the additional sales that are generated due to the replacement of the newly purchased handsets by these users in the period 2017-19.
- Using data from secondary sources, it has been observed that the average price of smartphone in 2016 was ~USD194 as per Cybermedia Research. We have assumed that users who are

interested in upgrading their smartphone are typically those data-light users (non-internet, and 2G-only users possessing smartphones) using basic smartphone. These basic phones offering decent specifications[37] typically cost ~USD45 (Reliance Jio Lyf Flame 3), and hence these users additional spend an amount of ~USD149 on average towards the upgradation of their smartphones.

A.4 Methodology: impact quantification on Telco revenues

For the estimation of the impact of public Wi-Fi on the revenues of the mobile telecom market, data from primary survey responses and proprietary quantitative analysis were used.

Primary survey responses indicated that users interested in purchasing a new mobile broadband (MBB) SIM were willing to pay an additional ~USD2.2 per month on average, and users interested in upgrading their existing data plans were willing to pay an additional ~USD2.3 per month on average. These figures were used to calculate the cumulative additional revenues that could be potentially captured by telecom operators.

To estimate the revenues generated to the mobile telecom market from the addition of new MBB users, the following proprietary analysis was conducted:

- To validate primary survey responses, we have conducted a user affordability analysis based on the population income distribution curve. The data on the distribution of the population across various income levels has been obtained from Euromonitor. Since Euromonitor reports this data only for the population aged 15 years and above, the population aged under 15 years of age has been added to the lowest income strata, assuming that they have a negligible income, to arrive at the distribution of the entire population of India across different income levels.
- Using the income distribution curve, the median income of the existing base of MBB users has been calculated. Data ARPU of these MBB users was determined to calculate the ratio of Data ARPU to median income of an average smartphone user (0.6% in 2016). Subsequently, we have estimated the median income of the incremental users who are interested in purchasing an MBB SIM. Using the ARPU to median income ratio of the existing MBB users, and scaling it up to account for the fact that lower income group users spend a higher fraction of their income on basic services such as food, shelter, Internet, etc., we arrive at the ARPU of the incremental MBB users. Further, we have assumed that users who are interested in purchasing a new MBB SIM are primarily those who are either currently not using any internet, or just using internet minimally by consuming 2G data. The difference between the data ARPU of these users purchasing their new SIM, and their current data ARPU is used to estimate their incremental ARPU.

To estimate the additional revenue generated from users who are interested in upgrading their existing data plans, we have assumed that these are the users whose data usage reaches the level of

[37] Screen size of 4 inches, Screen pixel density of 254, 512MB RAM, 1.5GHz CPU, 5MP rear camera, 2MP front camera, 1700mAh battery and internal memory of 4GB

an average 4G user, from a usage of an average data user (blended data usage for 2G, 3G and 4G users).

A.5 Sensitivities to the quantitative analysis

In order to capture a reliable range of estimates for our quantitative analysis, we have identified the sensitivity of our main output (cumulative number of new MBB users generated over 2017-19 from public Wi-Fi) to key input variables – rate of addition of first-time internet users on public Wi-Fi, and share of Railtel/Google Wi-Fi to overall public Wi-Fi in India.

The table below captures the results of this sensitivity analysis. In the report above, we have demonstrated results based on selecting base-case of both our key inputs.

Figure 5.1: Sensitivities of Number of new MBB users generated due to public Wi-Fi to key Inputs, over 2017-2019 [Source: Analysys Mason, 2018]

Cumulative number of new MBB users over 2017-19		Rate of addition of first-time internet users on public Wi-Fi		
		Pessimistic case	Base case	Aggressive case
Share of Railtel/Google Wi-Fi project to public Wi-Fi in India	Pessimistic case	38	40	42
	Base case	44	47	49
	Aggressive case	53	56	58

Figure 5.2: Description of the sensitivity analysis assumptions [Source: Analysys Mason, 2018]

		2017	2018	2019
Share of Railtel/Google Wi-Fi project to public Wi-Fi in India	Pessimistic case	37%	28%	21%
	Base case	31%	23%	17%
	Aggressive case	43%	32%	24%

Annex B Detailed report notes

B.1 Regulatory reforms recommended for promoting Wi-Fi in India

- De-licensing Wi-Fi spectrum and liberalising technical usage: Unlicensed Wi-Fi spectrum has been a major driver of Wi-Fi ecosystem development across the world. Despite some de-licensing of Wi-Fi spectrum carried out in India over the past years, our country severely lags other developed and even developing markets in availability of unlicensed spectrum airwaves for Wi-Fi propagation. Only a limited quantity of unlicensed spectrum in India is available over 2.4GHz and 5.8GHz.

  Further technical restrictions on the radiated power of Wi-Fi access points in the 5.1-5.3GHz and 5.7-5.8GHz spectrum limits the true coverage potential of the technology and leads to technical and cost inefficiencies in current Wi-Fi based network deployments.

Figure 5.3: Recommendations on de-licensing Wi-Fi spectrum [Source: Analysys Mason, 2018]

Frequency Range (MHz)	Licensing Recommendation	Technical Recommendation
5150 – 5350	De-license outdoor usage	Allow up to 4W EIRP
5725 – 5875	De-license outdoor usage	Allow up to 4W EIRP

  - Spectrum in the 5.1 – 5.3 and 5.7 – 5.8GHz bands are currently licensed for outdoor applications, which severely limits their potential. De-licensing these band will ensure greater availability of Wi-Fi spectrum for traditional offloading in urban area and hotspot deployment in rural areas, and will relieve congestion in the 2.4GHz band which is currently the de-facto band for Wi-Fi deployment due no restrictions of licensing and technical power radiation
  - Moreover, limiting access points to lower power (of 200mW) also acts as a constraint to Wi-Fi deployment. Increasing the limitation of EIRP for 5GHz frequency bands to the commensurate levels of 4W (as in the case of 2.4GHz frequency band) could help in making Wi-Fi deployment commercially viable through cost effective deployments

- Making more EHF spectrum available: The regulator and DOT must also consider de-licensing, or at the most, light licensing spectrum available in the millimetre-wave portion to provide a greater set of economical alternatives to the industry to promote backhaul connectivity.

  - The V-band (60-GHz) is de-licensed in many countries such as the US, Canada and Australia. The band offers a viable alternative to 2.4GHz and 5GHz frequencies for carrying Wi-Fi traffic and given that the band enjoys good device ecosystem in the country its use must be de-licensed in India.

  - The E-band (71 – 76GHz and 81 – 86GHz) has favourable technological properties to provide high-capacity wireless links, especially suited for backhaul. Several countries, including the US, UK and Australia, have adopted a light licensing framework for allocating the E-band which operates on a self-coordinated, first-come-first-served basis with a register maintained by spectrum authority. This model typically resulting in lower fees for users and emergence of innovative use-cases such as high altitude balloons for connectivity. Therefore, a light licensing framework could enable widespread adoption.

- Sharing of Wi-Fi infrastructure to promote neutral networks: Bilateral arrangements between different Wi-Fi ISPs to share Wi-Fi infrastructure such as access points and backhaul infrastructure will result in several productivity benefits including sharing of upfront capex burden, reduction of duplicate Wi-Fi infrastructure from multiple providers and bypass problem of network interoperability for a user to travel from one provider's network to another within a geographical area. However, DOT's current active infrastructure sharing requirements do not explicitly allow sharing of Wi-Fi infrastructure. Modification of active sharing requirements or explicit clarification regarding W-Fi sharing will be a step in the right direction.

- Ecosystem collaboration for Wi-Fi delivery: In line with the recommendations of the regulator, a hub based model for Wi-Fi delivery will be most suited for India. A Wi-Fi aggregator can offer a platform connecting multiple Telcos or ISPs on one end and multiple downstream Wi-Fi networks or WISPs on the other end. The Wi-Fi aggregator can offer authentication and payments infrastructure in compliance with the regulator and the government. Multiple such Wi-Fi aggregators operating across the country could lead to healthy competition and its associated benefits of innovation, lower prices and multiple choices for the Internet users. Following recommendations could foster a world-class Wi-Fi ecosystem in the country:

  - It is vital to unencumber the Wi-Fi delivery model, so Wi-Fi aggregators and downstream Wi-Fi ISPs shouldn't be mandated to follow any licensing or registration restrictions, as these legal obligations could be met by upstream Telcos / ISPs
  - Offloading of mobile data onto these aggregated Wi-Fi networks should be explicitly allowed, to enable the full utilization of unlicensed spectrum for the propagation of broadband connectivity
  - Aggregators should be allowed to sign roaming agreements with Telcos and other Wi-Fi aggregators to create a truly interoperable mesh of Wi-Fi network in the country
  - To induce efficiencies in the value chain, this model should allow Wi-Fi aggregators to outsource the authentication and payments interface service provision to third parties to ensure value chain specialization efficiencies

- Reducing import duty burden: Wi-Fi and WLAN equipment imported into the country currently attracts import duty to the tune of 10% for Access Point equipment, with an additional 12.5% and 4% applicable for Countervailing and Special Countervailing Duty. Rationalization of these duties, in collaboration between DOT and Ministry of Commerce, could help further the cause of Wi-Fi ecosystem development.

- Robust payments framework: Digital payment channels[38] including means such as debit cards (1.05 billion), credit cards (124 million), retail electronic clearing[39] (470 million), mobile wallets (288 million), and mobile banking (251 million) are restricted to a limited section of the Indian population. In this context, direct carrier billing (DCB) gains significance as a potential payment tool for Public Wi-Fi.

  DCB allows a subscriber to use their mobile phone number to pay for digital goods and services, with the bill either getting deducted from their prepaid balance or getting added to their monthly post-paid bill. With just over 1 billion active mobile SIMs[40] in the country, DCB could be a potent tool to take digital payments to the unbanked and underbanked section of the society. While globally, DCB remains a potent tool to propagate digital payments, in India DCB was earlier only allowed in a limited scope for purchasing ringtones and wallpapers, and later in a wider scope for post-paid subscribers only. Recently based on the Watal Committee report[41] released in December 2016, the DOT allowed[42] DCB for prepaid and post-paid subscribers for low value transactions. However, it is unclear if DCB is allowed as a digital currency i.e. subscriber of Telco A purchasing digital services (such as Wi-Fi) from Telco B. Such allowance will allow true ISP interoperability and unlock payments bottleneck restricting Wi-Fi proliferation in India.

  Further, the regulator and government should enable market forces to germinate new digital payment platforms such as UPI, Mobile Wallets, DCB, etc. Given the nascent state of digital payments in India, mandating one platform over others could be counter-beneficial to the development of the Wi-Fi industry.

- Seamless authentication infrastructure: Instant and non-repeatable authentication is a key enabler of seamless Wi-Fi connectivity and great user experience. Current authentication processes revolve around mechanisms such as One Time Password (OTP) which are predicated on the availability of mobile SIMs with users and limit potential Wi-Fi take-up. Creation of a unified ecosystem for authentication and payments by leveraging national infrastructure such as Application Program Interfaces (APIs) implemented for e-Know Your Customer (eKYC) can enable rapid take-up of public Wi-Fi in the country.

38 Corresponding to the number of monthly transactions during March 2017 as reported in RBI Bulletin

39 Includes ECS, EFT / NEFT, IMPS and NACH transactions

40 As per TRAI, in the month of December 2016

41 http://finmin.nic.in/reports/watal_report271216.pdf

42 http://dot.gov.in/sites/default/files/DCB.PDF?download=1

B.2 International case studies of Wi-Fi deployment by venues

International case studies of Wi-Fi deployment by Venues

Venue owner type	Venue owner name	Description
Restaurant	Subway	• In 2016, Subway introduced a Wi-Fi enabled loyalty program across all its Canadian stores. A rewards platform allowed customers to receive a coupon for a free sandwich on their mobile phone upon signing on to Subway's Wi-Fi network for the first time. Customers subsequently receive more rewards as they continue to frequent the store, with promotions linked to frequency of visits • It was observed that customers who accessed Subway's free Wi-Fi frequented its restaurants 1.8 times more than others. Customers who redeemed their free sandwich coupons increased their store visits 5.2 times more than previously • Subway also witnessed a 17% redemption rate for its digital coupons, significantly higher than the typical industry figures for direct mail coupons, which are typically 1-3%
Restaurant	Starbucks	• In 2010, Starbucks started offering free Wi-Fi in its cafes. To differentiate itself from other restaurants offering free Wi-Fi, Starbucks also launched its proprietary content platform called Starbucks Digital Networks which hosts free content due to its partnerships with content providers like The New York Times, The Wall Street Journal, iTunes, The Economist, ESPN Insider, and LinkedIn • Starbucks's mobile strategy has resulted in over 7 million mobile apps users by 2013. Further, Starbucks has extended the use of free Wi-Fi to enable mobile payments, with over 25% of payments in 2016 made through mobile. This success resulted in Starbucks also enabling mobile payments in its Chinese and Japanese cafes in 2016.
Banks	HSBC	• In 2014, HSBC started offering free Wi-Fi in its branches, after a BT and Avaya study revealed that ~49% of UK banking customers felt that free Wi-Fi would greatly improve in-branch experience • Wi-Fi access to customers was critical towards increasing the adoption of HSBC's mobile banking apps; while in-branch demo of various digital products was influential in increasing customer awareness
Banks	RBS	• In 2014, RBS and NatWest started offering free Wi-Fi in their UK branches. RBS used free Wi-Fi as a platform to help educate its customers about its digital product offerings • The initiative has seen a strong customer uptake, with more than 1 million users availing Wi-Fi soon after launch

International case studies of Wi-Fi deployment by Venues (continued)

Venue owner type	Venue owner name	Description
Retail	Tesco	• In 2011, Tesco, in collaboration with BT, started offering free Wi-Fi to customers inside its stores, first as a pilot and later across all its stores • Customers with Tesco Clubcards got unlimited access to the Internet, while those without a Clubcard got free Internet access for 15 minutes within every 24 hours • Research carried out by BT and ICM, showed that 44% of people use Wi-Fi in shops to browse items or compare prices. The research also found that 34% of people download discounts or vouchers to use in store via Wi-Fi
Community based	European Union	• In 2016, the European Union approved deployment of free Wi-Fi under the scheme WiFi4EU across all member countries by 2020 • The scheme is open to entities with a public mission like local municipalities, libraries and health centres. The scheme will fund equipment and installation costs, while local entity will pay for the bandwidth and maintenance of the equipment • The WiFi4EU scheme targets at least 6,000 to 8,000 local communities and up to 40-50 million connections per day, with an initial budget of EUR120 million between 2017-2019
Community based	Taiwan Ministry of Tourism	• In 2013, Taiwan extended its free public Wi-Fi initiative to foreign tourists in addition to its citizens. The government had previously launched its free public Wi-Fi scheme called iTaiwan in 2011, and it expanded to >4,000 hotspots by 2013 • The scheme is immensely tourist friendly, and visitors who do not have a local SIM can open an iTaiwan account at a Tourism Bureau counter, show their passport as ID and they can login using their account • Tourist footfall in 2013 increased by 24% compared to an average of ~13% increase in tourist footfall per annum from 2010 to 2012. While other factors may have contributed to this growth, Wi-Fi seems to have also played an important role in projecting a tourist friendly image for Taiwan

Annex C Findings from visits to Indian Railway stations

To supplement the quantitative primary surveys carried out by IPSOS in Indian Railway stations with high-speed Wi-Fi from Railtel/Google, the Analysys Mason team also carried out field visits to four prominent railway stations[43] in June 2017. These visits were an avenue for us to experience the service first-hand, to gain qualitative insights into the impact the Railtel/Google public Wi-Fi project is having on the stakeholders, and to validate some of the key findings from the IPSOS primary surveys. Responses from over 30[44] passengers and vendors were collected and analysed to generate the following insights:

Drivers of service experience: ease of access, reliability, speed and awareness

With a straight forward OTP based log-in process, connecting to the Wi-Fi is simple and most passengers can easily access the service. The ones who do face some difficulties are duly helped by the vendors and by the numerous posters outlining the login process. The connection quality across platforms was stable to a great degree, with Ajmer station standing out as the best in terms of connection reliability. Instances of connection drops that required the user to login again were rare, but present. The drop was more noticeable on some of the stations, but they weren't frequent enough to affect the service experience of the users.

Starting speeds of the connection were impressive with mobile apps (~15MB) taking less than 20 seconds to download. Speed throttling occurred between 30 minutes to 1 hour of starting the service, but the speed thereafter was still good enough for passengers who didn't use the service for data heavy tasks like videos and app downloads. Marketing across the 4 stations was done in multiple ways ranging from posters and boards to announcements and videos. While the branding on most stations was sufficient to raise awareness among potential users, the New Delhi railway station was observed to be lacking in this respect.

Passengers impressed with the Wi-Fi speed

Wi-Fi connections at the stations delivered maximum downloading speeds of 24Mb/s[45], and consequently over 70% of the passengers mentioned speed of the connection as their key highlight of the service. Over 40% of the respondents also claimed that the speed was at least equal to or better than that being offered by 4G service providers. It was also observed that one of the stations had lower than average speeds and the same was observed in the feedback from the passengers. 4 out of 5 respondents, in the aforementioned station, identified speed as a possible improvement opportunity clearly indicating the importance users place on broadband throughput.

43 New Delhi, Old Delhi, Jaipur and Ajmer

44 A total of 34 passengers and vendors were interviewed across the 4 railway stations

45 Average of the maximum across the 4 stations (New Delhi – 24 Mb/s, Old Delhi & Ajmer – 28 Mb/s and Jaipur 15 Mb/s). Speed data collected through spedtest.net

Quick train enquiries one of the key benefits for passengers

Many of the respondents used the service to get train status on their mobile phones. “I no longer have to wait in line at the enquiry desk”, quoted a passenger in Old Delhi while mentioning an incident where he was traveling with his mother to Rohtak and was thankful for the Wi-Fi which helped him get quick updates on train and PNR status. Similarly, a passenger had once missed his train in Vishakhapatnam and had no more data available on his Internet pack. He used the Wi-Fi service to enquire for trains and booked a ticket for his departure.

Benefits aren’t limited to train enquiries, with people traveling on business also making good use of the service. “Wi-Fi provides respite from high 4G data charges”, quoted a customer sitting in the executive waiting room while narrating an incident where he made use of the free high-speed Wi-Fi to work on and send a business-related presentation. Numerous passengers also mentioned using the Wi-Fi to pass time while waiting for their delayed trains.

Improvements to business and productivity of vendors and employees

Access to high-speed Internet on the railway platforms has enabled vendors and employees to become more productive at their jobs. “The Wi-Fi service has made my life a lot easier”, quoted an operator of a passenger transport vehicle in the New Delhi railway station. He has greatly benefitted from the service because it helps him in planning his trips to platforms based on the actual arrival times of the trains. A passenger, a railway employee, was also very happy with the service since it helps him excel at his job which requires him to know the running status of multiple trains.

Consistent access to the Internet has also improved the business of many vendors. The owner of a refreshment room at Jaipur railway station observed improvement in footfalls post the installation of a router in the room. The room not only helped passengers get a place to hang out and access the Internet, but also improved the sales of the owner. Multiple small shop owners also mentioned about an inflow of customers who preferred paying through Paytm.