The Hidden Network: addressing digital equity through meaningful connectivity in urban India

by
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Submitted to the Department of Urban Studies and Planning in partial fulfillment of the requirements for the degree of
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at the
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Abstract

This research explores the transformative impact of digital technologies, particularly mobile internet access, on digital equity in informal settlements in urban India. It investigates the nationwide expansion of 4G LTE infrastructure, driven by Jio's cost-effective high-speed data telecom revolution, which led to a shift towards smartphone-first internet access across diverse socio-economic classes. A market analysis demonstrates the rise of digital applications, enabling financial transactions, e-commerce, and service deliveries. Additionally, the study investigates internet activity patterns in New Delhi, revealing that infrastructure and connectivity are more significant predictors of digital equity than literacy rates. Notably, the research highlights the pivotal role played by Civil Society Organizations (CSOs) in promoting digital equity through initiatives in these urban informal settlements, emphasizing the significance of community engagement and technology-awareness efforts. It centers on the human aspect of technology, utilizing a smartphone-friendly website media to communicate research findings in an accessible format. The research seeks to empower residents, enhance digital inclusion, and bridge the digital divide through community-centric interventions. The central research question guiding this work is to identify key determinants and barriers in achieving digital equity for marginalized communities in urban informal settlements and explore effective strategies to bridge the digital divide for their empowerment and socio-economic upliftment.

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Chapter 1
Introduction

Today, access to the internet has become a critical component of infrastructure for ensuring equal access to information, communication, economic development, political participation, and social inclusion. In this accelerated turn to digitally supported working and living, the lack of access to meaningful internet connectivity, including equitable internet access and digital literacy, poses significant challenges for individuals. This disproportionately affects socially disadvantaged groups, such as low-income individuals, the unemployed or underemployed, and historically underserved and marginalized communities due to the systemic disadvantages they face. The unequal distribution of the implications of the digital divide brings to the forefront the issue of digital equity.

While there is a global push for increased digital connectivity and the development of internet-based infrastructure, digital equity goes beyond mere connectivity and accessibility to the internet itself. The divide often emerges from communicability: the motivation, skills, and purpose of use (Ragnedda, 2019). The case of India provides an interesting context. In 2016, the country experienced a nationwide telecom revolution supported by a new telecom company called Jio, which made high-speed cellular internet access affordable and widely available across the country. Major metropolitan areas were the first to benefit from this shift, including residents of informal settlements who often face challenges accessing basic urban services and infrastructure. Many of these residents now have access to affordable high-speed digital connectivity and cellular devices. However, this increase in internet accessibility did not result in equal socio-economic development opportunities across all sections of society. The compounding effects of marginalization such as income, employment status, education level, and geographic location (Ragnedda, 2019) greatly determined people's quality of access and ability to meaningfully engage with the internet.

There are many documented benefits of mobile media and communication on the socioeconomic development of marginalized communities and developing countries (Buthelezi & Dalvit, 2019). At a preliminary level, affordable cellular internet access provides opportunities for communication channels, social media usage, information search, and entertainment services. With improved digital literacy and higher quality of access, individuals can access a range of digital services in areas such as finance, education, entrepreneurship, digital marketplaces, and government, non-government platforms. Thus, improved access to the internet has the potential to bridge some of the traditional infrastructural gaps faced by these marginalized populations.

This study employs a mixed-methods approach, combining qualitative and quantitative methods, to investigate the digital divide and its relationship with underlying socio-economic inequities in the context of the major urban metropolitan areas in India. The central research question guiding this study is: What are the key determinants and barriers in achieving digital equity for marginalized communities in urban informal settlements, and how can community-

centric interventions effectively bridge the digital divide, fostering inclusive socio-economic development and empowering residents?

The research begins by mapping the initiation and expansion of 4G LTE cellular infrastructure in the country and analyzes its impact on internet penetration, data consumption, and digital innovations. Subsequently, the study focuses on the city of Delhi, exploring the correlation between location-based internet activity and the socio-demographic characteristics of the population. The findings underscore the socio-economic nature of the digital divide.

To address the gap, the study engages with Civil Society Organizations (CSOs) working on addressing digital literacy and building socio-technical capacity in residents in informal settlements in Delhi, Mumbai, and Kolkata. This engagement is rooted in a ‘meaningful digital connectivity framework’, emphasizing the pivotal played by CSOs and consistent on-ground mobilization in fostering meaningful connectivity within marginalized communities and areas with limited digital resources. The research seeks to empower residents, enhance digital inclusion, and promote digital equity through community-centric interventions.

To ensure that the research findings reach a wide and diverse audience, a smartphone-friendly website was developed as a central component of this study. The website serves as a platform to present the research in an interactive and accessible manner, catering to a broad audience, with a special focus on the residents whose stories are featured in the research. Recognizing the significance of meaningful digital connectivity and the core idea of addressing barriers to digital equity, the website's media-based focus emerges as a compelling approach to convey the story of digital equity and its profound impact on people's lives.

By utilizing media and communication effectively, the website aims to raise awareness and garner support for inclusive policies and initiatives related to digital equity. The power of media lies in its ability to convey complex information in an engaging and easily understandable manner, enabling the audience to connect emotionally with the subject matter. The website goes beyond the traditional academic report, seeking to communicate the research findings in a universally accessible format, embracing a wide range of audiences beyond the academic community.

Through the website, the stories and experiences of individuals from marginalized communities are effectively captured, making their voices heard and highlighting the real-life impact of digital equity initiatives. By prioritizing accessibility and user-friendliness, the website breaks down barriers to information and ensures that the research is comprehensible to all, regardless of their technical proficiency.

Furthermore, the website aligns with the central goal of the thesis, which revolves around meaningful digital connectivity and addressing the challenges that hinder digital equity. By creating an inclusive digital space that facilitates dialogue and understanding, the website becomes a powerful tool for advancing the cause of digital equity.

The research concludes with a powerful call to action in the form of a meaningful connectivity manifesto, emphasizing the significance of addressing digital equity in India. Bridging the digital divide and ensuring meaningful connectivity hold far-reaching implications for the country's social and economic development. Achieving this goal requires collaborative efforts from various stakeholders, including CSOs, planners, and policymakers. Throughout the discussion, the study underscores the human aspect of technology, emphasizing the importance of understanding the socio-demographic context and needs of the people when implementing digital initiatives.

In conclusion, this research constitutes a significant contribution to understanding digital equity in India's urban landscape. It presents a compelling case for harnessing the transformative power of digital technologies to drive positive and inclusive impacts. By recognizing the crucial role of CSOs, planners, and policymakers, and by emphasizing community engagement and awareness, this study offers valuable insights for promoting digital empowerment and bridging the digital divide in India.

Chapter 2
Literature Review

Digital equity is a critical factor for the advancement of societies, particularly in urban spaces where the potential for digital connectivity to bridge gaps and equalize opportunities is high. This literature review will examine and synthesize key theories and existing literature to provide a comprehensive overview of the subject, with a particular focus on urban India. It explores key theories and concepts relevant to the study, including Platform Urbanism, the digital divide, digital equity, digital literacy, and meaningful connectivity. It also highlights significant works that provide insights into the implications of digital disparities and the experiences of marginalized communities concerning technology access and usage.

Digital Infrastructure and Platform Urbanism

The Internet is now an essential service, a critical infrastructure for equal access to information, economic development, political participation, and social inclusion. As noted by the UN General Assembly in 2016, internet access is a human right (UN, 2016). This is central to the concept of Platform Urbanism, a theoretical framework that examines the spatial nature of digital platforms and their role in urban life. Platforms facilitate connections between specific geographical locations and the wider digital economy, reshaping the digital experiences of individuals and communities (Caprotti, Chang, & Joss, 2020). In this regard, Jordan (2015) underlines how Platform Urbanism, deeply spatial in its essence, is embedded in specific socio-economic urban realities at city, neighborhood, and street levels (Caprotti, Chang, & Joss, 2020). The specific geographic locations where digital exchanges take place are crucial, as platforms facilitate connections between these areas and the wider digital economy. (Jordan, 2015)

Digital Divide and Digital Equity

The digital divide, defined as the gap in access, skills, and support for effective engagement with digital technologies, disproportionately affects marginalized groups. Bridging this divide is crucial for achieving digital equity, which ensures equal participation and opportunities in society, democracy, and the economy (National Digital Inclusion Alliance, 2021). Ragnedda (2020) offers an insightful analysis of digital equity in his book ‘Enhancing digital equity: connecting the digital underclass,’ highlighting the digital revolution's potential to reduce social disparities, but also its unintended side effect of creating a digital oligarchy, thereby penalizing the digital underclass (Ragnedda, 2020).

Ragnedda emphasizes the significance of socio-economic factors in shaping the digital divide and digital equity. He underlines that access to digital technologies is not only influenced by

technical factors but also deeply intertwined with socio-economic conditions. Issues such as income levels, education, employment opportunities, and geographic location play a critical role in determining an individual's access to digital resources and the ability to engage effectively in the digital world. The unequal distribution of these socio-economic factors leads to varying degrees of digital inclusion or exclusion among different population groups.

Access and Skills

Van Dijk (2005) and Wilson (2006) provide nuanced perspectives on access skills, relating them to the availability of various resources as well as personal factors such as gender, intelligence, ability, ethnicity, age, and health. Wilson identifies eight factors related to internet access: physical, financial, cognitive, production, design, content, institutional, and political access. These access levels can create or reinforce divides in online experiences, eventually affecting the tangible outcomes users get from the Internet (Wilson, 2006).

Digital Literacy

Digital literacy is integral to promoting digital equity. The Ministry of Electronics and Information Technology, India, suggests that digital literacy extends beyond technical skills and includes the ability to navigate online platforms, critically evaluate information, and engage in meaningful digital interactions.

The Global Perspective

The digital divide and issues of digital equity are not limited to India alone; they are global concerns that affect various regions and countries. Scholars have extensively studied this phenomenon in different parts of the world, shedding light on the challenges and progress related to digital disparities. For instance, Bruce Mutsvairo's work, 'Mapping the Digital Divide in Africa: A Mediated Analysis,' provides a valuable perspective on the digital divide in the African context. The study examines how access to and usage of digital technologies vary across African nations, considering factors such as infrastructure, government policies, and socio-economic conditions. By analyzing these complexities, Mutsvairo highlights the need for context-specific interventions to address digital inequalities in the region.

Similarly, Karen Mossberger et al.'s book 'Virtual Inequality Beyond the Digital Divide' (2003) explores the digital divide in the context of the United States. The authors delve into the disparities that exist in internet access and usage among different demographic groups, such as income levels, education, and race. Their research emphasizes the role of socio-economic factors in shaping digital disparities and underscores the importance of policy initiatives aimed

at bridging the divide. Through comparative analyses and case studies, the book offers insights that contribute to the understanding of digital equity challenges in developed countries.

Technology of the Oppressed

In his highly relevant book 'Technology of the Oppressed' (2022), David Nemer provides a compelling and deeply insightful ethnographic account of how marginalized communities, specifically residents of favelas in Brazil, engage with technology. Nemer's research uncovers a nuanced narrative of both the oppressive and liberating aspects of digital tools in the lives of these communities. He demonstrates how technology can be a double-edged sword, exacerbating existing inequalities while also offering potential avenues for empowerment and social change.

Through his ethnographic approach, Nemer presents the lived experiences of favela residents, showcasing the complex ways in which they navigate digital platforms and information networks. He brings to light the struggles faced by these communities in accessing and using technology, shedding light on the challenges they encounter in a society that often marginalizes them. At the same time, Nemer reveals instances where technology has been harnessed as a tool for activism, community building, and resistance against oppressive structures.

By studying the dynamics of technology within the favelas, Nemer's work transcends geographical boundaries, offering valuable insights into the broader implications of technology for marginalized populations worldwide. His research prompts us to critically examine the role of technology in perpetuating or dismantling systemic inequalities, making a significant contribution to the discourse on digital equity and social justice.

Meaningful Digital Connectivity

The concept of meaningful digital connectivity, as recognized by the United Nations, emphasizes that access to the internet enables individuals to communicate, access information, conduct transactions, learn, participate in online communities, and access government services (UN, 2021). These aspects highlight the multifaceted benefits and opportunities associated with internet access. However, meaningful connectivity, as it is defined in the United Nations' framework, does not follow a comprehensive and granular approach. It focuses on evaluating fast and reliable infrastructure, affordable data plans and device ownership and adequate digital skills for safe navigation. However, it does not evaluate participation in the digital economy. Participation in the digital economy is a crucial aspect of meaningful connectivity, particularly in today's increasingly digitalized world. Access to the internet is not merely about being able to communicate, access information, or engage in online communities; it is also about being able to leverage the internet for economic opportunities. The digital economy

offers numerous avenues for financial empowerment, entrepreneurship, and access to digital marketplaces, all of which can significantly impact individuals' socio-economic well-being.

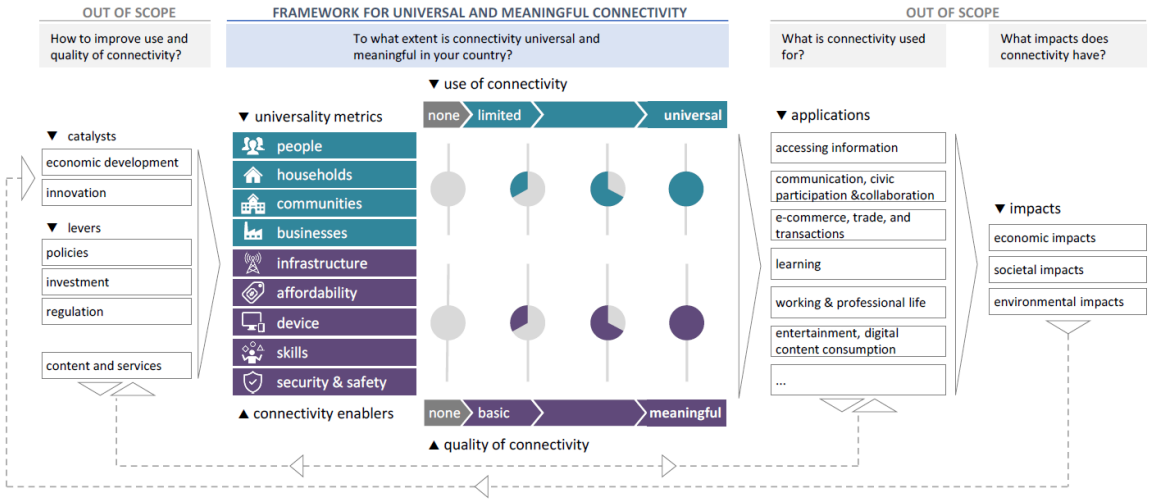


Figure 1. United Nations Framework for Meaningful Connectivity

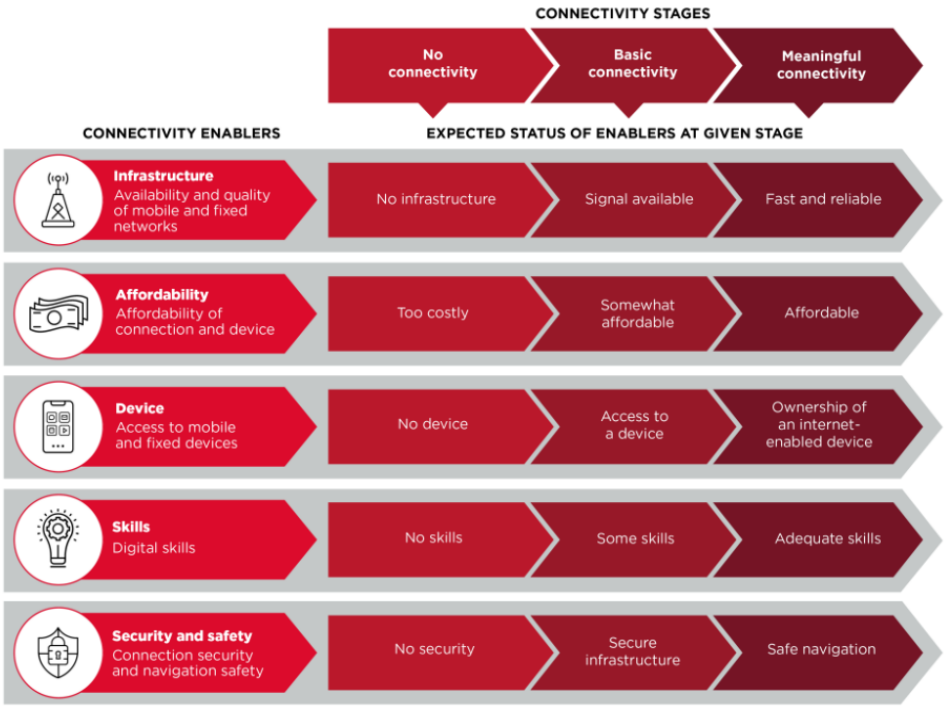


Figure 2. United Nations Framework for Meaningful Connectivity

Gaps and Future Directions

Despite the significant body of research on digital equity and the progress made in addressing the digital divide, there remain several crucial gaps that warrant further investigation. One of the key gaps is the need to understand and create meaningful connectivity for marginalized communities in urban India. While efforts have been made to improve internet infrastructure, affordability, and digital skills, the concept of meaningful connectivity requires a more comprehensive and granular approach

Another significant gap pertains to understanding the role of civil society organizations (CSOs) and community-centric actions in bridging the digital divide. While governments and private entities have made significant efforts in promoting digital inclusion, community-based interventions often offer unique advantages. CSOs, with their close ties to the communities they serve, are better positioned to address local needs and challenges. They can foster a sense of ownership and empowerment among community members, leading to more sustained and impactful digital equity initiatives.

Research in this area is critical to identify successful models of community-centric digital equity interventions that can be replicated and scaled up to benefit marginalized communities not only in urban India but also in other regions facing similar challenges. Understanding the best practices and lessons learned from successful CSO-driven initiatives, policymakers and stakeholders will contribute to the development of more effective policies and interventions to bridge the digital divide and foster socio-economic empowerments for all.

Chapter 3
Conceptual Framework

Meaningful connectivity

Meaningful connectivity, the central concept of this study, goes beyond the basic access to digital technologies and emphasizes the need for purposeful and beneficial engagement with these technologies. The framework of Meaningful Connectivity, inspired by Duarte et al.'s (2014) analysis of United Nations' documents on the information society, comprises three interconnected components: Connectivity, Accessibility, and Communicability.

Connectivity

Connectivity refers to the physical and infrastructural aspects of internet access. This includes the availability of reliable internet services, the speed of the internet, and the presence of necessary hardware such as computers or smartphones. In the urban Indian context, connectivity might be influenced by various factors like urban infrastructure, regional policies, or the presence of service providers.

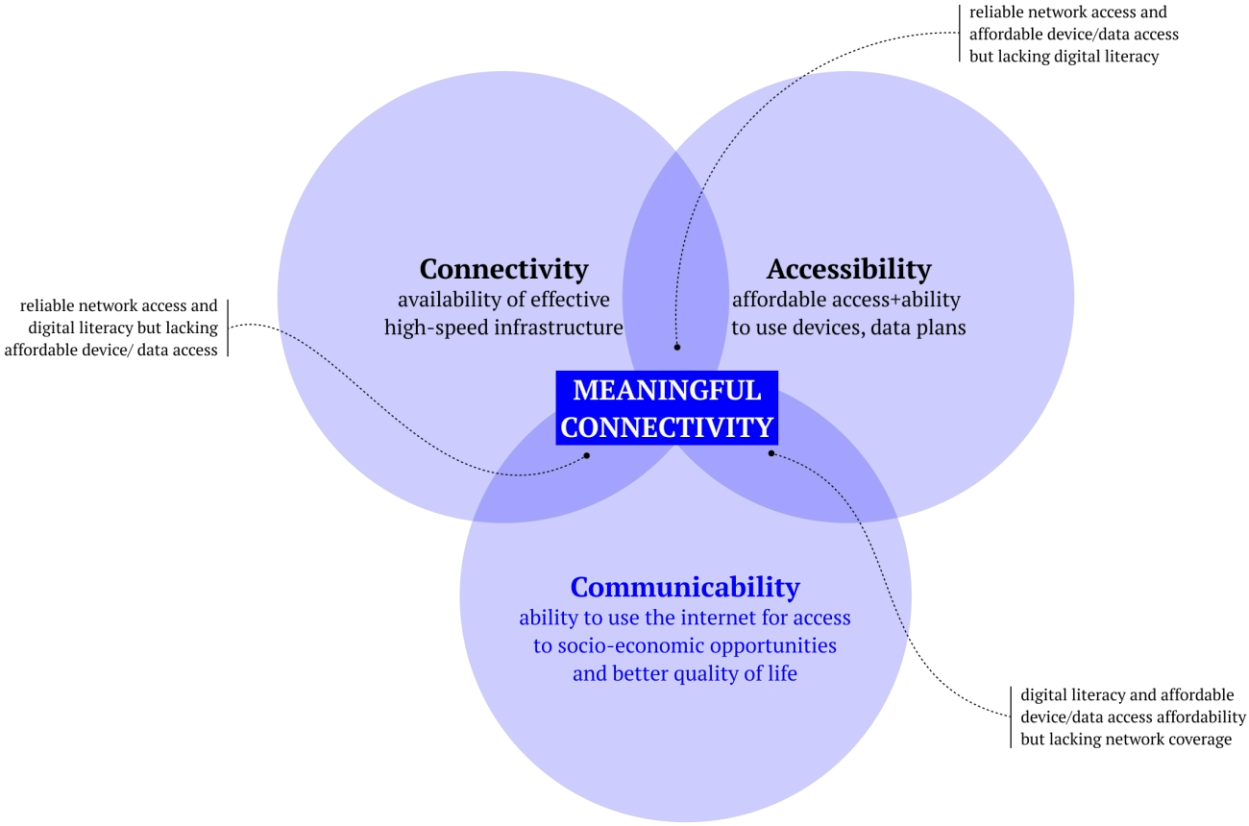
Accessibility

Accessibility encapsulates the financial aspect of internet access. It concerns the affordability of internet services and digital devices for all individuals, irrespective of their socio-economic status. Affordability is a significant factor influencing the digital divide, particularly in urban areas with a high disparity in income levels.

Communicability

Communicability, the third aspect of the framework, encompasses the ability of individuals to effectively use the internet in meaningful ways. This goes beyond mere technical skills and involves digital literacy and active participation. It entails the capacity to understand, interpret, and create digital content, as well as the ability to leverage the internet for various purposes, such as education, economic activities, social interaction, and civic engagement. Nurturing communicability is essential for empowering individuals to make the most of digital technologies for personal and community development.

In sum, this conceptual framework provides a robust tool for assessing digital equity. It argues that only when individuals have reliable and affordable internet access, and the ability to use this access in meaningful ways, can digital equity be achieved. Applying this framework to the study of urban India could yield significant insights into the state of digital equity in this region and provide the basis for effective interventions. By recognizing the interconnectedness of Connectivity, Accessibility, and Communicability, this framework offers a holistic approach to advancing digital equity and empowering marginalized communities by including underlying socio-economic factors.



The Meaningful Connectivity Framework (Duarte et al, 2015)

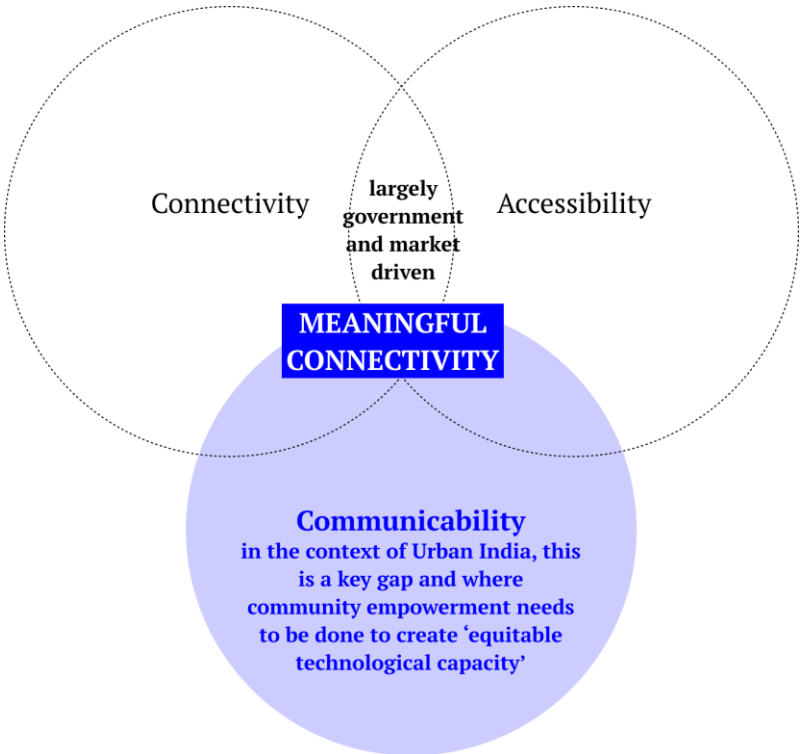


Figure 3. The Meaningful Connectivity Framework

Chapter 4
Methodology

A combination of quantitative and qualitative techniques was employed in this study. Most of the data used for the study was obtained from open-source databases.

1. Mapping 4G LTE infrastructure expansion

To investigate the expansion and improvement of 4G cellular internet access in India, the opencellid.org database of Cell Phone towers was utilized. This dataset provides geolocations of all cell towers in the country, along with information about the type of signal and the dates the towers were added to the dataset. The "date created" field was used as an approximation for the year when each tower was installed. The study mapped the locations where 4G LTE towers were added during the years 2015 to 2022, visualizing the expansion timeline of 4G infrastructure throughout the country.

	radio	mcc	net	area	cell	unit	lon	lat	range	samples	changeable	created	updated	averageSignal	year_added
0	GSM	404	5	2312	12805	0	70.123672	21.126022	1000	1	1	2016-04-03 07:40:22	2016-04-03 07:40:22	0	2016
1	GSM	404	69	441	40912	0	73.019943	19.039993	1000	1	1	2016-04-04 09:04:34	2016-04-04 09:04:34	0	2016
2	GSM	404	45	25033	53132	0	77.543466	12.903442	1369	14	1	2016-04-03 17:05:41	2017-04-03 15:15:40	0	2016
3	GSM	404	10	310	27942	0	77.236404	28.601303	1000	3	1	2016-04-04 05:08:20	2016-04-18 04:17:26	0	2016
4	GSM	404	42	52400	38596	0	79.679031	12.259859	1286	7	1	2016-04-04 05:08:21	2017-01-30 01:37:29	0	2016

Figure 4. Data frame showing the opencellid.org cell phone tower dataset.

2. Market analysis of internet penetration and growth

To investigate the growth and impact of cellular internet in India, various sources were utilized. Publications such as the quarterly Akamai State of the Internet and Ookla Speedtest reports provided valuable data on the annual growth in national average cellular internet speeds. In addition to speed measurements, annual reports published by dataportal.com offered insights into internet penetration and usage trends in the country. These reports provided data on metrics such as the average daily time spent on the internet by individuals, the percentage of the population with cellular connections, and the percentage of the population with access to the internet. These indicators were crucial in understanding the progress and reach of internet connectivity in India.

To assess the affordability of data plans and cellular devices, a market analysis was conducted. This analysis focused on determining the price of the cheapest smartphone and 1GB of cellular mobile data relative to the average per capita income in 2022. By considering the economic aspect of internet access, the study gained insights into the accessibility of digital resources for different segments of the population. Recognizing the dominance of smartphones and web-based applications (apps) as the primary means of internet access in India, an additional

market analysis was performed to identify the most downloaded apps in the country and emerging local digital innovations.

3. Internet Activity and Socio-demographic factors

To investigate the spatial distribution of internet activity and its correlation with socio-demographic factors in the city of New Delhi, this study utilized a combination of open-source datasets due to the proprietary nature of cellular data.

While studies such as "Singapore calling" (Xu et al., 2019) by the MIT Senseable City Lab and "Stockholm Flows"(Heine et al., 2021) by the MIT Senseable City Lab (SCL) have utilized large-scale mobile datasets and geotagged Twitter data, respectively, to study socio-economic patterns in cities, these specific datasets were not suitable for this study in the context of Delhi. Commonly used open-source datasets for place-based internet activity like Twitter, Flickr, and Swarm were not suitable due to limitations in representativeness and geographic precision.

Instead, the study relied on datasets from the Google places API to explore the association between the number of ratings as a proxy for place-based internet activity and socio-demographic factors. Data on the population and infrastructure was obtained from various sources, including Census 2011, WRI's Resource Watch 2019 Land Use dataset, Data for Good at Meta population datasets, and Opencellid's cell tower locations datasets. As these datasets had different areal units, a unified spatial unit of a 1000-meter diameter hex grid was utilized to aggregate and harmonize the data (Fig 5).

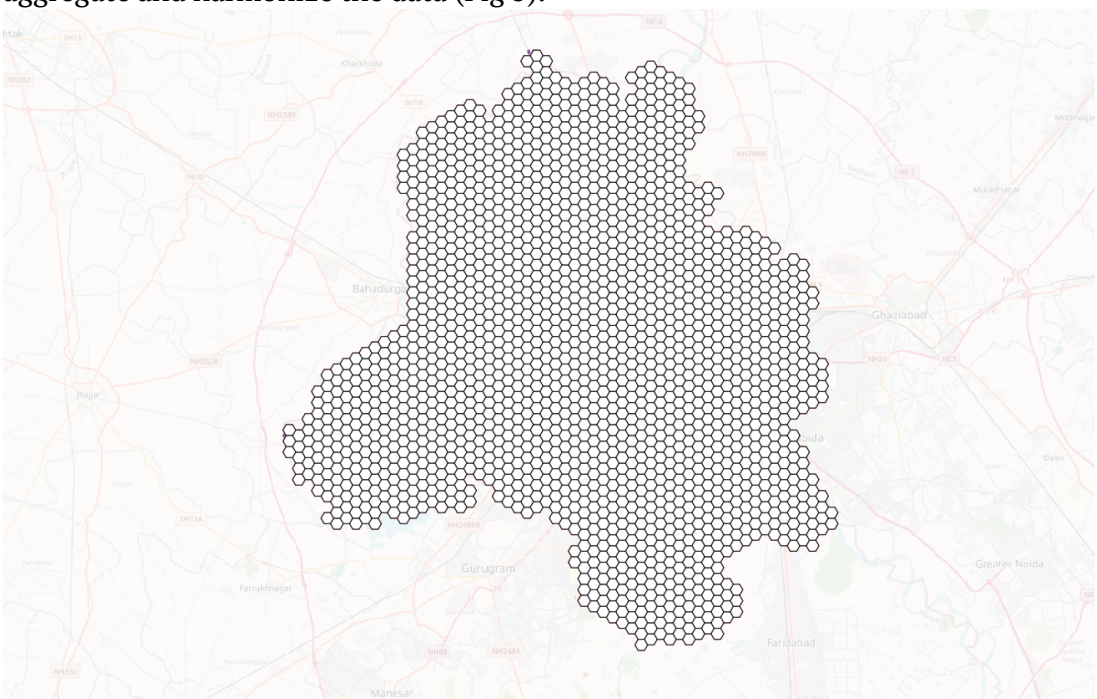


Figure 5. 1000m diameter hexagonal grid generated over New Delhi (Census 2011 Boundary)

By integrating these datasets and adopting a unified spatial unit, the study aimed to examine the relationship between place-based internet activity, as represented by the number of ratings, and socio-demographic factors in New Delhi. This methodology allowed for an analysis

of the spatial distribution of internet activity in relation to the city's population and infrastructure.

3a. Google place API for mapping place-based internet activity

The Google places API was used as the data source for studying place-based internet activity in Delhi. The Places API is a service that allows for HTTP requests to retrieve location data, including latitude, longitude, number of ratings, reviews, and other attributes, for establishments, geographic locations, and points of interest across the city. The total count of ratings for each point of interest (POI) in the API was used as a proxy for place-based internet activity, as it indicates the level of digital engagement associated with a particular location.

To ensure representative data from across all points in the city, a 1000x1000 meter grid was generated using the 2011 municipal boundary of Delhi (Fig 6).

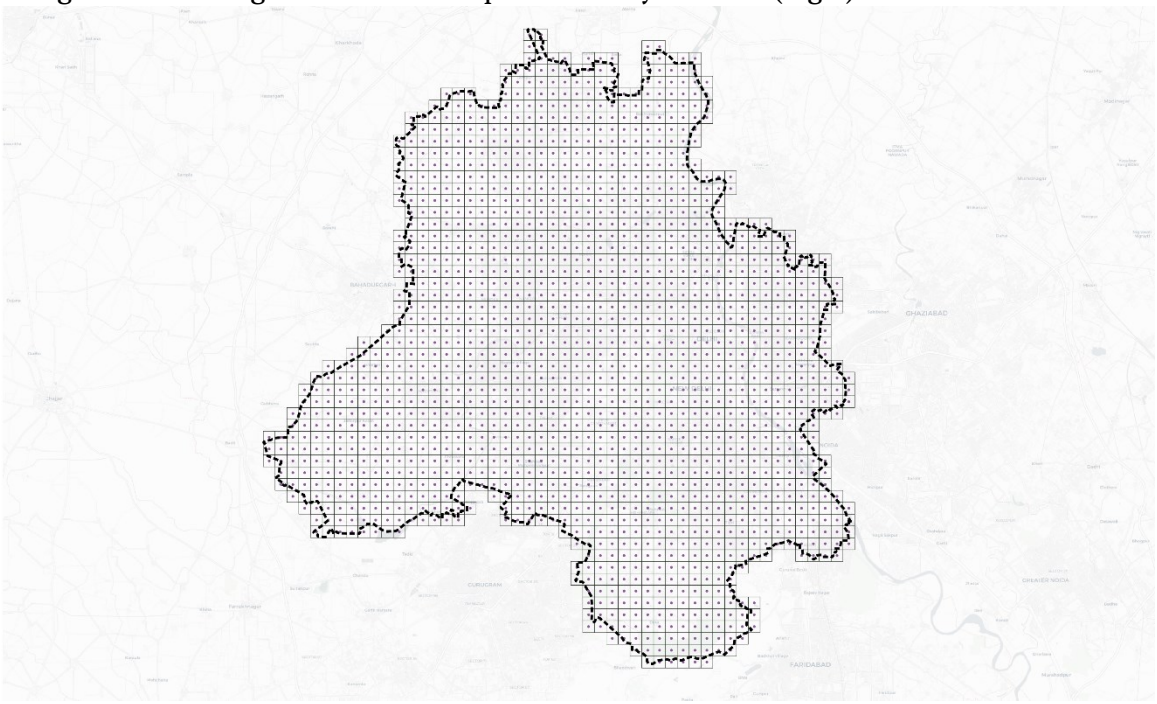


Figure 6. 1000x1000 square grid (and their centroids) generated over the Cenus 2011 boundary of New Delhi

The centroids of each grid cell were stored as a list of coordinates, which were used to query the API and retrieve POIs within a 1000-meter radius for each centroid. A total of 55,598 unique POIs under the location typology of amenities were captured (Fig 7).

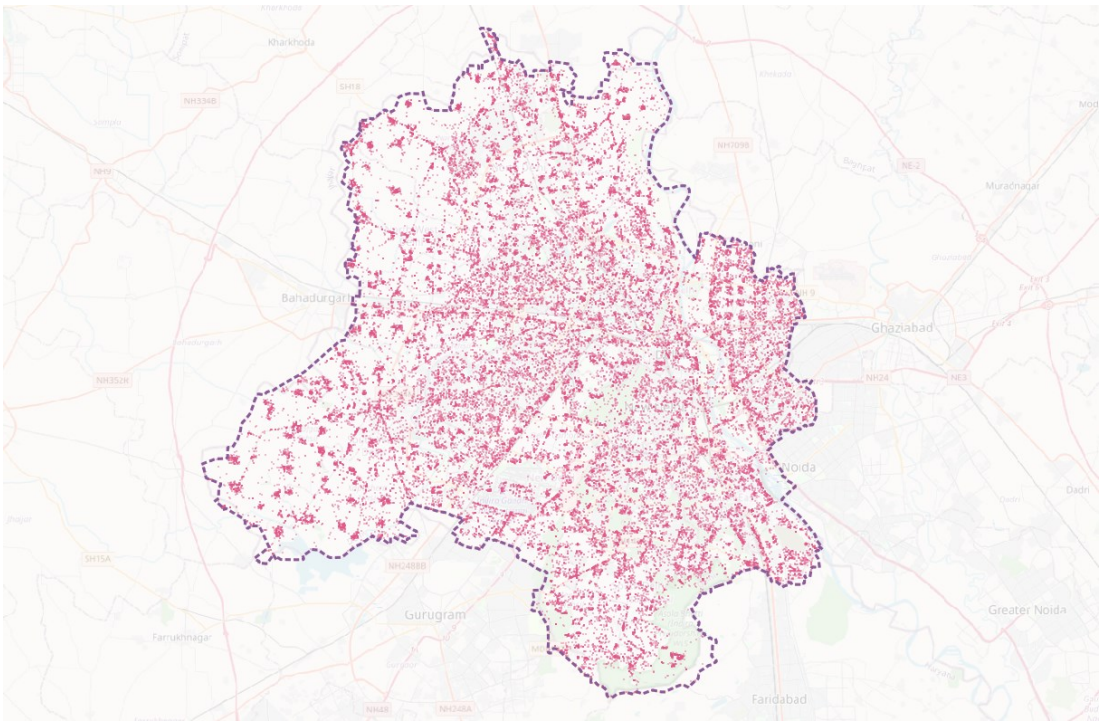


Figure 7. Google places POIs captured in Delhi

3b. Data Cleaning and Processing

The data had some outliers with an exceptionally higher number of ratings (Fig 8). These outliers primarily consisted of points of significant touristic and local interest, like monuments and famous restaurants in the city, which might skew the representation of general internet activity. Specifically, points with ratings above the 95th percentile, exceeding 273 total ratings, were dropped from the dataset. The cleaned dataset (Fig 9), consisting of 34,992 POIs and their respective number of ratings, was then aggregated to the unified hex grid using summary statistics (Fig 8).

```
count     36838.000000
mean        134.362778
std        2142.520386
min           1.000000
25%           2.000000
50%           5.000000
75%          20.000000
max      232299.000000
Name: user_ratings_total, dtype: float64
```

```
count    34992.000000
mean        19.541152
std         39.532600
min          1.000000
25%          2.000000
50%          5.000000
75%         16.000000
max        273.000000
Name: user_ratings_total, dtype: float64
```

Figure 8. Original (left) and Cleaned (Right) POIs dataset.

To obtain data on the socio-economic distribution of the population, data from India's latest available Census (2011) was utilized. The proportion of literate (Fig 9) and working populations (Fig 10) was determined for each census tract in Delhi and disaggregated to the hex grid using a proportional split method in GIS software (QGIS).

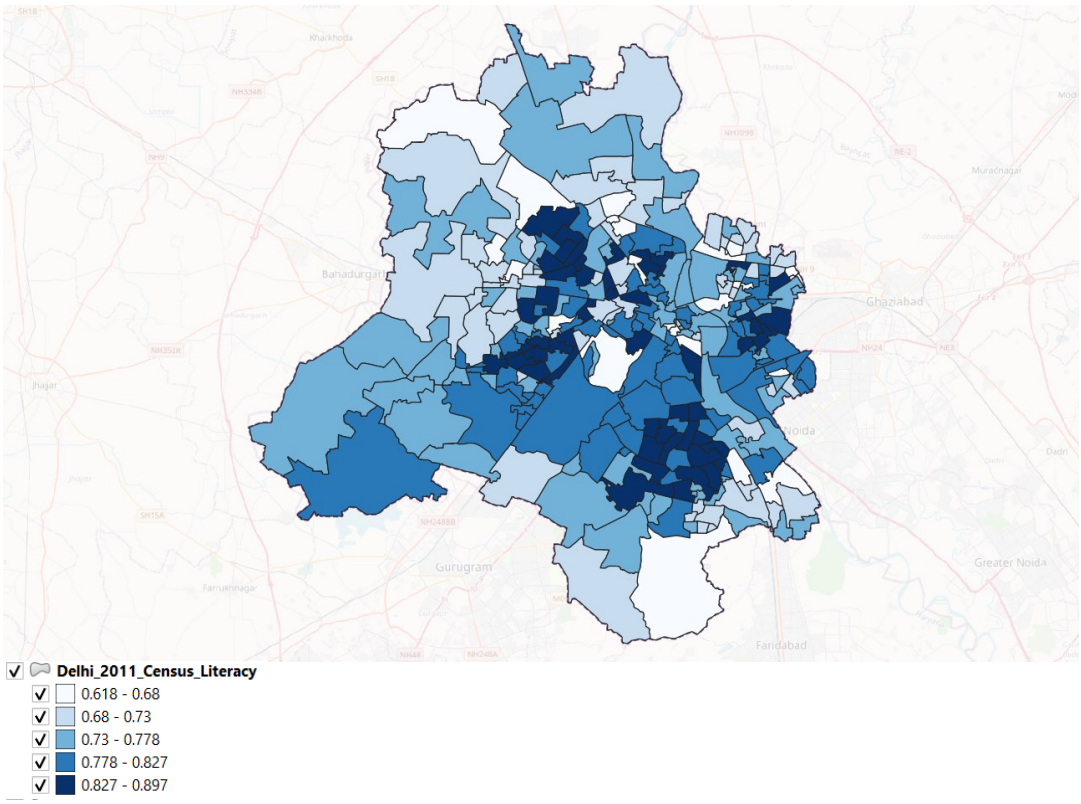


Figure 9. Choropleth Map showing the proportion of Literate Population in Delhi (Census 2011)

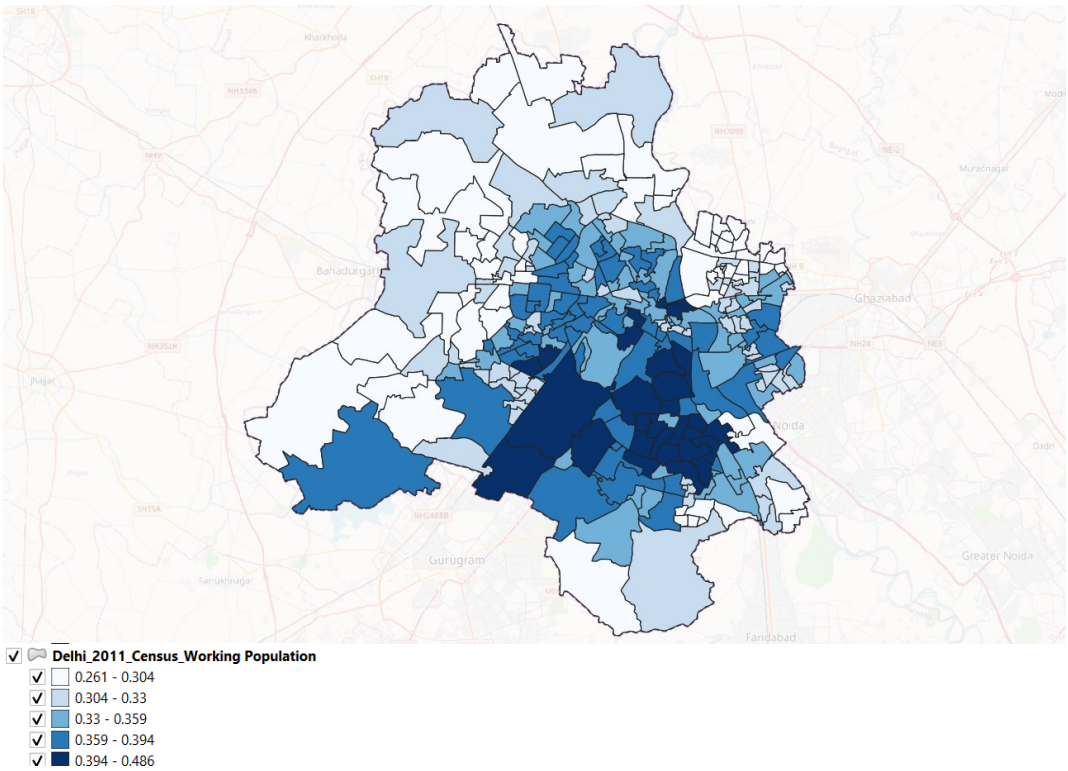


Figure 10. Choropleth Map showing the proportion of Working Population in Delhi (Census 2011)

Additional datasets were incorporated to gather relevant information. Population density data was obtained from Data for Good at Meta, which was available at a 30m x 30m geo-located grid resolution (Fig 11). The population density data was aggregated to the hex grid using summary statistics.

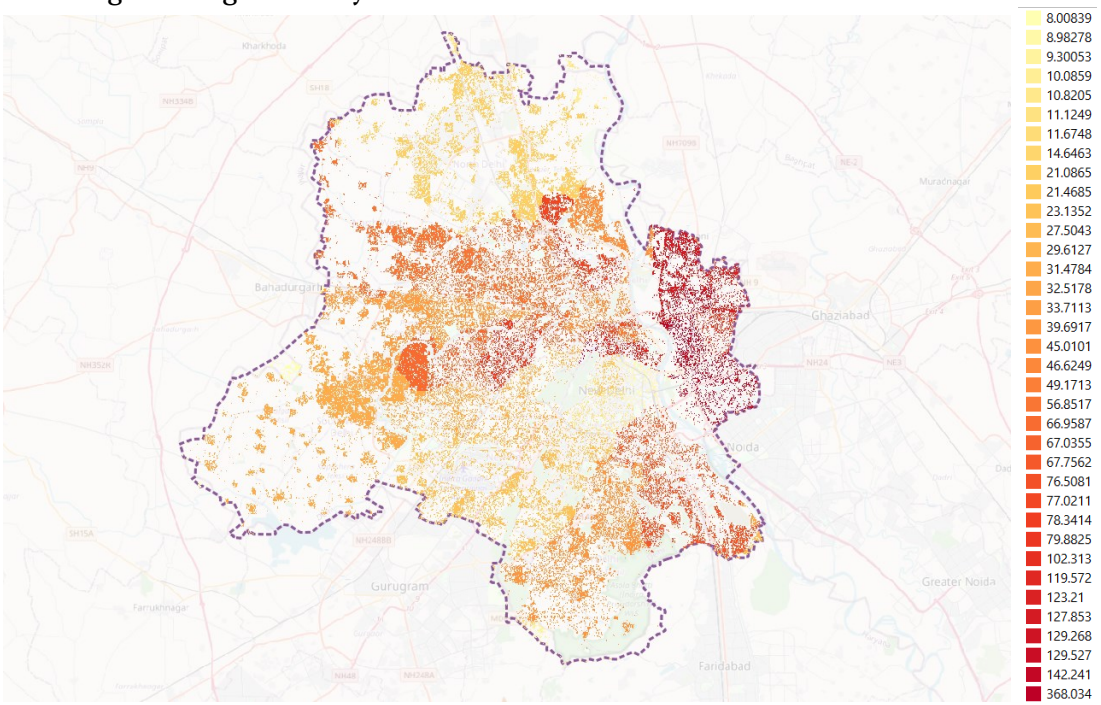


Figure 11. Distribution of population density in Delhi (Data for Good at Meta, 2022), legend (left) # people/30 sqm

Similarly, information on the presence of LTE (4G) towers was sourced from opencellid.org's dataset (Fig 12). The point locations of these towers were aggregated to the hex grid using summary statistics.

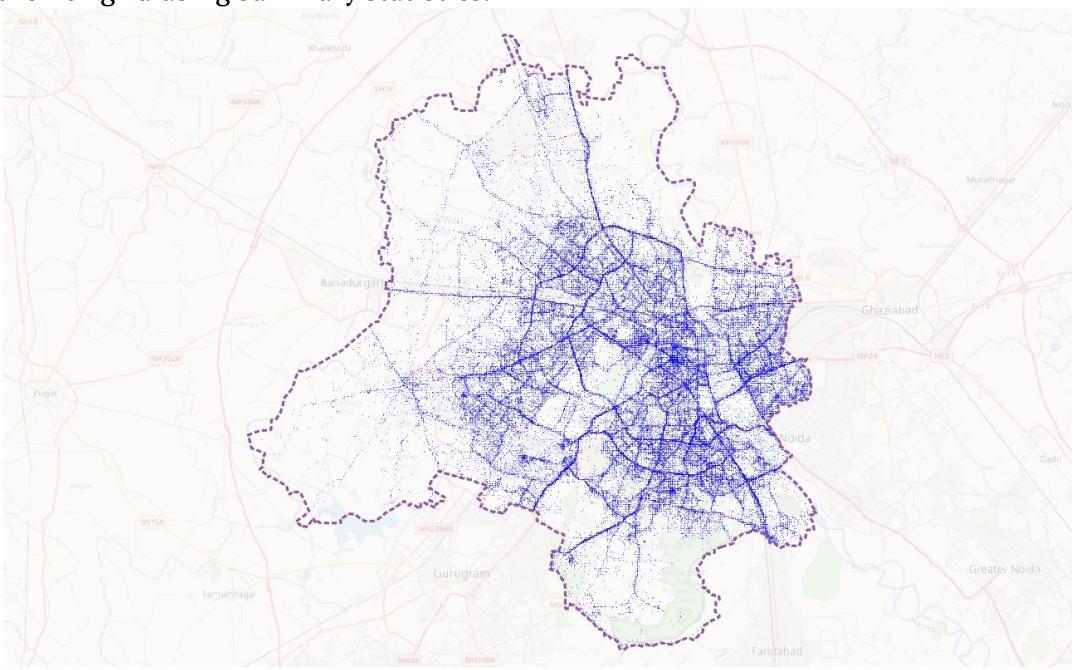


Figure 12. Location of 4G Cellphone towers (Opencellid.org, 2023)

Ookla's internet speed dataset, available at a geo-located grid resolution of about 610m x 610m, was used to derive data on internet speed. The dataset was disaggregated to point data using centroids of the grid (Fig13) and then aggregated to the hex grid by calculating the average download speed per bin using summary statistics.

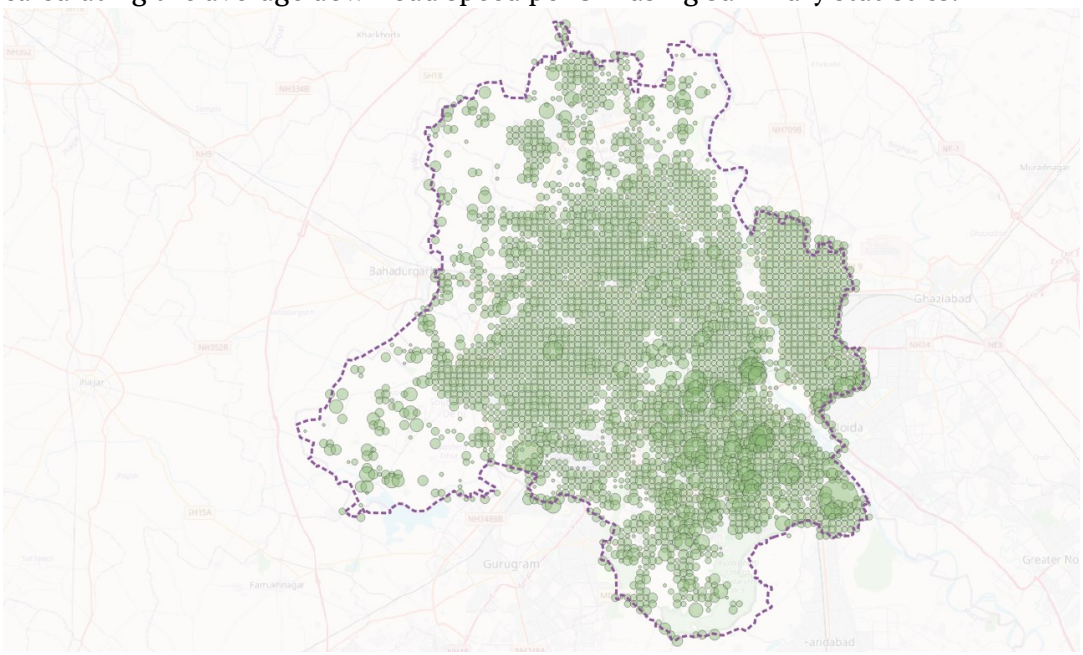


Figure 13. Proportional symbol map depicting the distribution of avg dnld speeds in Delhi (Ookla Speedtest Data, 2019)

Data on the presence of informal settlements was derived from the World Resource Institute's Urban Land Use (Areal) 2019 dataset. This raster data was used to determine the proportion of informal settlements per hex grid, to understand the relationship between informality and internet activity in the city.

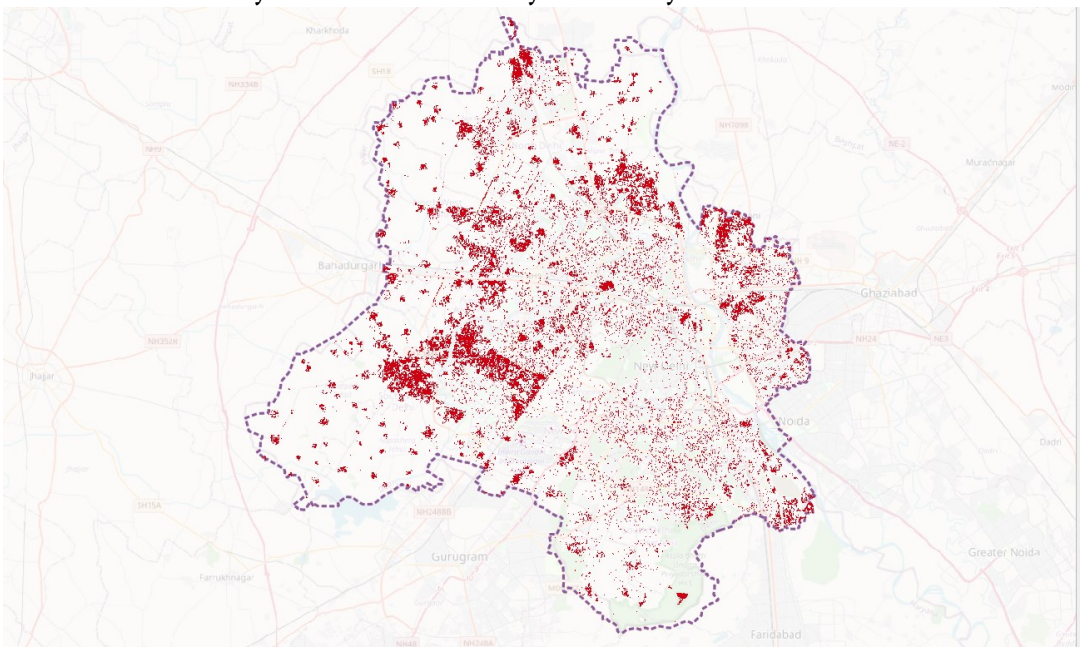


Figure 14. Presence of informal settlements in Delhi (WRI Urban Land Use Data, 2019)

3c. Poisson Regression

To study the association between place-based internet activity and socio-economic factors of the population, a regression was employed using the data from the hex grid. The total number of ratings per hex grid was used as the dependent variable to capture the level of internet activity associated with each location.

Before conducting the regression analysis, it was necessary to assess the distribution of the number of ratings per hex grid. As point count data, the distribution typically exhibits a heavy right skewness (Fig 15). In such cases, a traditional multi-linear regression model, which assumes a normal distribution of the data, is not appropriate. Instead, a Poisson regression model was selected, as it is more suitable for analyzing count data with non-normal distributions. Essentially, a Poisson Regression is a statistical model to understand how much different factors influence the number of times something happens, which in this case in the number of times there is digital engagement with a place on google maps by the act of someone rating the place online/ digitally.

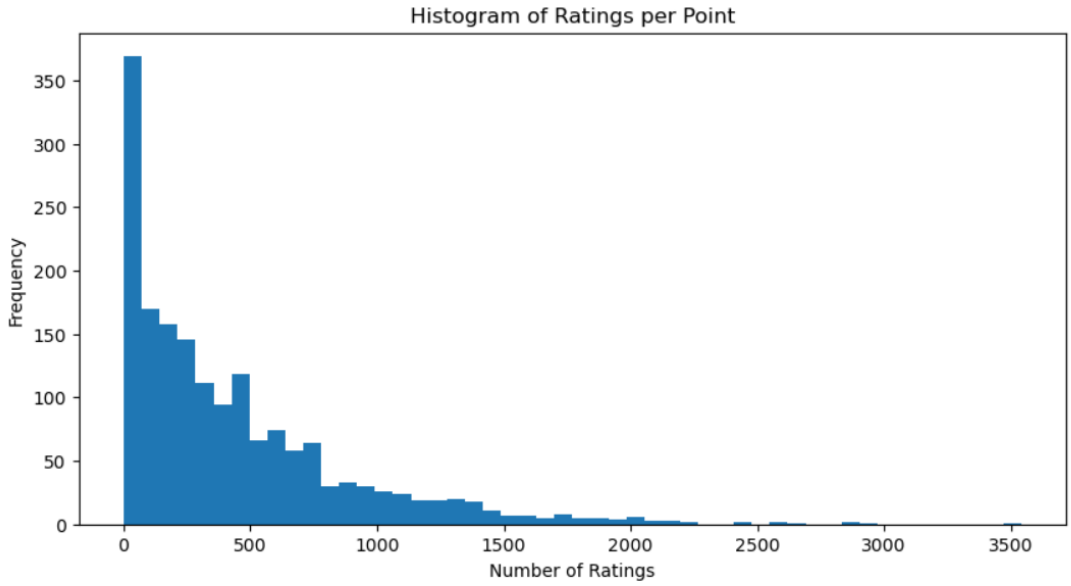


Figure 15. Histogram representing the distribution of total ratings per point for Google POIs (cleaned data)

The independent variables used in the Poisson regression model included the percentage of literacy, the percentage of the working population, the percentage of the population living in informal settlements, the presence of LTE towers, and the average download speeds per hex bin. Additionally, the count of POIs and population density were included as independent variables to control for their effects on the ratings. By incorporating these socio-economic and infrastructural factors into the regression model, it aimed to identify any associations or relationships between these variables and the level of place-based internet activity, as represented by the number of ratings per hex grid.

4. Site Visits and Semi-structured interviews

4a. Engagement with Civil Society Organizations

As part of the research process, active engagement and collaboration with civil society organizations (CSOs) were undertaken. These collaborations aimed to gain a deeper understanding of the experiences and internet usage patterns of residents in informal settlements in Mumbai, Delhi, and Kolkata and community-centric actions toward building digital capacity in the communities.

CSOs working in the areas of digital inclusion, education, and community development were identified and approached for collaboration. These organizations were Digital Empowerment Foundation (DEF), Addressing the Unaddressed (ATU), and Shelter Associates (SA) (see Chapter 8 Section 2 for more details about the partner organizations). They had existing networks and relationships with communities in informal settlements, making them valuable partners for accessing and understanding the target population. The CSOs have implemented various initiatives to address the digital divide and empower communities through internet access, digital literacy, and socio-technical innovations. Engaging with these projects in these settlements also helped gain valuable insights about these interventions and their impact on the lives of residents in informal settlements through observations, interviews, and feedback from the residents.

Figure 16. Photo from a visit to a DEF digital literacy center in Sarai Kale Khan, New Delhi

Organizations and their respective projects explored in this research:

Plus codes project by Addressing the Unaddressed, Kolkata:
This project is focused on using google's mapping technology to create digitally enabled address plates and access to address based services for residents of informal settlements who do not have a formal address. This research engages with their project sites across Kolkata.

Plus codes project by Shelter Associates, Maharashtra:
This project is focused on using google's mapping technology to create digitally enabled address plates and access to address based services for residents of informal settlements who do not have a formal address. This research engages with their project sites in Navi Mumbai.

Digital Literacy Centers (DLC) Centers by the Digital Empowerment Foundation (DEF), Delhi
DLCs have been established by DEF across various cities and towns in the country in areas with informal settlements and marginalized populations to promote digital literacy and provide access to devices and training. This research engages with their DLCs across informal settlements and night shelters in Delhi.

Soochnapreneur (SP) Centers by the Digital Empowerment Foundation, Delhi
SP are community information agents those who bridge the gap between government and citizens and make information available to the last mile beneficiaries. Under this program, a pool of information entrepreneurs strengthen and democratize the environment of public schemes information dissemination, services and final entitlement gains. DEF has set up SP centers across the county, especially in rural areas with a goal of of strengthening the poor information ecosystem in under resourced communities. This research engages with their SPs in informal settlements and night shelters in Delhi.

4b. Visits to Informal Settlements and Digital Learning Centers
In collaboration with partner organizations, visits were made to informal settlements in Mumbai, Delhi, and Kolkata. These visits provided an opportunity to directly engage with the residents and observe their internet usage practices in their local environments. The visits were conducted in a respectful and participatory manner, with a focus on building trust and rapport with the community members.

Figure 17. Photos from a visit to ATU's plus-codes project site in Chetla, Kolkata

A focal point of the visits were the plus code project sites, digital learning centers and internet-enabled social entrepreneurship hubs run by the CSOs. These centers served as important hubs for digital literacy and social entrepreneurship initiatives within the communities. Visiting these spaces provided opportunities for observing and interacting with residents undergoing training for using the internet for various purposes, such as education, communication, and accessing government services.

4c. Semi-Structured and Unstructured Interviews

A combination of semi-structured and unstructured approaches was used to conduct interviews with residents in the informal settlements, program managers and social workers at the CSOs, and facilitators and organizers at community centers. This allowed for flexibility in capturing the diverse experiences and perspectives of individuals and various stakeholders associated with the projects. (See Chapter 8 Section 3 for detailed interview logs)

Semi-structured interviews provided a framework of key topics to be covered, such as basic demographic information about the residents and their families, device ownership and internet access plans, types of online activities engaged in, challenges faced in accessing the internet, impact of internet access on their daily lives and the impact of the CSO driven projects. However, the interviews also allowed for open-ended exploration and encouraged participants to share their own stories and insights.

Figure 18. Semi-structured interview with Aarti, a Soochnapreneur running an SP Center in Kalibari, Delhi

Unstructured interviews provided an opportunity for more spontaneous and informal conversations. These interactions often took place during group discussions or casual interactions with community members. The unstructured nature of these conversations allowed for unexpected insights and personal narratives to emerge, providing a rich source of qualitative data.

Figure 19. Group discussion with kids and teachers at DEF's Nizamuddin DLC in New Delhi

Details of Site Visits and Interviews in Various Cities (see Chapter 7 for detailed interview logs):

City	Site	Organization	Date	Interviews
Kolkata	Ward 82, Chetla	Addressing the Unaddressed (ATU)	08 Jan 2023	Unstructured
Kolkata	Child in Need Institute (CINI) Office, Sealdah	ATU and CINI	09 Jan 2023	Unstructured
Kolkata	Ward 58	ATU and CINI	09 Jan 2023	Unstructured
Delhi	Digital Learning Center (DLC), Sarai Kale Khan	Digital Empowerment Foundation (DEF)	16 Jan 2023	Unstructured
Delhi	DLC at Ren Basera Basti, Hazrat Nizamuddin	DEF	16 Jan 2023	Unstructured
Delhi	DEF Head Office, Hauz Khas	DEF	17 Jan 2023	Semi-structured
Delhi	Soochnapreneur (SP) Center, Kalyanpuri	DEF	17 Jan 2023	Unstructured
Delhi	DLC, Gazipur	DEF	17 Jan 2023	Unstructured
Delhi	CURE Head Office, IHC	Center for Urban and Regional Excellence (CURE)	17 Jan 2023	Unstructured
Delhi	Community Center, Andrew Ganj	CURE	17 Jan 2023	Semi-structured
Delhi	Women's Group, Kalibari	CURE	17 Jan 2023	Semi-structured
Pune	SA Head Office (virtual)	Shelter Associates (SA)	28 Dec 2022	Unstructured
Navi Mumbai	Airoli Naka	SA	20 Jan 2023	Semi-structured
Mumbai	Arnab Jana at IIT Bombay (virtual)	IIT Bombay and KRVIA	10 Jan 2023	Unstructured

4d. Thematic Analysis and Insights

The data collected through these visits, interviews, and observations were transcribed, coded, and analyzed using a deductive thematic analysis. Common themes and patterns related to internet usage in informal settlements, challenges faced, and the impact of internet access and digital capacity-building efforts of civil society organizations on various aspects of residents' lives were identified.

Theme 1: Smart Phone Usage In Urban Informal Settlements

This theme explores the prevalence of smart phone ownership in informal settlements and highlights the popular apps and online activities among residents. It also examines the usage of smart phones for digital transactions, online education, and social media engagement. Codes:

- Smart Phone Ownership
- Popular Apps and Activities
- Digital Transactions
- Online Education
- Social Media Engagement

Theme 2: Impact of Digital Literacy Initiatives

This theme focuses on the impact of digital literacy training programs in informal settlements. It examines the outcomes of the training, including beneficiaries' proficiency levels and financial literacy. Additionally, it explores how digital skills empower residents to access information and services. Codes:

- Digital Literacy Training Programs
- Training Outcomes
- Financial Literacy
- Empowerment through Digital Skills
- Project success drivers

Theme 3: Impact and Uptake of Plus Codes Project

This theme delves into the awareness and understanding of the plus codes project among residents in informal settlements. It also analyzes the usage of plus codes as digital addresses for various purposes and explores challenges and barriers to the project's uptake. Furthermore, it examines the integration of plus codes in government schemes for improved service delivery and systemic unification. Codes:

- Awareness of Plus Codes
- Usage of Plus Codes
- Challenges and Barriers
- Government Scheme Integration

Insights gained from these qualitative engagements provided a deeper understanding of the ways in which residents in informal settlements were utilizing the Internet. It shed light on the potential benefits of internet access in terms of education, livelihood opportunities, access to information and services, and community connectivity. It also highlighted the challenges and barriers faced by residents, such as limited infrastructure, affordability, and digital literacy gaps.
Further, these interactions helped explore innovative digital empowerment projects run by the CSOs and develop an understanding of the enablers and challenges in the ecosystem that led to their relative successes and shortcomings. A participatory approach ensured that the findings and recommendations of the study were grounded in the lived realities of the population under investigation.

Overall, the collaboration with NGOs and civic society organizations, along with the visits to informal settlements and digital learning centers, provided a valuable qualitative dimension to the study, complementing the quantitative analysis and contributing to a more comprehensive understanding of internet usage in these underserved communities.

5. Media approach: Smart phone accessible website

In addition to the research methods employed, a smartphone-friendly website was developed, to make the research findings and information accessible to a wider audience. The website served as a digital platform to disseminate the research outcomes, share insights, and create awareness about the experiences of residents in informal settlements and the crucial role of CSOs regarding internet usage and digital empowerment.

5a. Design and User Interface

A user-friendly and easily accessible website was designed as wireframes in Figma, a UI/UX development platform. A responsive design, friendly for smartphones, was developed on the web-development platform, Cargo, an online website-building platform. The layout was optimized for smaller screens, ensuring easy navigation and readability. The design elements were chosen to enhance the visual appeal and engage the users effectively.

5b. Content Creation

The research findings, key insights, and recommendations were translated into concise and easily understandable content suitable for online consumption. The content was structured into sections and supplemented with relevant visuals, such as infographics, images, and videos, to enhance engagement and comprehension.

5c. Mobile Responsiveness

The website was developed using responsive web design techniques supported by Cargo, ensuring compatibility and adaptability across various screen sizes and resolutions. This allowed users to access the website seamlessly on their smartphones, eliminating the need for additional devices or adjustments. The development of a smartphone-friendly website

expanded the reach and impact of the research, making it accessible to a broader audience. By leveraging the ubiquity of smartphones and the convenience they offer, the website facilitated the dissemination of knowledge, increased awareness, and encouraged engagement with the research findings. Through the website, the research findings were not limited to academic publications but made accessible to individuals who could directly benefit from the work, including residents and CSOs involved in the research.

Chapter 5
Results

1. Mapping 4G LTE infrastructure expansion

The study conducted a comprehensive mapping of the growth and expansion of LTE (4G) cell phone towers in India using data obtained from the opencellid.org database. The analysis covered the period from 2014 to 2022. It was observed that in 2014, the network coverage across most areas of the country primarily consisted of 2G and 3G networks, with a national average cellular download speed of approximately 2.0 Mbps. In 2015, the deployment of 4G towers commenced, starting with major urban centers. These cities were the initial focus of the network expansion efforts. By 2016, the expansion of 4G infrastructure extended to smaller cities across India. Over the years, there has been a significant and rapid increase in the number of 4G towers throughout the country, with continued expansion until 2022. This expansion resulted in a significant improvement in average download speeds, increasing from 2.0 Mbps in 2015 to 14.4 Mbps in 2022.

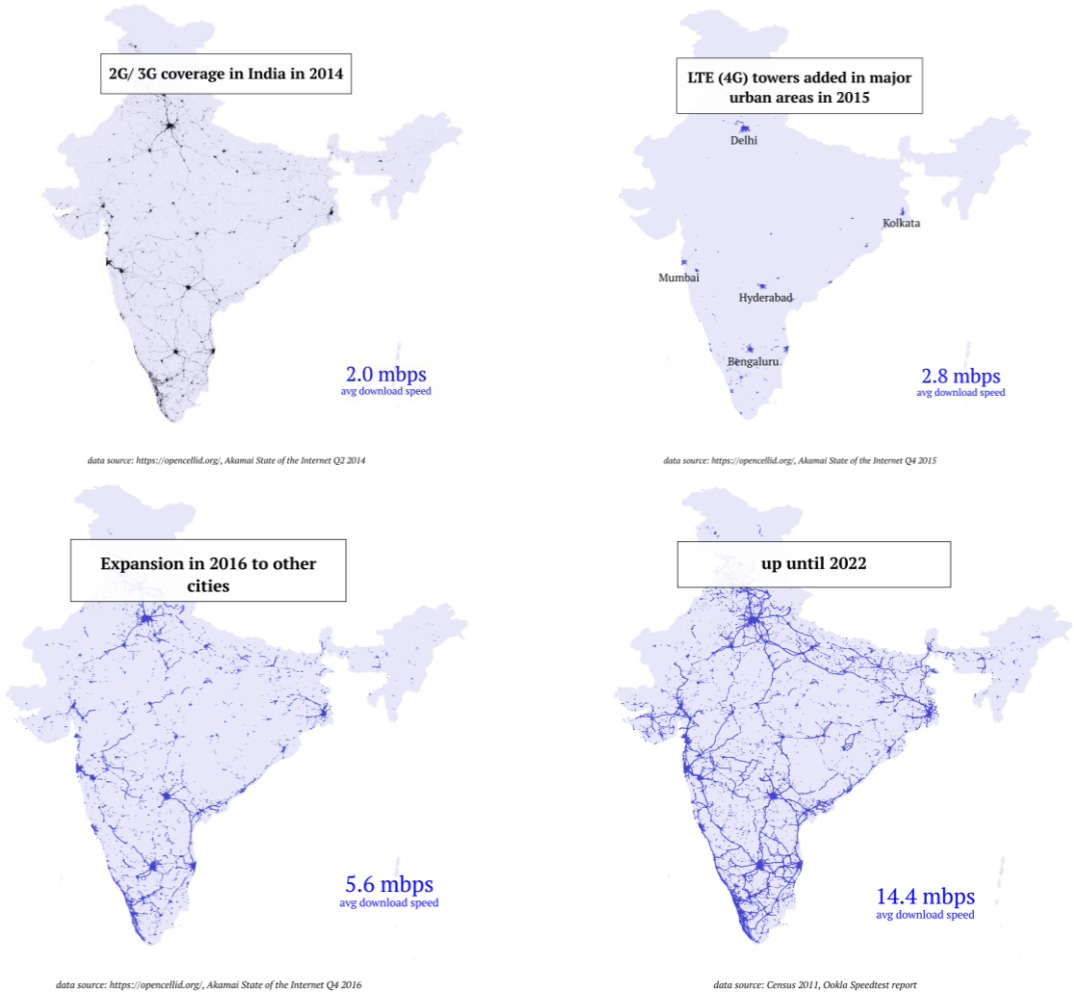
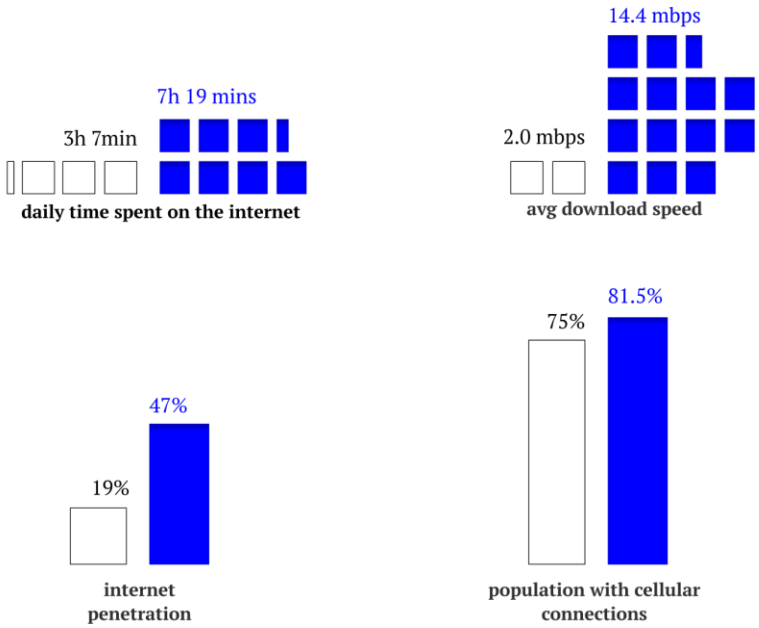


Figure 20. Mapping the growth of 4G LTE cell towers in India from 2015 to 2022 (opencellid.org data, 2023)

2. Market analysis of internet penetration and growth

Analysis of data from publications like Akamai State of the Internet, Ookla Speedtest and dataportal.com reports revealed a significant increase in the daily time spent by an average person on the internet, which more than doubled from approximately 3 hours in 2015 to over 7 hours in 2022. Furthermore, the data highlighted a substantial leap in internet penetration, rising from 19% to 47%. This increase was accompanied by a 6% rise in cellular connections, indicating that both existing and new cellular users were now accessing the internet through their mobile devices.



https://datareportal.com/reports/digital-2022-india

Figure 21. Growth in cellular internet penetration from 2015(white) to 2022 (blue)

The findings from dataportal.com's Digital 2022: India reports were particularly noteworthy. As of 2022, it was found that 91.3% of internet users in India primarily accessed the internet through smartphones. Moreover, 96.7% of individuals aged 14-64 owned smartphones. It was observed that the cheapest smartphone available cost approximately $68, which accounted for 42.7% of the average monthly income and 3.8% of the average annual income, equivalent to approximately $1550. Data costs were also relatively affordable, with 1 GB of data amounting to only 0.04% of the average annual income. In effect, smart phones have become the primary way of accessing the internet for a large portion of the population in the country.

https://datareportal.com/reports/digital-2022-india *https://www.businessofapps.com/data/most-popular-apps/*

Figure 22. Affordability of cellular internet (left) and most downloaded phone apps, their number of downloads (right) in India in 2022

According to the data.ia's State of the Mobile 2022 report, Indian users downloaded a staggering total of 26.7 billion apps in 2022 alone, with an average of approximately 19 apps per user. This data underscores the widespread adoption of mobile applications and their significant impact on digital experiences and interactions. Some of the most downloaded apps included popular social media apps platforms like Instagram, Snapchat, and Facebook, e-commerce apps like WhatsApp Business (a business version of the popular communication app), PhonePe (a digital payments app), and Meesho (an affordable web shopping app). (Fig 22)

3. Internet Activity and Socio-demographic factors

3a. Mapping Google POIs' number of ratings

The results from mapping the number of ratings for POIs show an interesting distribution of place-based internet activity across the city. For visualizing this distribution, the hex grid generated over New Delhi was extruded using the total number of ratings per hex cell as the variable for the height (Fig 23). The web-mapping platform kelper.gl was used for generating these visualizations. Areas with higher internet activity are represented by hex polygons with greater heights, while areas with lower activity are represented by hex polygons with lesser heights. It was observed that areas in the central, and southern parts of the city exhibited higher levels of internet activity (historically more affluent and populated areas).

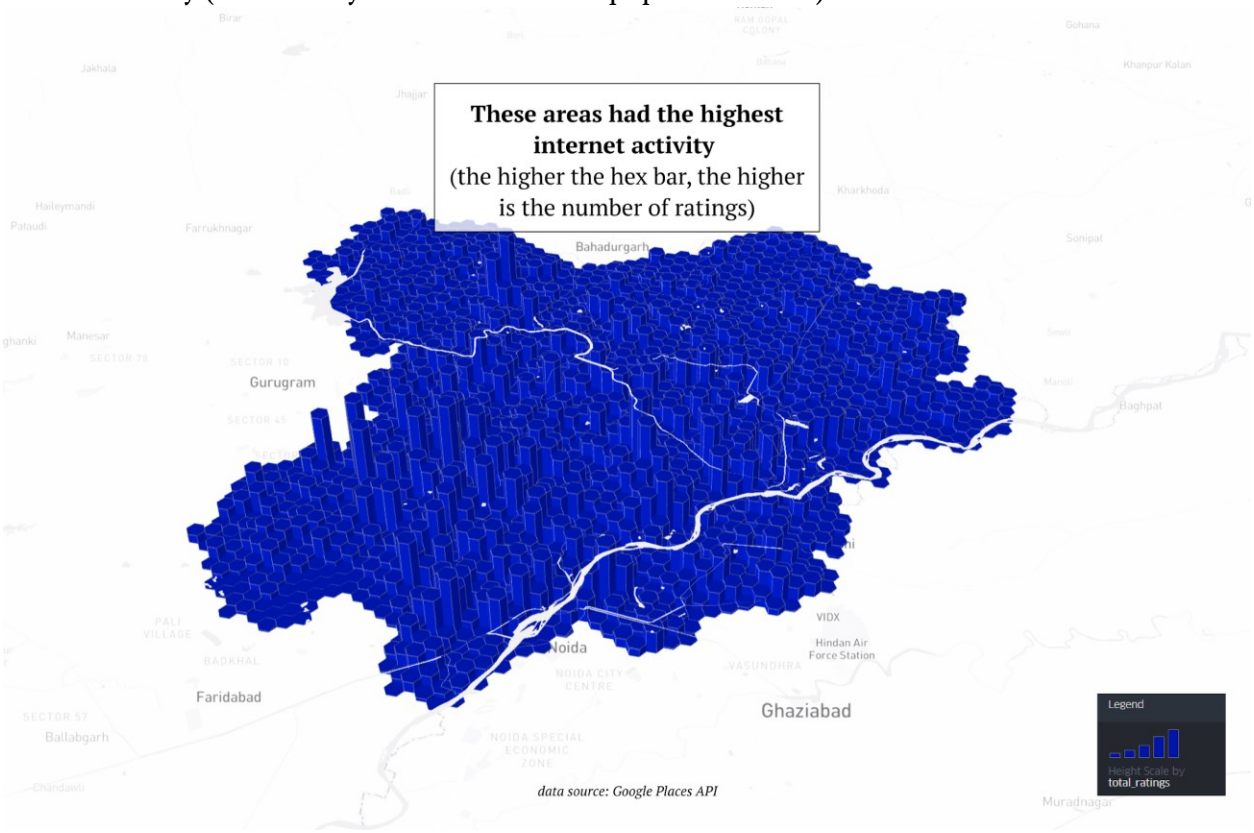


Figure 23. 1000m radius hex grid map over Delhi, extruded in proportion to the distribution of place-based internet activity as determined by total counts of ratings per hex cell on Google Places (Google Places API, 2023)

3b. Mapping relationship of internet activity with place-based internet activity

To analyze the relationship between internet activity and various socio-economic factors, the height-based hex-bin map was overlaid with choropleth maps representing factors such as the distribution of 4G LTE towers, working populations, and literacy rates. The goal was to visualize how these factors influenced the distribution of POI ratings.

The findings revealed interesting patterns. Areas with a higher concentration of 4G LTE towers, indicating better connectivity, exhibited higher levels of place-based internet activity. This suggests that improved access to high-speed infrastructure positively impacts internet engagement in those areas (Fig 24).

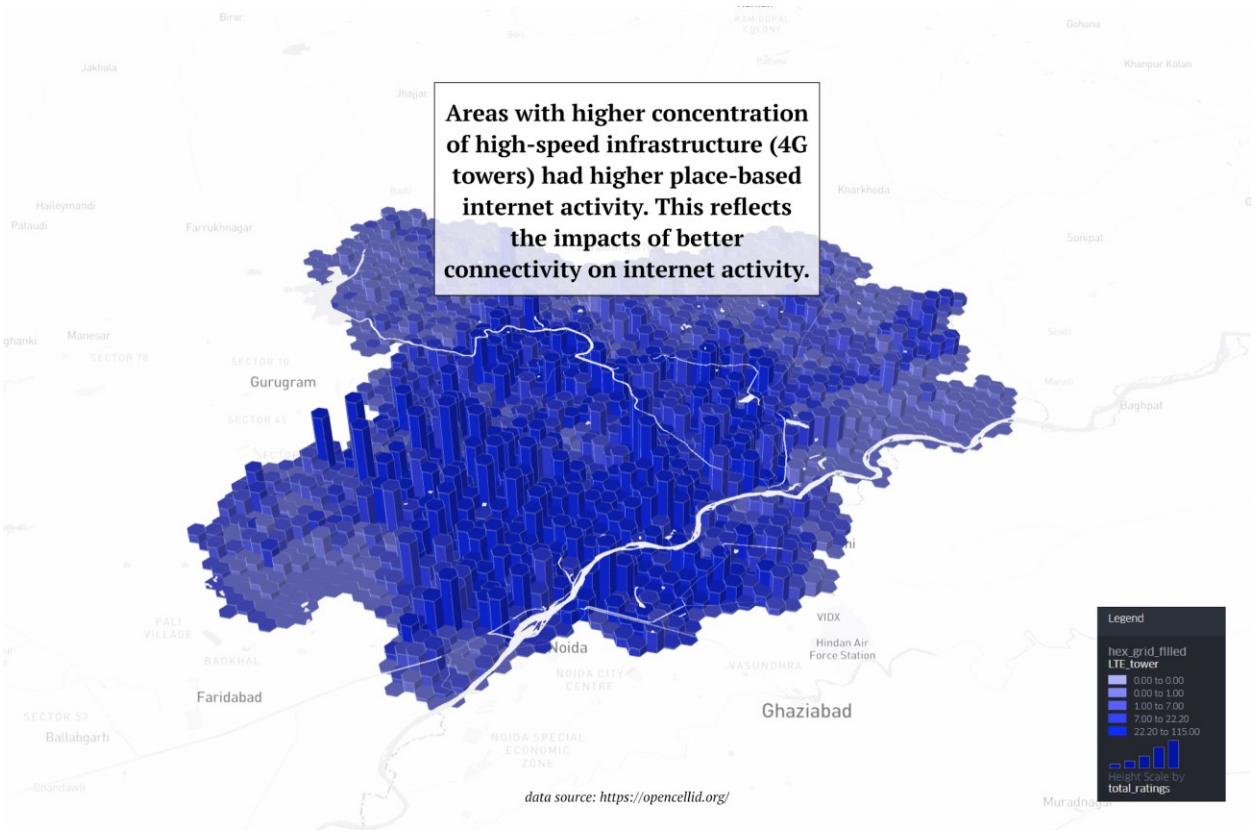


Figure 24. Hex grid height distribution of internet activity in Delhi (Google Places API, 2023) overlaid with a choropleth of the distribution of 4G LTE towers (opencellid.org, 2023)

Additionally, areas with a historically high concentration of working populations, as recorded in the 2011 Census, displayed high levels of internet activity. This correlation could be attributed to the influence of higher income levels, which typically accompany areas with a significant working population (Fig 25).

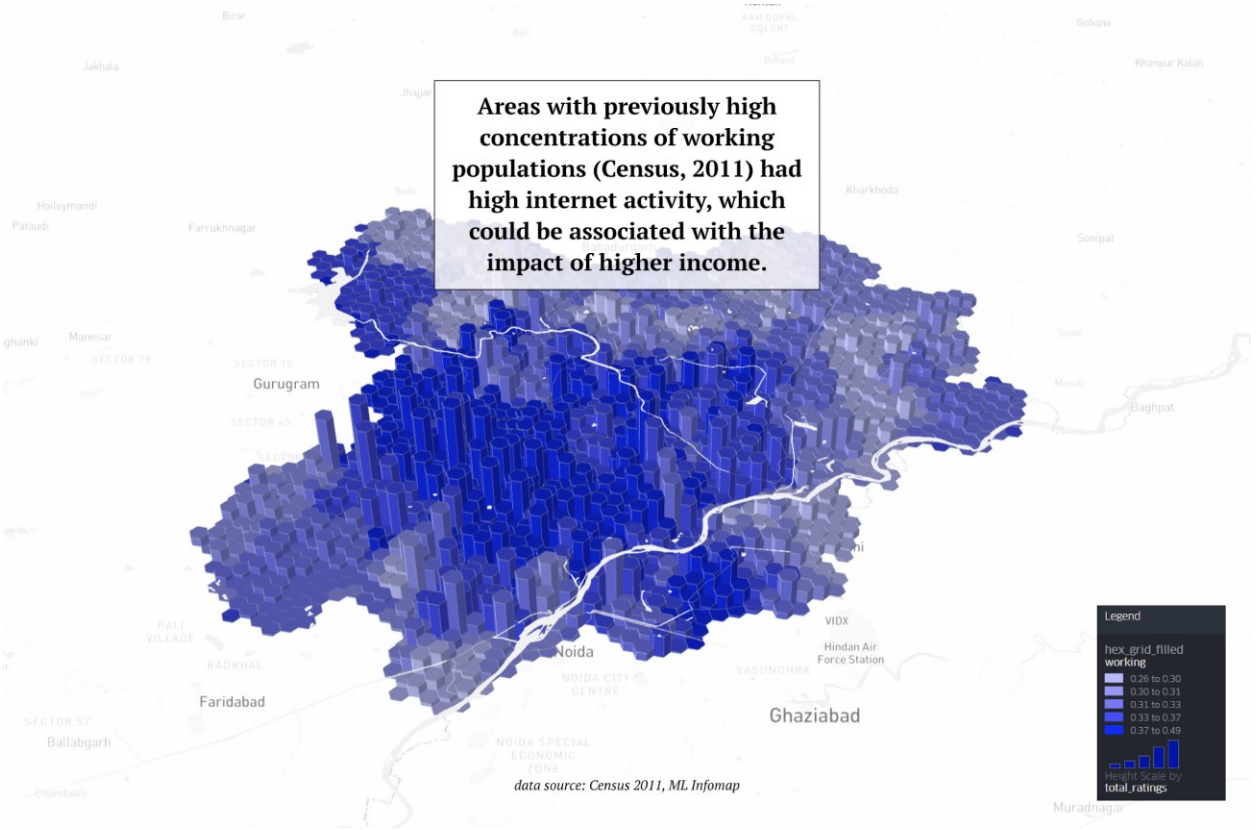


Figure 25. Hex grid height distribution of internet activity in Delhi (Google Places API 2023) overlaid with a choropleth of the distribution of proportions on working populations (Census 2011)

Furthermore, areas with previously high literacy rates also demonstrated elevated levels of internet activity, although the association was not as strong as the previous factors mentioned. This suggests that internet activity cuts across a diverse demographic, extending beyond just areas with high literacy rates (Fig 26).

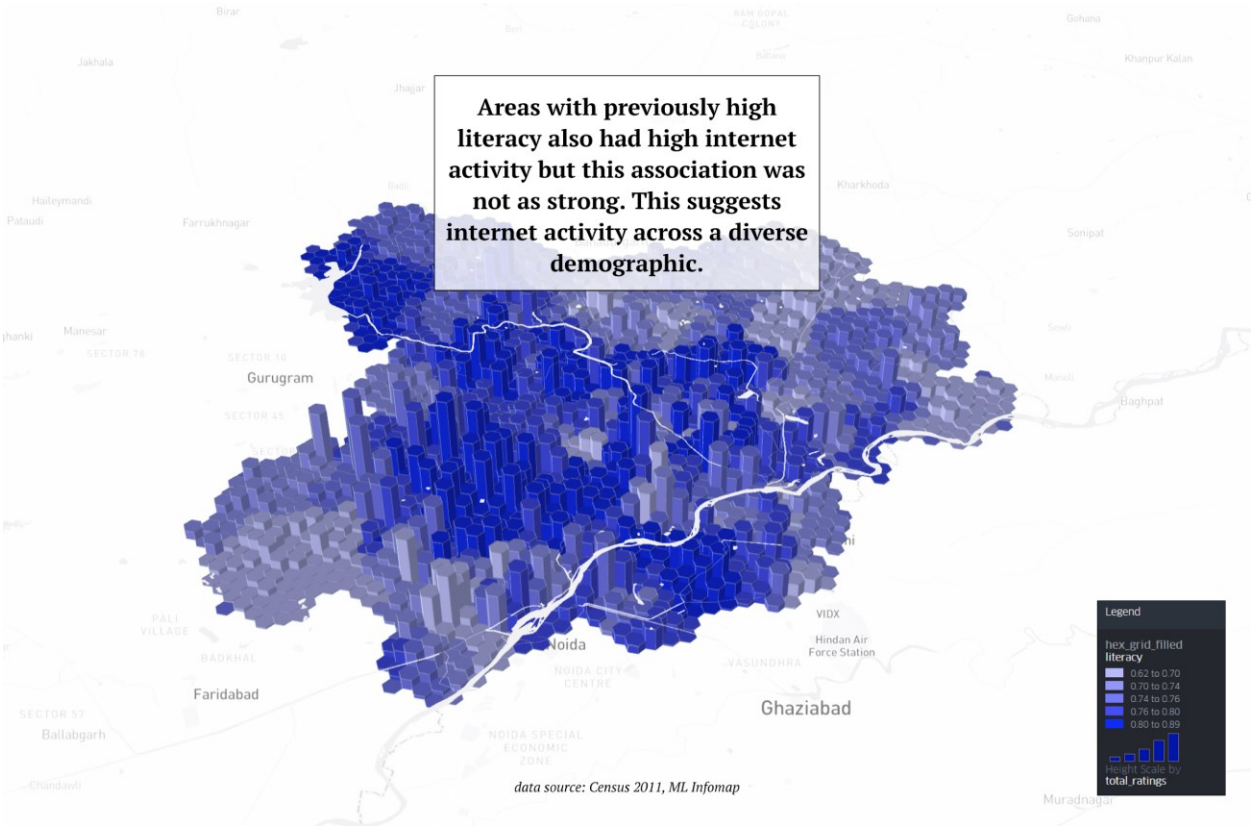


Figure 26. Hex grid height distribution of internet activity in Delhi (Google Places API 2023) overlaid with a choropleth of the distribution of proportions on literate populations (Census 2011)

Overall, these findings indicate that socio-economic factors such as connectivity, working population density, and literacy rates play a role in shaping internet activity patterns across the city.

3c. Poisson regression results

We see that controlling for factors like population density and number of points per hex, factors like higher concentration of cell towers (infrastructure) and working populations (income) had strong associations with the distribution of internet activity. We see a less strong but positive association with the area covered by informal settlements and internet activity, which indicates the penetration of access to these marginalized areas too.
The association with literacy, while positive is also not very strong.

Interpreting the model results:
The model converged successfully, indicating a well-fitted regression model. The pseudo-R-squared value was 0.5852, suggesting that the model explained approximately 58.52% of the variance in internet activity.

The likelihood ratio test showed a significant improvement in model fit compared to the null model (LLR $p < 0.001$), indicating that the predictors significantly contributed to explaining the variation in internet activity.

The coefficients of the predictors were estimated, and their standard errors, z-values, and p-values were calculated. The results are presented in (Fig 27).

```
         Current function value: 96.366501
         Iterations 7
                          Poisson Regression Results
==============================================================================
Dep. Variable:          total_ratings   No. Observations:                 1845
Model:                        Poisson   Df Residuals:                     1837
Method:                           MLE   Df Model:                            7
Date:                Thu, 27 Apr 2023   Pseudo R-squ.:                  0.5852
Time:                        02:03:30   Log-Likelihood:            -1.7780e+05
converged:                       True   LL-Null:                   -4.2863e+05
Covariance Type:            nonrobust   LLR p-value:                     0.000
============================================================================================
                               coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------------------
const                        5.6856      0.001   3806.122      0.000       5.683       5.689
population_counts            0.1019      0.001     82.983      0.000       0.100       0.104
prop_area_informal           0.1196      0.001     98.112      0.000       0.117       0.122
count_of_points              0.4571      0.001    403.013      0.000       0.455       0.459
LTE_tower                    0.2516      0.001    242.610      0.000       0.250       0.254
avg_d_mbps                   0.0206      0.001     18.365      0.000       0.018       0.023
literacy                     0.1014      0.002     67.353      0.000       0.098       0.104
working                      0.1888      0.001    131.006      0.000       0.186       0.192
============================================================================================
```

Figure 27. Results from the Poisson Regression with the number of ratings per hex as the dependent variable

The count of points showed a positive coefficient of 0.4571 ($p < 0.001$), indicating that a one-unit increase in the number of points is associated with a 45.71% increase in internet activity.

The concentration of 4G LTE towers, represented by the LTE Tower variable, had a positive coefficient of 0.2516 ($p < 0.001$), suggesting that a one-unit increase in the concentration of 4G LTE towers is associated with a 25.16% increase in internet activity.

Average download speed, represented by the Average Download Speed variable, had a positive coefficient of 0.0206 ($p < 0.001$), indicating that a one-unit increase in average download speed is associated with a 2.06% increase in internet activity.

Literacy had a positive coefficient of 0.1014 ($p < 0.001$), suggesting that a one-unit increase in literacy is associated with a 10.14% increase in internet activity.

Working population density, represented by the Working variable, had a positive coefficient of 0.1888 ($p < 0.001$), indicating that a one-unit increase in working population density is associated with an 18.88% increase in internet activity.

These results provide robust evidence of the significant associations between various socio-demographic factors and internet activity. The findings indicate that factors such as population density, presence of informal settlements, number of points, 4G LTE tower concentration, average download speed, literacy, and working population density play important roles in shaping internet activity patterns in the studied area.

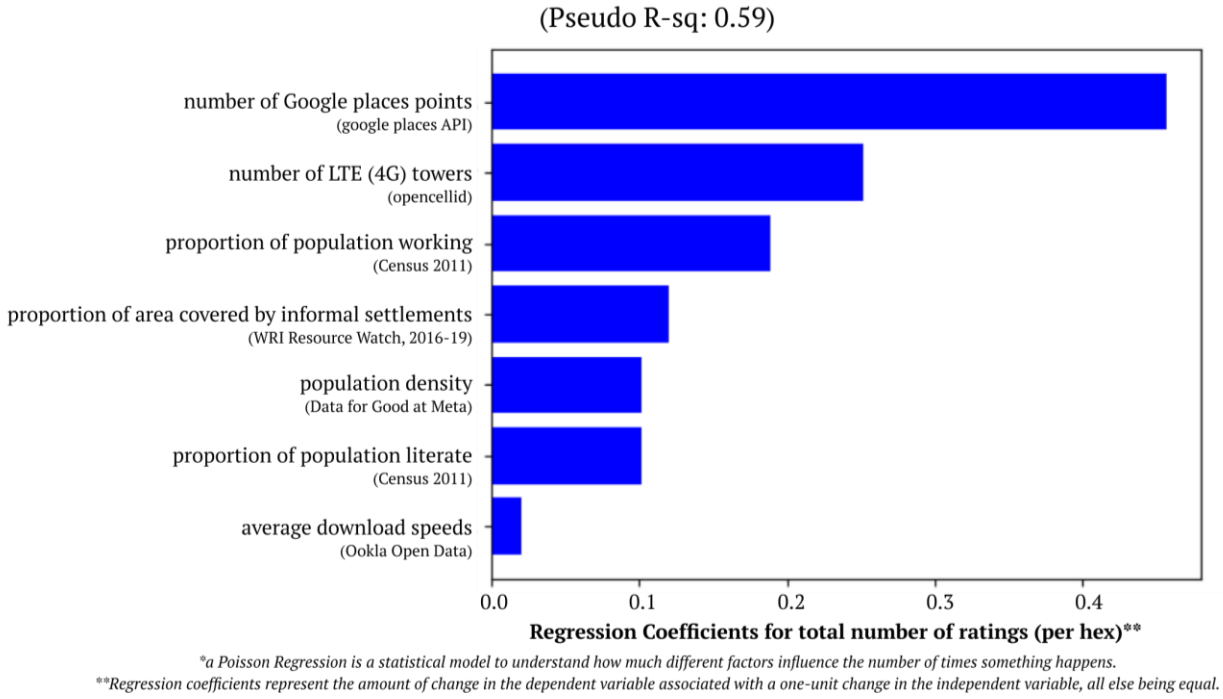


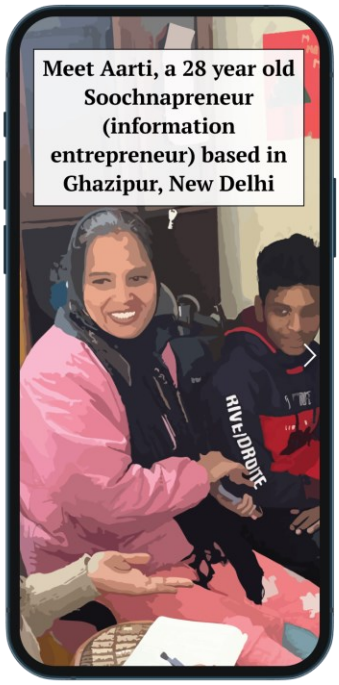
Figure 28. Bar Chart representing the strength of association of regression coefficients on the number of ratings per hex grid.

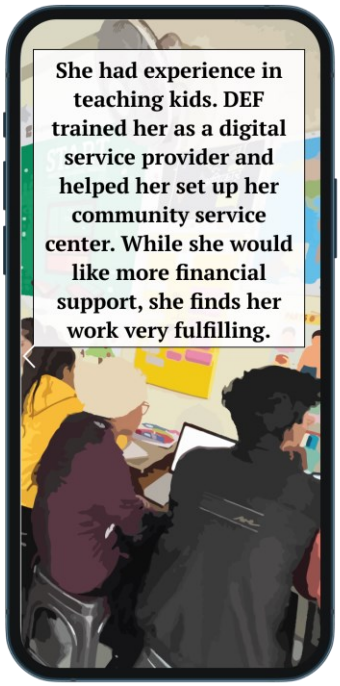
4. Site Visits and Semi-Structured Interviews

4a. Civil Society Organization Projects

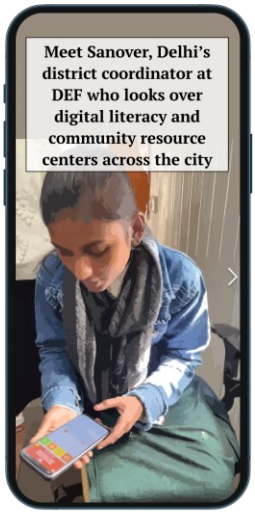
Google Plus-Codes as digital addresses

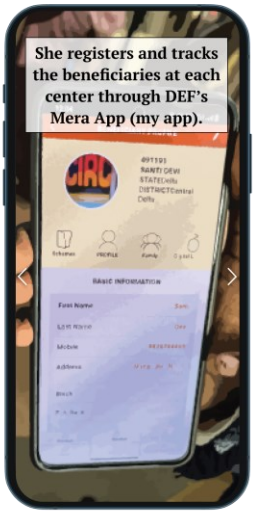
Google Plus-Codes as digital addresses

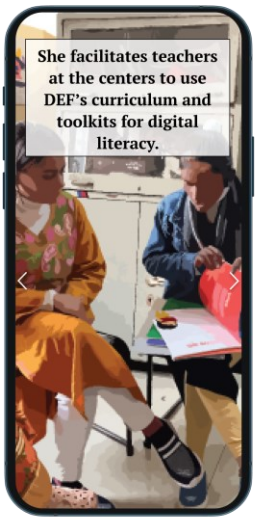


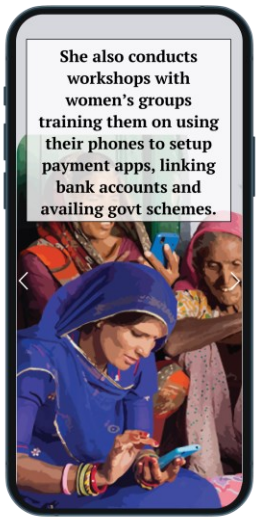


Digital Learning Centers for digital literacy









4b. Thematic Analysis

Based on the site visits to the CSOs and their project sites and analysis of the interview transcripts with various stakeholders, his thematic analysis explores the prevalence of smart phone ownership in urban informal settlements and highlights the popular apps and online activities among residents. It also examines the usage of smart phones for digital transactions, online education, and social media engagement.

Theme 1: Smart Phone Usage in Urban Informal Settlements

This theme explores the prevalence of smart phone ownership in urban informal settlements and highlights the popular apps and online activities among residents. It also examines the usage of smart phones for digital transactions, online education, and social media engagement.

a. **Smart Phone Ownership:** Smart phones are prevalent in most of the informal settlements, with at least one shared smart phone per family. Younger residents are early adopters of smart phones.

b. **Popular Apps and Activities:** The most common apps used by residents include social media platforms (Facebook, WhatsApp, Instagram, YouTube) and online shopping apps (Flipkart, Amazon). Some residents use food delivery apps (Zomato, Swiggy) for work and daily needs.

c. **Digital Transactions:** Residents are gradually adopting digital transactions, especially for online payments using apps like Google Pay and PhonePe. Digital transactions are becoming more common, but some residents still lack digital financial literacy and have trust issues with using technology for banking and payments.

d. **Online Education:** Smart phones are being used for online education, with students accessing educational platforms like Zoom and Google Duo for online classes and WhatsApp and Telegram groups for educational purposes.

e. **Social Media Engagement:** Social media platforms, especially Facebook, WhatsApp, and YouTube, are popular among residents for staying connected with friends and family and accessing information.

Theme 2: Impact of Digital Literacy Initiatives

This theme focuses on the impact of digital literacy training programs in informal settlements. It examines the outcomes of the training, including beneficiaries' proficiency levels and financial literacy. Additionally, it explores how digital skills empower residents to access information and services.

a. **Digital Literacy Training Programs:** Digital Empowerment Foundation (DEF) and other organizations have been conducting digital literacy training programs in several informal settlements. These programs aim to equip residents with basic computer skills and smart phone usage.

b. **Training Outcomes:** The training programs have led to increased digital literacy among the beneficiaries. Residents are now proficient in using basic applications like MS Word, Excel, and PowerPoint, and some have advanced to online transactions and e-learning.

c. **Financial Literacy:** Digital literacy programs have also focused on enhancing financial literacy. Residents are being trained to use digital payment apps for banking and transactions, facilitating access to financial services.

d. **Empowerment through Digital Skills:** Digital skills and community-centric social entrepreneurship efforts have empowered residents to access information, educational resources, and government schemes more effectively. Residents can now participate in online government initiatives and have easier access to various services.

e. **Project Success Drivers:** Successful implementation of digital literacy programs depends on strong on-site presence, community mobilization, and partnerships with local organizations. Peer-to-peer learning and local stewardship contribute to the sustainability of these initiatives. The surrounding urban context also plays a strong role in the socio-economic conditions of the population, and thus also the successful understanding and uptake of the project by the residents.

Theme 3: Impact and Uptake of Plus Codes Project

This theme delves into the awareness and understanding of the plus codes project among residents in informal settlements. It also analyzes the usage of plus codes as digital addresses for various purposes and explores challenges and barriers to the project's uptake. Furthermore, it examines the integration of plus codes in government schemes for improved service delivery and systemic unification.

a. **Awareness of Plus Codes:** Awareness about the plus codes project varies among residents. Some are familiar with plus codes as house numbers but lack knowledge of using them as digital addresses or with Google Maps.

b. **Usage of Plus Codes:** While some residents use plus codes for specific purposes like online shopping deliveries, others have limited or no utilization of this addressing system.

c. **Challenges and Barriers:** The uptake of plus codes faces challenges, such as a lack of community awareness and mobilization efforts, and low knowledge among residents, and undocumented migrant workers in the settlements. Government initiatives like the National Register of Citizens (NRC) also affect project implementation.

d. **Government Scheme Integration:** Plus codes have the potential to improve government service delivery by providing unique digital addresses for beneficiaries. Integrating plus codes into government databases can streamline services and prevent duplication of addresses.

The thematic analysis highlights the significance of smart phone ownership and digital literacy in urban informal settlements. Smart phones are transforming the lives of residents, enabling access to information, online education, and digital transactions. Digital literacy initiatives have played a vital role in improving digital skills and empowering residents to avail various services. However, the uptake of plus codes and other digital literacy initiatives faces challenges, necessitating increased community awareness and targeted training, through the action of community-based organizations and civil society organizations, to harness its full potential for improving the lives of the residents through digital empowerment.

5. Media Approach: Website Wireframes

The following wireframes were produced for the website, accessible on both computers and phone screens. The website aims to represent the findings of the thesis in a widely accessible and easy-to-understand format.

- Website url: **https://digitalequity.cargo.site**
- Complete set of wireframes in Chapter 7: Section 2

Chapter 6
Discussion

The discussion section of this research provides a comprehensive overview of the transformative impact of digital technologies, particularly cell phones, and mobile internet access, on India's digital landscape. The key findings underscore the importance of addressing digital equity in the country and highlight the role of various stakeholders, including civil society organizations (CSOs), planners, and policymakers, in promoting meaningful connectivity and digital empowerment.

1. LTE Expansion

The study begins by analyzing the growth and expansion of 4G LTE infrastructure in India, primarily driven by the disruptive entry of the telecom company Jio. The introduction of affordable high-speed data plans and unlimited calling had a profound impact on how people in India accessed the internet, making cell phones the primary means of connectivity. This rapid shift not only disrupted the telecom industry but also had significant implications for digital equity. The affordability and accessibility of high-speed internet through cell phones reduced the digital divide and provided opportunities for traditionally marginalized populations to engage with digital services. This led to a shift where cell phones became the primary means of accessing the internet through 4G connectivity.

Monopolistic disruption: Jio's aggressive pricing and innovative offerings disrupted the telecom industry, leading to other companies having to quickly offer competitive prices to retain consumers. This rapid shift changed the dynamics of the telecom market in India.

Implications: The introduction of affordable, high-speed internet through Jio's offerings had profound implications for India's digital economy. It enabled greater internet penetration and digital inclusion, providing opportunities for individuals and businesses to access and engage with digital services.

Equity: The expansion of 4G LTE infrastructure and the affordability of Jio's plans contributed to reducing the digital divide and improving digital equity in the country. Populations that previously lacked access to the internet due to coverage, affordability, and device constraints now had greater availability and affordability to use the internet.

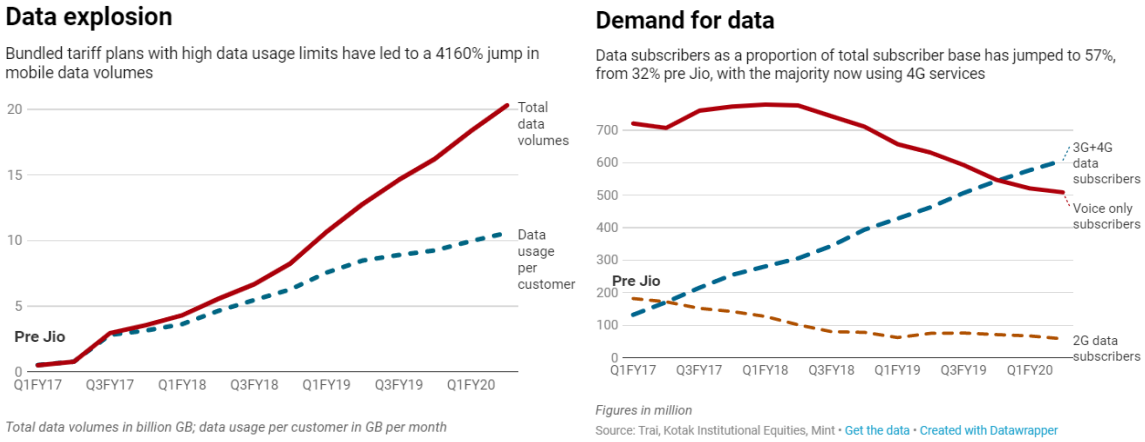


Figure 29. Growth in cellular data consumption and demand for 4G data after Jio's 4G network expansion

2. Impact on the market and digital economy

The research also delves into the impact of this digital revolution on the market and digital economy in India. The widespread usage of the internet on cell phones opened up numerous opportunities, ranging from digital transactions to video consumption and access to various online services. Along with accessing popular global apps, this access led to the development of several innovative digital applications in India, such as Paytm and PhonePe for online payments, Urban Company for home-based service delivery, Zepto, and Dunzo for on-demand quick grocery delivery, Swiggy and Zomato for rapid food delivery emerged and revolutionized the way people interacted with digital services in urban areas. This growth in digital applications and services contributed to improving digital equity by providing access to essential services, even in informal settlements. Most apps in India, including international apps like amazon have a cash-on-delivery payment option to be friendly to the local cash-based economy. This also helps people without formal bank accounts being able to access these digitally supported services.

The widespread adoption of cell phones as the primary means of accessing the internet led to several innovations and changes in the digital economy of India.

Cell phone's first usage of the internet: The boom in usage of the internet on cell phones opened up opportunities for individuals to access a wide range of services and information on the go. It allowed users to engage with digital services, perform online transactions, access education and health resources, and connect with others through social media platforms.

Challenges and opportunities: While the widespread use of cell phones for internet access opened numerous opportunities, it also brought challenges, such as addressing digital literacy, ensuring secure online transactions, and fostering digital equity.

Jio's higher data packs and video consumption: Jio's introduction of cheap high-speed high-volume data packs enabled high-volume video consumption on cell phones, leading to a surge in video content consumption, online streaming, and video-sharing platforms.

Some app-based digital innovations:

- Paytm: Revolutionized digital payments and financial services, enabling people without bank accounts to make and accept digital payments through a Unified Payment Interface (UPI) linked to phone numbers and Aadhar cards.
- Urban Company: Connected customers with local service professionals for various home services, including beauty and wellness services.
- Zepto: Introduced hyperlocal, 10-minute grocery delivery service, revolutionizing the grocery delivery market.
- Dunzo: Hyperlocal delivery service allowing users to get items picked up and delivered within a city.
- JioCinema: Video content app freely available with a Jio subscription with access to movies and shows made good quality entertainment available at almost no cost to a wide audience.
- Meesho: Highly affordable online shopping, making e-commerce accessible for a wide socio-economic group, very popular in people from lower income groups
- Ola: On-demand mobility including taxis and local options like autos (tuk-tuks) and motorcycle-based transit.
- Swiggy: Rapid, on-demand food delivery app with options for cash-on-delivery for paying for meals. Swiggy also offers a 'genie' service which lets customers send small goods and parcels to other addresses in the city within an hour or so.

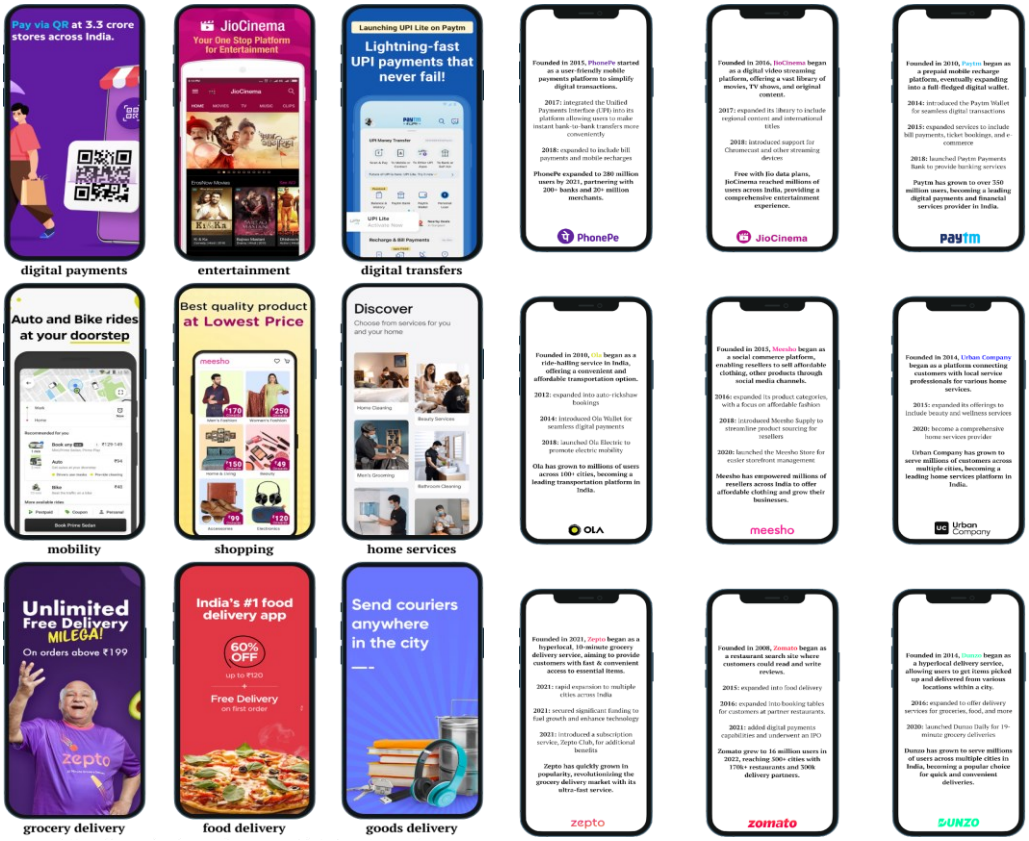


Figure 30. Innovative smartphone apps developed in India(left) and their market growth and innovation (right)

The shift towards cell phone-based internet access and the affordability of data plans contributed to reducing the digital divide, making digital services accessible to a broader section of society, including residents of informal settlements. Planners and policymakers need to recognize the significance of cell phones as a primary tool for internet access and ensure that digital services and development schemes are inclusive and accessible to all, including those with low digital literacy.

3. Internet Activity and Socio-demographic factors in New Delhi:

Furthermore, the study explores the relationship between internet activity and socio-demographic factors in New Delhi. While literacy showed a positive association with internet activity, the concentration of 4G LTE towers and working population density had stronger correlations. This emphasizes the role of improved infrastructure and connectivity in shaping internet activity patterns. The findings also highlight the importance of data and further research to gain deeper insights into the intersection of internet activity with various demographic factors.

The study of internet activity and its relationship with socio-demographic factors in New Delhi revealed interesting findings, highlighting the importance of infrastructure in shaping internet activity patterns. While literacy showed a positive association with internet activity, the concentration of 4G LTE towers and working population density had stronger associations, emphasizing the impact of improved connectivity and accessibility on internet engagement.

Google POIs as a representation of internet activity: Google Places of Interest (POIs) provided a useful and accessible representation of internet activity in the city, as it captured the locations where people interacted with digital platforms and services.

Need for socio-economic characteristics variable: While infrastructure factors played a crucial role in internet activity, incorporating socio-economic characteristics as a variable could further enhance the understanding of how internet activity intersects with different demographic factors.

Importance of data and additional research: The study acknowledged the need for more data and additional research to further investigate the relationships between internet activity and socio-economic factors.

4. Site Visit and Collaborations with CSOs

The on-site visits and collaborations with CSOs in informal settlements provided valuable insights into digital equity initiatives. Projects such as the plus codes project and the digital learning centers demonstrated the potential of technology-based interventions in improving digital inclusion. However, the importance of community engagement and awareness about the technology's benefits was evident, emphasizing the need for socially rooted and people-first approaches to digital empowerment.

The site visits and collaborations with CSOs provided valuable insights into digital equity initiatives in informal settlements in India.

- Addressing the Unaddressed Kolkata: An NGO working with local partners and Google Maps on the Plus-Codes project to provide addresses for dwellings in informal settlements. While the implementation of address plates was widespread, there was a need for community engagement and awareness about the technology's potential benefits.
- Shelter Associates: Another NGO working on the integration of digital learning centers with literacy centers in informal settlements, promoting a holistic education approach.
- Comparison and takeaways:

4a. Google Plus codes

Cities in India have several informal settlements which are often homes to the marginalized and economically challenged populations in the city. Most of these informal settlements do not have recognized legal status in the country as they are encroached lands on which clusters of temporary to semi-permanent dwellings are built organically. Even when the settlements are granted legitimacy by the local governments, often there are no formal addresses for each dwelling in the settlement and the settlement as a whole has one collective address. Services like postage and parcels are generally delivered to community centers and prominent shops in the settlement and residents collect these from such a shop/ center, with low reliability or delivery assurance. This lack of addresses is also a barrier to accessing several services like government IDs, opening bank accounts, voting rights, online delivery, and e-commerce. Even the simple act of inviting someone to your home can involve a seemingly endless description of trees, shops, and temples at which to turn left or right.

This research engages with 2 NGOs in India working on using Google's plus-codes technology in combination with digital connectivity to provide addresses for dwellings in these settlements. 'Plus-Codes', is a global open-source code (see www.plus.codes), developed by Google using an algorithm that uses Google Maps's geo grid to generate up to 12-digit codes at a 50m. These Plus-Codes have been printed on plates and installed as address plates on dwellings in these settlements. This was done alongside the integration of the lanes and addresses of these previously unmapped settlements into the widely used system of Google Maps.

Figure 31. Plus code address plate outside a house in Ward 82, Chetla, Kolkata

The wide penetration of cellular internet in these communities in parallel with the implementation of the plus codes projects has the potential to create digitally supported and navigable addresses for the residents. However, there is a strong need for building capacity and awareness in the communities about the technology, its usage, and potential benefits. Both projects involved technological interventions, but differences in community mobilization and urban context significantly impacted the uptake of the projects.

4b. Addressing the Unaddressed Kolkata

The NGO Addressing the Unaddressed is an Ireland-based organization that has been working in partnership with two local NGOs the Hope Foundation and Child in Need Institute (CINI), and Google Maps on the plus-codes project in informal settlements across Kolkata since 2013.

Over the years, they have covered 18 wards and 200,000 dwellings in the city (Fig 32). Up until 2017, they worked with an in-house technique to generate ‘Go-Codes’ for settlements, a geo-grid-based 8-digit address that they printed on physical plates and placed as house number plates outside residences. In 2018, they collaborated with Google and started using ‘Plus-Codes’ for their projects.

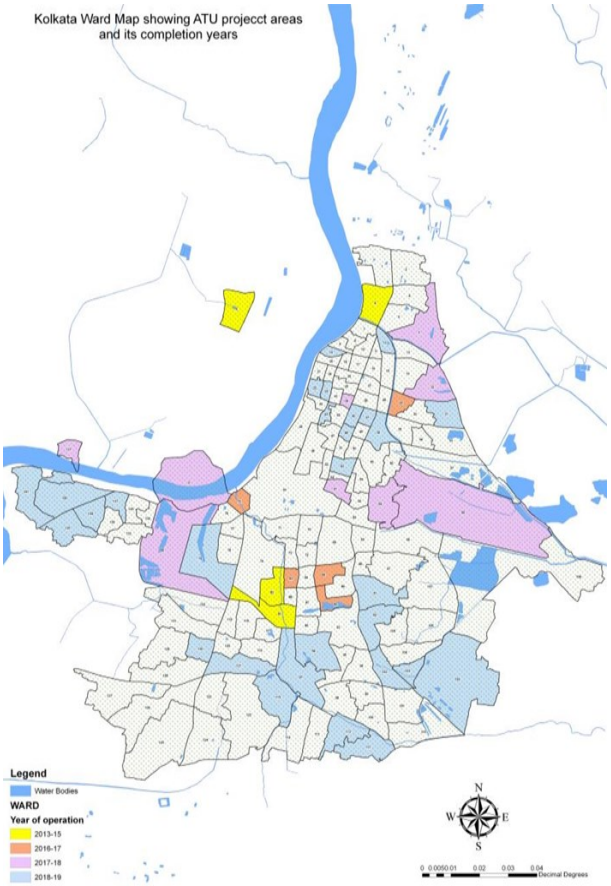


Figure 32. Map showing coverage of settlements in Kolkata by ATU under the plus codes project until 2022

An important part of the project was community sensitization about the technology and gathering community consensus around its installation. The goal of the project was to enable residents in these informal settlements to have an address to be able to access address-based services such as postal delivery, opening bank accounts, registering for identification documents, and filling governmental and service-based forms. However, in the recent phases, the focus has been on the widespread installation of the address plates with plans of extensive community engagement and training about the usability of the technology at a later stage.

During visits to 3 of the project sites in January, through interviews with the residents it was discovered that while most of the households had access to at least one smartphone with an active internet connection, the residents were not aware of how to use these plus codes for intended purposes. They understood these to be just 'house-number' plates but were not sure of how and where they could utilize the number.

Conversations with the residents in these settlements gave provided an opportunity to understand its uptake and usability in the community. One of the residents, Purnima Mondal, had used her dwelling's go-code as her home address for opening a bank account in 2013.

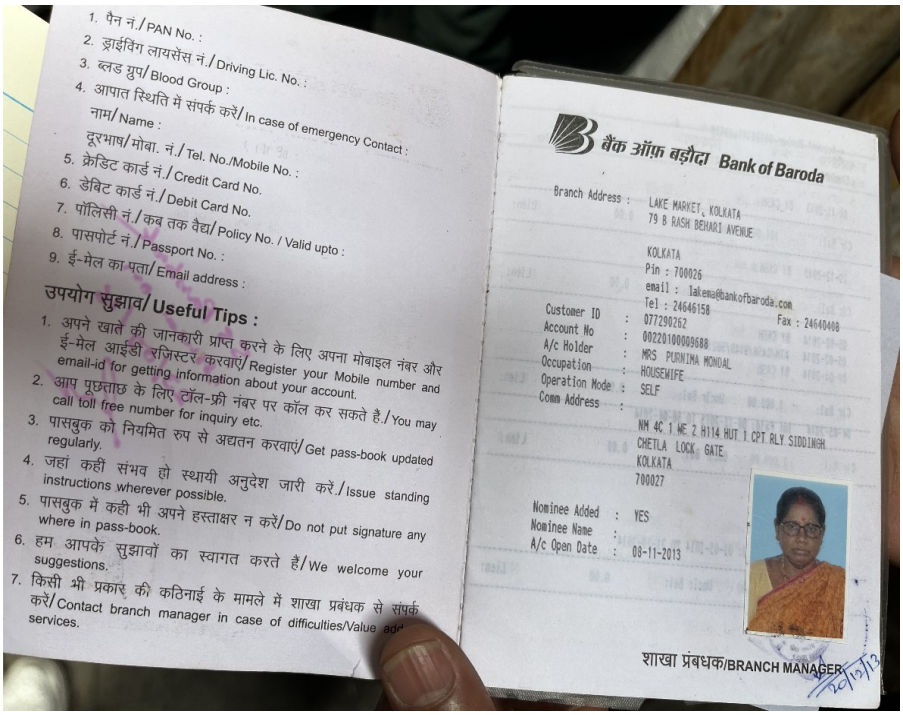


Figure 33. Usage of plus code as an address in banking document by a resident of an ATU project site in Kolkata

4c. Shelter Associates, Maharashtra

Shelter Associates have working on the plus codes project in various parts of Maharashtra. This research engages with their work in Airoli Naka in Navi Mumbai. The project there has seen strong uptake by community members who are increasingly using the digital address for various purposes like banking, e-commerce, and navigation. A key component of the project's success can be attributed to their strong relationship and years of work with the community on other issues like sanitation and housing upgradation efforts. Their strong and continuous community mobilization efforts helped build effective digital capacity in the residents. The urban environment of Mumbai, India's financial capital, also has positive effects on the general socio-economic and literacy levels of the population.

4d. Digital Empowerment Foundation

Digital Empowerment Foundation (DEF) in addressing digital equity in urban informal settlements. DEF, along with other civil society organizations, has played a pivotal role in implementing digital literacy training programs to empower residents with essential digital skills and knowledge. These efforts have aimed to bridge the digital divide and enable marginalized communities to access the benefits of the internet and digital technologies. While they have been doing widespread work on digital literacy and infrastructure development across several cities and villages in India, this research engages with their Digital Learning Centers and Soochnapreneur (Social Information Entrepreneurship) centers in the city of Delhi.

Digital Literacy Training Programs: DEF has been actively conducting digital literacy training programs in various cities and villages across India. These programs focus on equipping residents with basic computer skills and smartphone usage, ensuring they can navigate and utilize digital tools effectively.

Enhancing Financial Literacy: In addition to digital skills, DEF's initiatives have also placed a strong emphasis on enhancing financial literacy among residents. Training sessions are conducted to familiarize individuals with digital payment apps and online banking, providing them with better access to financial services.

Empowerment through Digital Skills: Through DEF's efforts, residents in informal settlements have gained empowerment through digital skills. These newfound abilities allow them to access crucial information, educational resources, and government schemes more effectively. Digital literacy has proven to be a key enabler for socioeconomic development in these communities.

Community Mobilization and On-Site Presence: The success of DEF's digital equity initiatives can be attributed to its strong on-site presence and community mobilization efforts. By establishing a meaningful connection with the residents, the organization has been able to understand their unique needs and tailor their programs accordingly.

Partnerships and Peer-to-Peer Learning: DEF's collaboration with other local organizations and stakeholders has been vital in ensuring the sustainability and impact of their initiatives. Peer-to-peer learning within the community has also contributed to the successful dissemination of digital knowledge.

Challenges and Barriers: Despite the progress made, DEF has encountered challenges in the implementation of digital literacy programs. Issues such as low community awareness, limited knowledge among residents, and the presence of undocumented migrant workers in the settlements have posed obstacles to the uptake of digital skills. Another important challenge is the compounding effects of socio-economic factors like literacy and quality of access. Many of the children enrolled in the digital literacy centers struggled with basic literacy. While they were gaining digital skills, they often were unable to navigate the language and commands on the computers and use visual and auditory cues to navigate the devices. Digital literacy in this case is not truly meaningful or empowering because of the underlying literacy gap. In one of the centers (the DLC in Gazipur), there was another NGO which ran a literacy center in the same complex. From the interviews with the kids, it was evident that they were able to transfer the digital skills gained towards applications for assignments in schools and filing forms etc. as the combination of literacy and digital training they were able to access at this center was transformative.

Overall, DEF's endeavors in promoting digital equity have had a significant impact on the lives of residents in urban informal settlements. By equipping them with digital literacy

and fostering meaningful connectivity, these initiatives have contributed to bridging the digital divide and empowering marginalized communities with new opportunities for social and economic development. Strategies to enhance community awareness, targeted training for specific groups, continuous development of innovative approaches to overcome barriers, and systemic support from governmental and private welfare agencies could help further support and strengthen their work. However, these efforts need to be attuned to the context of these settlements and populations, to understand other barriers like education and quality of access and develop partnerships that help address a combination of capacity barriers.

5. Media Approach (see Chapter 8 Section 1 for website wireframes)

The study employed a compelling media-based focus to effectively communicate the narrative of digital equity and its profound impact on people's lives. The utilization of various media and communication channels has proven to be a powerful tool in raising awareness and mobilizing support for inclusive policies and initiatives.

A central aspect of the media approach was the development of a smartphone-friendly website to represent the research findings in an interactive and accessible manner. This website served as a pivotal component of the study, aiming to reach a broad audience, particularly those whose stories and experiences were represented in the research. By presenting the information in a user-friendly and visually engaging format, the website sought to break down complex concepts into easily digestible insights.

While the current design of the website attempts to make the research findings accessible in an easy-to-understand manner, it would be important to test it out with users with varying levels of literacy and device access to gauge if it is truly accessible and representative. The feedback and insights gathered from such user testing could provide valuable inputs for refining the website's design and making it truly accessible and representative of the communities it seeks to empower.

The media approach adopted in this study aligned with the core idea of meaningful digital connectivity, recognizing and addressing barriers to digital equity. By leveraging media and communication, the research sought to amplify the voices of marginalized communities and shed light on their experiences in navigating the digital landscape. Through compelling storytelling and data visualization, the media approach aimed to bridge the gap between academic research and public understanding, encouraging broader engagement with the topic of digital equity.

Overall, the media approach plays a vital role in engaging a wider audience and creating a meaningful impact beyond academic circles.

6. Takeaways

The research concludes with a powerful call to action, emphasizing the significance of addressing digital equity in India. Bridging the digital divide and ensuring meaningful connectivity have far-reaching implications for the country's social and economic development. It requires collaborative efforts from various stakeholders, including CSOs, planners, and policymakers. The human aspect of technology is highlighted throughout this discussion, underlining the importance of understanding the socio-demographic context and needs of the people when implementing digital initiatives.

This research has underscored the importance of addressing digital equity in India, particularly focusing on accessibility and communicability in urban areas with improved connectivity and accessibility. Despite the nationwide telecom revolution, increased access to the internet, and affordable data and devices, the quality and impact of this access remain unequal, with traditionally disadvantaged social groups often unable to fully capitalize on the opportunities provided by digital connectivity.

Government policies have primarily focused on infrastructure improvement and digital delivery of government services, while the private sector has acted in line with market forces to reduce data and device prices. However, civil society organizations (CSOs) and on-ground mobilization play a critical role in promoting meaningful connectivity, particularly in marginalized communities and areas with limited digital resources. Local knowledge of the communities and their barriers to quality digital access and engagement are crucial.

CSOs serve as intermediaries between the government, private sector, and local communities, working to ensure that digital equity initiatives are tailored to the unique needs of each community. They provide critical on-ground support and community mobilization, forming a key piece of the ‘Theory of Change’. Furthermore, CSOs can help create a feedback loop and data empowerment for the informal economy and marginalized residents by integrating technology and data inclusivity and literacy into urban systems.

In conclusion, this research serves as a significant contribution to the understanding of digital equity in India's urban landscape. It presents a strong argument for harnessing the transformative power of digital technologies to create positive and inclusive impacts. By recognizing the critical role of CSOs, planners, and policymakers, and emphasizing the importance of community engagement and awareness, this study provides important learnings for promoting digital empowerment and bridging the digital divide in India.

Chapter 7
Conclusion: Digital Equity Manifesto

This research has underscored the importance of addressing digital equity in India, particularly focusing on accessibility and communicability. Despite the nationwide telecom revolution, increased access to the internet, and affordable data and devices, the quality and impact of this access remain unequal, with traditionally disadvantaged social groups often unable to fully capitalize on the opportunities provided by digital connectivity.

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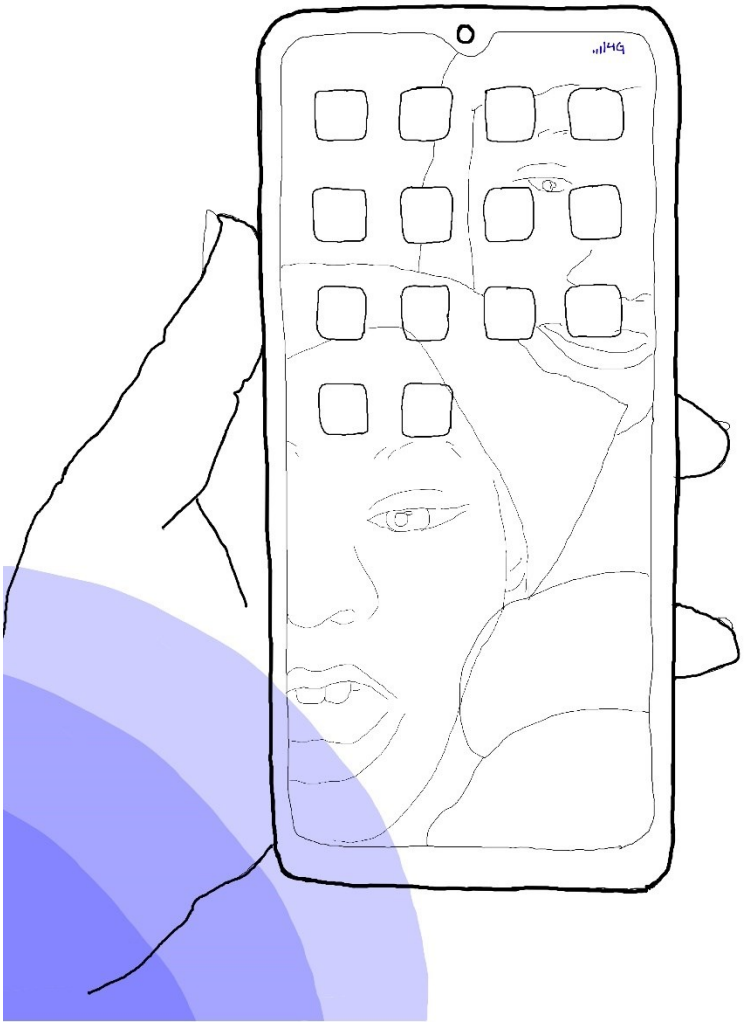
Achieving digital equity has far-reaching implications for India's social and economic development, making it vital for stakeholders to collaborate and continuously adapt to evolving technology. While this research has provided valuable insights, future research could delve deeper into existing government policies and how they can be strengthened to enable CSOs to bridge the digital divide. The current regression is also preliminary and could benefit from the inclusion of interaction terms and controlling for variables like age. It would be important to develop a measurement for communicability and include that in the regression to understand the socio-economic disparities more clearly and to be able to address them effectively.

The key ideas from the research have been summarized into the following manifesto for strengthening digital equity efforts in Urban India:

MEANINGFUL CONNECTIVITY



a manifesto for digital equity

Manifesto for Digital Equity in Urban India

Building Meaningful Connectivity through Communicability and Civil Society Organizations

As India embraces the digital revolution, it is essential that all citizens have equal access to the internet and its benefits. While recent advancements in digital infrastructure and accessibility have bridged some gaps, there is still much work to be done. We cannot leave this gap to addressed solely by government and market actors. This manifesto aims to promote digital equity in urban India by focusing on communicability, and by highlighting the crucial role of civil society organizations in this effort.

...Recognize that digital equity is a fundamental right

We affirm that access to the internet is a basic human right, as recognized by the United Nations General Assembly. Digital equity is necessary for civic and cultural participation, employment, lifelong learning, and access to essential services. We call upon the government, businesses, and civil society organizations to work together to ensure that everyone has the opportunity to participate fully in the digital age.

...Promote meaningful connectivity

Connectivity and accessibility are essential, but they are not enough. We must ensure that people have the skills and support to use the internet meaningfully. This includes providing resources and training for digital literacy, as well as fostering a culture of digital inclusion and empowerment.

...Prioritize communicability

We call for greater emphasis on communicability - the ability to use the internet for access to socio-economic opportunities and a better quality of life. This requires not only access to the internet but also the development of digital skills and local content in vernacular languages that cater to diverse needs and interests.

...Support the role of civil society organizations

Civil society organizations play a critical role in promoting digital equity. We celebrate and support their efforts in providing digital learning centers, social entrepreneurship initiatives, and location-based services in marginalized communities. We call for greater collaboration between civil society organizations, the government, and the private sector to share knowledge, resources, and expertise.

...Encourage innovation and collaboration

We urge stakeholders to explore new ways of addressing digital inequality. This includes leveraging emerging technologies and fostering partnerships between public and private entities, as well as promoting research and development to create innovative solutions for bridging the digital divide.

...Advocate for policy reform

We call for policies and regulations that promote digital equity, including public investment in digital infrastructure, affordable internet access, and the development of digital skills. We also encourage the government to prioritize the needs of marginalized communities in policymaking and to work closely with civil society organizations to ensure that policies are inclusive and effective.

...Foster a culture of digital inclusion

We believe that digital equity is not just about access and skills, but also about creating an inclusive and supportive environment where everyone feels welcome and empowered to participate in the digital world. We call upon all stakeholders to promote a culture of digital inclusion, both online and offline, by celebrating diversity, promoting digital literacy, and fostering a sense of belonging.

Together, we can build a future where everyone in urban India has the opportunity to participate fully in the digital age. By focusing on communicability and supporting the work of civil society organizations, we can ensure that digital equity becomes a reality for all.

1

WORKING WITH STAKEHOLDERS

The Digital India Initiative, launched by the Government of India in 2105, has played a significant role in shaping the country's digital landscape. With its three core components - digital infrastructure, digital literacy, and digital service delivery - the initiative has laid the foundation for a digitally empowered society.

However, while the Digital India Initiative has made significant strides in bringing the internet to a broader audience, digital equity remains an ongoing challenge. The manifesto for digital equity in urban India seeks to build on the progress made by the Digital India Initiative while addressing the persistent gaps and challenges in achieving digital equity.

In this context, the manifesto emphasizes the need for a multi-stakeholder approach that includes the government, private sector, civil society organizations, and local communities.

1

The role of each stakeholder is crucial in ensuring that the benefits of the digital revolution reach every individual, regardless of their socio-economic background.

Government

The government plays a vital role in creating an enabling environment for digital equity. This includes investing in digital infrastructure, implementing policies and regulations that promote affordable access, and supporting digital literacy initiatives. The government should also prioritize the needs of marginalized communities in policy-making and enable civil society organizations.

Private sector

Businesses and technology companies can contribute to digital equity by offering affordable devices and data plans, developing innovative solutions for bridging the digital divide, and investing in local content and vernacular language resources. They should also collaborate with the government and civil society organizations to promote digital inclusion.

Civil society organizations

Civil society organizations have a critical role in promoting digital equity at the grassroots level. They can provide digital learning centers, social entrepreneurship initiatives, and location-based services in marginalized communities. Furthermore, they can advocate for policy reform and collaborate with the government and the private sector to ensure that digital equity initiatives are inclusive and effective.

Local communities

Community empowerment is crucial in achieving digital equity. Communities should be involved in the design and implementation of digital equity initiatives, ensuring that these programs address local needs and priorities. By fostering a sense of ownership and engagement, communities can contribute to the sustainability and success of digital equity efforts.

By drawing on the lessons learned from the Digital India Initiative and recognizing the role of various stakeholders and community empowerment, the manifesto for digital equity in urban India provides a roadmap for building a more inclusive and equitable digital future. The manifesto's focus on communicability and support for civil society organizations emphasizes the need for meaningful connectivity that transcends access and infrastructure, empowering every individual to participate fully in the digital age.

Some of the key roles that CSOs and on-ground mobilization play in the context of meaningful connectivity include:

Digital literacy and education

CSOs can set up digital learning centers and conduct training programs to help individuals develop digital skills, enabling them to use the internet effectively for communication, education, and accessing online services.

Community engagement and empowerment

Through on-ground mobilization, CSOs can engage with local communities, identify their specific digital needs, and involve them in the design and implementation of digital initiatives. This participatory approach ensures that digital equity programs are relevant, sustainable, and effective.

Advocacy and policy influence

CSOs can advocate for inclusive digital policies and regulatory frameworks, pushing for greater investment in digital infrastructure, affordable access, and digital literacy programs, particularly in underserved communities.

Local content development

CSOs can support the development of local content and vernacular language resources, ensuring that digital services and information are relevant and accessible to a diverse audience.

Ensuring digital inclusion

Through on-ground mobilization, CSOs can ensure that digital initiatives reach marginalized groups, such as women, people with disabilities, and rural populations, promoting digital inclusion and social equity.

Promoting digital safety and security

CSOs can raise awareness about online safety and security, helping individuals protect their privacy, avoid scams, and safely navigate the digital landscape.

Through their grassroots efforts, CSOs can empower communities, build digital skills, and foster a sense of ownership and engagement, ultimately contributing to a more inclusive and equitable digital future.

3

ASSESSING COMMUNICABILITY

Measuring communicability in the context of digital equity involves assessing the extent to which individuals can meaningfully use the Internet to access socio-economic opportunities and improve their quality of life. It is crucial to develop ways of measuring communicability to understand these disparities more clearly and to be able address them effectively.

Some thoughts on measuring communicability, using a combination of quantitative and qualitative indicators can be used. These indicators may include:

Digital literacy level

Assess the proportion of the population with the necessary skills to effectively use digital tools and resources. This could be done through targeted on line and offline surveys and integrating these questions into existing population surveys.

Availability of local content and vernacular language resources

Evaluate the extent to which online content and digital services are available in local languages and cater to the diverse needs and interests of the population.

Digital social inclusion

Examine the extent to which marginalized groups, such as women, people with disabilities, and lower literacy populations, can access and meaningfully use digital resources.

User experience and satisfaction

Collect qualitative data through surveys, interviews, or focus groups to gauge user experience and satisfaction with digital services and platforms and their ability to meet their needs and preferences.

Digital safety and security

Measure the awareness and adoption of practices that ensure online safety and security, such as the use of strong passwords, understanding of privacy settings, and ability to identify online scams.

By considering a range of indicators that cover different aspects of communicability, policymakers and stakeholders can identify areas where improvements are needed and develop targeted strategies to enhance the meaningful use of the internet for all members of society.

2 CIVIL SOCIETY ORGANIZATIONS

Civil society organizations (CSOs) and on-ground mobilization play a critical role in promoting meaningful connectivity, particularly in marginalized communities and areas with limited digital resources. They serve as intermediaries between the government, private sector, and local communities, working to ensure that digital equity initiatives are tailored to the unique needs of each community.

Chapter 8
Supplemental Material

1. Website Wireframes

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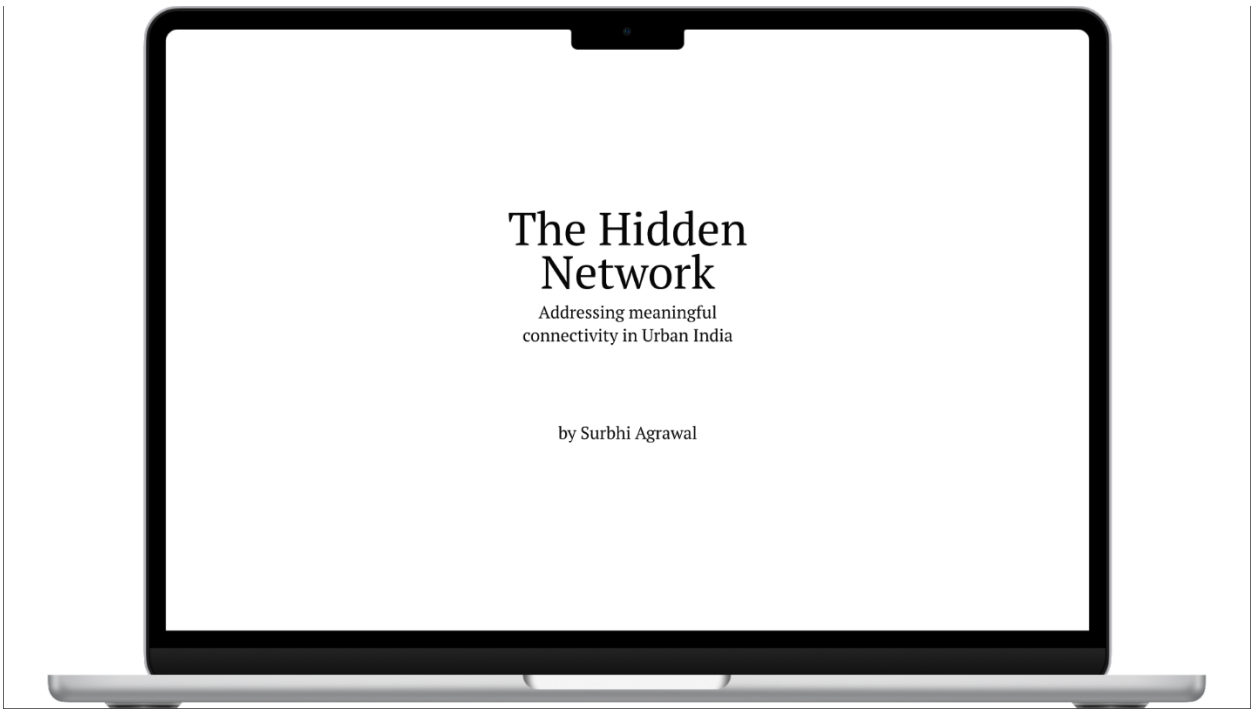
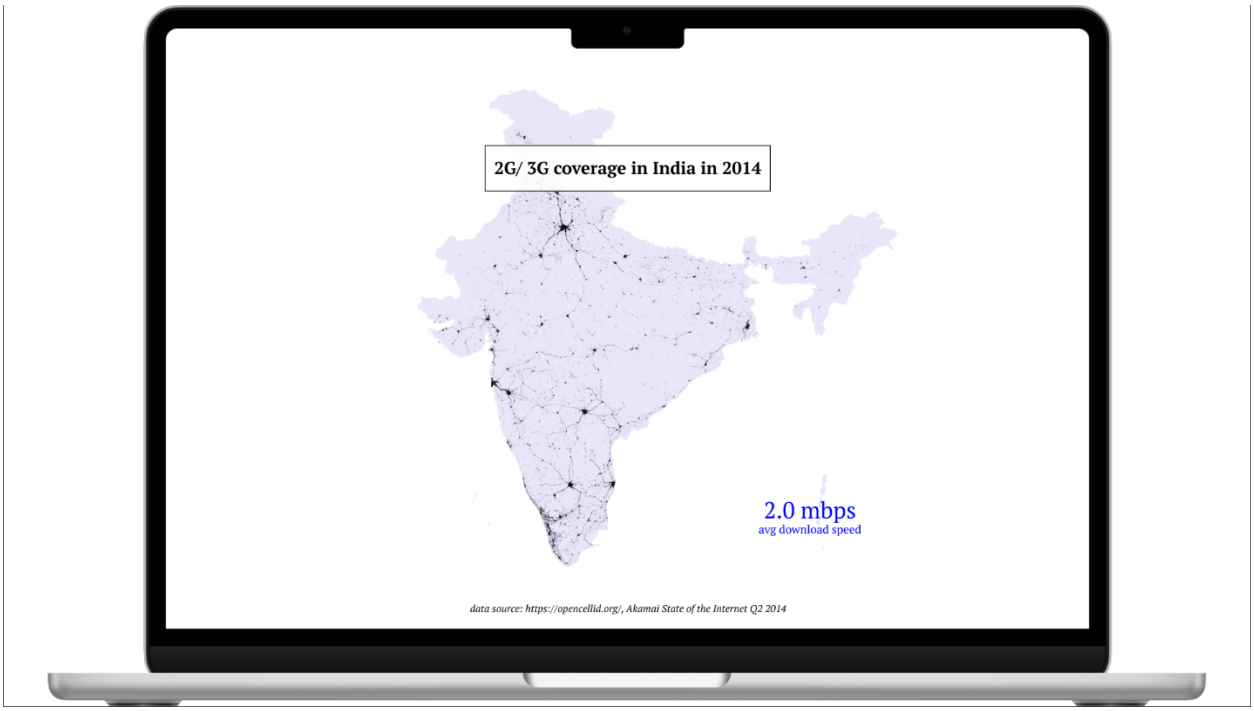
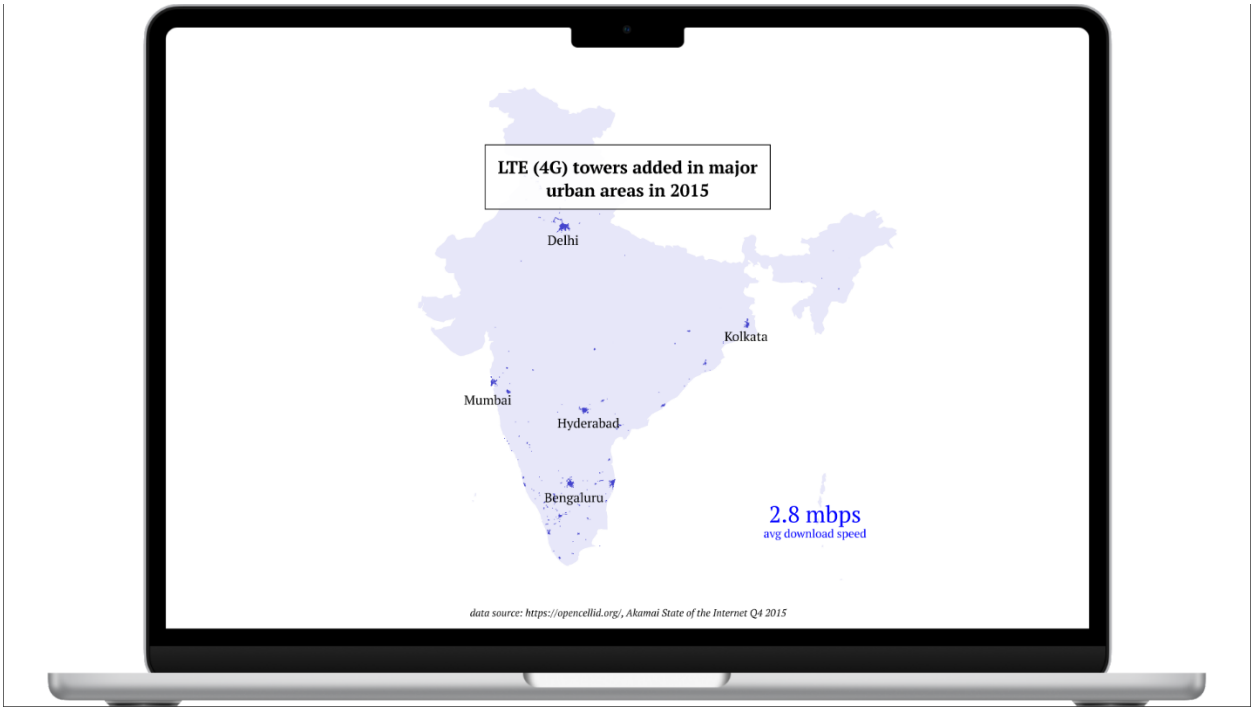
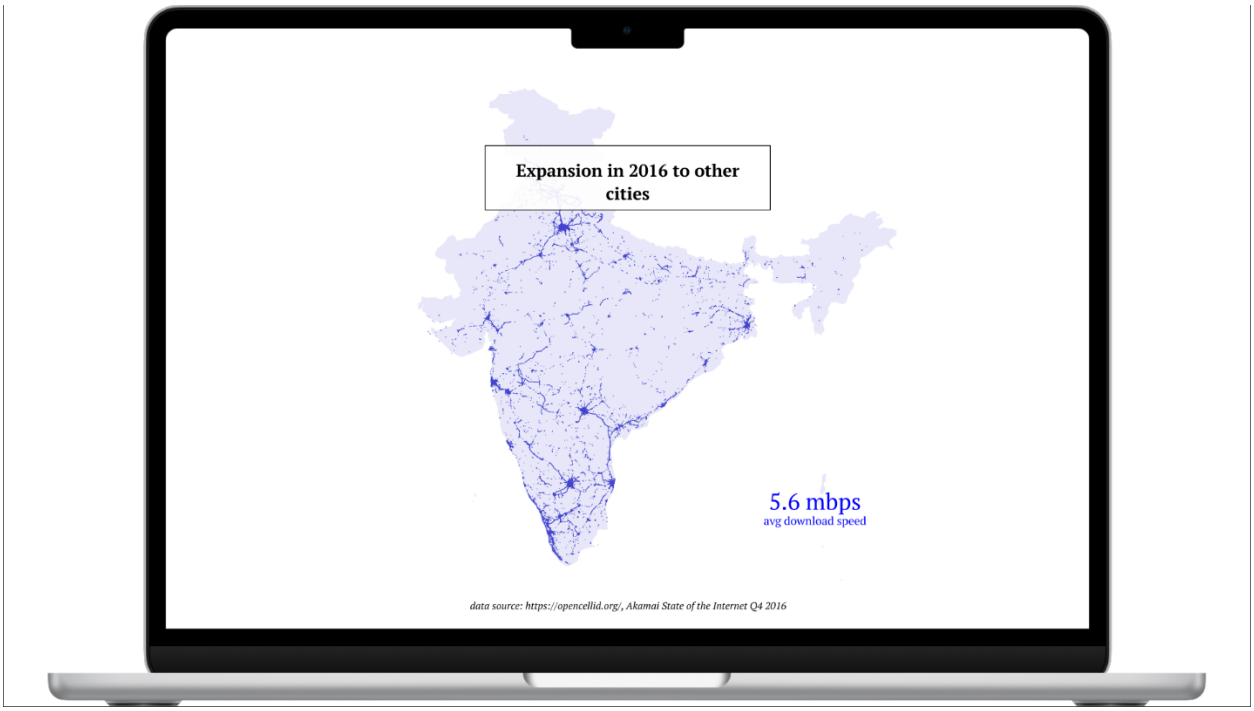


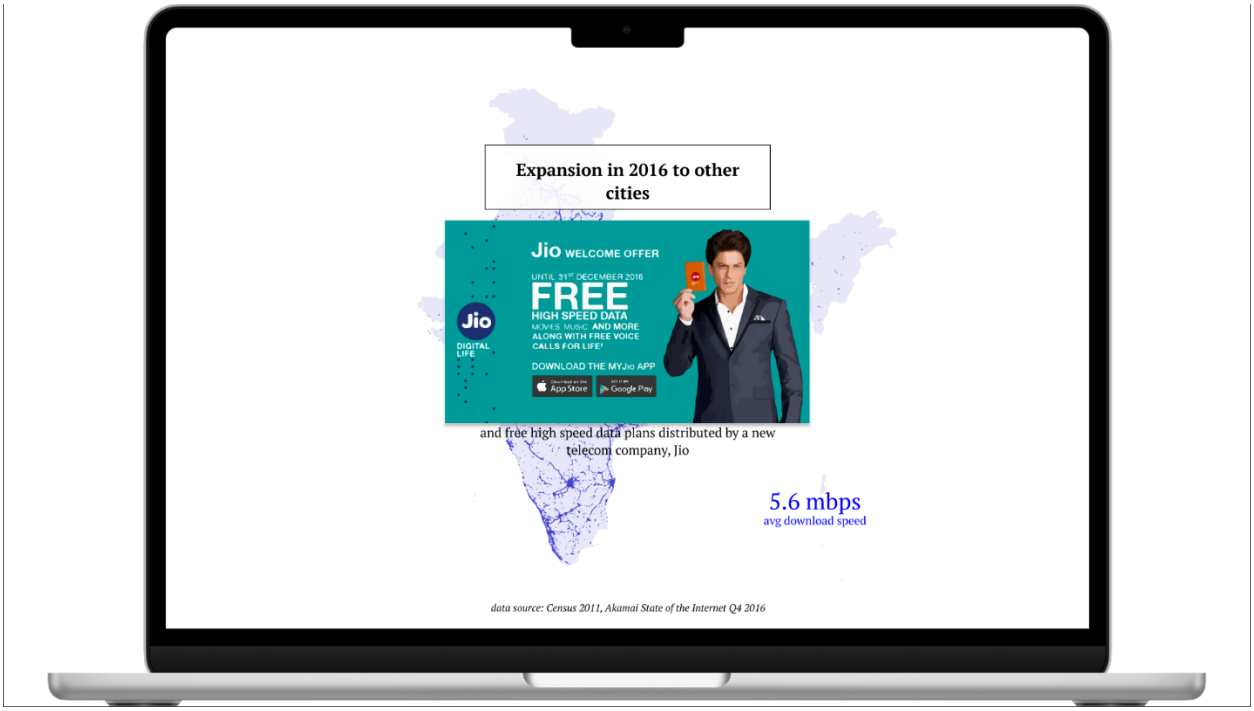
In 2015, a nationwide telecom revolution began.

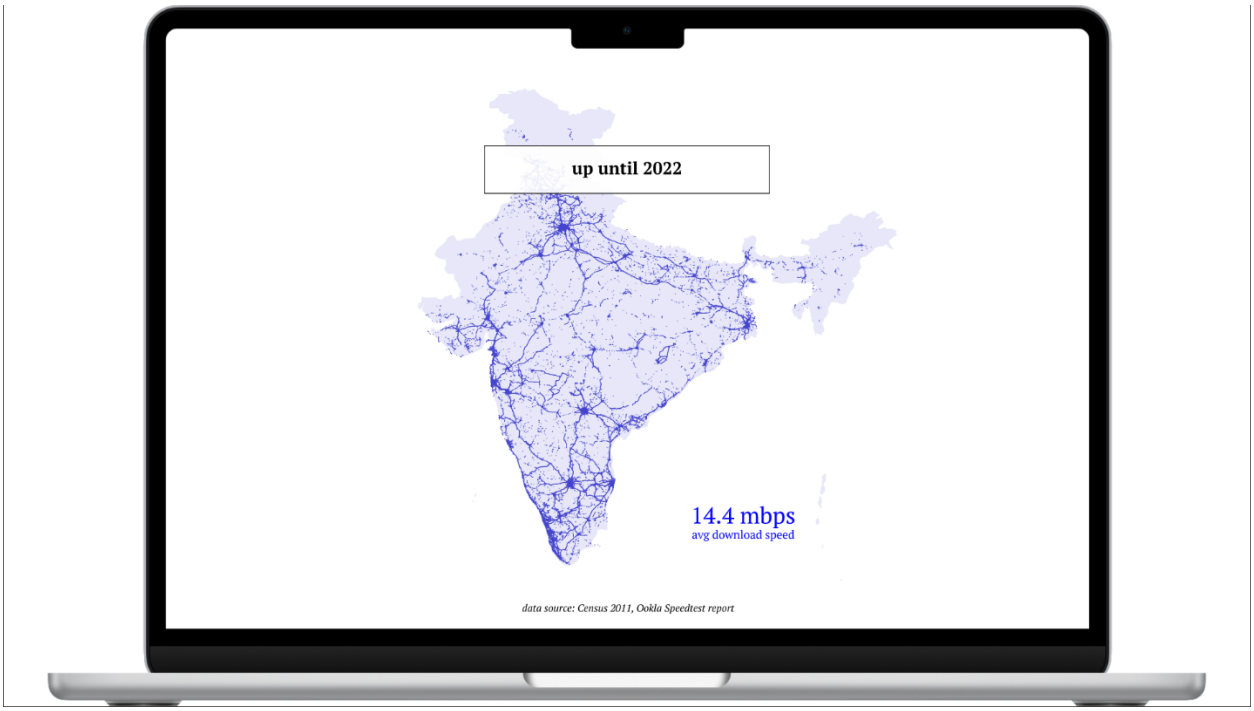
In 2015, a nationwide telecom revolution began.
New 4G infrastructure was set up nationwide and the Digital India mission was launched.

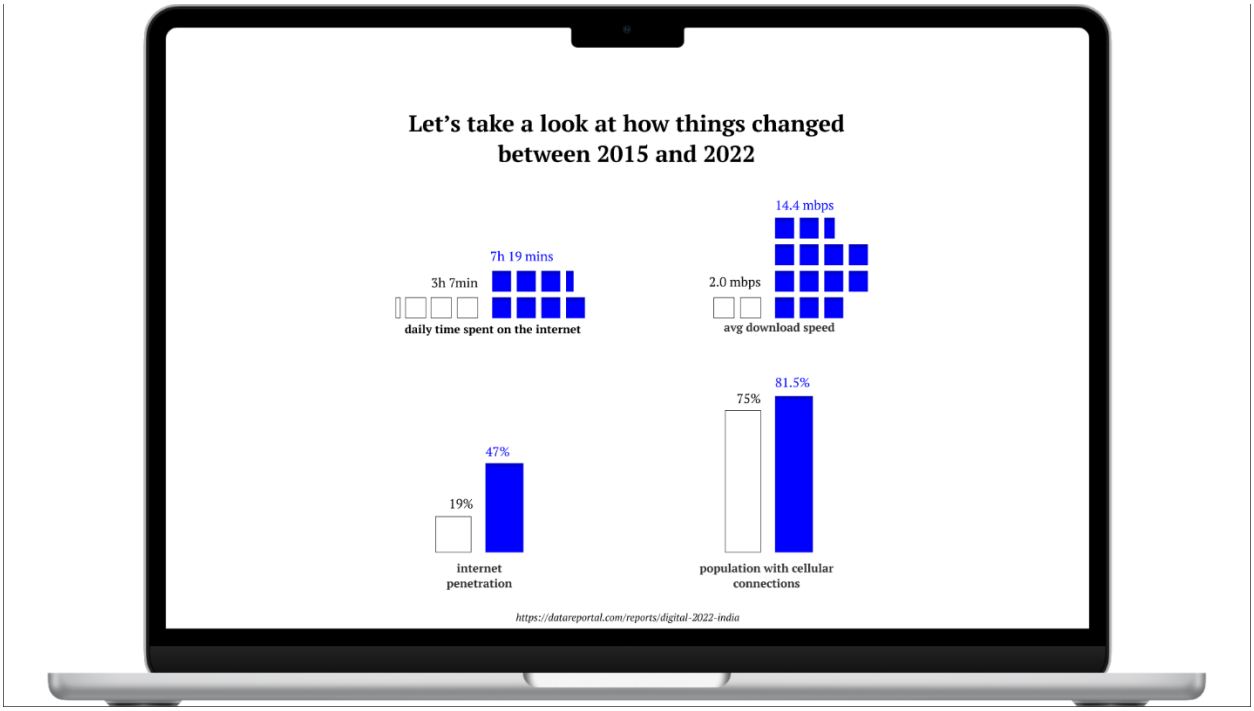

2G/ 3G coverage in India in 2014
2.0 mbps
avg download speed
data source: https://opencellid.org/, Akamai State of the Internet Q2 2014

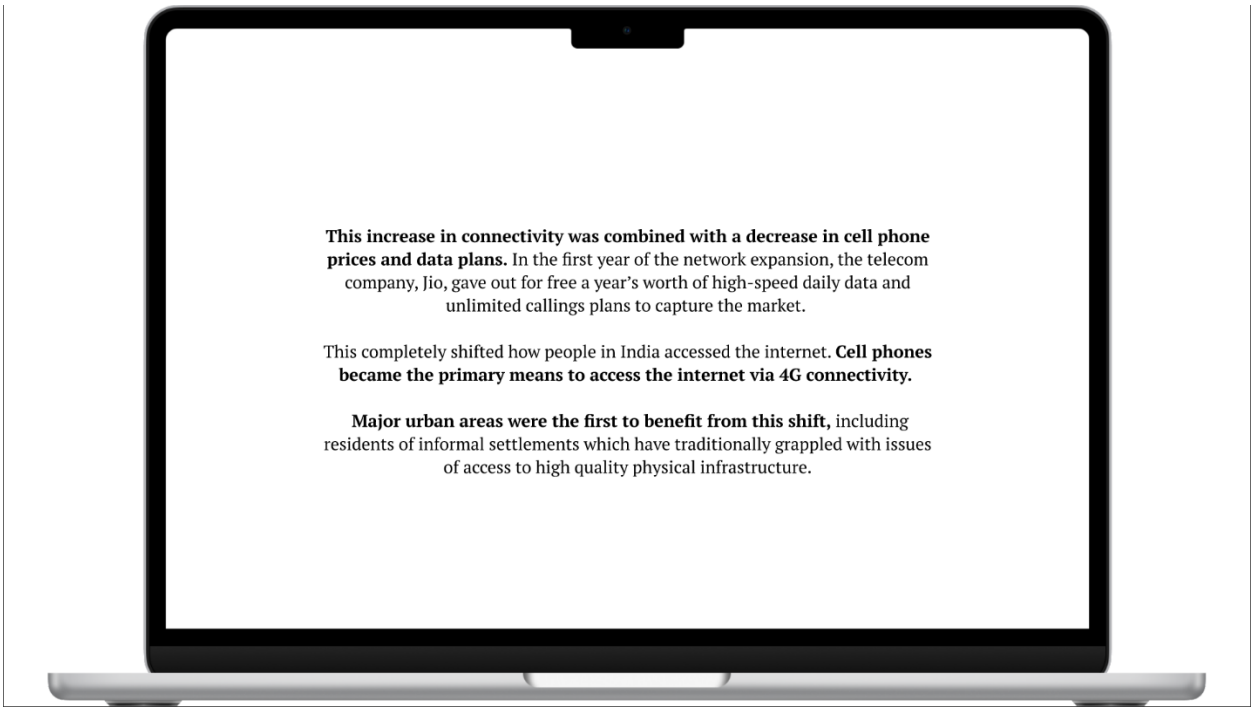

LTE (4G) towers added in major urban areas in 2015
Delhi
Kolkata
Mumbai
Hyderabad
Bengaluru
2.8 mbps
avg download speed
data source: https://opencellid.org/, Akamai State of the Internet Q4 2015


Expansion in 2016 to other cities
5.6 mbps
avg download speed
data source: https://opencellid.org/, Akamai State of the Internet Q4 2016


Expansion in 2016 to other cities
Jio WELCOME OFFER
UNTIL 31ST DECEMBER 2016
FREE
HIGH SPEED DATA
MOVIES MUSIC AND MORE
ALONG WITH FREE VOICE CALLS FOR LIFE!
DOWNLOAD THE MYJio APP
App Store
Google Pay
Jio
DIGITAL LIFE
and free high speed data plans distributed by a new telecom company, Jio
5.6 mbps
avg download speed
data source: Census 2011, Akamai State of the Internet Q4 2016


up until 2022
14.4 mbps
avg download speed
data source: Census 2011, Ookla Speedtest report


Let's take a look at how things changed between 2015 and 2022
7h 19 mins
3h 7min
daily time spent on the internet
14.4 mbps
2.0 mbps
avg download speed
47%
19%
internet penetration
81.5%
75%
population with cellular connections
https://datareportal.com/reports/digital-2022-india


This increase in connectivity was combined with a decrease in cell phone prices and data plans. In the first year of the network expansion, the telecom company, Jio, gave out for free a year's worth of high-speed daily data and unlimited callings plans to capture the market.
This completely shifted how people in India accessed the internet. **Cell phones became the primary means to access the internet via 4G connectivity.**
Major urban areas were the first to benefit from this shift, including residents of informal settlements which have traditionally grappled with issues of access to high quality physical infrastructure.

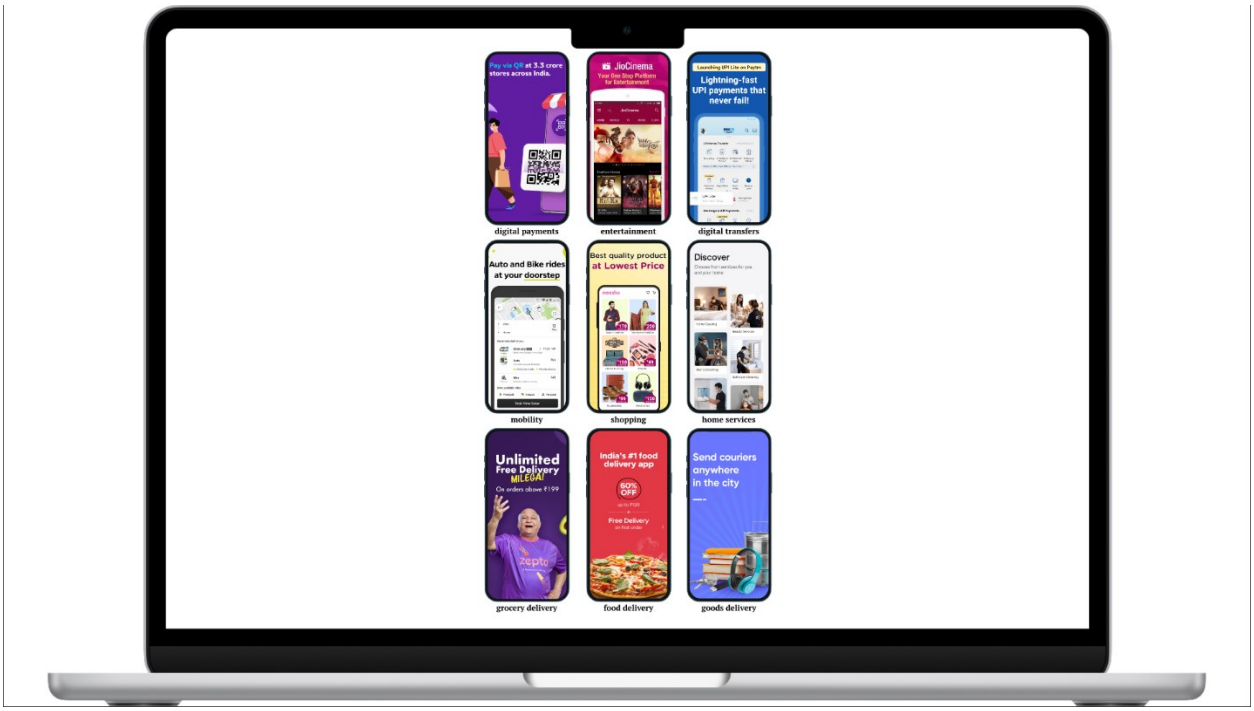
Today, in India, cell phones are the primary means of accessing the internet.
As of 2022, 91.3% of people in India accessed the internet from their phones and 96.7% of 14-64 year old internet users own smartphones.
https://datareportal.com/reports/digital-2022-india

Price of the cheapest smartphone
$68.59
Average price of 1GB cellular mobile data
$0.68
Price of the cheapest smartphone vs average income
3.8 %
Average price of 1GB cellular mobile data vs average income
0.04%
https://datareportal.com/reports/digital-2022-india

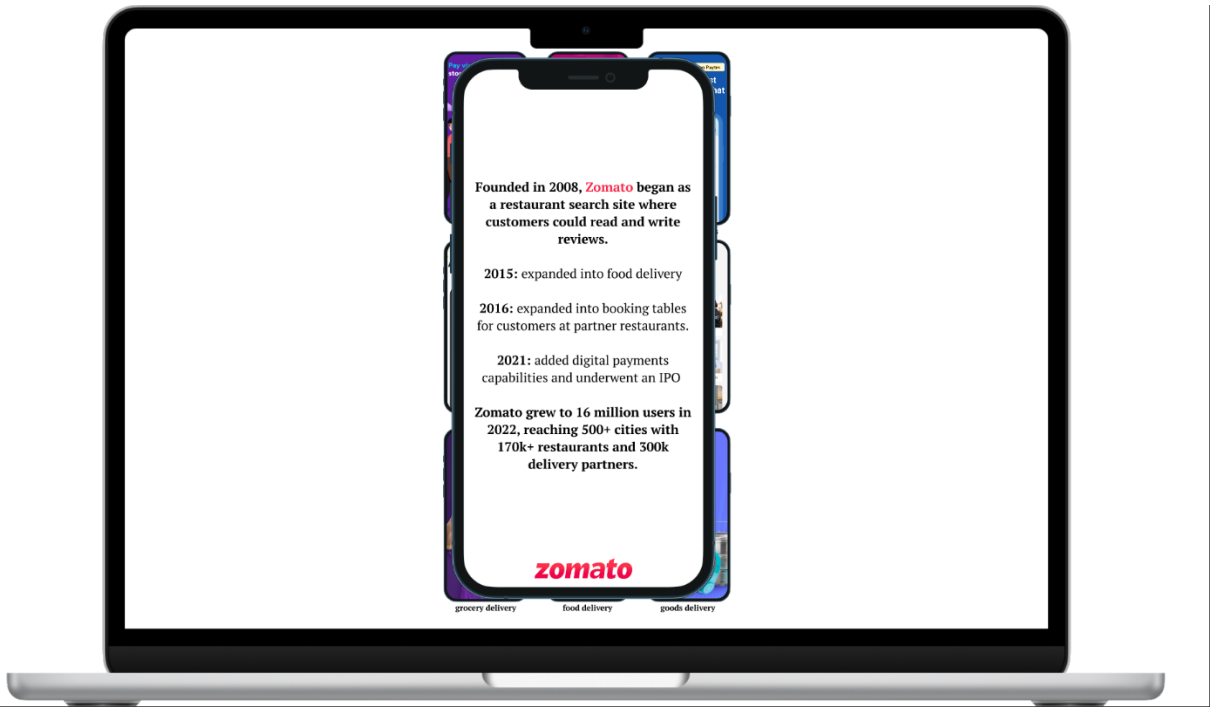
In 2022, phone app downloads in India totaled 26.7 billion, over a population of 1.4 billion. Here are some of the most popular apps and their number of downloads
https://datareportal.com/reports/digital-2022-india

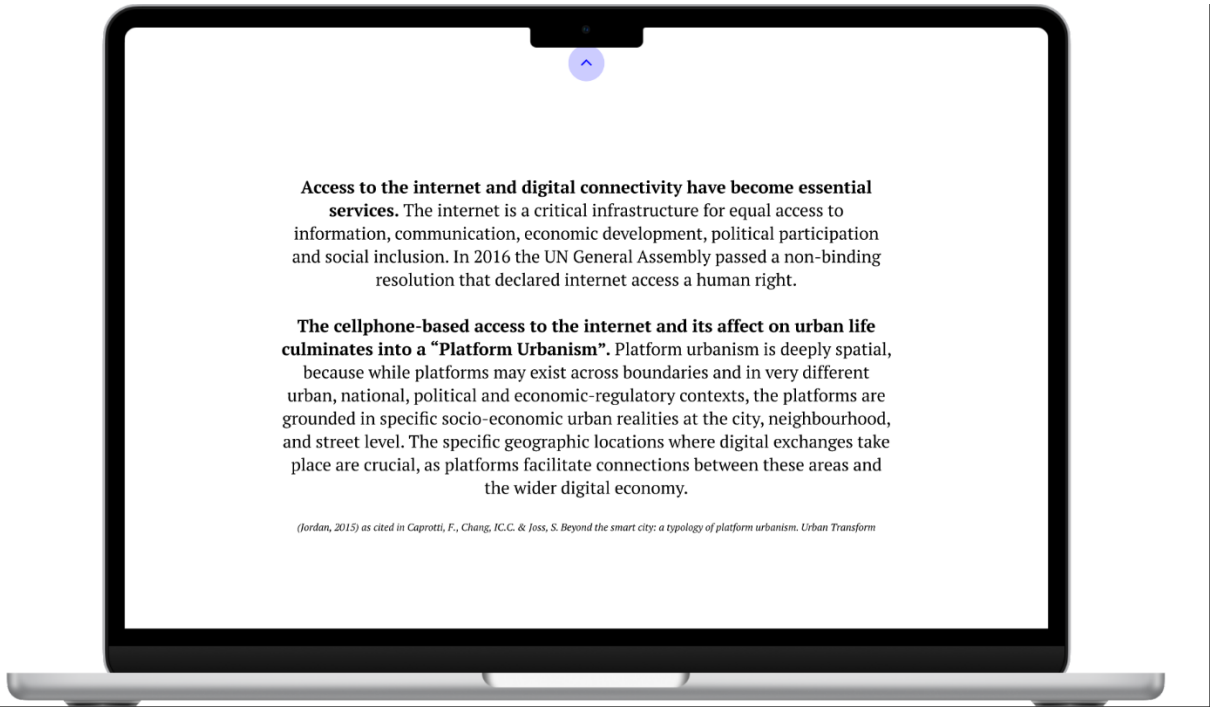
Instagram
327 million
Snapchat
188 million
facebook
193 million
PhonePe
133 million
WhatsApp Business
122 million
Flipkart
139 million
meesho
163 million
LUDO KING
124 million
true caller
124 million
https://www.businessofapps.com/data/most-popular-apps/

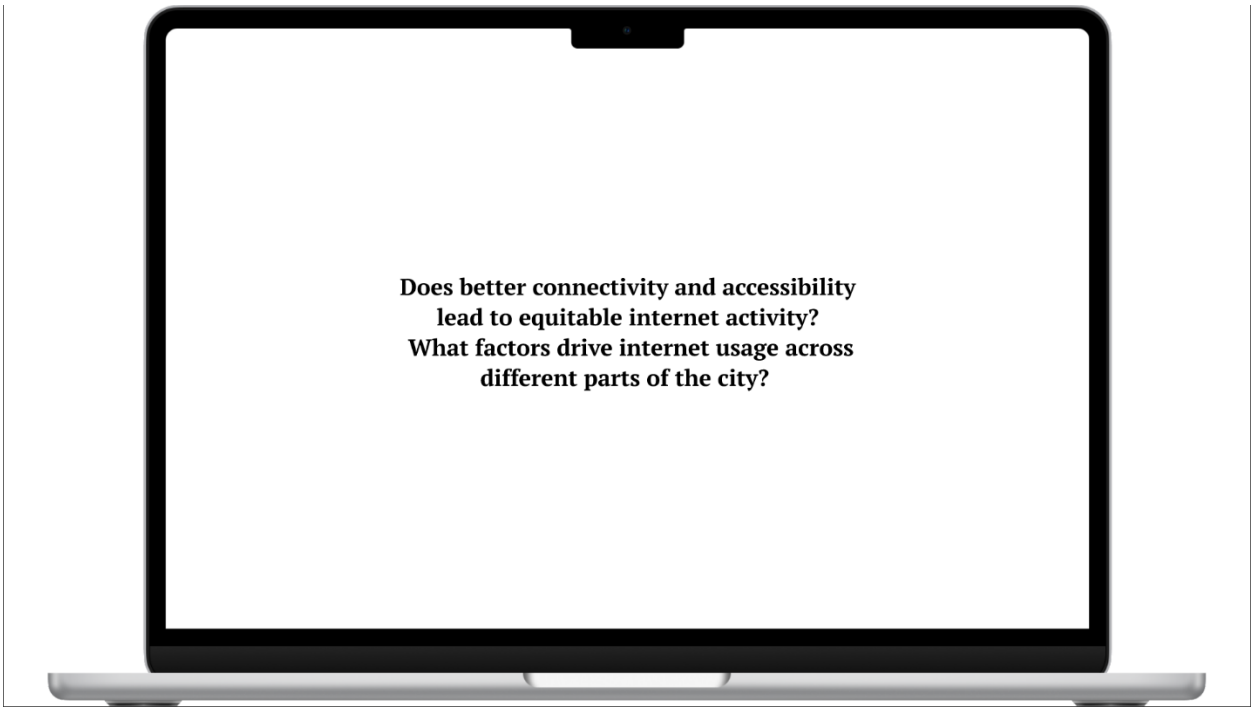
and some innovative apps from the Indian market

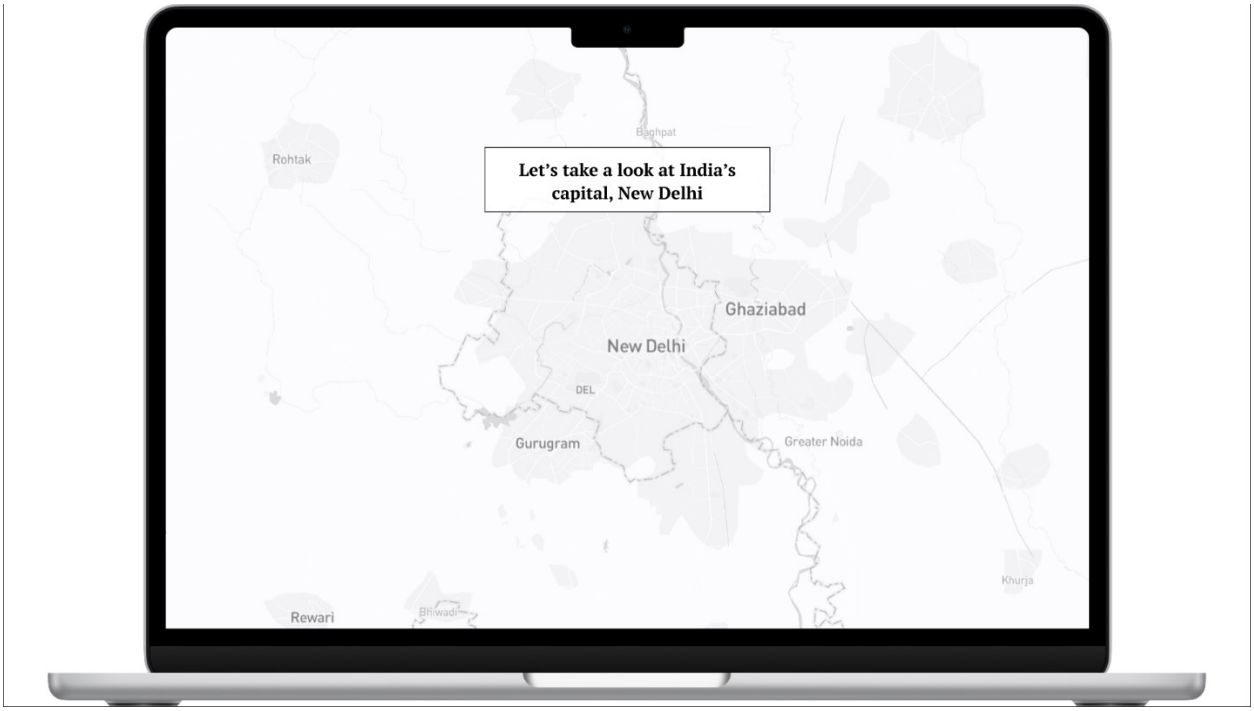

digital payments
entertainment
digital transfers
mobility
shopping
home services
grocery delivery
food delivery
goods delivery

Founded in 2015, PhonePe started as a user-friendly mobile payments platform to simplify digital transactions.
2017: integrated the Unified Payments Interface (UPI) into its platform allowing users to make instant bank-to-bank transfers more conveniently
2018: expanded to include bill payments and mobile recharges
PhonePe expanded to 280 million users by 2021, partnering with 200+ banks and 20+ million merchants.
PhonePe
grocery delivery
food delivery
goods delivery

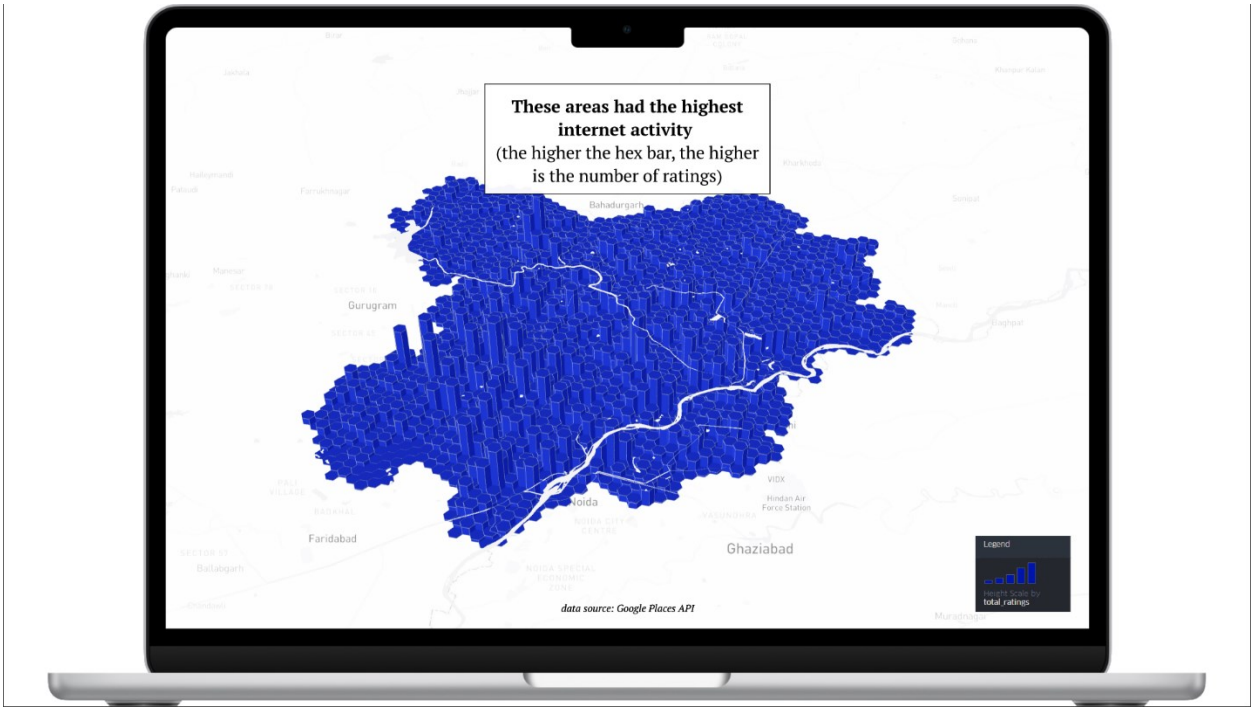

Founded in 2008, Zomato began as a restaurant search site where customers could read and write reviews.
2015: expanded into food delivery
2016: expanded into booking tables for customers at partner restaurants.
2021: added digital payments capabilities and underwent an IPO
Zomato grew to 16 million users in 2022, reaching 500+ cities with 170k+ restaurants and 300k delivery partners.
zomato
grocery delivery
food delivery
goods delivery

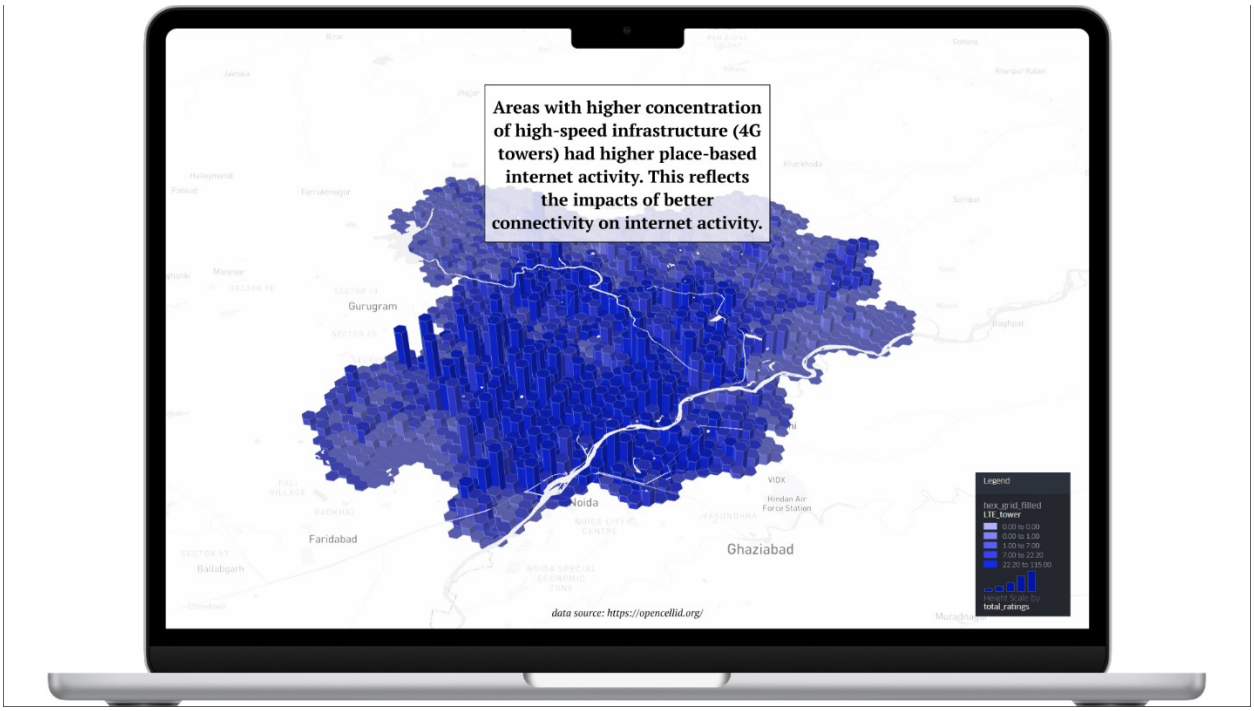

Access to the internet and digital connectivity have become essential services. The internet is a critical infrastructure for equal access to information, communication, economic development, political participation and social inclusion. In 2016 the UN General Assembly passed a non-binding resolution that declared internet access a human right.
The cellphone-based access to the internet and its affect on urban life culminates into a "Platform Urbanism". Platform urbanism is deeply spatial, because while platforms may exist across boundaries and in very different urban, national, political and economic-regulatory contexts, the platforms are grounded in specific socio-economic urban realities at the city, neighbourhood, and street level. The specific geographic locations where digital exchanges take place are crucial, as platforms facilitate connections between these areas and the wider digital economy.
(Jordan, 2015) as cited in Caprotti, F., Chang, IC.C. & Joss, S. Beyond the smart city: a typology of platform urbanism. Urban Transform

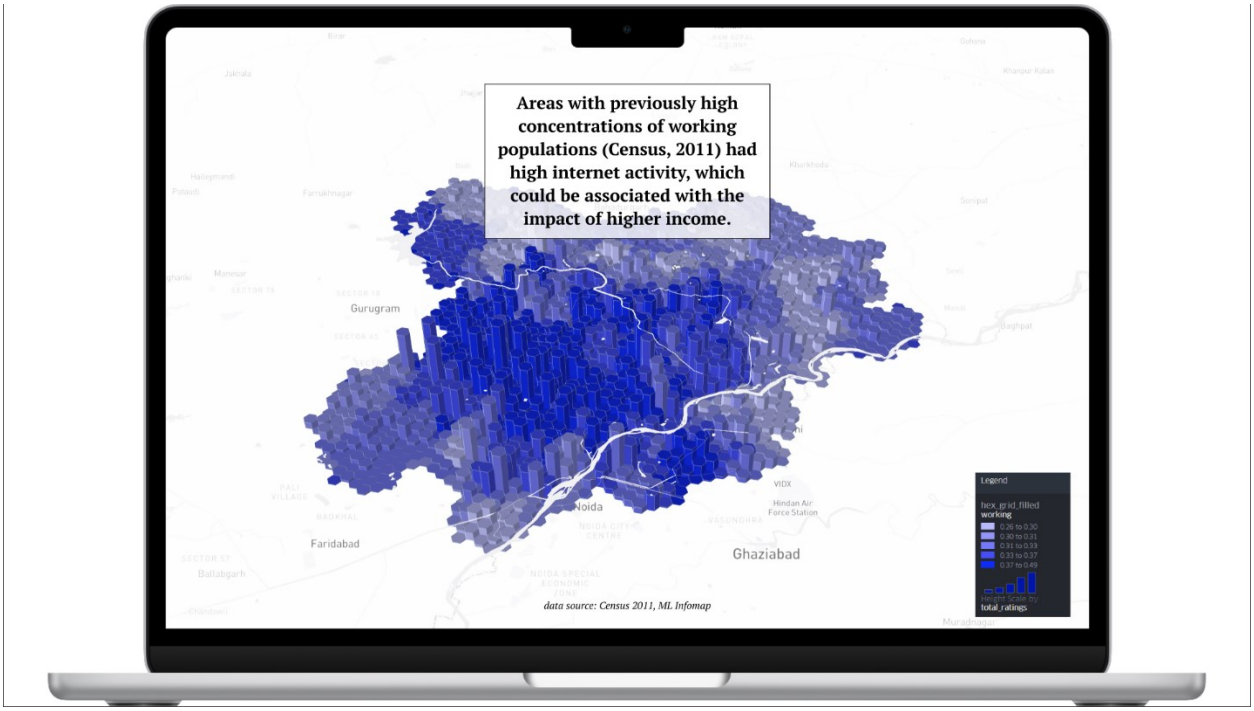

Does better connectivity and accessibility
lead to equitable internet activity?
What factors drive internet usage across
different parts of the city?


Let's take a look at India's
capital, New Delhi
Baghpat
Rohtak
Ghaziabad
New Delhi
DEL
Gurugram
Greater Noida
Khurja
Rewari
Bhiwadi

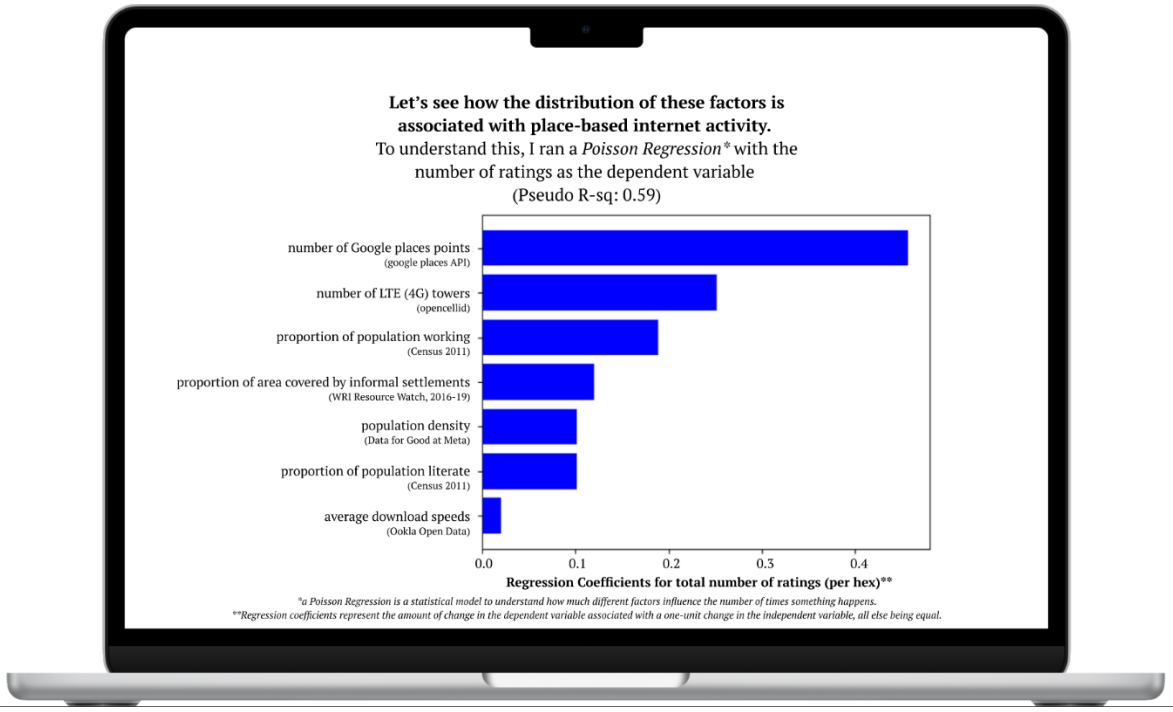
To study place-based internet activity in the city, I mapped the places marked on Google maps their corresponding number of ratings
Gurugram
New Delhi
Delhi
Noida
Faridabad
Ghaziabad


These areas had the highest internet activity
(the higher the hex bar, the higher is the number of ratings)
Gurugram
Noida
Faridabad
Ghaziabad
Legend
data source: Google Places API

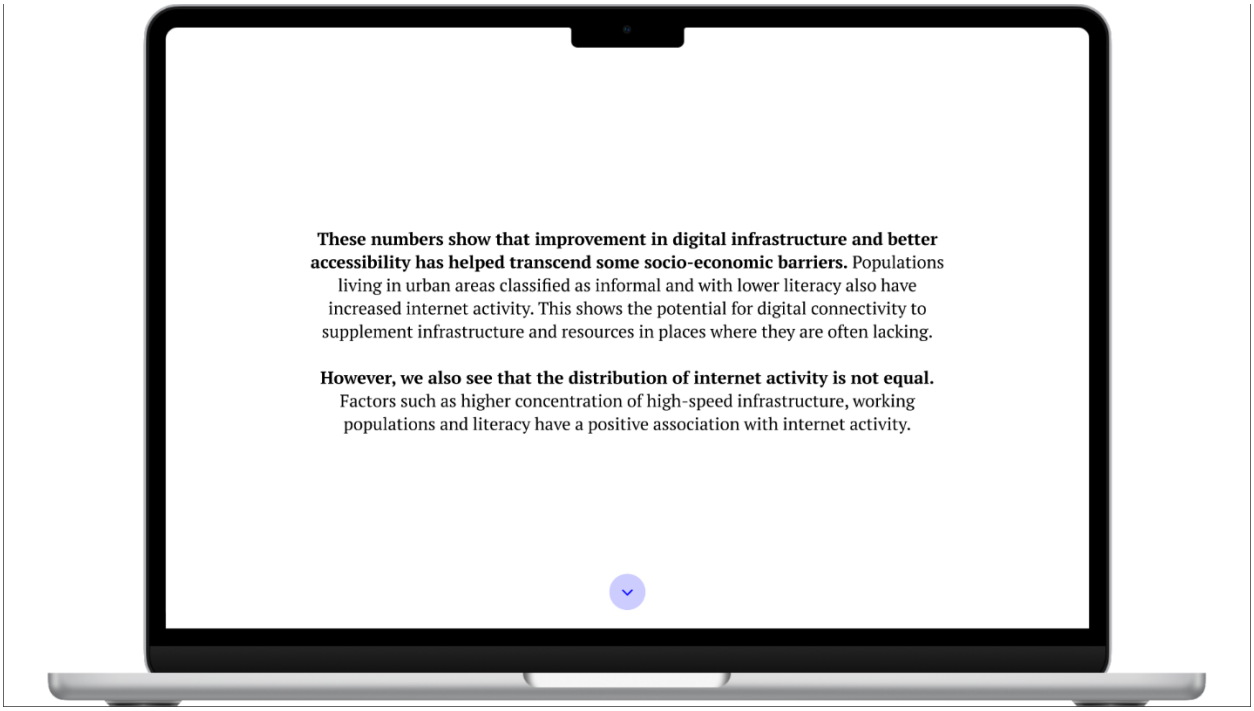

Areas with higher concentration of high-speed infrastructure (4G towers) had higher place-based internet activity. This reflects the impacts of better connectivity on internet activity.
Gurugram
Noida
Faridabad
Ghaziabad
Ballabgarh
Hindan Air Force Station
data source: https://opencellid.org/
Legend
hex_grid_filled
LTE_tower
0.00 to 0.00
0.00 to 1.00
1.00 to 7.00
7.00 to 22.20
22.20 to 135.00
total_ratings

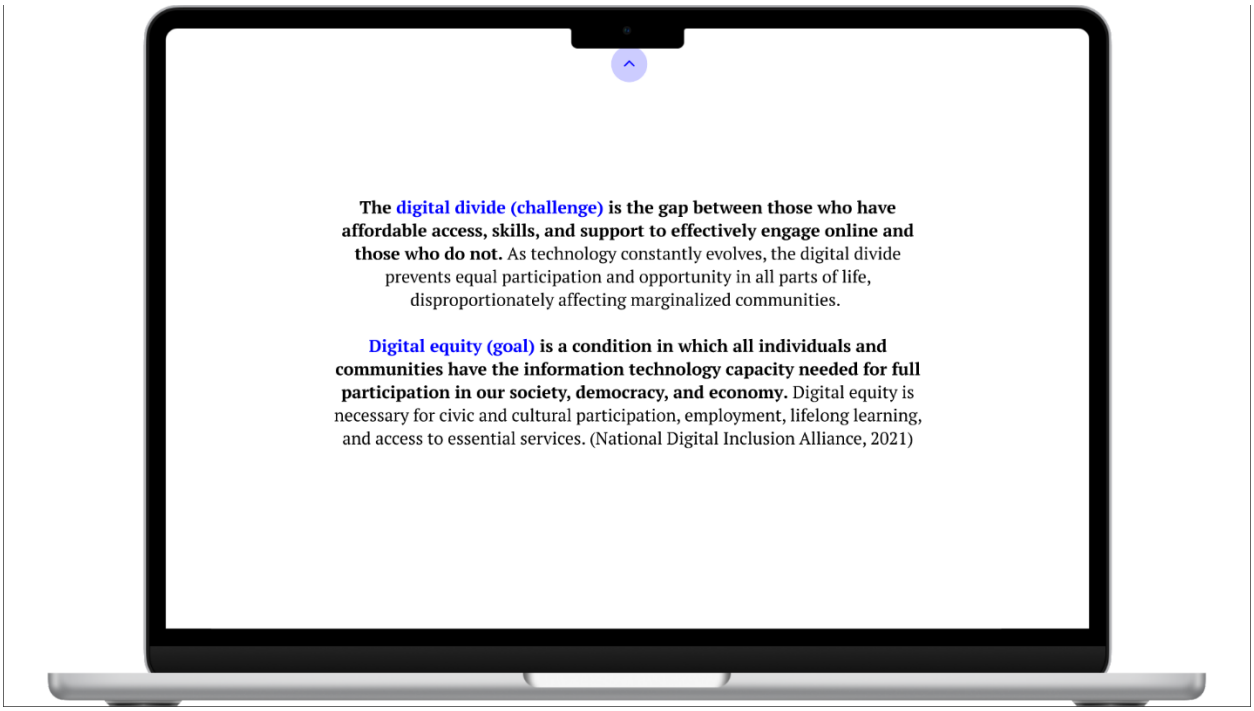

Areas with previously high concentrations of working populations (Census, 2011) had high internet activity, which could be associated with the impact of higher income.
Gurugram
Noida
Faridabad
Ghaziabad
Ballabgarh
Hindan Air Force Station
data source: Census 2011, ML Infomap
Legend
hex_grid_filled
working
0.26 to 0.30
0.30 to 0.31
0.31 to 0.33
0.33 to 0.37
0.37 to 0.49
total_ratings

Areas with previously high literacy also had high internet activity but this association was not as strong. This suggests internet activity across a diverse demographic.
Gurugram
Noida
Faridabad
Ghaziabad
Legend
hex_grid_filled
literacy
0.62 to 0.70
0.70 to 0.74
0.74 to 0.76
0.76 to 0.80
0.80 to 0.89
Height Scale by
total_ratings
data source: Census 2011, ML Infomap

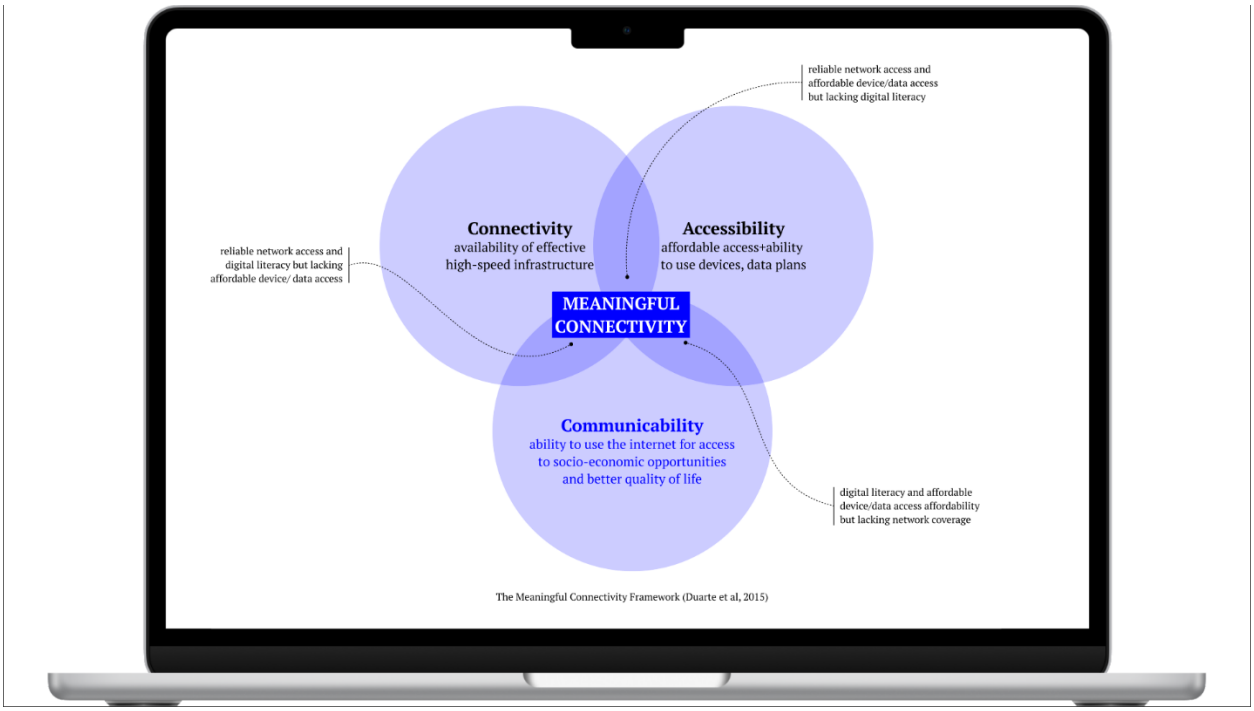

Let's see how the distribution of these factors is associated with place-based internet activity.
To understand this, I ran a *Poisson Regression** with the number of ratings as the dependent variable
(Pseudo R-sq: 0.59)
number of Google places points
(google places API)
number of LTE (4G) towers
(opencellid)
proportion of population working
(Census 2011)
proportion of area covered by informal settlements
(WRI Resource Watch, 2016-19)
population density
(Data for Good at Meta)
proportion of population literate
(Census 2011)
average download speeds
(Ookla Open Data)
0.0
0.1
0.2
0.3
0.4
Regression Coefficients for total number of ratings (per hex)**
*a Poisson Regression is a statistical model to understand how much different factors influence the number of times something happens.
**Regression coefficients represent the amount of change in the dependent variable associated with a one-unit change in the independent variable, all else being equal.

What do these numbers tell us about factors associated with place-based internet activity?

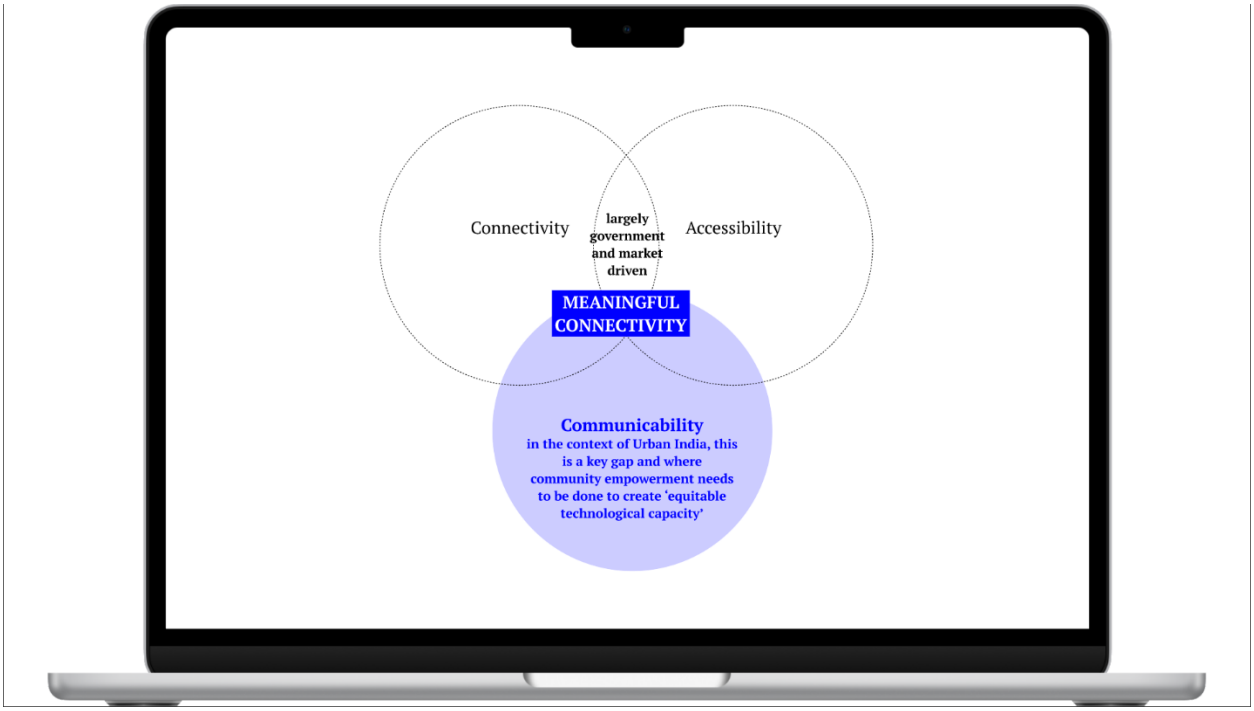

These numbers show that improvement in digital infrastructure and better accessibility has helped transcend some socio-economic barriers. Populations living in urban areas classified as informal and with lower literacy also have increased internet activity. This shows the potential for digital connectivity to supplement infrastructure and resources in places where they are often lacking.
However, we also see that the distribution of internet activity is not equal. Factors such as higher concentration of high-speed infrastructure, working populations and literacy have a positive association with internet activity.

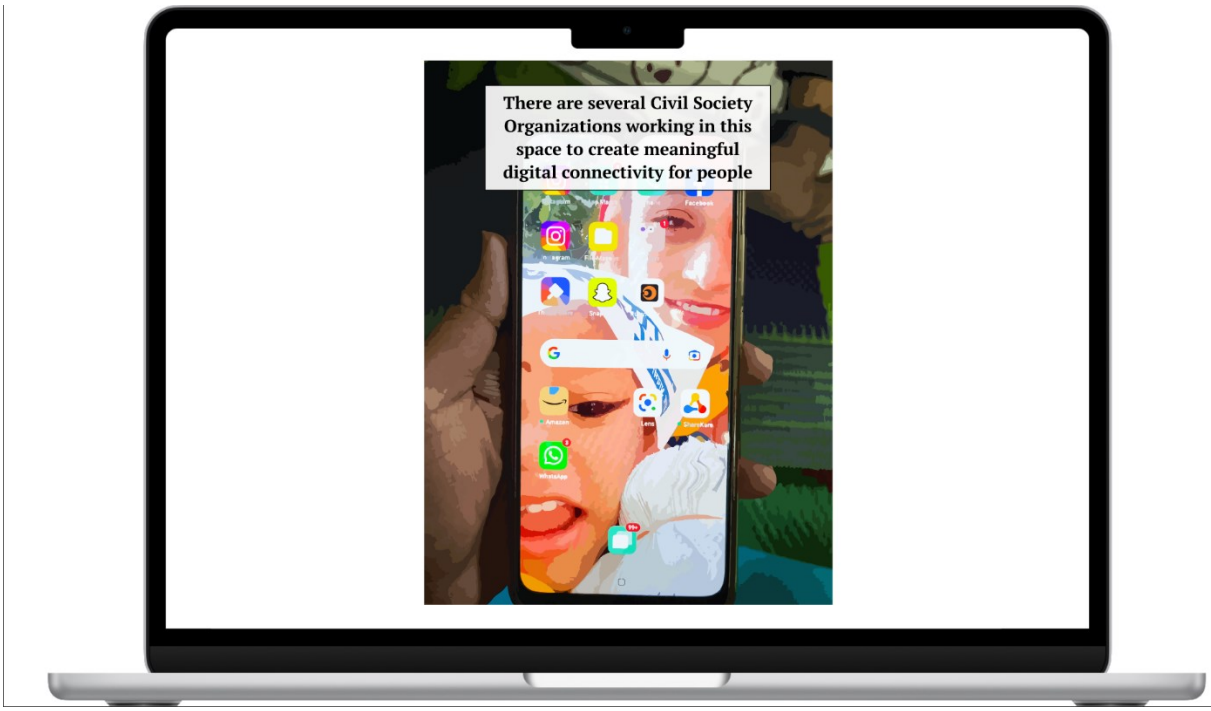

The digital divide (challenge) is the gap between those who have affordable access, skills, and support to effectively engage online and those who do not. As technology constantly evolves, the digital divide prevents equal participation and opportunity in all parts of life, disproportionately affecting marginalized communities.
Digital equity (goal) is a condition in which all individuals and communities have the information technology capacity needed for full participation in our society, democracy, and economy. Digital equity is necessary for civic and cultural participation, employment, lifelong learning, and access to essential services. (National Digital Inclusion Alliance, 2021)

To achieve digital equity, reliable connectivity and affordable accessibility are not sufficient. There is a third aspect to consider, communicability, which refers to people's ability to use the internet meaningfully.



The Meaningful Connectivity Framework (Duarte et al, 2015)

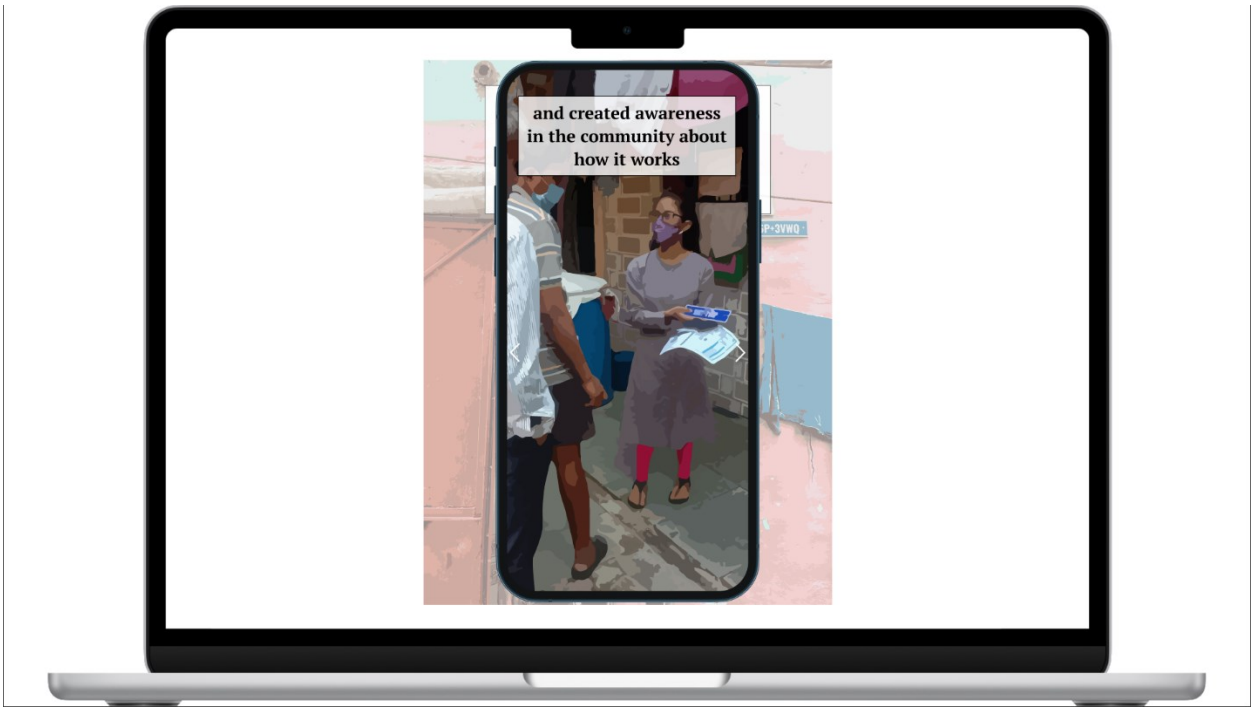


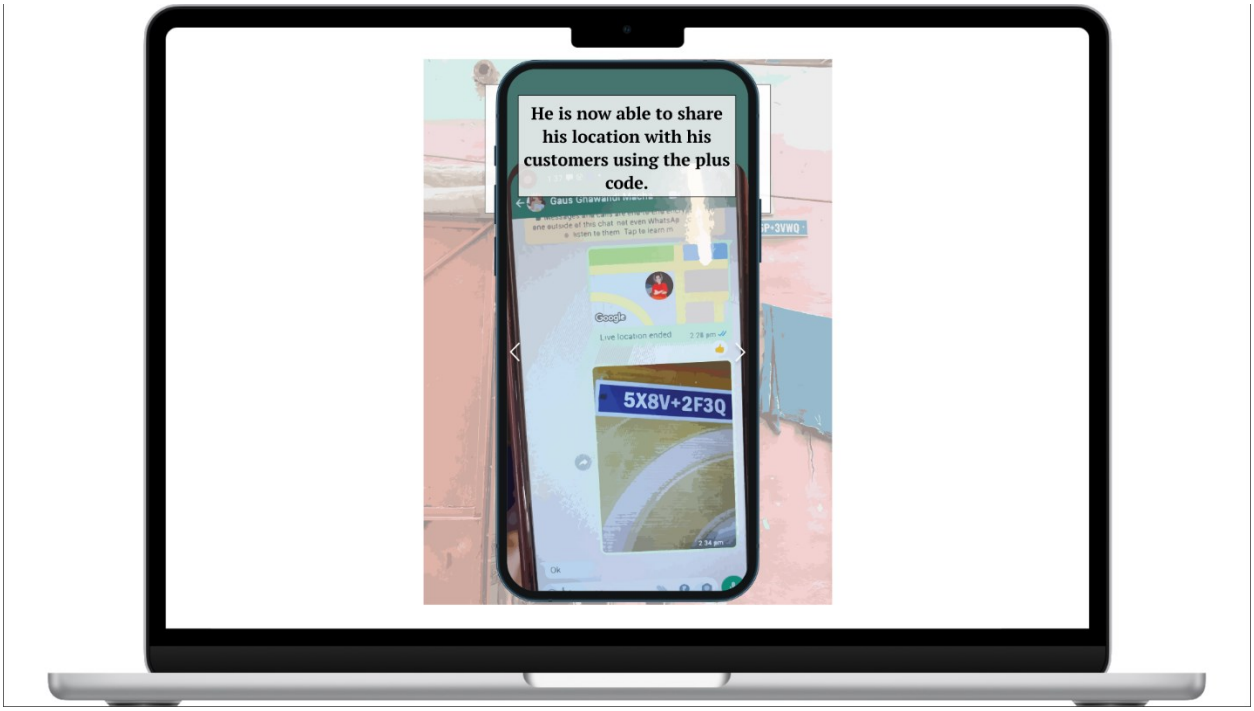

There are several Civil Society Organizations working in this space to create meaningful digital connectivity for people

Google geocodes are being used by Shelter Associates in Mumbai and Addressing the Unaddressed in Kolkata for improving location-based services in slums.
7MJCG86P+3VWQ

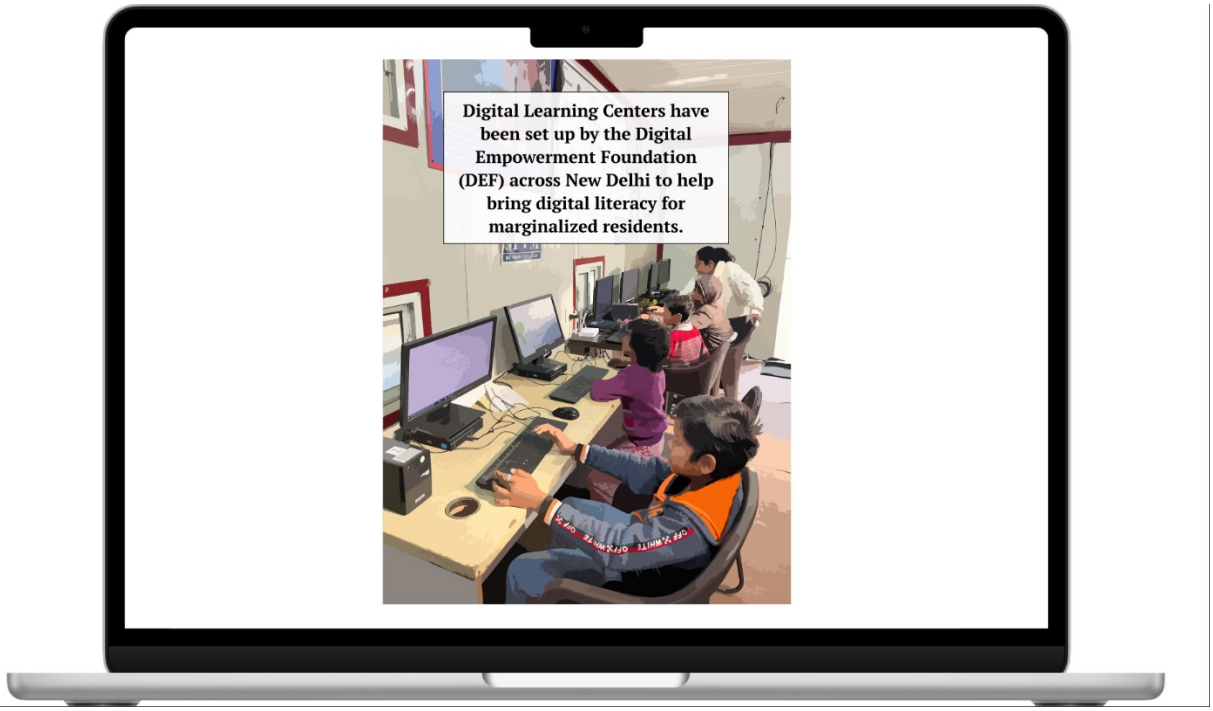
Meet Shivraj Kashinath Mitra, a 42 year old businessman operating a sewing business from an (informal) settlement in Airoli, Navi Mumbai

In 2022, Shelter Associates installed a plus-code based address plate on his door


and created awareness in the community about how it works


He is now able to share his location with his customers using the plus code.
5X8V+2F3Q

You can try out the Plus Code too: enter the code below on google maps to navigate to Shivraj's business
7JFJ5X8V+2F3Q


Digital Learning Centers have been set up by the Digital Empowerment Foundation (DEF) across New Delhi to help bring digital literacy for marginalized residents.

Meet Sanover, Delhi's district coordinator at DEF who looks over digital literacy and community resource centers across the city

She conducts weekly visit to the centers like Sarai Kallekha, a digital learning center located in a night shelter

She registers and tracks the beneficiaries at each center through DEF's Mera App (my app).

She facilitates teachers at the centers to use DEF's curriculum and toolkits for digital literacy.

She also conducts workshops with women's groups training them on using their phones to setup payment apps, linking bank accounts and availing govt schemes.

Explore the digital learning resources available on DEF's Helping Women Get Online platform

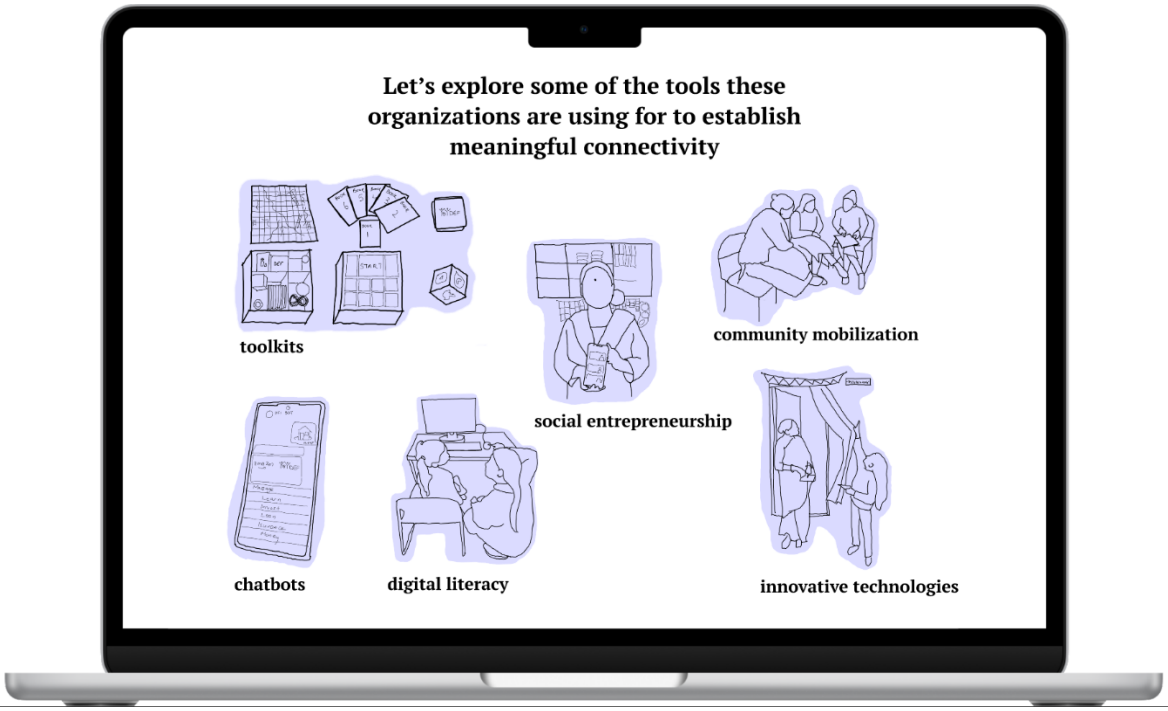
Social Entrepreneurship Centers have been set up by DEF in New Delhi to create community stewardess and self-reliance.
Community Information Resource Center
def@defindia.net
www.defindia.org
CSC ग्राहक सेवा केन्द्र
R.B. ALL ONLINE SOLUTIONS
M. 8448515384, 9958914050
मनी ट्रांसफर
डोमिसाईल
आयुष्मान कार्ड
INCOME सर्टिफिकेट
पैन कार्ड
आधार अपॉईन्टमेन्ट
लेबर कार्ड
ई-श्रम कार्ड
ऑल बिल पेमेन्ट
ट्रेन टिकट बुकिंग
FIR पुलिस वेरिफिकेशन
बैंक में खाता खुलवायें

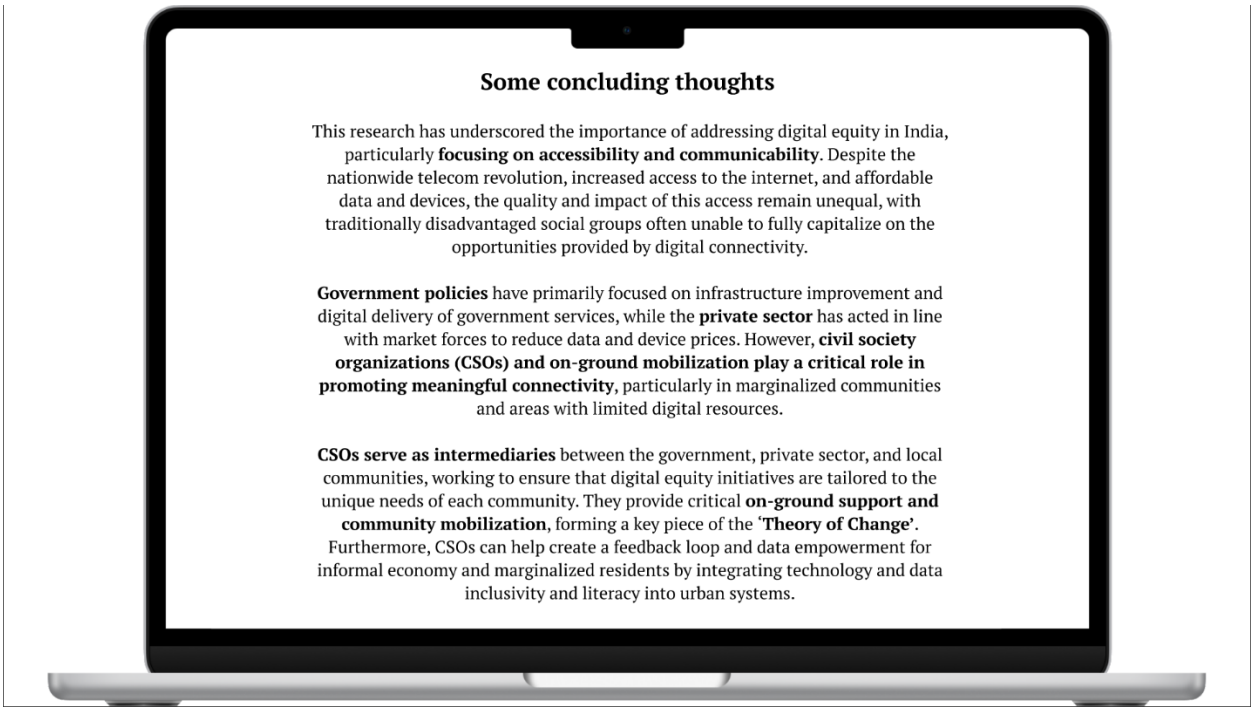
Meet Aarti, a 28 year old Soochnapreneur (information entrepreneur) based in Ghazipur, New Delhi
RIVERFORTE

She operates a digital services and learning center. In the mornings, she provides e-services like filling govt forms, e-payemnts to members in the community.
CSC ग्राहक सेवा केन्द्र
R.B. ALL ONLINE SOLUTIONS
M. 8448515384, 9958914050
मनी ट्रांसफर
डोमिसाईल
आयुष्मान कार्ड
INCOME सर्टिफिकेट
पैन कार्ड
रिज्यूम (सी.वी.)
आधार अपॉईन्टमेन्ट
लेबर कार्ड
ई-श्रम कार्ड
ऑल बिल पेमेन्ट
ट्रेन टिकट बुकिंग
FIR पुलिस वेरीफिकेशन
बैंक मे खाता खुलवायें

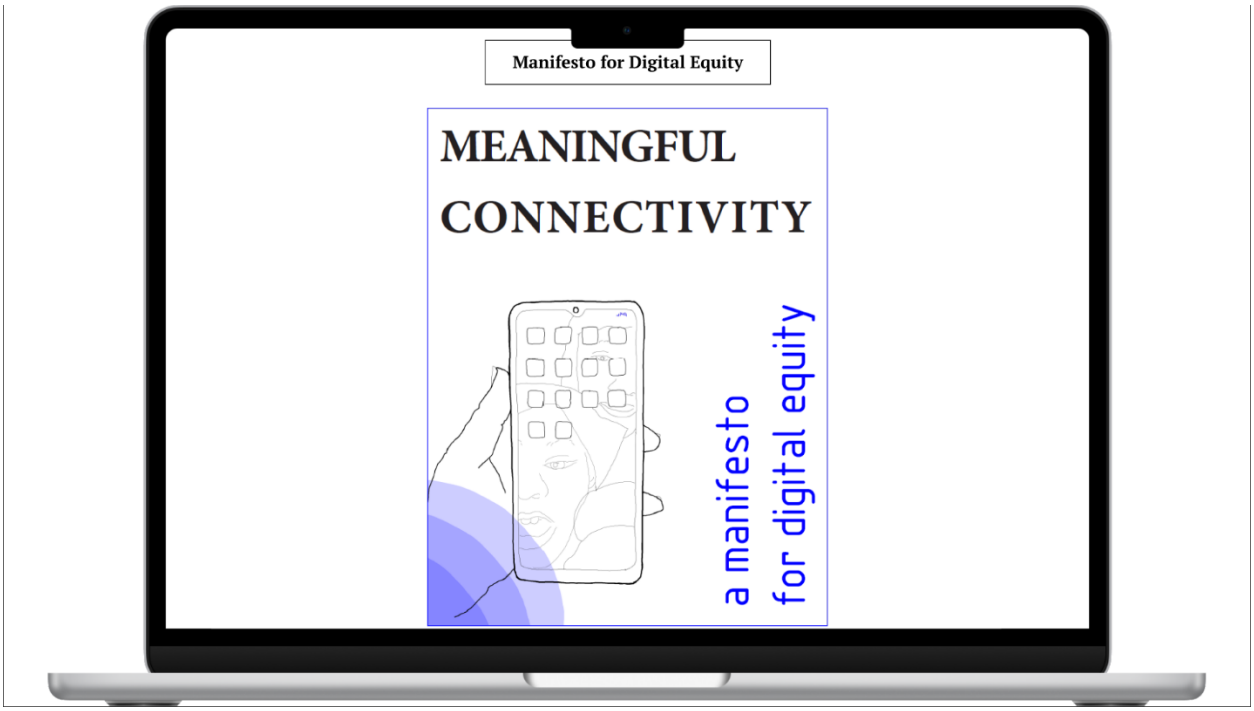
In the afternoon, she providers tutoring services to middle and high school kids from financially challenged families.

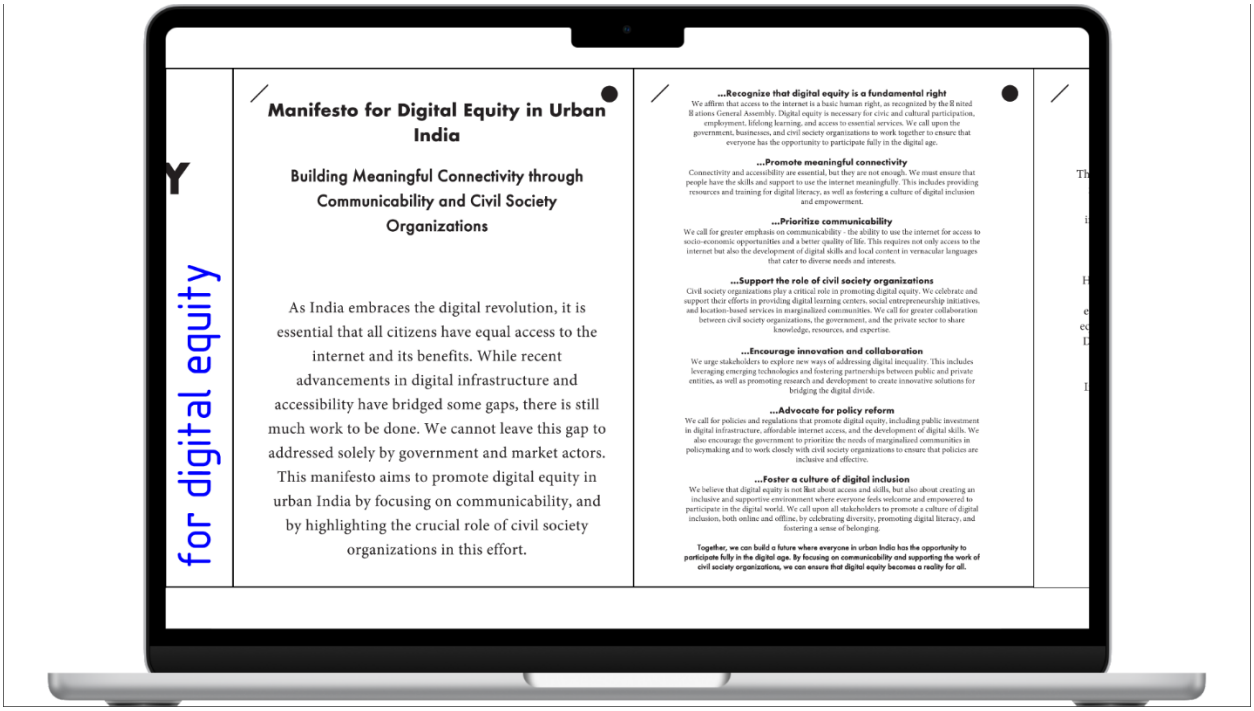
She had experience in teaching kids. DEF trained her as a digital service provider and helped her set up her community service center. While she would like more financial support, she finds her work very fulfilling.

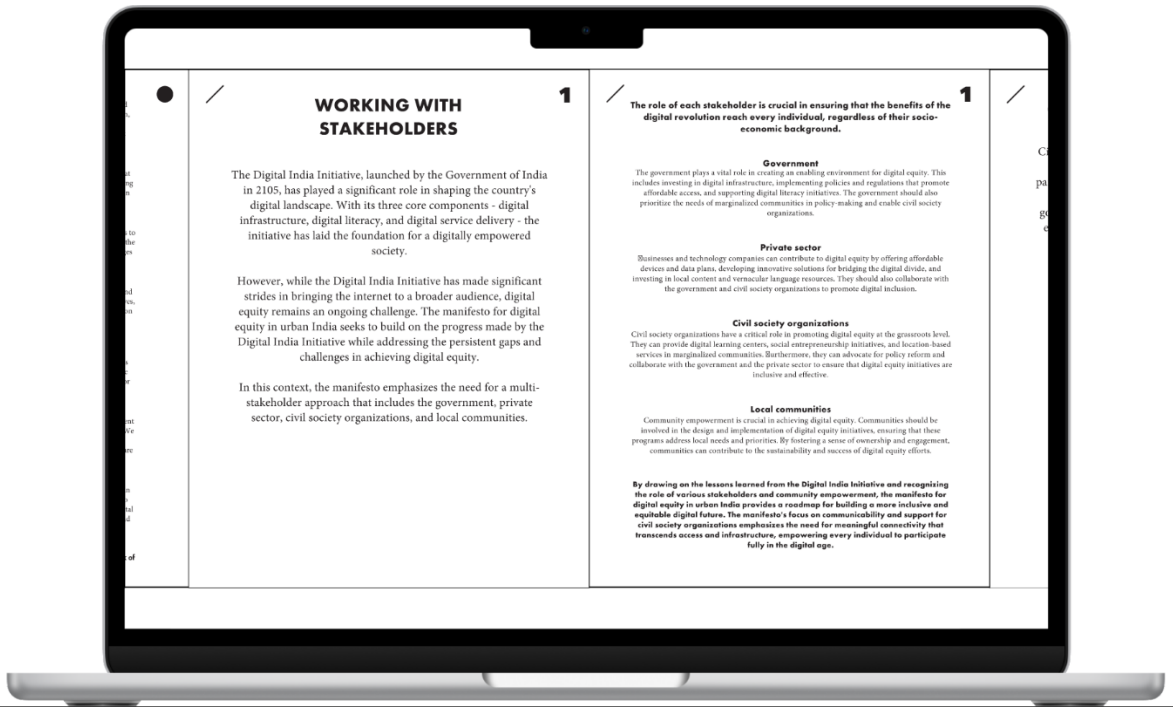

Let's explore some of the tools these organizations are using for to establish meaningful connectivity
toolkits
community mobilization
social entrepreneurship
chatbots
digital literacy
innovative technologies


Some concluding thoughts
This research has underscored the importance of addressing digital equity in India, particularly **focusing on accessibility and communicability**. Despite the nationwide telecom revolution, increased access to the internet, and affordable data and devices, the quality and impact of this access remain unequal, with traditionally disadvantaged social groups often unable to fully capitalize on the opportunities provided by digital connectivity.
Government policies have primarily focused on infrastructure improvement and digital delivery of government services, while the **private sector** has acted in line with market forces to reduce data and device prices. However, **civil society organizations (CSOs) and on-ground mobilization play a critical role in promoting meaningful connectivity**, particularly in marginalized communities and areas with limited digital resources.
CSOs serve as intermediaries between the government, private sector, and local communities, working to ensure that digital equity initiatives are tailored to the unique needs of each community. They provide critical **on-ground support and community mobilization**, forming a key piece of the '**Theory of Change'**. Furthermore, CSOs can help create a feedback loop and data empowerment for informal economy and marginalized residents by integrating technology and data inclusivity and literacy into urban systems.

Achieving digital equity has far-reaching implications for India's social and economic development, making it vital for stakeholders to collaborate and continuously adapt to evolving technology. While this research has provided valuable insights, future research could delve deeper into existing government policies and how they can be strengthened to enable CSOs to bridge the digital divide. The current regression is also preliminary and could benefit from inclusion of interaction terms and controlling for variables like age. It would be important to develop a measurement for communicability and include that in the regression to understand the socio-economic disparities more clearly and to be able address them effectively.


Manifesto for Digital Equity
MEANINGFUL
CONNECTIVITY
a manifesto
for digital equity


for digital equity
Manifesto for Digital Equity in Urban India
Building Meaningful Connectivity through Communicability and Civil Society Organizations
As India embraces the digital revolution, it is essential that all citizens have equal access to the internet and its benefits. While recent advancements in digital infrastructure and accessibility have bridged some gaps, there is still much work to be done. We cannot leave this gap to addressed solely by government and market actors. This manifesto aims to promote digital equity in urban India by focusing on communicability, and by highlighting the crucial role of civil society organizations in this effort.
...Recognize that digital equity is a fundamental right
We affirm that access to the internet is a basic human right, as recognized by the United Nations General Assembly. Digital equity is necessary for civic and cultural participation, employment, lifelong learning, and access to essential services. We call upon the government, businesses, and civil society organizations to work together to ensure that everyone has the opportunity to participate fully in the digital age.
...Promote meaningful connectivity
Connectivity and accessibility are essential, but they are not enough. We must ensure that people have the skills and support to use the internet meaningfully. This includes providing resources and training for digital literacy, as well as fostering a culture of digital inclusion and empowerment.
...Prioritize communicability
We call for greater emphasis on communicability - the ability to use the internet for access to socio-economic opportunities and a better quality of life. This requires not only access to the internet but also the development of digital skills and local content in vernacular languages that cater to diverse needs and interests.
...Support the role of civil society organizations
Civil society organizations play a critical role in promoting digital equity. We celebrate and support their efforts in providing digital learning centers, social entrepreneurship initiatives, and location-based services in marginalized communities. We call for greater collaboration between civil society organizations, the government, and the private sector to share knowledge, resources, and expertise.
...Encourage innovation and collaboration
We urge stakeholders to explore new ways of addressing digital inequality. This includes leveraging emerging technologies and fostering partnerships between public and private entities, as well as promoting research and development to create innovative solutions for bridging the digital divide.
...Advocate for policy reform
We call for policies and regulations that promote digital equity, including public investment in digital infrastructure, affordable internet access, and the development of digital skills. We also encourage the government to prioritize the needs of marginalized communities in policymaking and to work closely with civil society organizations to ensure that policies are inclusive and effective.
...Foster a culture of digital inclusion
We believe that digital equity is not just about access and skills, but also about creating an inclusive and supportive environment where everyone feels welcome and empowered to participate in the digital world. We call upon all stakeholders to promote a culture of digital inclusion, both online and offline, by celebrating diversity, promoting digital literacy, and fostering a sense of belonging.
Together, we can build a future where everyone in urban India has the opportunity to participate fully in the digital age. By focusing on communicability and supporting the work of civil society organizations, we can ensure that digital equity becomes a reality for all.



1

WORKING WITH STAKEHOLDERS

The Digital India Initiative, launched by the Government of India in 2105, has played a significant role in shaping the country's digital landscape. With its three core components - digital infrastructure, digital literacy, and digital service delivery - the initiative has laid the foundation for a digitally empowered society.

However, while the Digital India Initiative has made significant strides in bringing the internet to a broader audience, digital equity remains an ongoing challenge. The manifesto for digital equity in urban India seeks to build on the progress made by the Digital India Initiative while addressing the persistent gaps and challenges in achieving digital equity.

In this context, the manifesto emphasizes the need for a multi-stakeholder approach that includes the government, private sector, civil society organizations, and local communities.

1

The role of each stakeholder is crucial in ensuring that the benefits of the digital revolution reach every individual, regardless of their socio-economic background.

Government
The government plays a vital role in creating an enabling environment for digital equity. This includes investing in digital infrastructure, implementing policies and regulations that promote affordable access, and supporting digital literacy initiatives. The government should also prioritize the needs of marginalized communities in policy-making and enable civil society organizations.

Private sector
Businesses and technology companies can contribute to digital equity by offering affordable devices and data plans, developing innovative solutions for bridging the digital divide, and investing in local content and vernacular language resources. They should also collaborate with the government and civil society organizations to promote digital inclusion.

Civil society organizations
Civil society organizations have a critical role in promoting digital equity at the grassroots level. They can provide digital learning centers, social entrepreneurship initiatives, and location-based services in marginalized communities. Furthermore, they can advocate for policy reform and collaborate with the goverament and the private sector to ensure that digital equity initiatives are inclusive and effective.

Local communities
Community empowerment is crucial in achieving digital equity. Communities should be involved in the design and implementation of digital equity initiatives, ensuring that these programs address local needs and priorities. By fostering a sense of ownership and engagement, communities can contribute to the sustainability and success of digital equity efforts.

By drawing on the lessons learned from the Digital India Initiative and recognising the role of various stakeholders and community empowerment, the manifesto for digital equity in urban India provides a roadmap for building a more inclusive and equitable digital future. The manifesto's focus on communicability and support for civil society organizations emphasizes the need for meaningful connectivity that transcends access and infrastructure, empowering every individual to participate fully in the digital age.

1

CIVIL SOCIETY ORGANIZATIONS

2

Civil society organizations (CSOs) and on-ground mobilization play a critical role in promoting meaningful connectivity, particularly in marginalized communities and areas with limited digital resources. They serve as intermediaries between the government, private sector, and local communities, working to ensure that digital equity initiatives are tailored to the unique needs of each community.

2

Some of the key roles that CSOs and on-ground mobilization play in the context of meaningful connectivity include:

Digital literacy and education
CSOs can set up digital learning centers and conduct training programs to help individuals develop digital skills, enabling them to use the internet effectively for communication, education, and accessing online services.

Community engagement and empowerment
Through on-ground mobilization, CSOs can engage with local communities, identify their specific digital needs, and involve them in the design and implementation of digital initiatives. This participatory approach ensures that digital equity programs are relevant, sustainable, and effective.

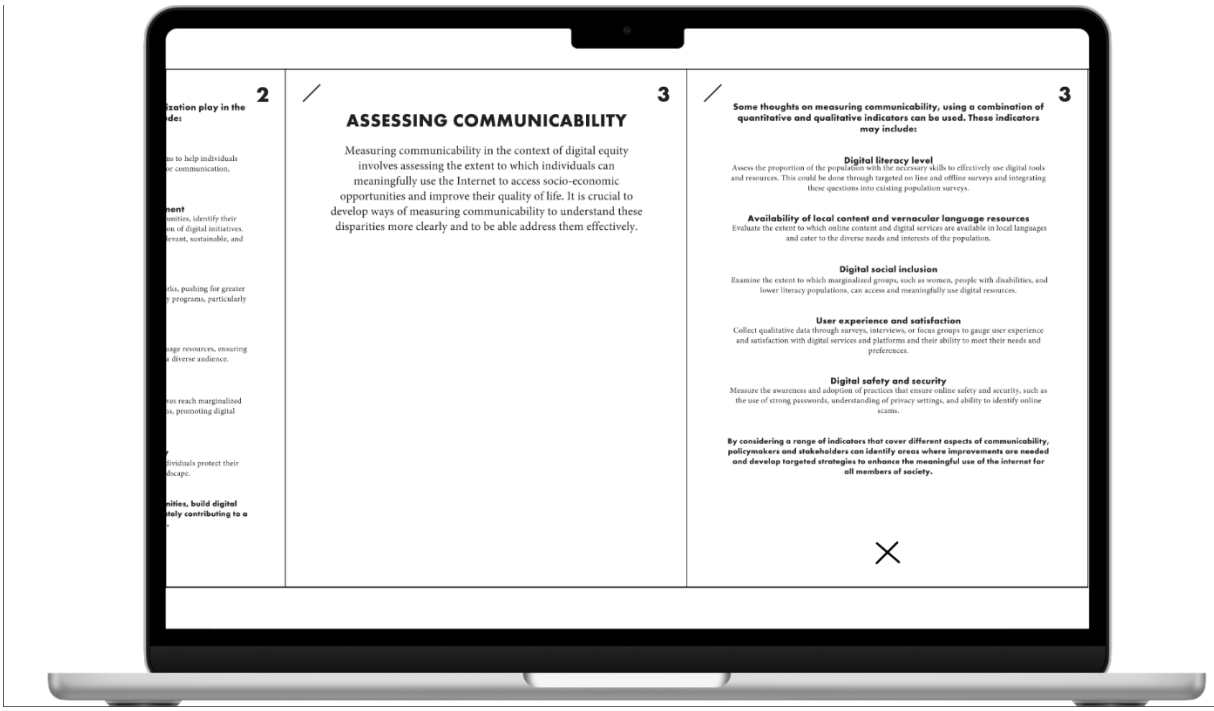
Advocacy and policy influence
CSOs can advocate for inclusive digital policies and regulatory frameworks, pushing for greater investment in digital infrastructure, affordable access, and digital literacy programs, particularly in underserved communities.

Local content development
CSOs can support the development of local content and vernacular language resources, ensuring that digital services and information are relevant and accessible to a diverse audience.

Ensuring digital inclusion
Through on-ground mobilization, CSOs can ensure that digital initiatives reach marginalized groups, such as women, people with disabilities, and rural populations, promoting digital inclusion and social equity.

Promoting digital safety and security
CSOs can raise awareness about online safety and security, helping individuals protect their privacy, avoid scams, and safely navigate the digital landscape.

Through their grassroots efforts, CSOs can empower communities, build digital skills, and foster a sense of ownership and engagement, ultimately contributing to a more inclusive and equitable digital future.


2
3
ASSESSING COMMUNICABILITY
Measuring communicability in the context of digital equity involves assessing the extent to which individuals can meaningfully use the Internet to access socio-economic opportunities and improve their quality of life. It is crucial to develop ways of measuring communicability to understand these disparities more clearly and to be able address them effectively.
3
Some thoughts on measuring communicability, using a combination of quantitative and qualitative indicators can be used. These indicators may include:
Digital literacy level
Assess the proportion of the population with the necessary skills to effectively use digital tools and resources. This could be done through targeted on line and offline surveys and integrating these questions into existing population surveys.
Availability of local content and vernacular language resources
Evaluate the extent to which online content and digital services are available in local languages and cater to the diverse needs and interests of the population.
Digital social inclusion
Examine the extent to which marginalized groups, such as women, people with disabilities, and lower literacy populations, can access and meaningfully use digital resources.
User experience and satisfaction
Collect qualitative data through surveys, interviews, or focus groups to gauge user experience and satisfaction with digital services and platforms and their ability to meet their needs and preferences.
Digital safety and security
Measure the awareness and adoption of practices that ensure online safety and security, such as the use of strong passwords, understanding of privacy settings, and ability to identify online scams.
By considering a range of indicators that cover different aspects of communicability, policymakers and stakeholders can identify areas where improvements are needed and develop targeted strategies to enhance the meaningful use of the internet for all members of society.

Dear reader, thank you for joining this exploration.
I am grateful that my work has reached you.
May the stories shared here spark curiosity and reflection.
contact: surbhiag@mit.edu

2. Civil Society Organizations and NGO Partners in India:

2a. CURE (Center for Urban and Regional Excellence), New Delhi

Through their network of community centers across informal settlements in New Delhi, CURE is working on community participatory planning and improving digital literacy. They have developed an application designed to transform city-citizen engagement from grievance-based to participatory planning. The application had a three-step process: identifying problem spots and sharing with the city, getting connected to concerned officials responsible for complaint redressal, and proposing contextual solutions to address these. Interspersed with direct facilitation processes, the application enables poor communities to raise demands, share ideas and be part of the solution using their phones. The poorest without access to phones, could access the app from the community centers. The purpose was to shrink the processing time between the identification of the problem (what, where, why) and its resolution (how, who) by implementing context-specific solutions.

2b. Shelter Associates, Pune

Believing strongly in a data-driven & community-centric approach, Shelter Associates (SA), an NGO based in Pune works towards equitable distribution of resources by enabling access to basic infrastructure, sanitation, and social housing to the urban poor. Through a thorough study of slum data and the challenges faced by communities, Shelter Associates have also recognized the importance of having an easily navigable location and ease of service delivery. With these objectives in mind, Project Plus Codes for the informal settlements have been undertaken by Shelter Associates jointly with Google and UNICEF Maharashtra in the slum settlements of Laxmi Nagar & Vadarwadi (Pune), Lokmanya Nagar (Thane) and Chinchpada (Navi Mumbai). Plus Code is a digital address given to every location on earth and through this project, Shelter Associates aims to map social and basic services of the slum settlements with unique location codes. This location code can be used on Google Maps and allows slum residents to access services such as postal, emergency services, gas cylinders & other online services.

2c. Digital Empowerment Foundation

Digital Empowerment Foundation (DEF) is a Delhi-based nonprofit organization working towards empowering people to gain access to better healthcare, education, skills, and livelihood opportunities through digital literacy and digital tools. The organization's main focus is to make technology easily accessible to the masses and to empower women, youth, persons with disabilities, and the elderly through providing functional digital literacy, media literacy, and digital up-skilling across agriculture, micro and nano-business, health, education, livelihood, and entrepreneurial skills. Over the last 20 years, the organization has been actively engaged in digitally empowering local communities through its 2,000 Community Information Resource Centers. These

centers are supported by a widespread network of 10,000 digital foot soldiers located across 24 states and 135 districts in rural, tribal, marginalized, and unreached areas. DEF has directly impacted the lives of more than 30 million people including people from below the poverty line, women, artisans, youth, persons with disabilities, and the elderly.

3. Interview logs:

Figure 34. Location of Chetla Ward 82 in Kolkata

3a. Kolkata: Ward 82, Chetla: 08 January 2023

- Ward 82 in Chetla, an informal settlement in a dense urban neighborhood in the urban core of the Metropolitan area (Fig 34)
- Project site for Addressing the Unaddressed's plus codes project

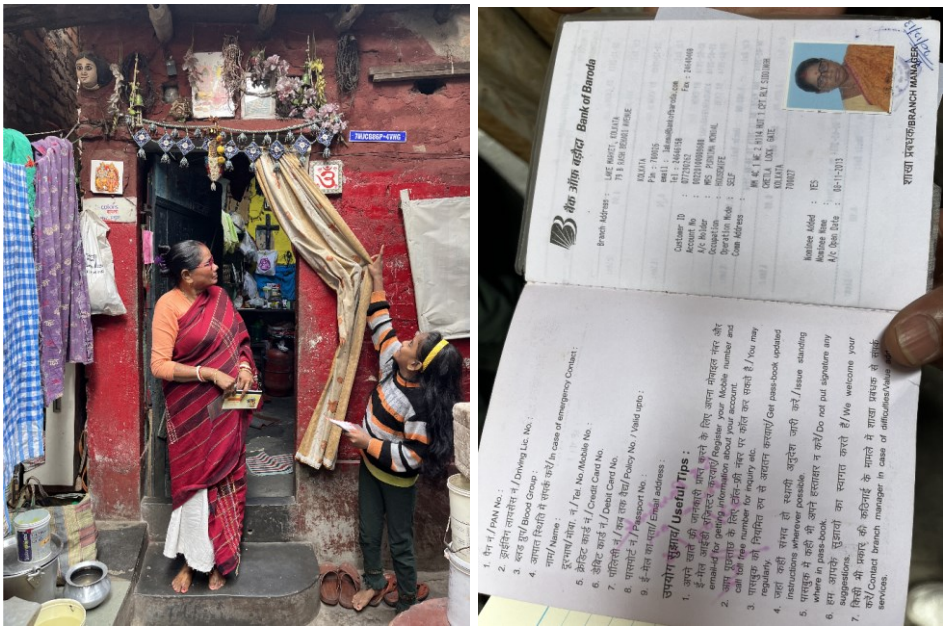


Figure 35. Purnima Mondal's house (left) and bank passbook (right) with plus codes address plate

- Purnima Mondal (Resident) (Fig 35)
  - Woman, 42 years old
  - Used plus code for bank address once but hasn't used it actively since then.
  - Understands the plus code plaque as a house number but does not know how to use the plus code as a digital address or with google maps.
  - Uses the internet on her smartphone for social media: Facebook, Youtube, and WhatsApp.
  - Her daughter is in college and uses Zoom and google duo for educational purposes.
  - 2 years ago, the West Bengal govt provided Rs.10,000 subsidy for online classes in schools, using which she purchased a smartphone for her daughter.

Figure 36. Anonymous resident with plus code address plate outside her house in Chetla, Ward 82, Kolkata

- Anonymous (Resident) (Fig 36)
    - Woman, 49 years old
    - Works as a cook at the West Bengal Chief Minister.
    - Has two sons, they all have smartphones, also a shared laptop in the house with an Internet connection.
    - The sons use the internet actively for facilitating their work and study.
    - Thinks of the plus code plaque as a house number, but does not know how to use the plus code and has never used it for anything.

Figure 37. A resident of Chelta, Ward 82, Kolkata (left) being shown his house location on google maps using the plus code (right)

- Anonymous (Resident) (Fig 37)
    - Man, 34 years old
    - Works as a service worker in a government office in the city.
    - Thinks of the plus code plaque as a house number, but does not know how to use the plus code and was surprised to discover that it could be used as an address code on google maps directly.

Figure 38. Informal conversation with a group of men using their phones while catching a break at a local tea shop in Chetla

- Informal conversation with a group of men catching a break at the local tea shop
    - Most of these men were scrolling through their phones as they chatted and shared tea and cigarettes at a local tea shop in the settlement.
    - One of them worked as a Zomato (food delivery app) delivery and used his phone and google maps to facilitate his work.
    - Another man discussed the various phone apps he uses on a day-to-day basis, including social media and online shopping apps. He had recently ordered a pair of shoes on Flipkart (an Indian online shopping app). On the day of delivery, he coordinated with the local delivery agent to have the package delivered to the local grocery store in the area where he paid in cash (most shopping apps in India have a cash-on-delivery payment option) and collected the shoes.

Figure 39. The door of the CINI Office in Sealdah, Kolkata

3b. Kolkata: Child in Need Institute (CINI) Office, Sealdah: 09 January 2023

- Office of an NGO, CINI, working to continue the Plus codes project in Kolkata after the pandemic.

Figure 40. Conversation with a social worker at the CINI office in Sealdah (left) and an informational flyer for the plus codes program (right)

- Duresh Sorkar (Social Worker, CINI) and Subhashish Nath (Manager Consultant, Addressing the Unaddressed) (Fig 40)
    - Working on the implementation of plus codes in various wards in collaboration with Addressing the Unaddressed.

- One of the latest initiatives is the integration of plus codes with CINI's 'Government at your doorstep' initiative which brings services like ration, health, *aadhar* identity card, and voting card to residents in these settlements. The plus codes are being to record the addresses of the beneficiaries.
- He shared that one of the main challenges with the current implementation of the plus codes project is the new enforcement of the National Register of Citizens (NRC) in India. Many of the residents of these informal settlements are undocumented migrant workers from neighboring countries like Bangladesh.
- The COVID pandemic also made the mobilization and community awareness around the project challenging as it became increasingly difficult to interact with people.
- Recently, the Government of West Bengal has also permitted tracking beneficiaries of the Mother Child Program (a government welfare scheme for pregnant mothers and newborns) using plus-code-based addresses.
- He believes that using the plus codes can help effectively track beneficiaries for various govt schemes, and identify dropouts from schemes like immunization.
- When asked about challenges faced during the fieldwork, he shared that it can be difficult to gather residents as many of them do not have an interest in learning about the program, or do not have availability due to their day jobs.
- He has personally found the usage of smartphones and tablet devices very useful for documentation during fieldwork.
- He believes one of the key efforts required for the successful uptake of the plus codes project in the community is creating community awareness about the usage of the codes. He said people need to understand what is happening and to be able to see tangible benefits like someone directly reaching their house using the plus codes.
- Currently, they are attempting to inform people about its usage when they conduct visits to various households in the community for various other surveys but he identifies the need for dedicated training in the community for its usage. However, there is low uptake and a lack of knowledge among the residents on the usage of the plus codes.
- CINI is planning to conduct community-wide training sessions for the usage of plus codes and google maps in the coming 6 months. They also partner with local social clubs to communicate and build trust in the community.

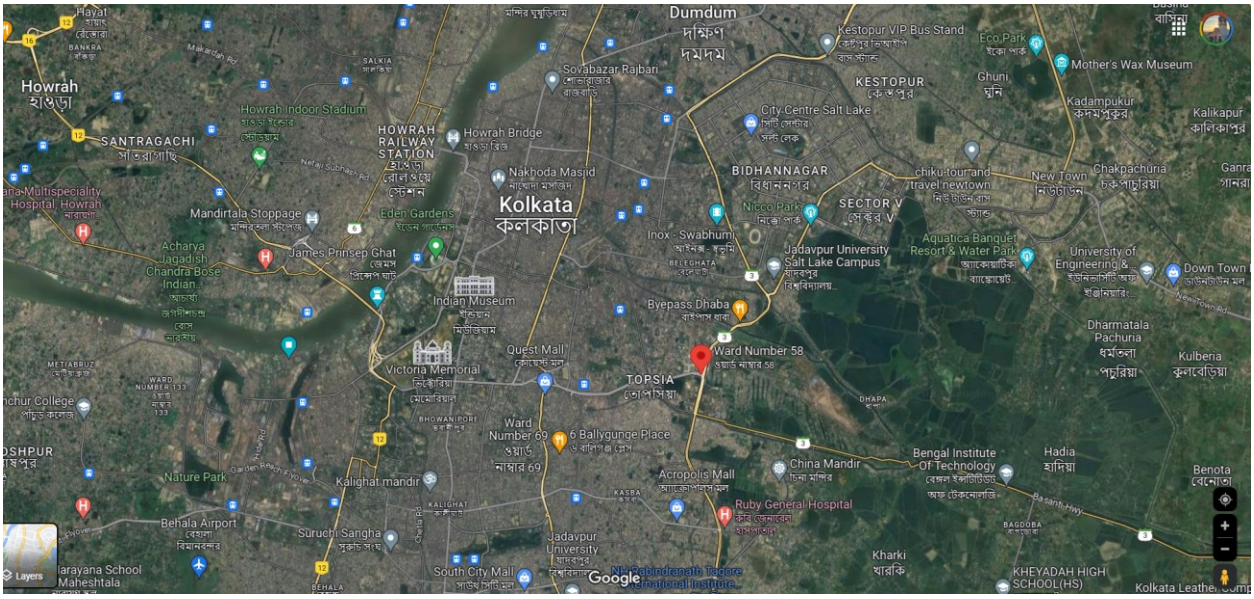


Figure 41. Location of Ward 58, ATU Project Site in Kolkata

3c. Kolkata: Ward 58: 09 January 2023

- Project site for Addressing the Unaddressed's plus codes project

Figure 42. Photos from the site visit (left), a plus code plate attached to the wall outside a house (right)

- This settlement was located in a more suburban area in the urban fringe, next to a large landfill site and as such, the socio-economic conditions were heavily underdeveloped.
- The awareness about and uptake of the plus codes project was very low in this area.
- During the site visit, several of the houses with the plus codes plaques were visited, but most of the residents did not understand what these plates were and why they were installed. Overall ownership and usage of smartphones were also low here.
- Several of the residents were workers in the nearby landfill.

3d. Mumbai: Conversation with Prof Arnab Jana, IIT Bombay: 10 January 2023

- Arnab Jana is an Associate Professor at, the Centre for Urban Science and Engineering (CUSE) at IIT Bombay and deals with the application of ICT in Urban and Regional Planning
    - Datasets are very restricted, and it is tough to map internet access in the country
    - A surrogate approach will have to be adopted, using Twitter data could be an alternative.
    - The widescale availability of smartphone applications for everyone is helping bridge the digital divide.
    - Access to the internet, especially through smartphones has become very cheap. Youngsters are early adopters, so it would be important to map access for housewives, and children, which could be done using a perception survey or sentiment analysis.
    - Informatics research is currently based on social media data analysis as telecom data is proprietary and cannot be accessed. TRAI releases its datasets every 6 months.
    - The government had coordinated with Meta during COVID for crowd monitoring, using the number of people using WhatsApp to determine the latest population grid density.
    - Building Digital capacity is an age-sensitive question. As people grow older, above 35-40 years, their risk appetite lowers, and thus there is lower trust in adapting new technology.
    - At the entry-level, people are enticed to use the internet by accessing social media platforms like Facebook and WhatsApp.
    - Level of education, social groups, and age greatly determine internet usage. Quick short motion content like YouTube shorts, and TikTok are attractive for blue-collar workers.

3e. Pune: Conversation with Pratima Joshi, Executive Director of Shelter Associates (SA): 28 December 2023

- Currently, 1000s of families in informal settlements share one address, the plus-codes project has been crucial to generate an address for each doorstep.
- SA has been doing a lot of GIS mapping, but govt did not have tools for GIS tracking, there needed to be a tool to develop addresses for people.
- There is a challenge in enabling people to reach their addresses using plus codes as not everyone in the slum is using digital addresses.
- The project aims to use access digital services, to help with infrastructural solutions and create a win-win solution for the community and bureaucracy.
- Plus codes can be used for a wide variety of uses: postal deliveries, cooking gas delivery, LPG cylinder, navigation, etc.

- SA has worked extensively in Kolhapur, all slums are now marked on google maps. Shelter Associates is trying to integrate this into municipal bodies' datasets. For instance, residents of these settlements people have metered water connections linked to the plus codes addresses, and new forms have fields for digital addresses. Such bottom-up integration of plus code-based digital addresses into the municipal and national systems is very important for the overall future success of the work. They were pleasantly surprised that the community was very open to this.
- Google Maps is not an alien concept to people anymore.
- In areas where people were using e-commerce businesses, the plus codes were super useful
- The first step was to put the plus codes on the people's doors.
- Younger people are much more savvy with technology, more than 50% of community members have access to smartphones.
- The project is very well documented on YouTube and SA's website.
- UPI payment system has also facilitated deep penetration of digital banking. Every tiny shop has a UPI code, linked to their bank accounts.

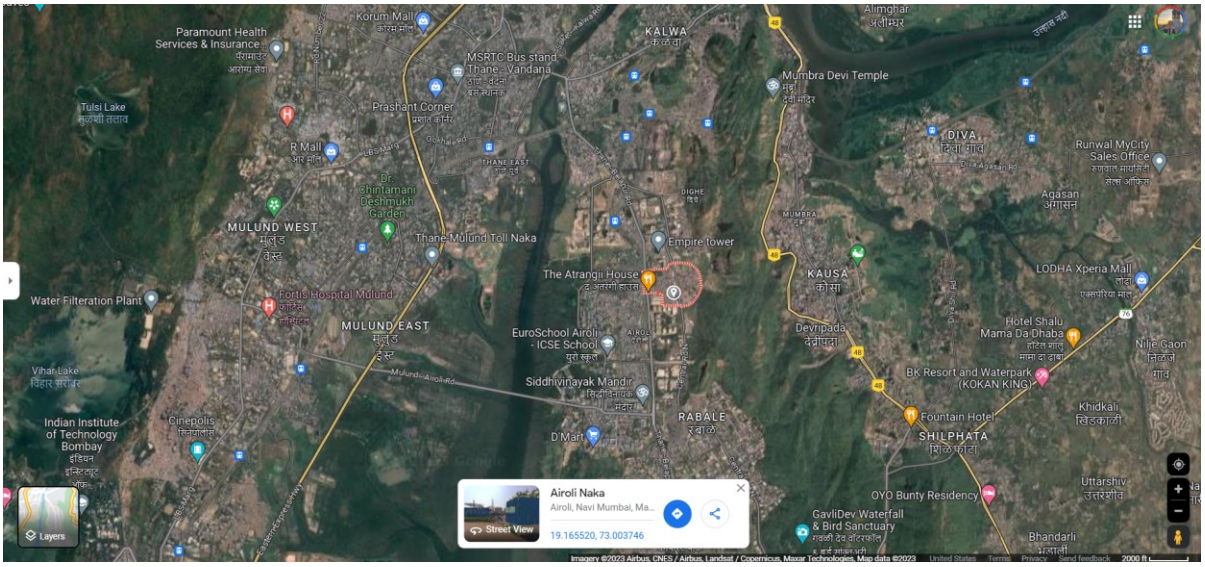


Figure 43. Location of Airoli Naka in Navi Mumbai, a project site for SA's plus codes project

3f. Mumbai: Airoli Naka: 20 January 2023

- Project site for Shelter Associates plus codes project
- Located in an informal settlement in Navi Mumbai, a new town in the greater metropolitan area of Mumbai.

Figure 44. SA Site Coordinator Amol sharing a flyer from the plus codes project

- Amol (Navi Mumbai Coordinator, Shelter Associates) (Fig 44)
    - 1500 houses covered to date in Airoli Naka
    - He has been working in Airoli with SA since 2018.
    - Most of these houses are legal, but a lot of them do not have a formal house number.
    - For successful project implementation, spoke with the local authorities.
    - Local social workers did community mobilization.
    - The plus codes were actively used during the pandemic to track vaccination.
    - Airoli is located in Navi Mumbai, a planned extension of Mumbai. Many of the houses, even in the informal settlements have relatively good socio-economic conditions and urban infrastructure, including wifi in many of the houses.

Figure 45. Unstructured interview with Sagar, a swiggy driver who lives in Airoli, Navi Mumbai

- Sagar (Resident) (Fig 45)
    - 25 years old, male
    - Works as a scooter-based delivery agent for Swiggy (food delivery app).
    - High school graduate
    - Speaks Marathi, Hindi, and Basic English
    - There are 4 people in his house, 3 adults and 1 kid in his house, and 3 smartphones. They bought their first smartphone about 10 years ago.
    - He uses plus codes sometimes for Swiggy deliveries.
    - He started his job at Swiggy about 4 months ago.
    - He shared that although there is some usage of plus codes in the community, they are mostly used by youngsters.
    - Phone apps he uses most frequently include Instagram, WhatsApp, Facebook, Snap Chat, GPay, phone-pe, and google maps.

Figure 46. Conversation with Ganesh, Shiv Kumar, and Subhash in Airoli, Navi Mumbai

- Ganesh Gajre (Resident) (Fig 46)
    - 50 years old, male
    - Works as a maintenance fitter
    - There are 4 people in the house, 2 adults and 2 kids, and 4 smartphones.
    - He uses plus codes for hailing rides via Ola (a cab-on-demand app) to reach his house
    - About 8 months ago, pieces of training were conducted for using plus codes in the community
    - Phone apps he uses most frequently include WhatsApp for video calls, YouTube, Gpay, and Google Maps.

- Shiv Kumar (Resident) (Fig 46)
    - 30 years old, male
    - About 8 months ago, training was conducted for using plus codes in the community
    - Phone apps he uses most frequently include Instamart, Swiggy, Zomato, and phone-pe for e-commerce purposes.

Figure 47. Local political office in Airoli, Navi Mumbai

- Subhash (Social Worker in the local political office) (Fig 47)
    - Aware of the plus code project and its implementation but does not know how to use the codes.
    - Believes that camps and pieces of training should be conducted for more awareness about the project and its usage in the community.
    - Currently, there is a lack of coordination of addresses in government databases in the community and the same house is given multiple house numbers every time a new survey is conducted by the local government. The plus codes could act as a unified addressing system for the houses in official records.

Figure 48. Kavita V Tapase, a resident of the project site of SA in Airoli, Navi Mumbai with a plus code address plate on her door

- Kavita Vilas Tapase (Resident) (Fig 48)
    - 45 years old, female
    - There are 5 people in her house, 2 adults and 3 teenagers, and 4 smartphones.
    - She and her husband are high school graduates, and her kids are all currently enrolled in school.
    - They also have WiFi in their house, for which they pay Rs.600 (about $7) per month. They use it to access internet on the smartphones and a smart TV for education and entertainment purposes.
    - They use the plus codes as their digital address. Recently, they used it in their bank account application and had the passbook delivered to their doorstep. Earlier, they used to have to get their post delivered to a post-box at a nearby grocery store and some of the post would even get lost due to lack of reliability. With the plus codes, the delivery of documents has improved drastically.
    - She runs a home business for selling jewelry and uses phone apps to support her work. She uses google maps and Google Search, YouTube to search for information and learning videos and finding new products. She would like to learn how to sell her products online.
    - She finds the barrier to learning has been lowered through easy access to the internet on her smartphone which has brought her easy access to a world of information and learning.

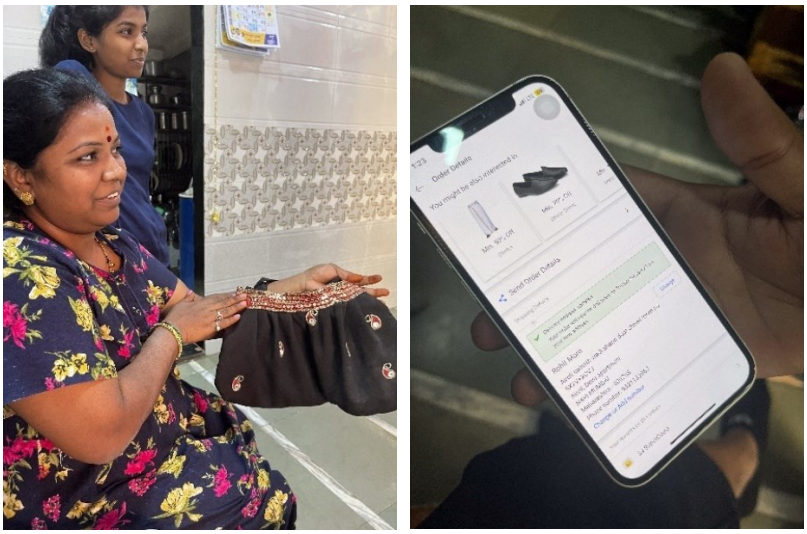


Figure 49. Pandya R More, a resident of the project site of SA in Airoli, Navi Mumbai (left), and a recent Amazon order she made using her plus code address for delivery (right).

- Pradnya Raju More (Resident) (Fig 49)
    - 38 years old, female
    - There are 5 people in her house, 3 adults and 2 kids, and 4 smartphones.

- She is a middle school dropout and her husband is an electrician, and her kids are all currently enrolled in school. She claims to have basic English proficiency.
- They also have Wi-Fi in their house.
- Her kids use the plus codes as their digital address for ordering goods online. They recently ordered shoes on Amazon using plus codes. They also use it to share their address with visiting relatives. Earlier they had to guide visitors using local landmarks but now sharing their house location has become much easier using plus codes.
- She runs a home business for sewing and uses her phone to coordinate orders and YouTube videos for learning new sewing techniques.
- Her children use smartphones for receiving school assignments on WhatsApp and Zoom for school meetings.

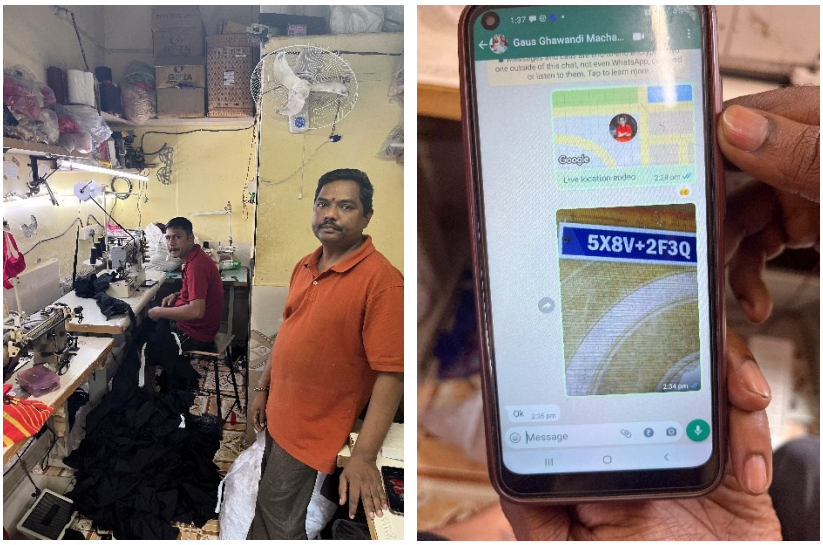


Figure 50. Shivraj K Mitra, a resident of the project site of SA in Airoli, Navi Mumbai (left), and a photo from his phone showing how he shares his business address with customers on WhatsApp (right).

- Shivraj Kashinath Mitra (Resident)
  - 42 years old, male
  - There are 4 people in his house, 2 adults and 2 kids, and 4 smartphones.
  - He is a middle school dropout and his wife is a high school graduate, and his kids are all currently enrolled in school.
  - They have a smart TV but no Wi-Fi in their house, they use a cellular data plan instead.
  - Her kids use the plus codes as their home address. He runs a wholesale sewing business from a workshop under his house and uses his digital address to coordinate deliveries and share his address with customers. He also uses it as an address for his Amazon and Flipkart orders.

- Phone apps he uses most frequently include WhatsApp, YouTube, Facebook, phone-pe, and google maps.

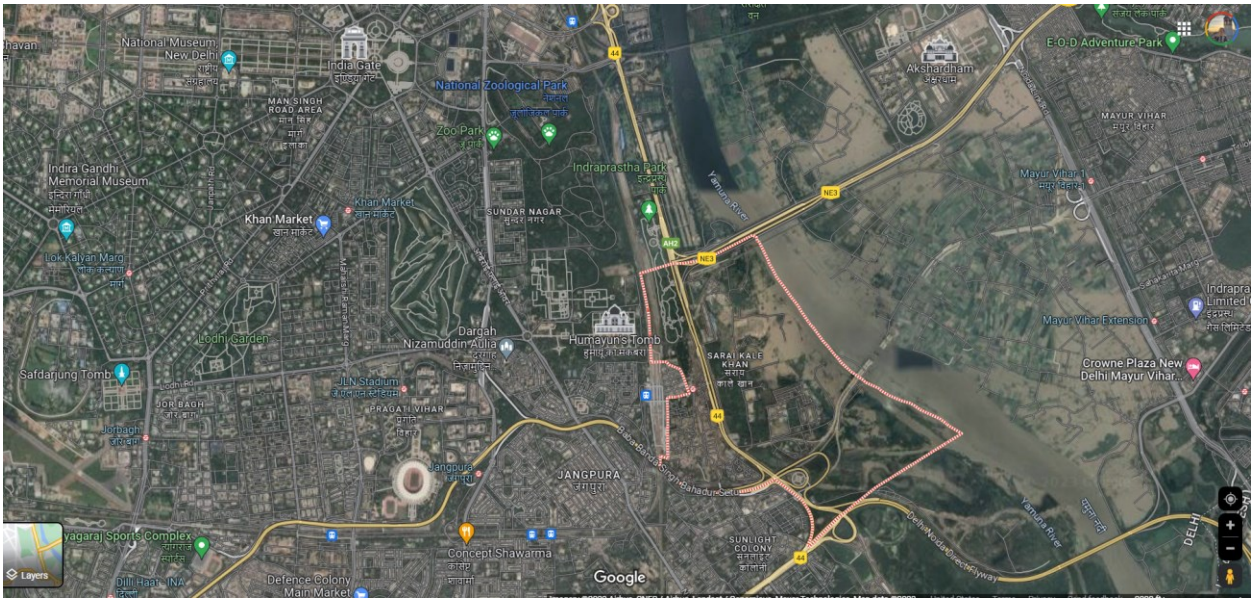


Figure 51. Location of Sarai Kale Khan, an urban village in Delhi and a project site for DEF's DLC

3g. Delhi: Digital Literacy Center at Sarai Kale Khan: 16 January 2023

- Project site for Digital Empowerment Foundation's Community Information Resource Center and Digital Learning Center.
- Located in, Sarai Kale Khan, an urban village in New Delhi, located inside a shipping container next to a night shelter and drug deaddiction center.

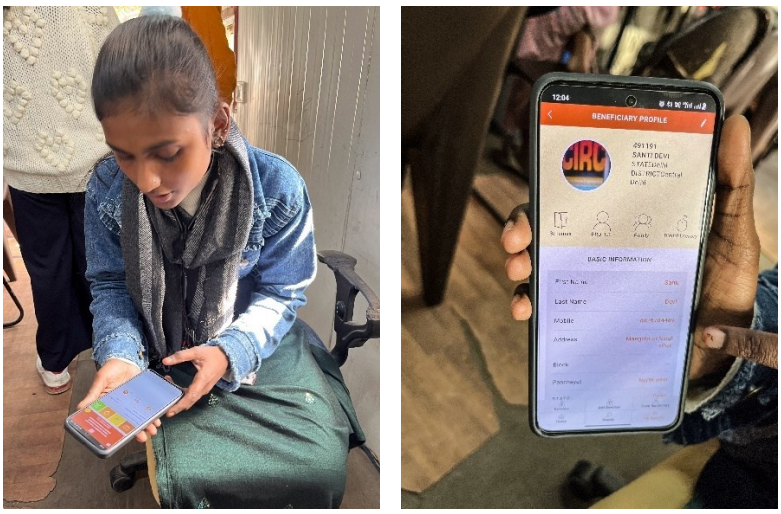


Figure 52. Sanower (left), DEF's Delhi District Coordinator explaining the Mera App (right) at the Sarai Kale Khan DLC

- Sanowar (District Coordinator for the Digital Empowerment Foundation (DEF) for New Delhi)
    - She looks over the operations of 2 DLCs and 2 Community Information Resource Centers (CIRCs) in Motibagh and Gazipur. She overlooks the enrolment of the beneficiaries at the various centers on DEF's Mera App (an inhouse app built for tracking beneficiaries), supporting the usage of Mera App at the centers, coordination of learning and training activities, conducting sessions for awareness about government welfare schemes available for residents.
    - The Sarai Kale Khan Center is a collaboration with another NGO, SPYN, located in a night shelter in an urban village in Southeast Delhi.
    - The digital literacy efforts at Sarai Kale Khan are focused on teaching DEF's basic curriculum (Startkit) for children and youth groups, and smartphone skills and online transactions for women groups. The center houses digital assets like computers, tablets, and printers and provides training and troubleshooting assistance for digital learning.
    - The Startkit includes 5 books: *Bhumi* (ground), *Ankur* (sprout), *Dahaliya* (stem), *Dhatu* (body), and *Titliya* (butterflies), based on the analogy of a growing plant.
    - Women's smartphone training is calibrated to their literacy levels. Women's availability can be challenging due to issues of time as many of them work as domestic helpers and rag pickers in the city.
    - The DEF's digital literacy curriculum covers basic usage of MS Word, MS Excel, MS Powerpoint, and Windows Paint supplemented by digital assignments and the advanced modules include internet surfing and smartphone usage.
    - Youth groups above 16 years are also trained for internet usage awareness, filling online forms for job and applications, resizing documents, etc
    - Sanowar has been working with DEF for 3 years. During this period, she has worked on the on-ground mobilization of the community members, which has been resolved in several areas with strong on-site presence through the setting up of digital literacy centers, collaboration with other NGOs working on-site on these efforts, and beneficiaries' word-of-mouth propagation.
    - Since the Sarai Kale Khan center is located in a night shelter, not a lot of the residents own smartphones but in most other centers, there is at least one shared smartphone per family.
    - A sample process of the smartphone training process:
        - Some of the most common apps they train for are online payment apps like phone pe and google pay.
        - They help the trainee create an id, find their bank account
        - Many of the residents now have a bank account because of enrollment in the government's Jan Dhan scheme (a social welfare scheme for minimum wage assistance), but if they don't have an account they help

with bank account opening too with assistance from the Soochnapreneurship scheme)

- Some of the trainees have trust issues with using digital technology, especially for banking and payments.
- Without training, the residents are usually able to use smartphones for calling, WhatsApp, YouTube, and voice-based searches using google assistant.
- Through the training, they aim to build capacity for e-payments, online form filling, and e-learning like spoken English, assistance for school assignments, self-learning, etc.

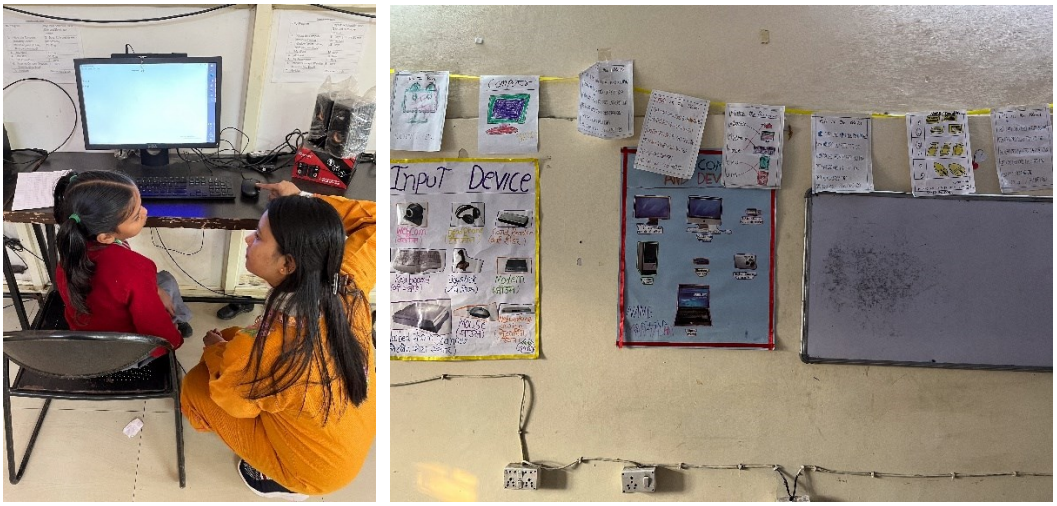


Figure 53. Shehnaz (left), DEF's Program Manager interacting with a beneficiary at DEF's Nizamuddin DLC(right)

- Shehnaz (Program Manager, DEF, Delhi)
  - Smartphones are very prevalent everywhere
  - COVID has created a big shift towards online services, including education, shopping, and entertainment
  - DEF was highly active during COVID and adopted to using Whatsapp and Zoom for coordinating work and conducting training, community group chats, and communication setup via Whatsapp
  - Digital literacy and Mobilization vans were deployed in certain states like Haryana for facilitating mobilization, access to govt schemes, registration for aadhar (national ID), and pan-cards (taxation records).
  - Soochnapreneur (SP) schemes have been successful in creating local access to id card registration and govt scheme delivery, saving travel and waiting times for beneficiaries in exchange for a small service fee. For instance, many villagers with access to local SP centers no longer have to spend the time and money to travel to cities.

- The SP model focuses on creating local stewardship by providing training and equipment to local SPs. If the SPs prove proficiency and create financial sustainability for the local center, they get ownership of the equipment and center assets, while getting continued support and training from DEF.
- DEF's main focus is on the accessibility of information technology by fostering digital literacy and social entrepreneurship programs through providing free training, IT equipment, and continued support and training.
- Local mobilization efforts have been crucial in the successful implementation and uptake of the programs.
- While discussing the positive impacts of internet connectivity on the residents' lives she shared the story of Babita, a SP who runs a center and shares her art and craft through her social media in the community. She has been recently recognized and awarded by the government for her creative work and she has been able to generate some additional income by providing creative services in her community (like application of henna in marriage functions).
- The SP at the Gazipur center, in an informal settlement with migrant residents, has benefitted from using a smartphone application for tracking accounts.
- Another focus at the CIRCs is financial literacy training for e-payments and transactions as residents usually find e-banking very challenging.
- They are also trying to use phones for improving access to healthcare by creating awareness around menstrual health, focusing on the participation of women groups.
- DEF is also supporting local schools without computer classes to provide setup for computer labs and training for the teachers.
- Trainers and other field coordinators are often procured from their network through recruitment using social media channels like Facebook. They also encourage beneficiaries who have gained proficiency to become future trainers and SPs, using a peer-to-peer learning model. Community center leads are mostly local people and are paid an incentive amount for mobilization of the local community.
- When approaching a new site, DEF attempts to find existing organizations to partner with, who are working on similar or related issues in the area to combine resources, impact, and outreach.
- CSR partnerships provide important support for their work, including funds, equipment, and furniture for the local centers. These include partners like Accenture, Microsoft, Amazon, and Google.

Figure 54. Salika (left), a teacher at DEF's Sarai Kale Khan DLC

- Salika (Trainer at the Sarai Kale Khan DLC)
    - She is a teacher of computer basics and teaches notepad, paint, and MS Word to the kids and learners at the center.
    - Some of the kids go to school and attend the 2.30 pm session while those who don't want to go to school or cannot afford to attend it come for the 11 am session
    - The lessons range from 30-60 minute sessions.
    - On Saturdays, she also conducts basic literacy training for teaching the alphabet, numbers, and cartoons as she said some of the 3rd and 4th graders do not even recognize the alphabet clearly. She also finds it very challenging to teach kids who do not go to school and thus do not know the basic alphabet and spellings.
    - Kids usually find paint applications very interesting.
    - DEF supports the provision of IT and training materials, conducts regular training, provides guidance, and conducts regular visits to the center every 3 months.

Figure 55. Kids at a computer class at the Sarai Kale Khan DLC

- Focus group with kids at the learning center
    - The kids ranged from ages 9-13 and were children of families living in the adjacent night shelter and from informal settlements around the shelter.
    - They were being trained in applications like Notepad, MS Powerpoint, and Paint.
    - They do not attend regular school but are enrolled in computer classes at the Sarai Kale Khan DLC for the morning 11 am classes.
    - Many of these kids were typing into the computer based on prompts and sample texts, some of them were typing into Notepad, some were creating drawings on paint, and another one was creating a slide on PowerPoint.
    - Upon talking to them, they said that they attended the classes thrice a week
    - Some of them struggled to understand the computer interface and basic options like open, save, files, etc fully. Their basic literacy and English proficiency were also somewhat challenged but they were able to complete the assignments on the computers with the teacher's assistance.

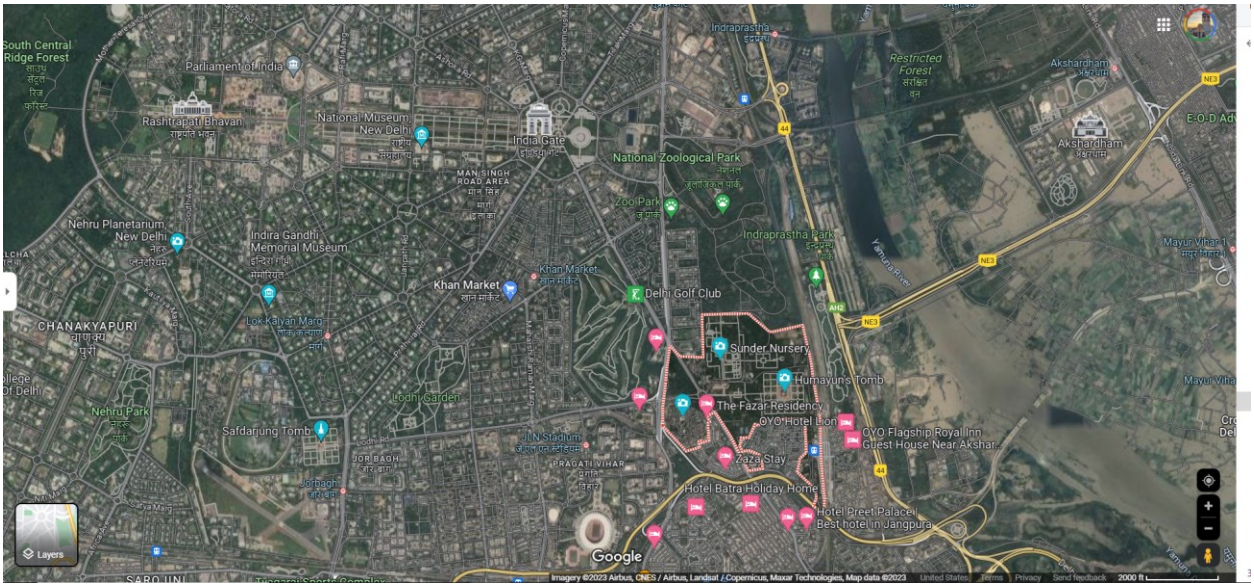


Figure 56. Location of the night shelter at Nizamuddin Basti in Delhi, a location for one of DEF's DLC

3h. Delhi: Digital Literacy Center at Nizamuddin Basti: 16 January 2023

- Project site for Digital Empowerment Foundation's DLC and SP Center
- Located in, the Nizamuddin Basti, an informal settlement in a crowded, busy neighborhood of narrow lanes lined with market stalls and tiny shops, known for two important historic sites in New Delhi.

Figure 57. Focus group with a group of beneficiaries (kids) and the teacher at DEF's Nizamuddin DLC

- Focus group with students and the teacher at the DLC
    - The children at the centers ranged from 8-14 years old and lived with their mothers at the night shelter in the Nizamuddin Basti.
    - They were completing assignments on MS Word, PowerPoint, and Excel guided by the teacher.
    - The teacher follows DEF's start kit syllabus and trains the kids on the basics of the various parts of the computer, typing a document in Word, making creative slides in Paint, making a resume in Word, etc.

- However, several of the kids do not have adequate English literacy. They were operating the computers based on a sense of visual placement of various components on the screen rather than understanding basic navigation features like open, close, save, etc. They were in many cases not able to understand the meaning of the text they were typing, which was very surprising. They often copied assignments, without much understanding of what they were doing.
- The teacher on the other hand seemed to be struggling with the lack of continuous attendance in classes, strict requirements by DEF, the literacy levels of the kids, and the support from their parents.

3i. Delhi: Digital Empowerment Foundation, Head Office at Hauz Khas, New Delhi: 17 January 2023

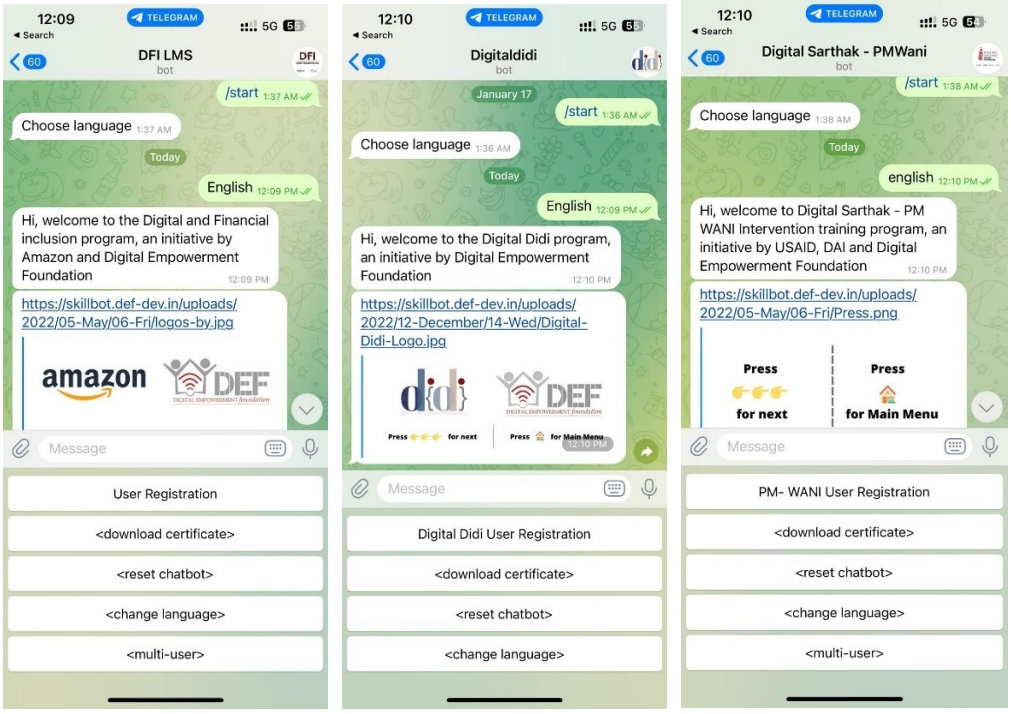


Figure 58. Screenshots of DEF's Telegram chatbots: DFI LMS (left), Digitaldidi (middle), Digital Sarthak (right)

Figure 59. DEF's Digital Learning START toolkit including learning tools like games and books.

- Shalini (Project and Curriculum Manager) and Anupriya (Program Officer)
    - Post-COVID and with Jio's infrastructural growth, internet access, and smartphone ownership have improved drastically. There are a lot of Internet and smartphone users.
    - Currently, 2 of the centers, Sarai Kale Khan and Nizamuddin are set up in partnership with SPYM.
    - In Gazipur a center located in an urban village with very poor migrant communities, the goal is to address digital and financial literacy and set up a STEM education hub. The current digital learning center there has about 15 computers and offers free education to the residents and their children.
    - 6 SP centers in Delhi currently: they charge for services like Photocopies, government services, ID card registrations, enrolling in government welfare schemes, and digital literacy initiatives.
    - These centers are run by people from the community who have been trained by DEF, often they run these centers from their homes. The SPs have fewer computers and fewer resources as compared to DLCs. Limited space availability and logistics pose major challenges at the SPs.
    - The DLCs are funded by various projects and CSRs.
    - DEF has built several publicly accessible smartphone apps to support its learning initiatives. These apps follow an edutainment approach for playful learning. These include skill-training chatbots, run on the Telegram app. Some of the chatbots are: Digital Sarthak- PMWani (to get information about government welfare schemes), Digitaldigi (a digital literacy resource hub), and DFI LMS (a financial literacy resource hub)
    - DEF also has a Start Kit, which is used for teaching digital literacy in the CIRCs and DLCs.

- She has observed that a lot of the students who do not have access to computers use smartphones and most of the students older than 15 years have smartphones. Smartphones have become an integral part of people's daily lives.
- However, she thinks that social media currently lacks privacy filters and users end up sharing too much data without being aware of it.
- When overseeing projects, she thinks the major challenges are program dropouts as the initial enrollments are promising but the stickiness is challenging.
- Important stakeholders in the DEF ecosystem include CRSs for funding support, Partner NGOs, Partner Government Organizations, Community Members, and District and State Coordinators.
- For SPs, the basic aim is to make them self-sufficient social entrepreneurs. In the initial stage, DEF provides them with logistical support through skills training, equipment, furniture, and service-based monetary support. The SPs are then encouraged to follow a business model where they charge the local communities small fees for the services they provide. Once the SP is financially independent, they transfer equipment ownership to the SP in charge and continue to provide training and troubleshooting support.
- For instance, the SP at Jangpura, a refugee settlement of the Afghan community, is a Microsoft-funded project. The focus here is on strengthening digital literacy, providing ID and photocopy services, and helping address citizenship issues.
- At Kalyanpuri, the SP also provides taxation help through pan-card enrollment services.
- The digital literacy centers have a focus on Digital + STEM education.
- All the centers are diverse, based on the needs of the local community, and in dynamic partnerships with local NGOs.

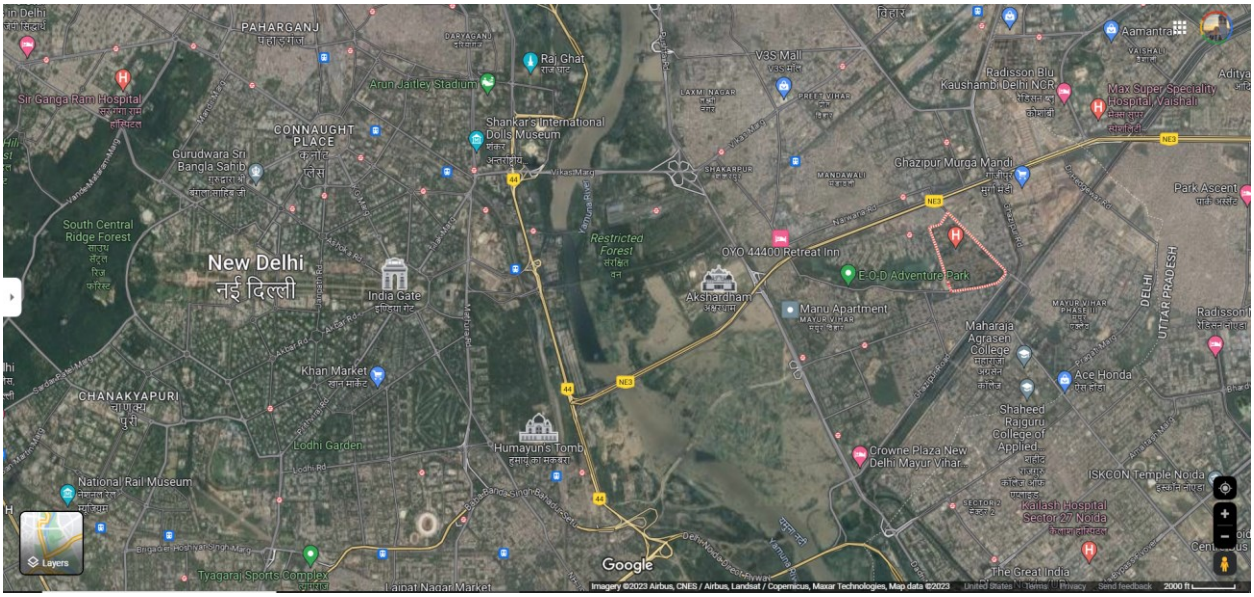


Figure 60. Location of DEF's SP Center in Kalyanpuri, Delhi

3j. Delhi: Social Entrepreneurship Center, Kalyanpuri: 17 January 2023

- Project site for Digital Empowerment Foundation's Soochanpreneur (social information entrepreneurship) Center
- Located in, Kalyanpuri, an informal settlement in Eastern Delhi

Figure 61. Interactions with one of DEF's SP's Aarti and her students (left), at her SP center in Kalyanpuri, Delhi

- Aarti (Soochanpreneur and Tutor)
    - Teaches kids after school up until 12th grade kids for all subjects including computer training and runs an SP center from the same shop.
    - In the mornings, she provides photocopying, PAN card, certification, admission applications, aadhar card registration, booking appointments, and basic online banking services to local community members at a small fee. Uses DEF's Mera App to track beneficiaries and customers.

- In the afternoons and evenings, she teaches the kids. She was trained by DEF in Gazipur after they found she had prior experience in teaching kids. Then they supported her becoming an SP in Kalyanpuri, about 8 months ago.
- She has found that many of the government school kids that study under her struggle with basic Hindi and English proficiency, even kids in 8 and 9th grade. Many of their parents are low-income earners with low education levels.
- She is also actively involved in the local women's groups, attends their meetings, and teaches women how to use smartphones. For such women, the focus is on teaching financial literacy skills, calling and messaging using WhatsApp, and voice-based searches on smartphones using Google Assistant.
- Some of the challenges in running the center are financial sustenance, small space, and very limited availability of computer systems. Although she is highly motivated and finds her work very satisfying, she needs more financial support to run her center. DEF has been supporting her by providing entrepreneurship training and teaching support.

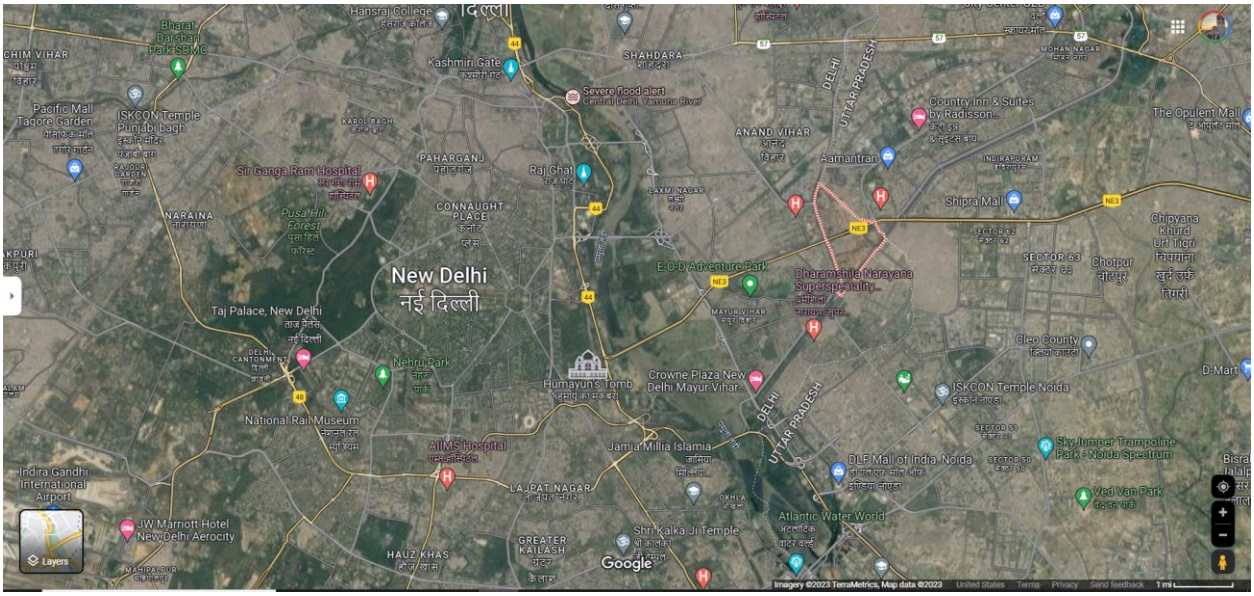


Figure 62. Location of DEF's DLC in a migrant community informal settlement in Gazipur, Delhi

3k. Delhi: Digital Literacy Center, Ghazipur: 17 January 2023

- Project site for Digital Empowerment Foundation's Community Information Resource Center and Digital Learning Center along with Shakti foundation's basic literacy center.
- Located in, Gazipur, an urban village in Eastern Delhi, and is home to a large population of migrant communities.

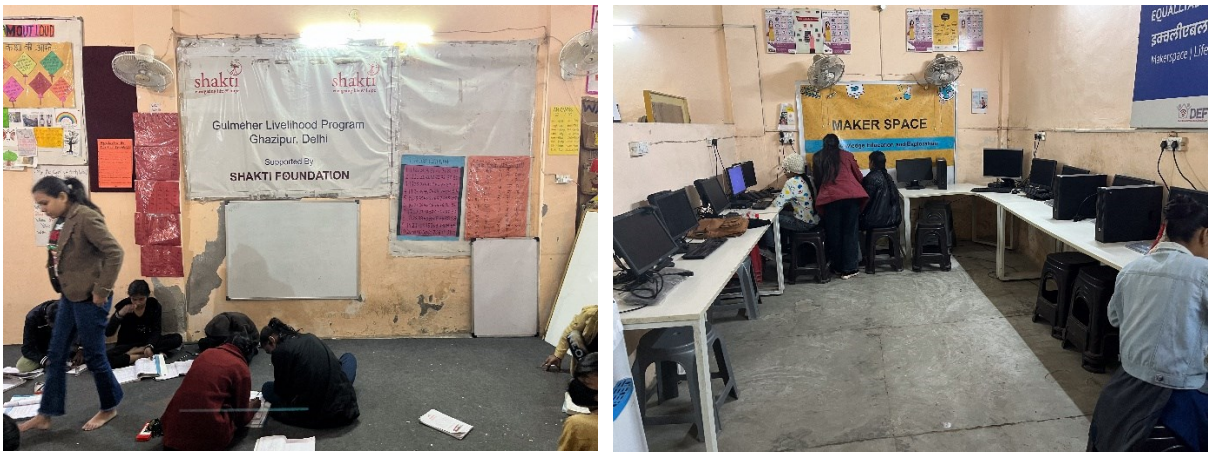


Figure 63. The teacher with her students at the Gazipur DLC

- Anonymous (Teacher)
    - About 60% of students have access to a smartphone and 11% to computers
    - 250 enrollments at the center, including older men and women students who are eager to learn new technology.
    - The center is DEF's largest DLC in the city and the complex also houses a basic literacy program run by a partner NGO.
    - When chatting with one of the students at the center, she said she was able to use Word on her mother's smartphone and apply the skills she was learning at the center to complete her school assignments.

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