



Working Paper

Using Smart Phones to Monitor Attendance in Public Facilities

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Executive Summary

Attendance Monitoring through Smart Phone Technology aims to address the problem of absenteeism in public schools, health facilities and other services that is prevalent in many developing countries. The premise of this intervention is based on finding a cost and process efficient technological system that would accurately monitor attendance, thereby providing an alternative quality check and balance system, which will in turn lead to an increase in the overall productivity of public institutions across the country.

We deployed an automatic attendance monitoring system based on a unique identification system that can either be face, voice or fingerprint recognition. This report records the progress made in this project since its inception. Our explorations suggest that face recognition through smart phones is the most viable solution for attendance monitoring.

We piloted this methodology in the field, where we provided smart phones to staff members of public schools and health facilities of Sheikhpura and Gujranwala to capture photos for recording attendance. Technological impediments faced while finding a cost effective voice and fingerprint recognition solution have also been documented. We show that using smartphones for attendance monitoring is feasible for creating a strong deterrent against absenteeism. However, there are several social, cultural and technological impediments that have to be given adequate consideration during any rollout of such technology.

Overview

A vital aspect of improvement of service in public facilities is the regular attendance of its staff members. It is a key indicator in ensuring that basic level of services are being provided by the facility; be it a school, hospital or any other government service organization. Currently, in majority of the facilities across Pakistan, attendance is recorded on paper, and maintained in file folders or registers. This process only serves as a basic deterrent to staff members, and is susceptible to forgery, which raises questions regarding its authenticity. To counter this problem, people based systems, involving an additional hierarchical structure of accountability, have been deployed and tested as an alternative but with limited success. Conversely, they have only resulted in an additional financial constraint of staff employment without achieving the desired objectives. Given these roadblocks and the massive scale at which public facilities are functioning in Pakistan (over 27000 public schools only are operating in the province of KPK alone), developing effective mechanisms for monitoring attendance is a significant challenge.

In this context, contemporary technology can be utilized to monitor and increase staff presence in public facilities. Recent technological strides have made it possible to produce exciting, innovative and cost effective ideas to counter the problem of absenteeism in public facilities. One possible solution within the technological realm is through the use of low-end smart phones, coupled with a custom made mobile application that utilizes unique identification methods that can be captured through a smart phone. We experimented with face, voice and fingerprint recognition. The data generated, in terms of pictures, fingerprints and voice notes, can then be viewed by an administrator via a dashboard that generates analytics for comparative analysis across a particular region.

This study documents different aspects of developing an attendance monitoring system within the aforementioned context. It contains the information regarding key achievements and impediments related to the development of a robust attendance monitoring system. We have been successful in the development and adaptation of a face recognition system for attendance. Pilot testing of this scheme and its results show its potential as an alternative check and balance system.

We piloted our attendance monitoring solution first in ten public schools in Sheikhpura district, and are currently in the process of deploying it in all ninety-three Basic Health Units of Gujranwala. This is in coordination with the respective District Coordinate Officers of these areas and their teams. For fingerprint and voice recognition, we encountered several technological hindrances that limited their usability relatively as a cellular attendance monitoring method. These problems have been detailed for readers opting to pursue these ideas for further development and exploration.

How can technology help?

Callen et al. (2013) recognized that technology might be used effectively to improve 'Monitoring of Monitors' at public health facilities, which can address misreporting of absence and increase employee presence at facilities. In this study, use of technology – previously used to monitor supervisory field visits only – is extended to daily attendance protocols. A technological intervention through the use of smart phones can allow for documentation of attendance through an automated process, making staff supervision effective, which in turn can increase the overall efficiency of public sector facilities. Our aim is to evolve attendance collection practices, which is achieved by developing accurate modes of verification that are distinct for every individual.

Currently, attendance is marked in registers present inside facilities. Entry and exit times are unreliable and non verifiable. Moreover, transferring registers holding attendance records is an inefficient and highly time consuming process, making it difficult for administrators to access it from separate offices, in case they want to check compliance of staff members themselves.

Marking attendance using smart phones can solve these problems. The recent surge in low-end smart phones, with enhanced technological capabilities; make them an ideal source for monitoring practices. Attendance marked through these phones can then be transferred over the Internet to a central server. A dashboard present on the central server can allow easy access of attendance figures to higher officials.

But how can the attendance data be verified? A simple application that records attendance on mobile phone can fall prey to similar types of forgeries that exist in keeping attendance file records. For accurate verification, it is necessary to record a unique identification of the individual. In our case, we explored three possibilities of voice, fingerprint and face recognition.

Voice or Speaker Recognition

Voice or Speaker recognition has recently gained traction and is being used for authentication of customers and users in large corporations. For instance, Nuance Communications (MA, USA) has developed a system for Barclay Wealth for identity verification of a customer over a phone call. In our case, we tried to replicate a similar system that makes use of voice biometrics to mark attendance of staff at government facilities.

In order to verify that the marked attendance is accurate, a voice sample of each employee needs to be collected along with the reported attendance. This is then recognized against the stored library of recordings for the same individual. As the number of voice recordings against each person increases, the accuracy of the voice recognition system also typically increases.

We explored this technology by implementing a Speaker Recognition algorithm. Voice samples from four different people were collected. These voice samples were taken in varying environments, ranging from extremely noisy to silent.

To verify this speech, an algorithm was developed that provided a verified output based on a probabilistic model. Almost 65% accuracy was achieved through this methodology. However, there were considerable issues that hampered verification process through voice detection, which are discussed below.

Challenges of using speaker recognition

Noise

Noise is the biggest source of error in speaker recognition systems. Even the best available speaker recognition systems make errors in noisy environments. This challenge is usually taken care of by using the systems in quiet surroundings.

Microphone Position

Speaker recognition works best if the microphone is close to the user. Distant microphones (e.g. on a table or wall) result in increased error rates. This can also be resolved by providing high quality microphones and ensuring that speaker is as near to the microphone as possible.

Room Acoustics

Sound waves reflect from hard surfaces. The microphone can catch multipath signals from the walls and other objects in a room thus adding delayed signals to the original voice sample, hence reducing the quality of the original data.

Emotional States/Sickness/Aging

These factors are linked to the speaker. In a situation when the speaker is in an abnormal emotional state, the recognition might not provide correct verification. In a similar case, if he is suffering from a sore throat, his voice sample might not match with the actual sample, thus leading to erroneous results.

Faking Voices Using Recorders

One of the potential risks is that there may be attempts to trick the system through voice recorders. However, a very high quality voice recorders would be required to successfully trick a voice recognition system. Normal voice recorders available in the market are unable to record the complete voice spectrum, and generate

enough distortions for the signal to be recognized as a different person.

Voice or Speaker Recognition work well only in specialized settings. These technology limitations restrict their use in our context, which is particularly challenging in terms of accuracy requirements and range of use.

Fingerprint Recognition

Fingerprint recognition is a popular form of biometric verification used to identify individuals. This technology makes use of a fingerprint scanner, which scans the finger and is connected to a low-end Android phone. The phone then transfers the fingerprint scan to a server. The fingerprint is then confirmed by the system and the attendance is thereafter recorded. The employees at a facility would mark their attendance by scanning their fingerprints every day. The fingerprints would then be stored and processed at the facility and the attendance figures would be sent to the central server.

In order to use fingerprint verification in attendance with a smart phone, a fingerprint device is needed. The smart phone needs to support USB OTG (USB On-The-Go). USB OTG is a specification in smartphones that allows external USB based devices such as hard drives and cameras to be attached to them. This specification is not available in low-end smartphones. Moreover, in order to power the fingerprint device, an external power supply is needed since a smart phone's battery is not powerful enough to handle external devices such as those used for fingerprint verification. The process to verify attendance through fingerprint verification therefore involves more than a single device. (Figure 1)

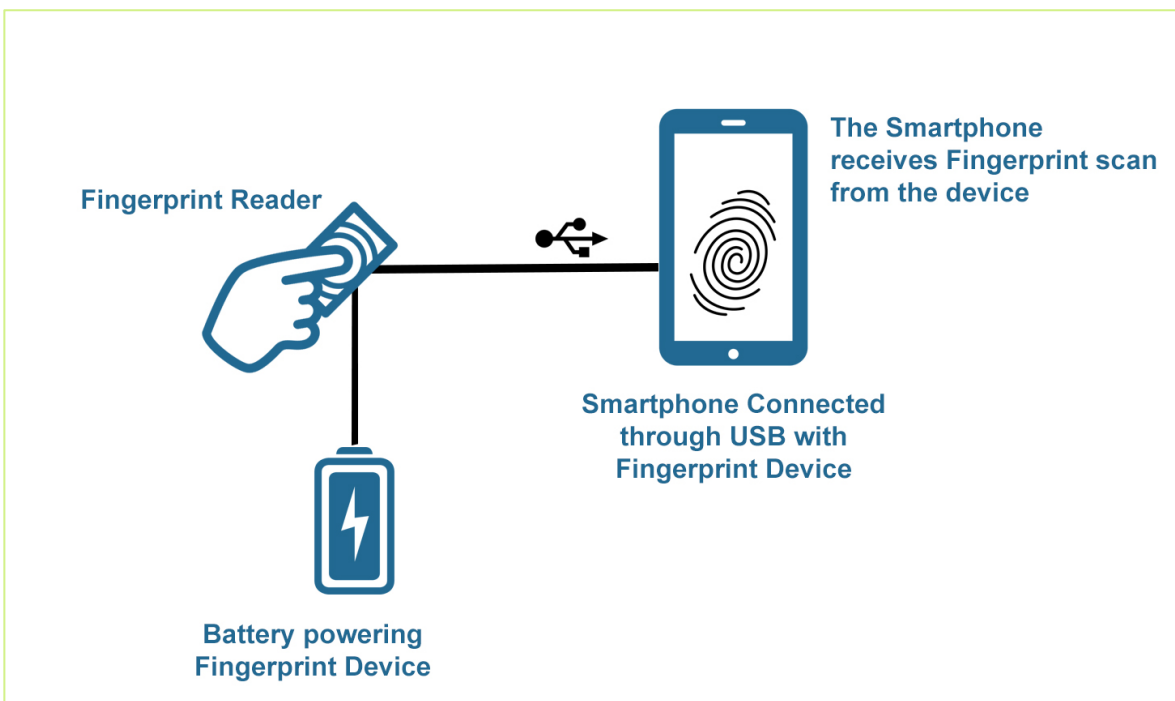


FIGURE 1 - OTG USB BASED FINGERPRINT SYSTEM

In order to replace the need for OTG USB supported smart phone, a Bluetooth fingerprint scanner can be used. Both these hardware flows are illustrated below. Bluetooth enabled fingerprint scanners usually have their own internal battery, and therefore there is no need to have a USB powered battery pack. (Figure 2)

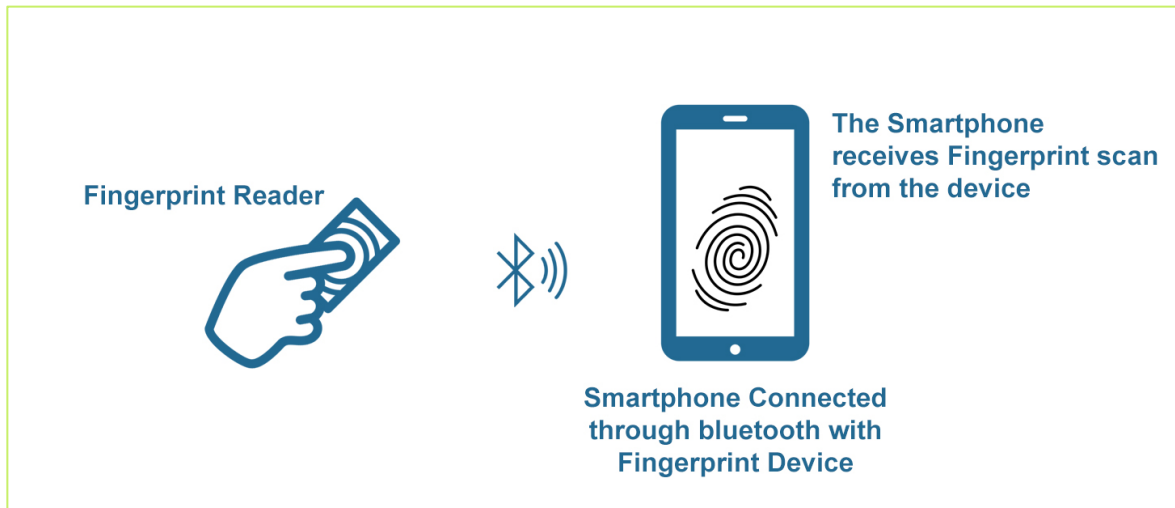


FIGURE 2 - BLUETOOTH BASED FINGERPRINT SYSTEM

One of the major advantages of using fingerprint is the small size of the data that needs to be transmitted over the network, which is typically around 1KB (even less than that in some cases). The results it produces are much more accurate than other biometric technologies that are contingent on external environmental factors. For example Face Recognition and Voice Recognition are dependent on external lighting conditions and background noise respectively. However, the technology is much more expensive in contrast to face and voice recognition. Two devices are required, a finger printing scanner and a phone, which is why the cost of this method increases significantly. It is also more intrusive and time consuming, as it requires each and every person to scan his or her fingers individually. Compared to that, through face recognition, one photo is able to mark the attendance of 10 people at a time. Some people might also resist this technology as it is closely related to criminal identification.

Despite the disadvantages, given the accurate results of fingerprint recognition, it is still a vital technology that can be deployed in practical scenarios.

Fingerprint options

Our discussion with one of the leading Cellular providers in Pakistan, Ufone, made us discover a few combinations they had tested for finger print reporting. The cellular company uses this technology for verification while handing out SIMS to individuals. Their reported options are as follows:

TABLE 1 SMARTPHONE AND FINGERPRINT SENSOR - PRICE COMPARISON

		Hardware	Appropriate Price
1.	Huawei Y220 Handset	Bluetooth SecuGen Scanner	US 250 dollars
2.	Ufone U5 Handset	Bluetooth HF-7000 Scanner	US 200 dollars
3.	Huawei M1 Tablet	USB HF-4000 Scanner	US 275 Dollars

All these devices support their in-house built Android application. All of the devices are at least on Android 4.0, except for Y200 which is still on Android 2.3. The least expensive option found in Android phones with OTG support for USB scanner is approximately US 190 dollars (Q-Mobile, etc.). Even Huawei's lower cost Android phones are not known to be supporting OTG. They also tested the solution of using Bluetooth scanner with one of the Nokia Asha model (approximately US 40 dollars), and it performed well.

In their experience, the scalability of the solution was dependent on the bandwidth between the device and the backend server. These devices use GSM Cellular data. The devices have the capability of connecting to WiFi, however that was not being used. The main reason for that was of security, as their backend services are not published over public Internet and are only accessible through the Internet available on Ufone SIMs.

Attendance monitoring through Face recognition

Almost all smart phones, low or high cost, have in built cameras. These cameras can be used to take pictures of employees present at a facility regularly, which can then be sent to a central location where the pictures are processed. Individuals present in the picture would be recognized in the processing phase and their attendance could be marked.

Initially, all the staff members are enrolled through a smartphone. This is a one-time activity and is repeated for each staff member only once. Each staff member's name, National Identity Card (CNIC) number and phone number are required. A list of staff members is generated through this process for future use. Once all staff members are enrolled, an Attendance Monitoring process is carried out regularly to mark attendance.

This Attendance Monitoring process is explained in the figure below:

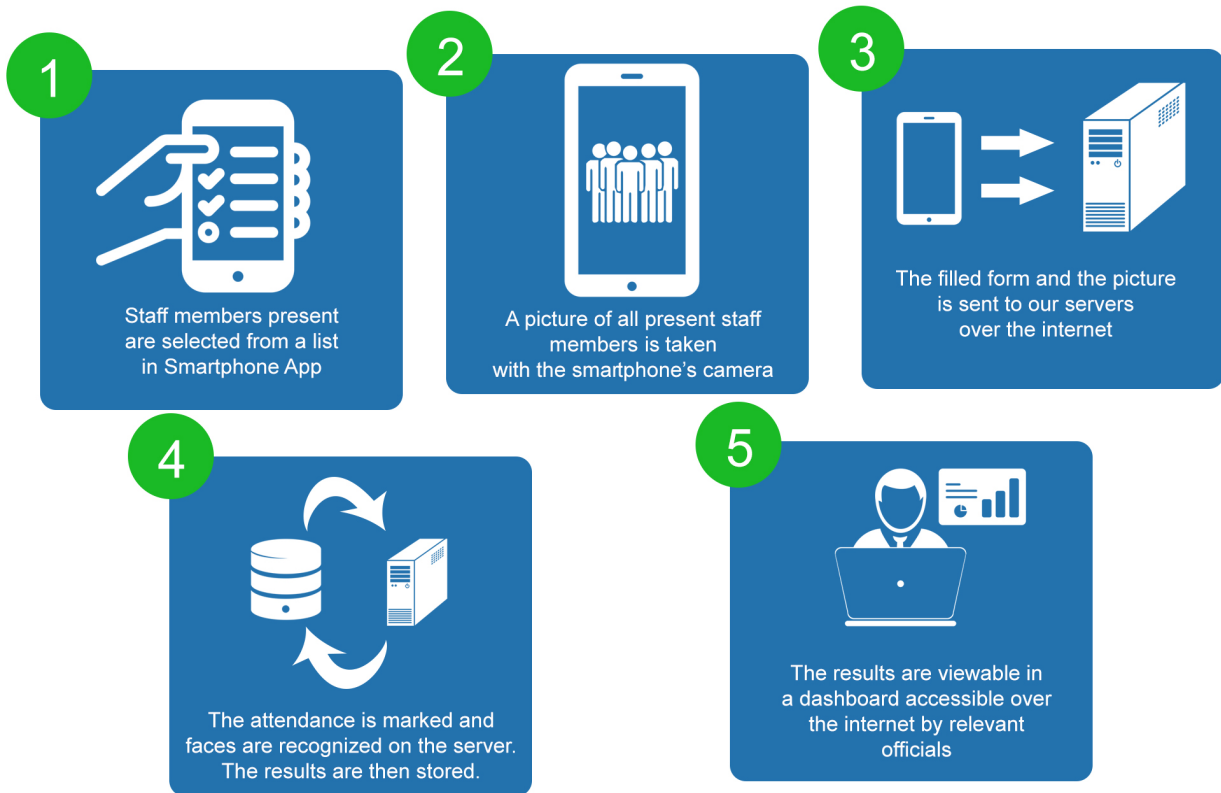


FIGURE 3 - DAILY ATTENDANCE MONITORING PROCESS

A list of all enrolled staff members is shown. Present staff members are selected in this list, after which a group picture of the staff is taken to mark the daily attendance. This form and picture is then sent to a central server through the application, where it is processed and stored. The processed results are then visible on a dashboard with access allowed to only the relevant officials. The pictures would allow verification through manual processing and automated face recognition that would be run at the server in the processing phase.

We have implemented this technology in primary schools in Sheikhpura and Basic Health Units (BHUs) in Gujranwala. Details of the technology in use are detailed below.

Technology Overview

The technology behind the Attendance Monitoring System consists of three components:

- Android Application
- Server Side Facial Recognition and Processing
- Attendance Monitoring Dashboard.

Android Application

The android application is one of the most crucial components of the whole process as the staff members on field interact with the whole system through the application installed on android devices. This application therefore needs to have an easy and simple to understand User Interface to be effective. These considerations were taken into account considerably while developing our application.

The application that we developed for BHUs in Gujranwala consists of three components; Add Staff Member, Daily Attendance and Pending/Send Forms. (Figure 4)

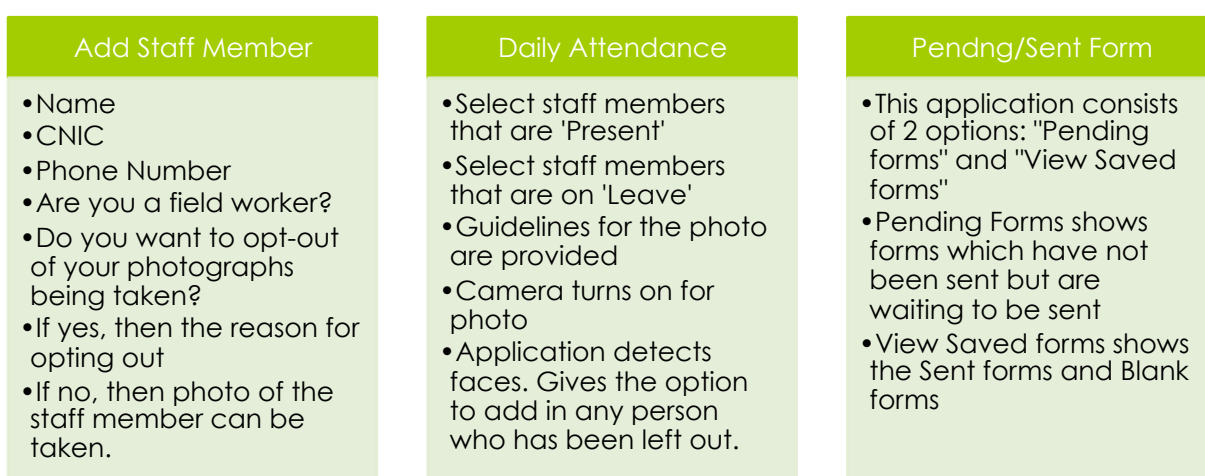


FIGURE 4 - ANDROID APPLICATION STRUCTURE

Add Staff Member

This form is used once for each employee during the entire process. The name, CNIC and Phone Number are requested from each staff member. This is used to serve as a record against which future attendance entries would be provided for each staff member. The application asks the staff member if he/she wants to opt-out of the photographs being taken. This option is added in order to provide flexibility to people in case they have any social or cultural reasons for not getting photographed. They are requested to input their reason for opting out. If they do not opt-out, they are requested to get their picture taken. Furthermore, the app confirms if the person is a field-worker. In that case, their daily entry is recorded only once. Otherwise, daily attendance through pictures is taken twice per day through daily attendance module, which is discussed in detail later on. This entry is the master entry against which future attendance entries are referenced. (Figure 5)

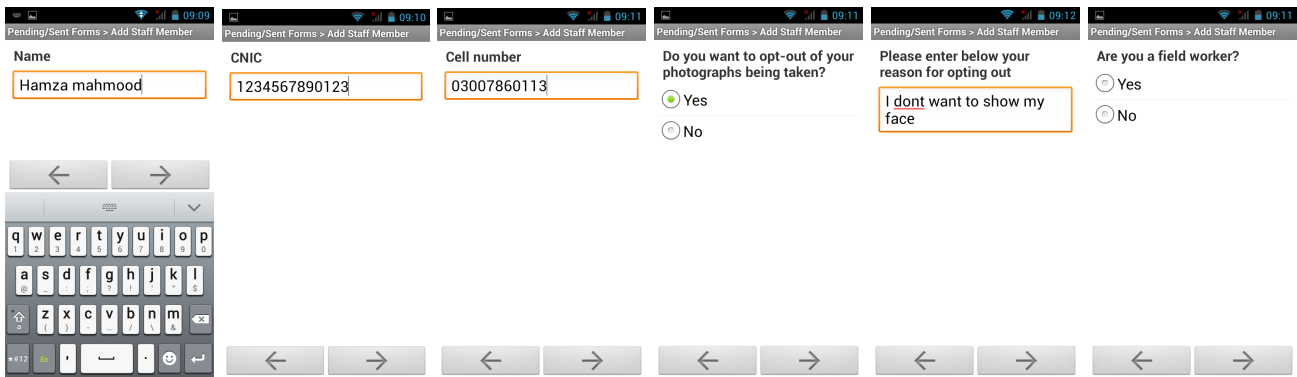


FIGURE 5 - SCREENSHOTS OF THE ADD STAFF MEMBER FORM

Daily Attendance

This is the main form of the application and gathers the data required to collect and verify attendance. It is expected that this form would be used once at the start of the day and once towards the end. In public service delivery facilities, the usual timings start from 9 AM in the morning to 5 PM in the evening. Therefore, it is expected that the first attendance entry is marked somewhere between 9:00 AM and 9:30 AM and the second entry is marked between 4:30 PM to 5:00 PM in the evening. The entries are time stamped at the time of storage and the original time is preserved when received at the central server, even if the entries are received the next day.

In order to mark attendance, the application's first screen shows a list of staff members. The user is required to mark the staff members present. The list shown is populated from the individually added staff members through the Add Staff Member component detailed above. Once the user marks the staff members present, he is shown another list of staff members. This new list excludes members that have been marked present. The user is requested to mark the people on official leave. In the next screen, the user is shown instructions for taking a photograph. The camera is turned on and the user is asked to photograph the people present in the facility. The user is allowed to take multiple pictures. The maximum amount of people present in a single photograph should be ten and the minimum could be as low as one. In case there are groups of people who want to be photographed separately, they can be accommodated as the app allows multiple pictures to be taken. Once a picture has been taken, the user is required to mark the faces of the people present in the pictures simply by tapping once on each face. This helps the server recognize faces more effectively. After that, the user can submit the form. (Figure 6)

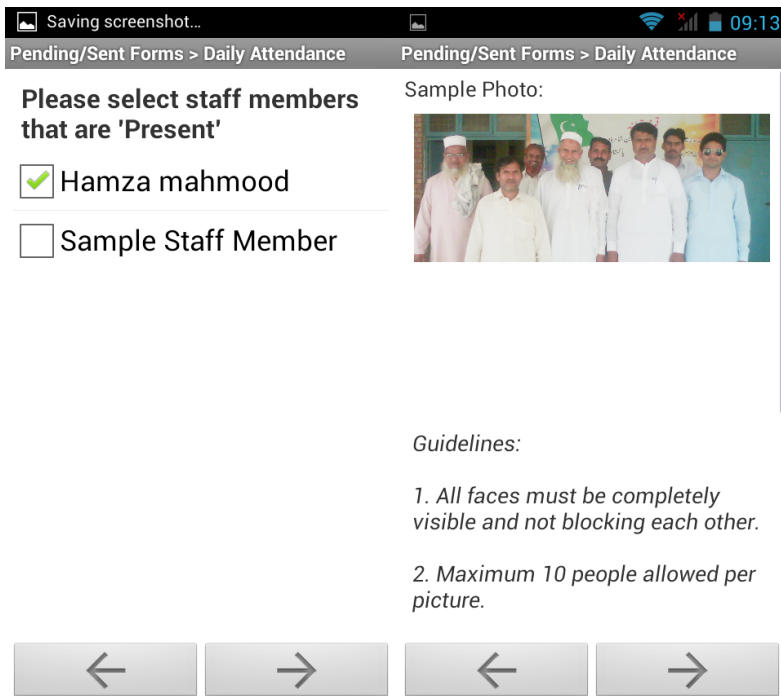


FIGURE 6 - SCREENSHOTS OF THE DAILY ATTENDANCE FORM

Pending/Sent Form

The entries made in the Add Staff Member and Daily Attendance form are stored within Pending/Sent Form components. This component has two sub-components: View Saved Forms and Pending Forms. (Figure 7)

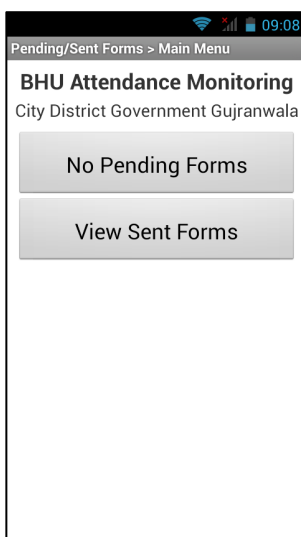


FIGURE 7 - SCREENSHOT OF THE PENDING/SENT FORMS VIEW

Pending Forms

This component shows all the entries that have been marked but have not been

sent to the server. This can be due to the unavailability of Internet at the location for a variety of reasons. Using the Send Forms button at the end of the form list, the user can resend all the forms.

View Saved Forms

This component shows all the entries that have been marked and sent to the server. This serves as a record for all the entries made from the application so far.

Server Side Face Recognition

As explained in the section above, the app allows users to self-report attendance of employees by tapping names of officials present. During inception stage of the program, it was envisaged that self-reporting may result in misreporting absenteeism and hence, need of an automatic attendance marking system was emphasized. However, anecdotal experience from field deployment dictates that mere introduction of app for marking attendance, even through self-reporting, can have a positive impact on absenteeism. Several factors can explain this impact of the intervention. For instance, employees recognize that unlike manual registers once attendance is submitted via photographs at the designated time, it cannot be tampered again for misreporting. The idea of submitting digitized photographs into a repository that can be tapped for verification, was observed to be powerful enough to ensure compliance. Even without automatic facial recognition, photographs can be used as evidence against misreporting which acts as a deterrent to misquoting absence.

Nevertheless, practical deployment of a robust facial recognition algorithm was explored during pilot in Sheikhpura and Gujranwala, and results documented to highlight its challenges and possibilities. The technical process of facial recognition was explored in two parts:

Face Detection

Several factors can affect what can be extracted from a photograph: clarity of picture, distance of object photographed from the camera, quality of camera, ambience lighting etc. Accuracy rate of automatic face detection – an essential pre-requisite before face recognition algorithm is applied - can also be affected by all these factors. During deployment, several issues were observed which affected the accuracy of the face-recognition algorithm:

- **Pictures shared were non-compliant with SOPs**

Although clear instructions regarding lighting, number of people in the picture, pose of personnel to be photographed etc. were highlighted during training on the use of app, a high percentage of received photographs were found to be non-compliant with defined SOPs.

- **Sensor Quality of Phone Camera**

Despite increase in availability of low-cost smart phones in the market with high quality specs, huge variation in quality of the hardware is observed. For the purpose of this pilot, market research of phones ranging from Rs. 11000 – 13000/- per device was conducted. Subtle differences in usability were observed in comparative devices, which are highlighted in detail in table below:

TABLE 2 – PHONE MODELS – FEATURE COMPARISON

No.	Phone model	Camera Quality	GPRS Quality	Durability
1	Q Mobile A7	Low	Low	Low
2	Voice V30	High	Low	Low
3	Huawei Ascend Y 300	Low	High	High
4	HTC Explorer	Low	High	Low
5	Sony Xperia Tipo Dual ST21i2	Average	Average	Low
6	Huawei Ascend Y 201	Low	Low	High
7	Huawei Ascend Y511	Average	High	High

For the purpose of this pilot, Huawei Ascend was chosen due to its generally superior specs although camera quality was poorer than its contemporaries.

The face detection algorithm finally deployed relied on the Viola Jones algorithm that relied on all features of the face for detection. As an alternative to detection through skin-color segmentation – detection through skin color segmentation had poor accuracy because similar color pixels detected in clothes or beard of dark-colored men gave rise to high number of false positives – results from Viola Jones algorithm were considerably higher.

Despite establishing high accuracy in detection, the exploration allowed us to establish the need to define strict SOPs for photographs to be taken and ensure their compliance as well. Lessons such as subjects of the picture must be facing the camera, pictures need to be well illuminated, subjects should be discouraged from wearing spectacles should be emphasized further in pre-deployment trainings.

Face Recognition:

Face recognition is performed on detected faces and the face images are compared against pre-stored images that are captured at the time of registration of staff members. We used Local Binary Patterns Histogram (LBPH) method for face recognition. Local binary patterns are popular features in computer vision that capture the local variation of an image patch. The LBP pattern of a face image is compared against the dataset of existing employees, and the best matching face, with confidence measure up to a certain threshold, is declared the match.

Dashboard

Once the data is sent from the smart phone, it is stored on our servers. The facial recognition algorithm described above recognized the people in the picture. This adds a “verified” count for each daily entry. A dashboard connected to the server allows accessing and browsing the data in a user-friendly manner. A web portal for attendance has been setup. There are a number of features of the dashboard.

Aggregated and Summarized View of Attendance

At the first level, overall district performance is viewable. A drop down to select date range is present. Once the date range is selected, the overall attendance in the selected range is displayed. Overall attendance and overall compliance is visible as individual highlighted numbers. Overall attendance shows the average presence of staff members. Overall compliance shows the number of days the attendance is reported at each facility as a percentage of the expected number of days the attendance should have been reported. This allows gauging whether the app is being used regularly to mark attendance at facilities. Performance graph for the whole district (attendance percentage over time) is also visible. Besides the overall districts performance, compliance and attendance of each facility is viewable in tabular format, for the selected date range. Trend lines are also visible for visualizing consistency and for identifying any drops in attendance. (Figure 8)

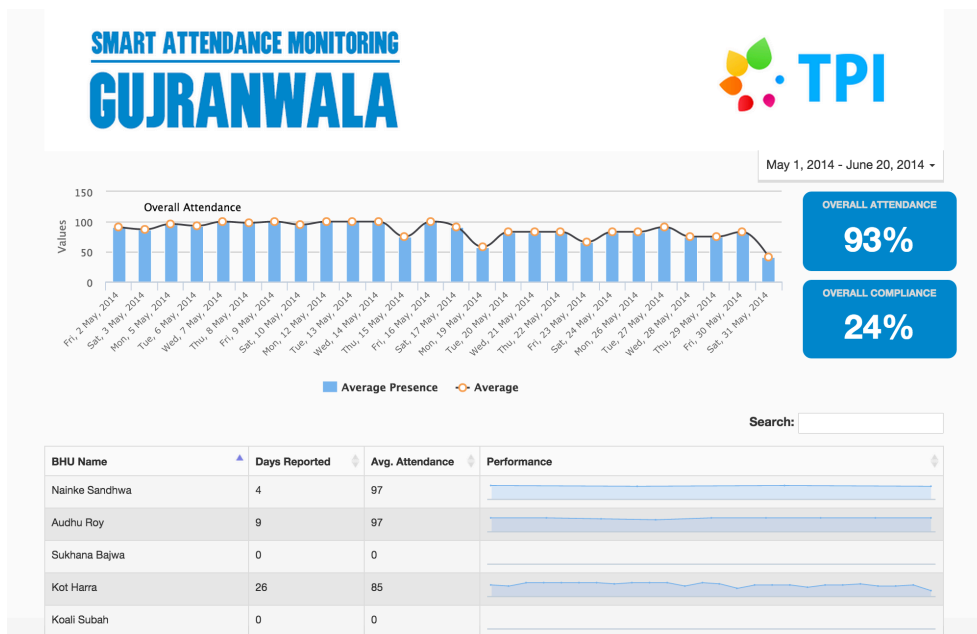


FIGURE 8: AGGREGATED / SUMMARIZED VIEW OF ATTENDANCE IN DASHBOARD

Drill Down Information

Once a facility is clicked, a popup containing information about the respective facility is opened. This popup contains data in drill-down format. All dates, in the selected date range, along with self-reported attendance are visible in the dashboard in a calendar format. Each working day of the facility, with its attendance, is shown as a block. (Figure 9)

Drill Across Capability

Once a date block is clicked in the drilled down popup, details for the day is shown. Each day is clickable and responds to a click by displaying the details for the respective day. The details shown include the number and names of people present, people absent and people on leave. The results of the face recognition and verification are shown alongside. The pictures that have been received for the day, along with the pictures of individuals that have been detected by the algorithm, are visible. This allows verifying that the results of the face verification and self-reported figures are the same. Any discrepancies between the two can be verified in case attendance has been over reported by a facility, or if our verification algorithm has not been able to recognize any one of the staff members.

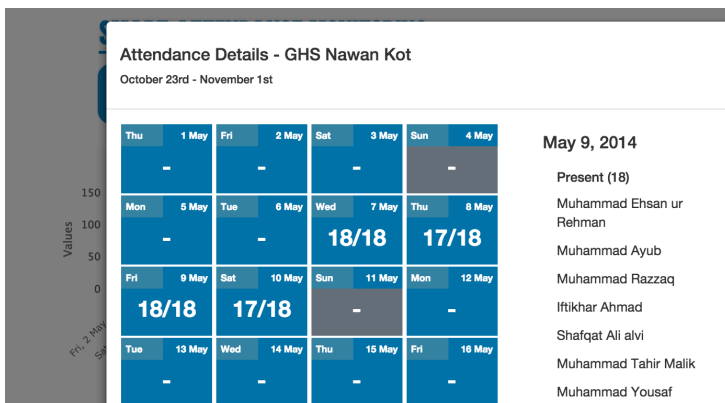


FIGURE 9: DRILLED-DOWN - THIS SCREEN IS SHOWN ONCE A SPECIFIC FACILITY IS SELECTED FROM THE MAIN SCREEN

Record Keeping

A major benefit of the dashboard is that it replaces the conventional inflexible method of taking attendance in registers. The problem of not being able to have an easily accessible and verifiable attendance register is solved since the dashboard allows anyone with Internet access and the required privileges to access the reported and verified attendance in a few clicks.

Practical Implementation

Smartphone deployment

Smartphones and cellular connections make up for the most important logistical expense of the entire project.

Costs

The major cost of deploying the system is the initial purchase of phones, initial training costs and monthly account usage. The cost of deploying the technology at a facility is the cost of a smart phone at Rs. 12,500 per phone and Rs. 300 for a SIM. Monthly telecommunication expense is Rs. 250 per SIM. A problem we faced in the pilots was that some users used these phones for their personal browsing. Because of this, they reached their credit limit of Rs. 350 and the photos could not be transferred. We are currently working on tackling this problem by limiting their browsing so that the phones are used for the purpose of attendance recording only.

These costs do not include software development or administration expenses.

Low End Smart Phone Issues

Since the smart phones that we deployed belonged to the low-cost bracket, there are a few compromises that were made. The quality of hardware varies significantly in this price range. Initially, while piloting in Sheikhpura, we purchased Voice V30 smartphones that cost around Rs. 12,000. The camera quality was extremely high in these phones. The high picture quality resulted in a facial recognition accuracy of more than 90%. The problem, however, was in other components in the phone, such as GPS and GPRS. The GPS hardware quality was inferior to other phones, such as those of Huawei. Due to the low quality GPRS, data transfers broke and a number of transmission issues were faced, ranging from incomplete data being received at the server to not having data transferred at all.

To address the problems with the data transfer, we looked at other smart phones in the same cost bracket and realized that as GPRS quality improved, camera and picture quality dropped. We made a compromise between picture quality and GPS quality and decided to use Huawei Y511 for our second pilot, in Gujranwala BHUs. The camera sensor quality of Huawei Y511 was inferior to that of the Voice V30 smart phone, but the GPRS quality was superior. We decided to prioritize data transmission over recognition accuracy.

As we move to a higher cost bracket, we can reach a smart phone category that allows us to compromise less between the various hardware components and increase the overall system efficiency. While deciding between GPRS and Camera Quality in our system, it would be important to prioritize GPRS since, without data transmission, pictures and other data would not be received at the server and the

benefits of a better camera would be irrelevant. Since the process of verification is carried out on the data received, it is preferable to prioritize transfers.

Cellular Connection Issues and Solutions

There are a few issues that need to be dealt related to cellular data on cell phones. Firstly, acquiring a large amount of SIM cards is a tedious task. Every smartphone deployed on field requires an active cellular connection along with available cellular data. In order to address that, we tested two different cellular networks; Ufone and Telenor.

In our experience with Telenor we noticed that the cost was high and the coverage quality was not as good in our pilot areas. Cellular data connectivity was not present inside many buildings in Sheikhpura. Data losses were considerable and in many cases the data received was broken.

We tested Ufone cellular connections in Gujranwala. The coverage quality was much better in our experience. All five smartphones deployed have been sending data currently. In some areas the connection drops but the data is synced simply by turning the data off and back on inside the smartphone's settings. This was not the case when Telenor connections were used. The Ufone option also turned out to be more attractive from cost point of view.

Field Deployment Issues

We are also facing several impediments while piloting our project in BHUs present in Gujranwala district. These are detailed below.

Cultural & Social

Women refusing to get pictures taken due to religious, social and cultural reasons

In some facilities, women refuse to get pictures taken because of religious or cultural reasons. In our attendance pilot in Gujranwala, several female staff members submitted written applications informing us that they would not be a part of the picture taking activity.

Potential Solutions / Responses

In order to maintain seriousness while accommodating non-compliance in some cases, a number of changes can be made to the app. One suggestion has been that we have a list of excuses for not getting a picture taken. At the time of enrollment of a staff member, we could either get a picture taken, or in case the respective person refuses, we could enter a reason as to why the person would not

be getting a picture taken. We have added this feature in our latest Smartphone application iteration for BHU Attendance in Gujranwala.

In cases where women do not prefer to show their faces for the pictures, they may be allowed to keep their face covered in all their pictures. This would maintain seriousness of the pilot, while still maintaining some possibility of manual verification

Structural & Hierarchical

High Position Employees vs. Low Position Employees

Employees at higher positions were reluctant to get pictures taken with those at lower positions, because it was deemed disrespectful that their attendance had to be verified in front of their subordinates. In order to address them, we incorporated functionality that multiple pictures can be taken in various batches. This could increase the amount of data being sent to the server, e.g. in the previous case where one or two pictures were being sent, now a larger number of pictures could be taken and sent.

Field Workers and Short Time staff

It is not possible for field staff to be available at all the required times for attendance. One of the reasons is that some of the field staff members are deployed at locations much farther away from the central facility. Reaching back in time for a picture is an inconvenience and could delay work. In one of the BHUs in Gujranwala, there was the case of a Lady Health Worker who got free at 5pm, and was never available for a picture at 2pm. We therefore have now incorporated functionality that allows employees to select if they are field workers in Add Staff Member form in the smartphone application. At the server, the attendance of field workers would be marked once a day.

Leaves and Short Leaves

The app needs to accommodate Leaves and short leaves. A staff member could have been absent with notice. In such a case a leave option should be present. Some staff members take half a day off, with application. In those cases a short leave feature is needed to keep a detailed track. We have added functionality at the server that automatically marks an individual on short leave if he or she was on leave in one of the daily entries (start of the day or end of the day) and present in the other.

Timing Changes

In winters, the timing changes to almost half an hour late. Therefore the time window for attendance to be marked valid needs to be flexible. This is a decision that needs to be taken by a higher official who handles the departments' affairs. In our pilot in Gujranwala, the District Officer Health decided to relax the window. Changes were made at the server end accordingly.

Technical & Logistical

Drained batteries

Smart phones consume a lot of energy and therefore need to be charged regularly. In some areas, excessive load shedding does not allow keeping the phones charged at all times. Attendance is therefore not submitted regularly in many cases. One solution is to provide extra batteries or battery power packs for charging. But such a solution could increase the overall costs. Our recommended strategy is to minimize the use of the phone for non-attendance related work in such areas, because the attendance-monitoring task itself is of short duration and does not consume much energy.

Maintenance: Replacements / Repairs + Connection charges

A smart phone is a high maintenance commodity and individuals responsible for the deployed phones in facilities are curious to know the consequences in case the phone is accidentally damaged or stolen. In our experience, one of the staff members who was in charge of the deployed smart phone kept the phone in the BHU, and did not carry it with himself to avoid any accidental damages or theft. He was extremely concerned and wanted to know the protocol in case of such mishaps.

Transfer Issues

There are always connection issues regardless of how good the Internet connection is. This is usually due to temporary drops in signals in rural areas. In many cases, smart phones are unable to resume connection with the Internet once the signals resume. In such a case, restarting the cellular data connection from the settings tab is one of the solutions. In one case in Gujranwala, there were some entries that had not been sent from a phone. We simply turned the phone's cellular data off and back on, and all the entries synced with the server. We taught the people in charge of phones this technique in Gujranwala and they were able to demonstrate it in front of us. This is a fairly simple yet extremely important technique to learn.

App Updates

In many cases the apps deployed in the field need to be updated to accommodate changes. In such cases, the way currently followed is to pull back all the phones and update changes. There is a need to automate this process and accommodate updates remotely since pulling back a huge number of phones becomes hectic. In our pilot in Gujranwala, our in-charge wanted an automatic update mechanism through which he can update the apps automatically once we rollout a change. He wanted something on the lines of how apps receive updates on android. We discussed with him the possibility of fetching a form once we update it on the server. He was used to that, and we would be figuring out a way of rolling out changes in the apps remotely. Applications in android smartphones are updated through the built-in Play Store by default. We, however, cannot use this method since we are using a customized version of Open Data Kit (ODK) that does not update forms when updated through the Play Store. In order to reflect changes in the app, one needs to manually fetch the forms inside the app. This process cannot be accommodated through the built-in Play Store.

Perceptions and Feedback

Placebo Effect

One of the most interesting effects of deploying technology, or any kind of intervention, on field for attendance is that it encourages change at the onset. Many supervisors in Sheikhpura and Gujranwala, both our pilots, reported that a number of people started reaching on time where earlier the same people used to be relatively relaxed about their timings. In cases where staff used to be absent a lot, they started decreasing their absences. The intervention introduces a placebo effect. Regardless of whether the system is faulty or working, it encourages compliance and helps achieving the desired effect.

Understanding and assumptions about the deployed technology in the field

In some cases, morale of staff on ground drops with the introduction of such interventions and initiatives. This is usually because people believe they are being kept an eye on and are not being trusted. In one of the BHUs in Gujranwala, the head reported that the staff feels demotivated due to the initiative. The initiative represented mistrust on their workings.

Conclusion

The experience of developing a technology-based solution to effectively monitor attendance has been a positive one. We endeavored to build a system that focuses on enhancing the quality of public service by targeting the very basics of organizational structure in public facilities, i.e. ensuring the availability of working staff. The project is in progress; full deployment in all the Basic Health Units of Gujranwala is expected by the end of January 2015.

Moreover, feedback from the people involved in the pilot testing of this system substantiates our claim of this system's organizational necessity. Overall willingness of stakeholders in its deployment is very encouraging. People are not averse to using technology for structural improvement; they themselves want to take the plunge in exploiting the benefits of the available contemporary technology. Any form of resistance is because of the cultural and social sensitivities embedded in our society, which should be respected in order to make any initiative successful, sustainable and scalable.