EPiC Series in Education Science
Volume 6, 2024, Pages 106–116
Proceedings of the NEMISA Digital Skills Summit and Colloquium 2024

Insights gained from smartphone logging data collection

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Abstract

The growth of digital technology usage by governments and societies has opened opportunities and new research within the digital space. It has become imperative to better understand the accessibility and utilisation of available digital technologies by all communities. This phenomenon is called digital inclusion, and we will be using smartphones as our digital tool. There is no known study of digital inclusion that links perceived and actual smartphone behaviour in South Africa. Our study aims to explore the benefits of linking perceived and actual smartphone behaviour in a digital inclusion study in South Africa. We conducted an initial study to ensure the technical aspects of the data collection tool before we executed the official pilot study. This study will share interesting smartphone usage insights measured by the mobileDNA application, which was used for the first time in a South African context. We will report on difficulties encountered, successes achieved, and proposed improvements to enhance the data collection for future studies to enhance digital inclusion in a South African context.

1. Background

Digital inclusion are initiatives that ensure everyone has meaningful access to digital technologies and the necessary skills to use those digital technologies (Reisdorf & Rhinesmith, 2020). We have seen a growth in digital technologies all over the world, and they have become crucial in many industries and our everyday lives. We now need digital technologies for almost everything, like paying for services, buying food, and a whole lot more. Hence, it is of utmost importance to determine if people have access to these digital technologies. We will be conducting a digital inclusion study by linking perceived and actual smartphone behaviour in South Africa. Before conducting our study, we need to first evaluate our data collection tool.

Western Cape Colab is an e-Inclusion (digital inclusion) and the social innovation laboratory affiliated with National Electronic Media Institute of South Africa (NEMISA). NEMISA aims to equip South African citizens with digital skills and capabilities for the Fourth Industrial Revolution. To achieve this goal, research on digital inclusion in South Africa is required, and Western Cape Colab will collaborate with Ghent University in Belgium to conduct this research. The statistical analysis will be conducted by the candidate registered at the Department of Statistics and Population Studies at the University of Western Cape and Ghent University. Interuniversity Microelectronics Centre (IMEC) is a research and development institution that aims to bridge the gap between research and industry in nanoelectronics and digital technologies. Media, Innovation, and Communication Technologies is an interdisciplinary research group at Ghent University, affiliated with the Departments of Communication Science, Industrial Systems Engineering, and Product Design, as well as IMEC (known as imec-mict-UGent). imec-mict-UGent has been conducting research on digital inclusion annually through the well-known Digimeter survey in Flanders. The Digimeter survey is an annual survey conducted in Flanders, a region in Belgium, with approximately 1500 Flemish respondents each year. The primary purpose of the IMEC digimeter study is to track developing media and information, communication, and technology (ICT) trends. These trends and insights can assist small businesses, large corporations, and governments in improving their ICTs.

We will be using the application mobileDNA as one of our data collection tools for our study. mobileDNA is a smartphone tracking application developed by the imec-mict-UGent research group in Belgium that collects smartphone logging data. This application will be used for the first time in South Africa, and the aim of this research is to evaluate the technical aspects of mobileDNA in the South African context and report on insights and difficulties in collecting smartphone logging data.

2. Literature review

2.1 Digital access

Digital access is defined as the ability to fully engage in the digital world. Full participation includes having access to digital technologies as well as the ability to effectively use these devices (Van Dijk, 2017).

According to Statistics South Africa (2021), 90.8% of South African households only use mobile phones, and the Western Cape has the highest proportion of landlines, namely, 1.1 percent. In South Africa, approximately 50% of mobile phones are smartphones which means they have advanced features and internet connectivity (ICASA, 2023).

Approximately 80% of South African households have internet access, either at home or elsewhere (Statistics South Africa, 2021), with the Western Cape having the most internet access (89.1%) anywhere compared to other provinces. Most (69.4%) South African citizens have access to the internet via mobile phone (Statistics South Africa, 2021), which has resulted in an increase in prepaid mobile data revenue and a decrease in voice prepaid revenue (ICASA, 2023). According to Statistics South Africa (2021), 10.4% of South African households have access to the internet at home.

2.2 Digital Literacy

Kass-Hanna and co-research (2022) outlined the importance of digital financial literacy focusing on South Asia and Sub-Saharan countries. The rapid growth in the Fintech industry was influenced by the increase in the number of people in the world owning mobile phones. Hence it is important for financial institution to teach global citizen about Fintech.

Masenya (2021) examined the significance of digital literacy in South African Higher Education Institutes. Literature was gathered from many sources, and it was discovered that a lack of digital technology and mobile devices by students were some of the variables affecting digital literacy at South African Higher Education Institutes. Although 90 percent of households in South Africa have mobile phones, some individuals in the household may not have access to a mobile phone (Statistics South Africa, 2021), which is why (Masenya, 2021) reported some students without mobile phones.

Pade-Khene (2018) examined how the government and citizens can interact through digital technology and why it is critical for South African citizens to become digital citizens. He suggests that the government should teach its residents about digital literacy, which can be accomplished by employing the Quadruple-E approach, which implies explore, enable, engage, and embed.

2.3 Digital Inclusion

Asmar and co-researchers (2020) suggest that social support can play a significant role in digital inclusion and defined social support for digital inclusion by helping digitally excluded individuals receive education on digital technologies by persons close to them. Keating and co-researchers (2022) looked at the social support of women in South Africa, and it was discovered from this study that social support can play an important role in digital inclusion as one member of the household with a mobile phone can teach other family members how to use a mobile phone, this can lead to a decrease in number of citizens that are digitally excluded.

Basdevant and co-researchers (2012) examined inequities in Southern African countries and the strategies put in place to address them. There are three major challenges that inequalities can pose to the country's growth: first, inequalities can cause market imperfections because the poor have limited resources (economic resources) to invest; second, inequalities can affect the country's political system because the government must redistribute resources to the poor ensuring all citizens have equal access to resources, which can discourage investments; and finally, inequalities can lead to an increase in low-skilled workers (Basdevant et al., 2012).

Basdevant and co-researchers (2012) detailed key findings that can help Southern African countries address inequality. Firstly Basdevant says that reducing income inequalities can have a good impact on the country's growth; secondly, putting in place the correct policies is the most effective strategy to minimise inequalities and assist the country to thrive. The goal of this research is to eliminate inequities in the usage of digital technologies in South Africa. In South Africa, policies such as the National Integrated ICT Policy have been implemented to combat digital inequality. Chapter 10 of the National Integrated ICT Policy, named A Digital Society will be of importance in this study. (Department of Telecommunications and Postal Services, 2016) identified three key pillars that will help South Africans become digital citizens: digital transformation of government, digital access, and digital inclusion.

2.4 Smartphone logging data

One of the challenges in collecting smartphone logging data is that collection using the mobileDNA application is limited to Android smartphones which reduces the potential pool of participants in the study. Johannes et al. (2021) suggested the use of reimbursements to increase the number of participants in their studies conducted on smartphone logging data. They explored the relationship between online vigilance and affective well-being in everyday life by linking smartphone logging with a survey. The study had 75 participants and found that online vigilance does not sufficiently affect the everyday well-being of the participants.

Ahlström looked at smartphone usage in traffic by linking driving data, surveillance camera images, smartphone logging data and survey results. Ahlström et al. (2020) found that smartphone logging data complemented other data collection tools in exploring smartphone usage of drivers in the traffic.

The use of smartphone logging data can lead to the collection of rich data; however, researchers must guarantee that the application used to collect this data captures the actual event (Pieterse et al., 2018). Pieterse et al. (2018) further suggested that researchers need to evaluate the application used to collect the smartphone logging data and make sure smartphone logging data is authenticated before analysing the data and drawing conclusion from it.

These views in the literature led to the technical test of our mobileDNA application. The mobileDNA application captures smartphone logging data such as the name of application used, time spent on application, global positioning system (GPS) location information, battery level, type of device, and type of network used. This application gives Android smartphone users insights into their smartphone use.

3. The research objectives

The focus of this study will be analysing the smartphone logging data collected by the mobileDNA application.

The following are the research problems and hypotheses:

- Uncover the technical issues with mobileDNA application if any;
- Determine if mobileDNA captures smartphone logging data during load shedding; and
- If mobileDNA does capture smartphone logging data during load shedding, explore smartphone usage during load shedding and compare this to times during which there was no load shedding.

4. Methodology

4.1 Data

The mobileDNA application was used to collect the smartphone logging data of six second year statistical science students. The students were asked to stay on the mobileDNA application for a period of two weeks. We also used EskomSePush (ESP) load shedding stages data and the load shedding schedule of all the suburbs in the City of Cape (Herman & Dan, 2023).

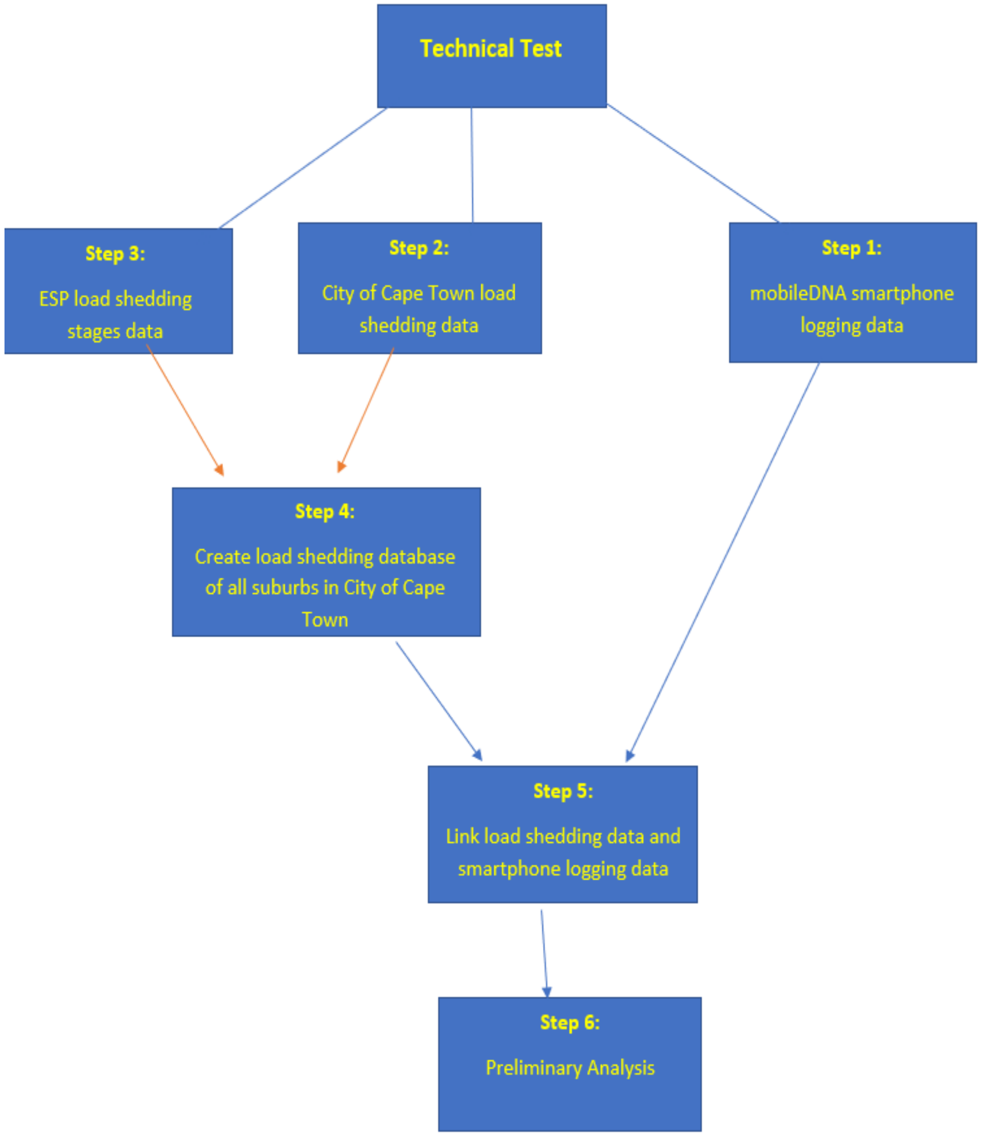

Figure 1: Flow chart of methodology

Figure 1 gives a summary of the methodology that was used for this technical test. The first step was to collect the smartphone logging data of the participants using mobileDNA application. The next step involved the use of the application EskomSePush (ESP) load shedding stages data created by Herman & Dan (2023) and the City of Cape Town load shedding data to create a database of load shedding periods for all suburbs in City of Cape Town, for all the load shedding days (City of Cape Town, 2023). The link was then created between the ESP load shedding stages, the City of Cape Town load shedding database and smartphone logging data collected by the mobileDNA application. This enabled an accurate exploratory analysis of how people use their smartphone during load shedding and during non-load shedding periods through visualisation.

The creation of the City of Cape Town load shedding database, data preparation of mobileDNA smartphone logging data and visualisations will all be done using Python version 3.10.

5. Results

We can observe from Figure 2 that the battery level of user 5 on the 12th of October 2023, one hour before the second load shedding period, was low (less than 20 percent). Although the battery was low one hour before the second load shedding period the user still used their smartphone. User 5 used applications such as WhatsApp, Google Drive, Gmail and TikTok during this load shedding period.

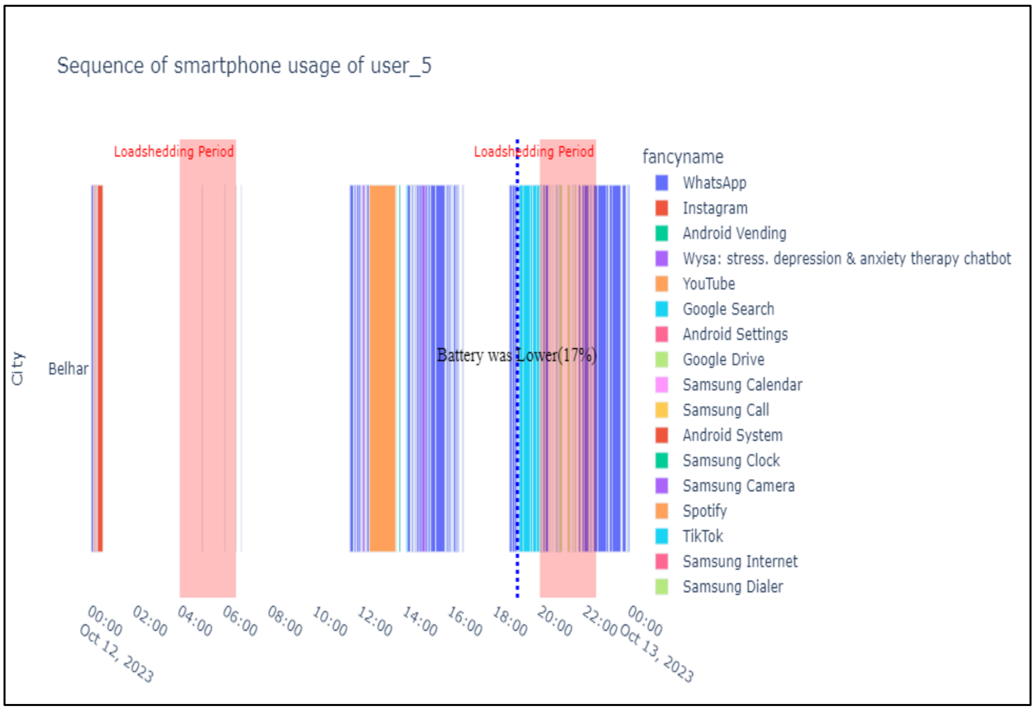

Figure 2: Sequence of smartphone usage during load shedding of user 5 on the 12th of October 2023

Figure 3 shows that the applications used during the second load shedding period for user 1 are WhatsApp, Facebook, Messenger and Music Player. We can also observe from

Figure 3 that the battery level was in the middle (between 40 and 60 percent) an hour before the second period of load shedding. During the first period of load shedding user 1 only used one application, namely, Samsung Clock.

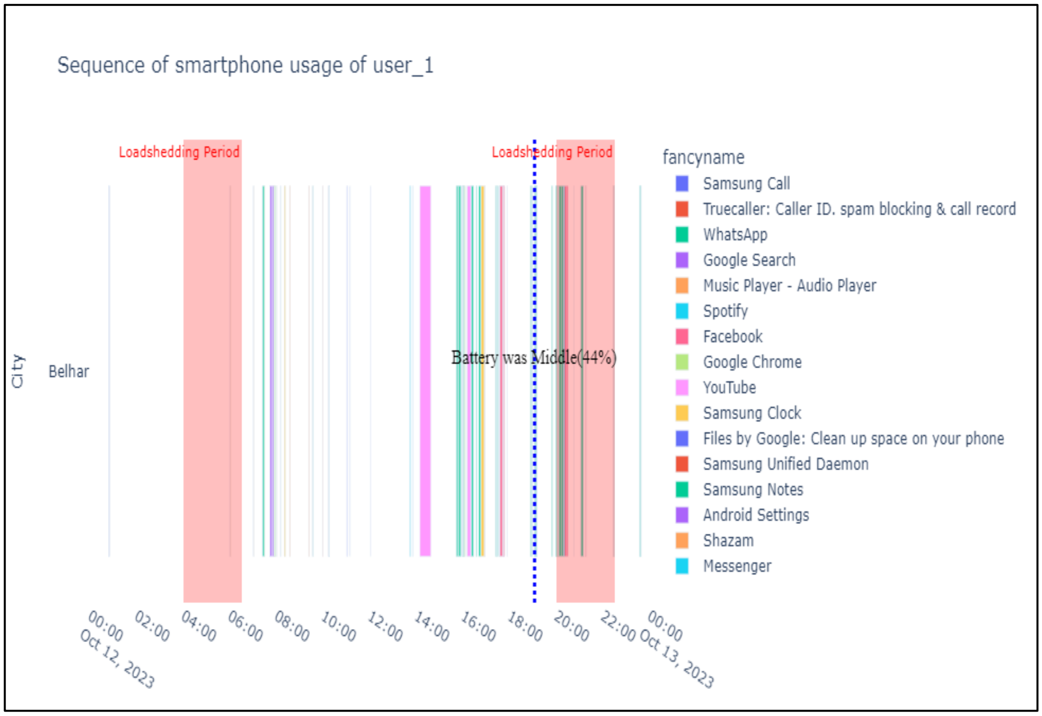

Figure 3: Sequence of smartphone usage during load shedding of user 1 on the 12th of October 2023

We can observe from Figure 4 that on average user 5 used the WhatsApp application the most when compared to other applications. We can also observe that less time was spent on WhatsApp during load shedding periods compared to outside load shedding periods. YouTube, Wysa, Samsung Clock and Instagram applications were only used outside the load shedding periods.

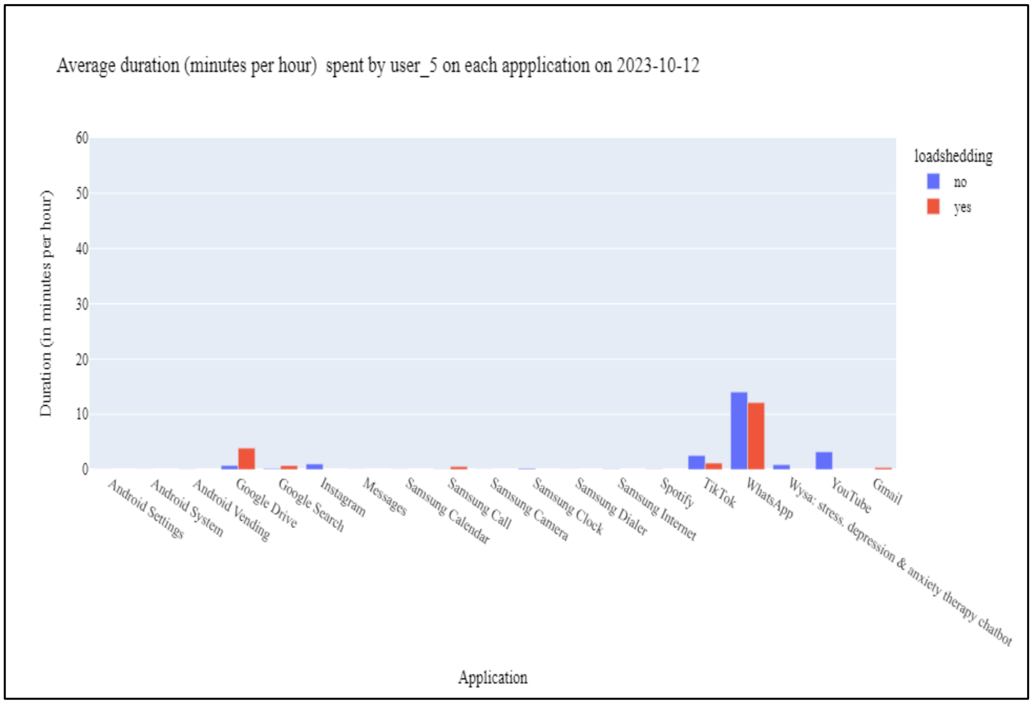

Figure 4: Average duration per hour for each application of user 5 on the 12th of October 2023 during load shedding periods and outside the load shedding periods

Figure 5 shows that on average WhatsApp was the most used application per hour during load shedding periods compared to outside load shedding periods. We can also observe that user 5 spent more time on Facebook during load shedding periods compared to outside load shedding periods. Messenger was only used during load shedding periods for an average duration of 1.84 minutes per hour.

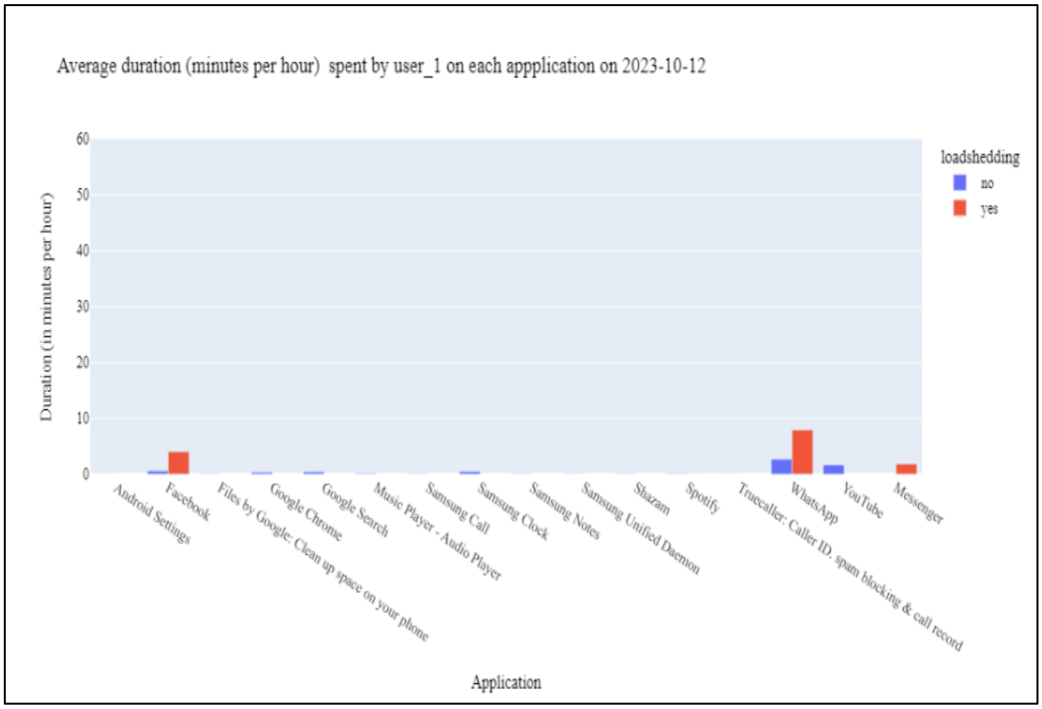

Figure 5: Average duration per hour for each application of user 1 on the 12th of October 2023 during load shedding periods and outside the load shedding periods

Table 1: Summary of smartphone usage from 12th September to 22nd of October 2023 during load shedding and no load shedding days

User	Number of load shedding days	Number of no-load shedding days	Average number of applications used during load shedding day	Average number of applications used on no load shedding day	Total time spent on smartphone on load shedding days (minutes)	Total time spent on smartphone on no load shedding days (minutes)	Average time spent on smartphone used on load shedding day (minutes per day)	Average time spent on smartphone used during on no load shedding day (minutes per day)
user 1	5	2	14	8	1385.122	143.830	277.025	71.915
user 2	2	0	8	0	112.730	0	56.365	0
user 3	1	0	1	0	4.0400	0	4.040	0
user 4	1	1	18	8	385.4807	109.179	385.481	109.178
user 5	5	2	15	18	3941.338	2834.201	437.927	566.840
user 6	1	0	14	0	49.0324	0	49.032	0

We can observe from Table 1 that user 5 used his/her smartphone more than user 1. We can also observe that more time was spent on average on no load shedding days than load shedding days for user 5. For all the other users the average time spent on their smartphone was more on load shedding days compared to no load shedding days.

6. Discussion

During our technical test, the mobileDNA application could not be installed for the latest Android smartphone versions; hence, participants who had latest Android version (Android 12 and up) could not enroll for mobileDNA. This led to a decrease in the pool of participants who enrolled in mobileDNA.

Because it was the first time the mobileDNA application was used in South Africa we were interested in whether smartphone logging data was captured during load shedding. We discovered that indeed mobileDNA captures the participants smartphone logging data during load shedding. Load shedding can sometimes affect the mobile network, if there is no mobile network the information is temporarily stored on the smartphone and then uploaded to mobileDNA server when the network is stable again.

The mobileDNA application has a manual button that users need to switch on to allow the application to track the smartphone logging details after installing the application. We discovered that for some smartphone brands, such as Huawei, the enable button switches off from time to time and the user needs to manually switch it on again. This resulted in data not being collected for long periods, which can have an effect when aggregating the data and misleading conclusions can be drawn.

We discovered that keeping participants on the mobileDNA for the whole duration of the study was challenging. We are considering various options to encourage participants to stay on the application for the specified period.

We found that by successfully linking the load shedding and mobileDNA logging data, insightful results were obtained, and these can aid the study of digital inclusion in South Africa. We will explore this aspect further in our pilot study.

7. Conclusion and recommendations

We have seen in the Results from the technical test, that linking mobileDNA smartphone logging data and load shedding data, can provide interesting insights that can be further explored in our pilot study.

Before we can conduct our pilot study, technical improvements are needed on the mobileDNA. We suggest that the mobileDNA application be updated to be installed on newer versions of Android smartphones. This will increase the pool of participants that can be recruited to enroll in mobileDNA. We further suggest that the mobileDNA enable button needs to be changed from manual to automatic, to ensure that the data of all the days for the specified period is captured. Capturing the smartphone logging data for the entire duration of the study for all users, will ensure more accurate conclusions from aggregated data.

We aim to recruit approximately 50 participants for our pilot study. The requirement will be for participants to enroll in both survey and mobileDNA applications. To reach our target number of participants for the pilot study and keep the participants on the mobileDNA for the required period, some motivation needs to be given to the participants. Reimbursement incentives can be one of the solutions.

A comprehensive research paper will be drafted for our pilot study and will include the complete methodology employed, literature review and insights that can aid in the development of the first South African digital inclusion framework.

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