Final Report

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Summary

Major Goals and Objectives

This report focuses solely on the technological aspects of the research.

The primary technological goal of this study was to harness the potential of AI techniques and advancements to help the reintegration of justice-involved individuals (JII) into the community. Our study centered on developing an AI-based system, referred to as the Support and Monitoring System for Community Supervision (SMS4CS), designed for the benefit of both JII and their case managers, focusing on aiding JII during their reentry into the community. While our primary focus was on JII within our system design, we acknowledged the critical role of practitioners or case managers. Our overarching aim for the SMS4CS was to equip case managers with early warning indicators of risky behavior and empower JII with tools and mechanisms to mitigate these risks, aligning with best practices in hybrid supervision approaches (e.g., 5-Key Model).

At the core of our system was the implementation of intelligent tracking mechanisms to monitor potentially risky behavior and provide support to JII in avoiding such behaviors. Our system fundamentally aimed to deliver personalized resources and opportunities to JII, augmenting and enriching the support offered by case managers.

To enable the implementation of our system, JII were equipped with smartphones and health-related wearable devices (smartwatches). Concurrently, a case specialist (research team member) was provided access to specific web dashboards (user interfaces), facilitating monitoring and communication with the JII. The SMS4CS leveraged intelligent data analytics and algorithms

to help offenders and case managers by streamlining their tasks and offering intelligent support to the JII.

Our innovative SMS4CS was deployed as a novel intervention, based on the 5-Key Model, for offender reentry through collaboration with Tippecanoe County Community Corrections (TCCC). TCCC played a pivotal role in acquiring participant data, deploying our system, and evaluating its effectiveness through testing and assessment.

Our key technology goals for this study were:

1) **Develop a novel AI-based intervention system based on the 5-Key Model, for JII and case managers to reduce the workload, and support JIIs in more successful reentry into the community.**
2) **Deploy our technology with TCCC.**
3) **Analyze the functionality and use of the technology and revise our system based on feedback and analysis of the deployment.**

Research Questions

The technology research questions guiding this study were:

1) Is it possible to create an automated system that can effectively facilitate the implementation of innovative approaches, such as the 5-Key Model, to assist individuals under supervised release in their successful community reintegration while concurrently alleviating the workload of officers and case managers?
2) How can a mobile app be designed to enhance motivation and task completion among JIIs, thereby supporting their successful reintegration?

3) What features of the Dashboard system are most effective for assisting case managers in monitoring, analyzing, and improving the engagement of JIIs within the SMS4CS environment?

Research Design, Methods, Analytical and Data Analysis Techniques

The SMS4CS system was designed to offer a comprehensive range of functions by developing several applications. These applications are accessible to both the client, often referred to as a Justice-Involved Individual (JII), and their case manager. It is important to note that when we mention a set of applications, we specifically refer to software that can be downloaded and installed on a smartphone, which can connect seamlessly to a smartwatch. These applications were pivotal in supporting and monitoring JII during their reentry into the community.

The SMS4CS system is composed of the following essential components (further elaborated in the Outcomes Section):

1. GOALS

2. HEALTH

3. GAMIFICATION

4. DASHBOARD

These components collectively formed a cohesive system to enhance the reintegration process for JII while providing valuable tools and insights for case managers.

Architecture Design

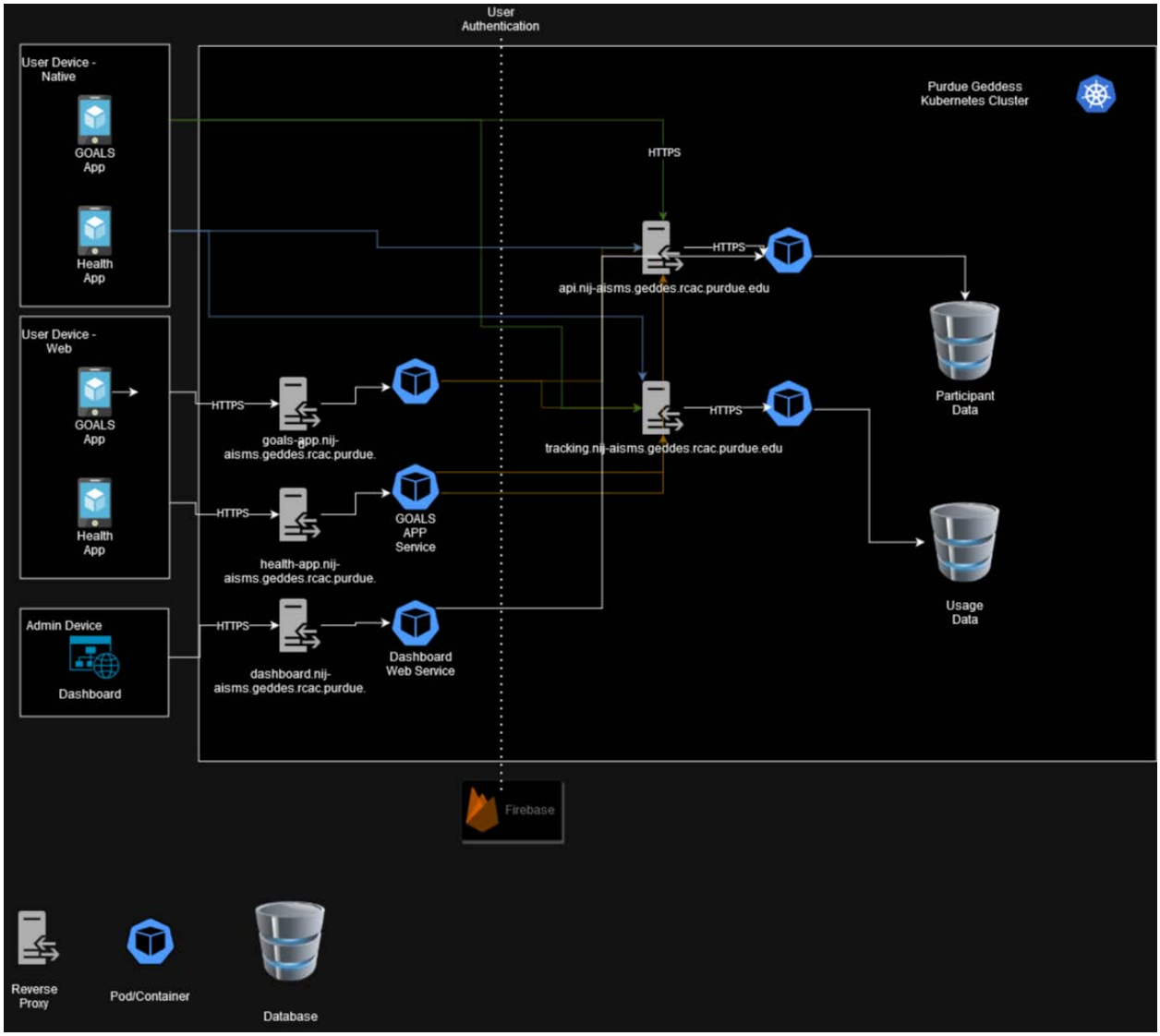

Figure 1: Deployment

Our innovative architecture seamlessly integrates two cutting-edge mobile applications and a robust web dashboard, creating a cohesive and powerful user experience. The backbone of this architecture is built upon microservices strategically hosted within a Kubernetes cluster, leveraging the efficiency and scalability of containerization.

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1. Client Apps:

- Our client apps consisted of the GOALS and HEALTH apps and the Dashboard. These applications were connected to and received data from microservices hosted inside our Kubernetes cluster.

2. Microservices Architecture:

- *Containerization with Kubernetes:* The microservices architecture is containerized and orchestrated using Kubernetes, ensuring efficient resource utilization and scalability. Kubernetes provides seamless deployment, scaling, and management of containerized applications, optimizing performance and reliability.
- *Scalability and Flexibility:* Microservices are structured to be independent, allowing for modular development, deployment, and scaling. This architecture enables rapid iteration and the introduction of new features without disrupting the entire system.

3. Authentication via Google Firebase:

- *Secure Access:* Google Firebase is employed for robust user authentication, ensuring secure access to the entire ecosystem. Users can log in seamlessly using their Google credentials, enhancing convenience and trust.
- *Identity Management:* Firebase provides a reliable identity management system, offering features like multi-factor authentication and role-based access control. This ensures that sensitive data is accessed only by authorized users.

In summary, our product architecture combines containerization efficiency with Kubernetes's scalability, ensuring a seamless user experience across two mobile apps and a web dashboard. The integration of Google Firebase enhances security and user authentication, making our platform

more reliable and user-friendly.

Expected applicability of the research

As of 2023, over 5 million individuals are under correctional supervision in our communities every year. These individuals, due to a multitude of structural and public health disparities, often face elevated rates of recidivism, leading to poorer well-being and community stability outcomes. While evidence-based practices are appearing for justice-involved populations, the tools available to effectively support those under correctional supervision remain insufficient. This challenge is further compounded by the sheer volume of individuals under correctional supervision, far outnumbering the available corrections and service professionals. Consequently, unmanageably high caseloads hinder the ability of these professionals to provide the necessary levels of support to their clients.

Furthermore, a body of research has consistently highlighted the difficulties faced by individuals under correctional supervision in accessing support services. Factors such as transportation constraints, financial limitations, time restrictions, stigma, and various other barriers make it challenging for them to engage effectively with available support services.

The technology we have developed promises to enhance human support services provided by community corrections. It aims to increase the use of supportive interventions, surmount the barriers to accessing help, and ultimately enhance JII's outcomes within the community corrections system. Through creating the SMS4CS system tailored to this population, we unveil an innovative approach that can more effectively address the support needs of those under correctional supervision through its practical application. This technology identifies new research

directions and leverages mobile applications powered by artificial intelligence and machine learning to foster justice-involved individuals' well-being and community stability.

The United States is experiencing an unprecedented number of individuals under correctional supervision. Given the substantial investment in long sentences and high levels of community supervision over the past four decades, we must redirect funding toward understanding how best to serve this population while under community supervision. Completing community supervision significantly reduces the likelihood of future criminal engagement and, consequently, the number of potential victims. Thus, providing support services to this population is vital for public health and safety but also for the financial stability of our communities. This study bridges a critical knowledge gap in responding to the multifaceted needs of this population, resulting in a technology solution that can be readily deployed and used within the correctional system.

Participants and other collaborating organizations

The following individuals were involved in the project:

Purdue University

Dr. Marcus Rogers - PI

Dr. Umit Karabiyik - Co-PI

Assisted by Graduate and Undergraduate Research Assistants

Florida State University

Dr. Sudhir Aggarwal - Co-PI

Assisted by Graduate Research Assistants

University of Alabama, Huntsville

Dr. Tathagata Mukherjee - Co-PI

Dr. Haeyong Chung - Co-PI

Assisted by Undergraduate and Graduate Research Assistants

Justice System Partners

Dr. Carrie Pettus - Co-PI (Courtesy appointment FSU)

Jessica Le - Project Director

The following organizations were involved in the project:

Tippecanoe County Community Corrections (TCCC)

Changes in approach from original design and reason for change, if applicable

The technological aspect of our study remained relatively unchanged from its initial design. However, only usage data from the installed app on the phone and related usage data from the smartwatch were collected and analyzed. This involved data on network usage and bandwidth, bug reports done by the users in relation to problems encountered while using the system, and reports related to bug report resolution by the development and research team. The goal of the usage analysis was to ensure that the system was usable by a group of people in parallel without facing any issues related to the designed functionalities of the system.

In consultation with the NIJ's research ethics office, it was decided that no internet history from browsers or data from other devices would be collected. It was also decided that only research personnel acting as case managers would have access to the dashboard system.

Due to protocol constraints, we could not conduct an analysis to assess the impact of the SMS4CS system on the success of community reentry and recidivism rates of justice-involved

individuals (JII).

Outcomes

Activities and accomplishments

SMS4CS

This section discusses technical results related to the design, development, implementation, and deployment of the SMS4CS system during the award period: January 1, 2020, through December 31, 2023.

This system provides additional motivation and support to the rehabilitation goals of the 5-Key Model, aimed at an audience of JII who are re-establishing their lives, relationships, and occupations in the aftermath of incarceration or other interactions with law enforcement.

A production version of the SMS4CS system was deployed and implemented with Tippecanoe County Community Corrections (TCCC) in Indiana and has worked essentially flawlessly.

The **Support and Monitoring System for Community Supervision (SMS4CS)** system is our overall system to provide additional motivation to a rehabilitation application (the 5-Key Model) aimed at an audience of JII who are re-establishing their lives, relationships, and occupations in the aftermath of incarceration.

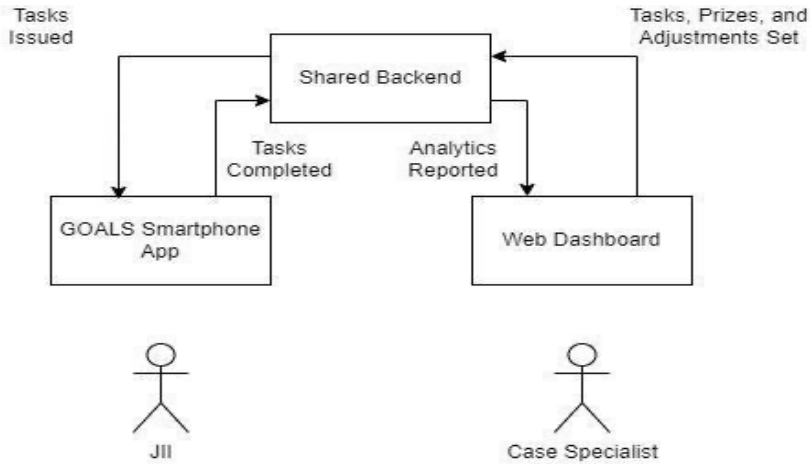


Figure 2: The flow of information through the back- and front end of the SMS4CS system.

The SMS4CS system refers to the totality of (a) the GOALS phone app (this app also integrates a separate health app), (b) the dashboard web app, and (c) the backend system that enables their operation (Figure 2). The SMS4CS system also serves as a real-world implementation of the gamification of parallelized advancement. In this system, JII are tasked with completing various tasks that will help them re-establish solid social, psychological, and financial standing after being uprooted as part of their incarceration or difficulty with the legal system. The 5-Key Model serves as the basis of the SMS4CS system, where each key represents a support system that is a "key" to arrive at a stable, fulfilling life for these JII.

The system's user base is split by the different interfaces developed in the overall system. JII uses the GOALS phone application to interact with the SMS4CS subsystems, such as location and gamification. Case managers use the Dashboard web application to review and interact with the cases under their supervision. The primary method by which these two interfaces overlap is the issuance of tasks, elements of the **gamification system.** These tasks are issued by managers, fulfilled by JII, and monitored for completion by SMS4CS subsystems.

The issued tasks fall into three broad archetypes. The first is restriction tasks, wherein JII

are required to obey the legal terms of their release. Not only does the GOALs app use GPS monitoring to warn users when they are approaching a geographically restricted area, but gamification points are also issued weekly, as long as participants obey their restrictions for the entirety of that week.

The second is meeting tasks. As traditional corrections methodology is carried out mainly face-to-face, many steps in the process require human intervention to monitor progress, plan future actions, and discuss JII behavior. Through an integration of the Zoom API, both JII and case managers can request meetings from one another. Then, the meeting can be tracked for who attended it, how long it occurred, and why either party declined to show.

The third and final task archetype is the 5-Key task. These tasks are used to advance JII through the 5-Keys of reentry, cultivating skills such as "healthy thinking patterns" and "meaningful work trajectories" that will lead them to successful rehabilitation and reentry after prison life or other justice-related correction. This category is much broader than the previous two and catches all tasks used for the betterment of JII. Due to these highly personal tasks, they will often be verified for completion by direct case-manager interaction with the dashboard.

With the technical requirements of these three task archetypes in mind, the SMS4CS app is divided into four subsystems and three interfaces. Note, however, that the Health system app also has a task of type "health," which is also displayed to the user (See Figure 3).

The **Location** and **Health** subsystems use hardware on the user's person to temporarily record information to a database. The location system uses the smartphone's onboard GPS to gather the user's location data, primarily used to advocate that the user obeys the physical parameters of their parole. The health subsystem uses the connected smartwatch to gather vital indicators like heart rate and temperature, primarily used to detect when and how the user

experiences acute stress. Both systems save their data to the database in logs periodically wiped; once the gamification system uses this data to evaluate user activity, it is no longer needed and would be a privacy risk to retain.

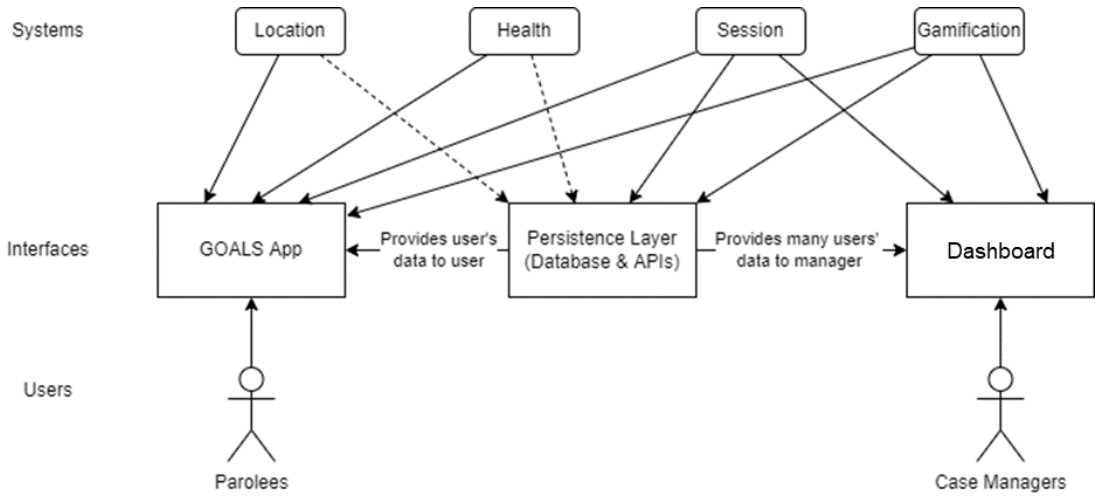


Figure 3: Each type of user has an exclusive form of interface that they use to interact with the system. The session and gamification systems take user input from the interfaces and write permanent logs.

The **Session** system allows users and managers to petition one another for meetings, connect easily through an automated Zoom meeting API, and automatically write the success or failure of a meeting to the database for use in gamification and record-keeping. Unlike the data belonging to the location and health systems, these meetings' records pose no threat to personal privacy and provide valuable data when observed in aggregate over time. Thus, these additions to the database are not subject to any periodic erasure.

The **Gamification** system has thus far only been briefly mentioned. It issues tasks to the JII, checks for task completion using the persistence layer as an intermediary, and issues both Vista and prize-track progress on task completion. Additionally, the gamification system reads input from case managers, who can shape the gamified experience through issuing tasks, deciding the

prize track, and query the user's current vista as a snapshot of their overall gamification progress. The components of the SMS4CS system and their associated actors are summarized in Figure 3.

The overall SMS4CS system involves the actions of participants (JII) and case managers. The two types of users are supposed to use two different subsystems of the SMS4CS system, respectively. Specifically, each participant (JII) uses a smartphone running the GOALS app, and a case manager uses the Dashboard to communicate and view relevant data related to the user and manage several sessions and assessments for the participants.

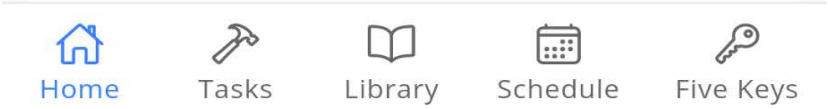
GOALS

The GOALS app allows participants to interact with the SMS4CS system using their smartphone, giving them access to the required tasks, assessments, sessions, and meetings assigned by the case worker through the SMS4CS Dashboard system.

Since participants are expected to engage with the system during a long period of time (at least 3 months), we thought it prudent to cultivate features and designs that would foster longer-term, voluntary engagement with the gamified aspects of the app . Thus, the GOALS app is incorporated into the game mechanics, notably through points, rewards, levels, and supportive visual feedback. Integral to the design of the gamification system is support for the 5-Key Model for Reentry: encouraging participants to complete several tasks and assessments related to meaningful work; developing effective coping strategies, positive engagement, and positive relationships; and healthy thinking patterns. Notably, the GOALS app allows the users to engage and motivate several assigned tasks based on the 5-Key model, through which the participants improve themselves and get points and rewards. The app also helps them comply with court orders without direct interaction with case officers.

When the GOALS app starts, the participant is asked to log in. Afterward, they may access

several views. They may switch between these views at any time using tabs at the bottom of the app screen. The GOALS App is functionally divided into the following five views:



- **The Home view:** Gives a general overview of the participant's current progress levels, a few upcoming tasks, a chart detailing their points, and access to a map with their current location and exclusion information.
- **The Tasks view:** Listing the currently assigned tasks, reward information, and an interactive game Vista using their progress.
- **The Library view:** Supporting important resources and documents the participants must refer to.
- **The Schedule View:** showing a calendar with all scheduled meetings, allowing the participants to request meetings themselves.
- **The 5-Keys View:** giving the participants the ability to complete assessments and sessions through forms and chatbot sessions.

Additionally, navigation and login are handled through two separate ways: a login page accessible upon initial opening, or Home View, and the navigation bar, accessible always on the bottom of the app. From each section of Home View, the user may also access an associated view for more detailed information (see Figures 4 - 6).

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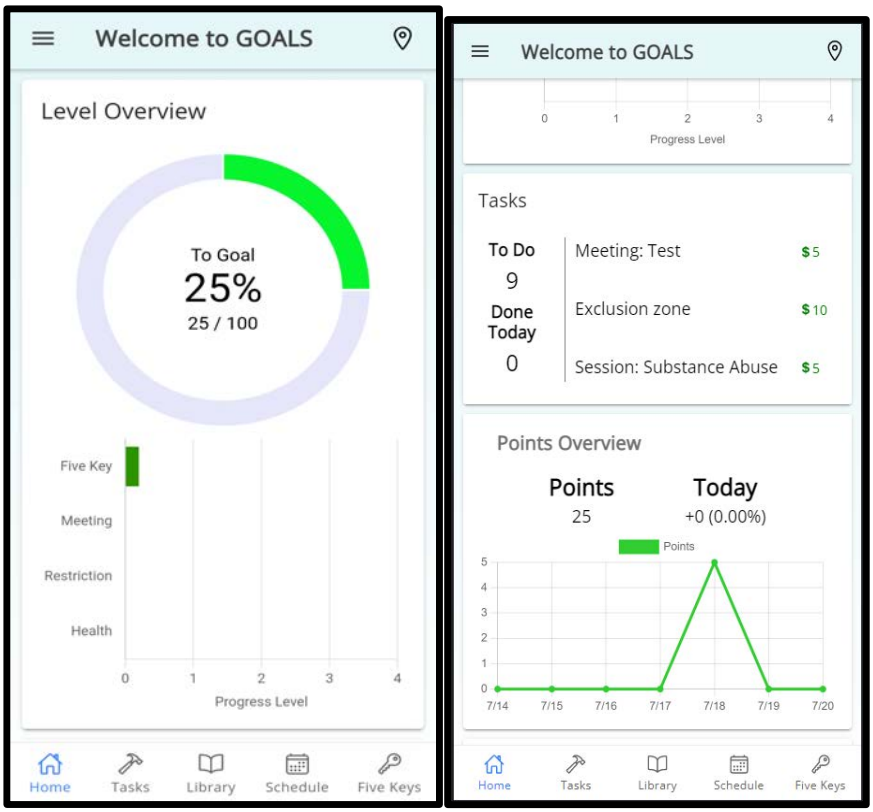

Figure 4. The Home view of the GOALS app, in two different states of scrolling -- top (left) and bottom (right).

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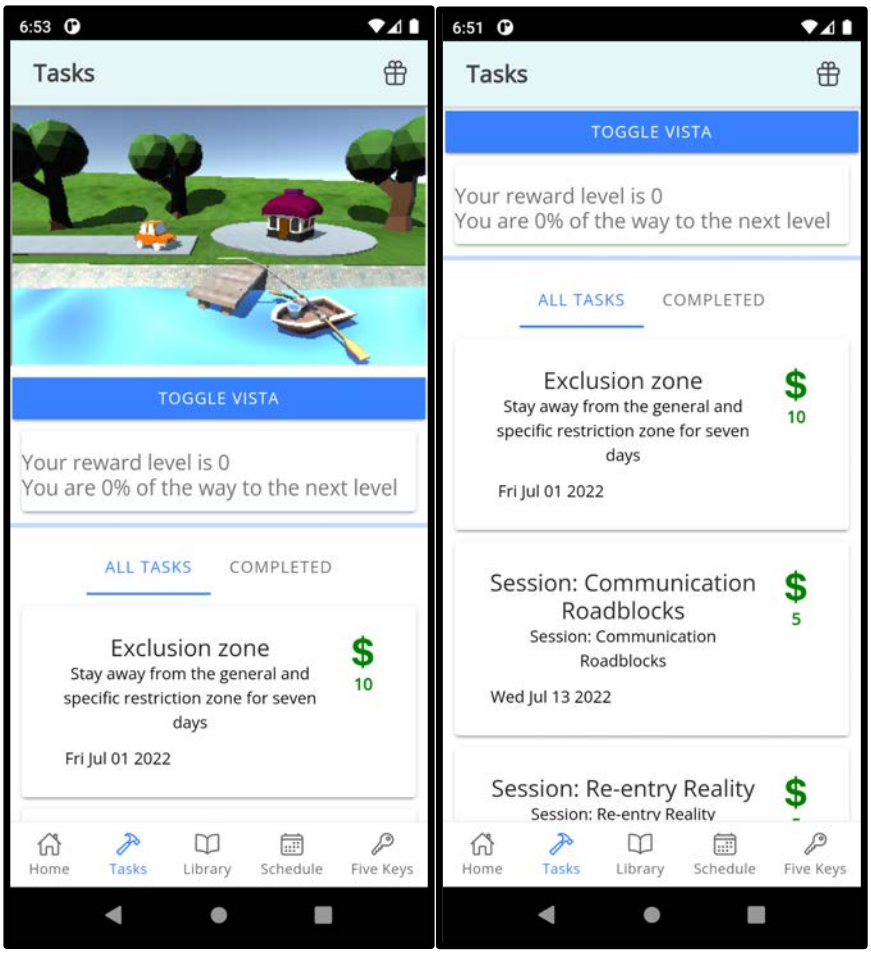

Figure 5. The task screen composes the vista as a banner along the top (left) and presents a descending list of tasks and their rewards beneath (right).

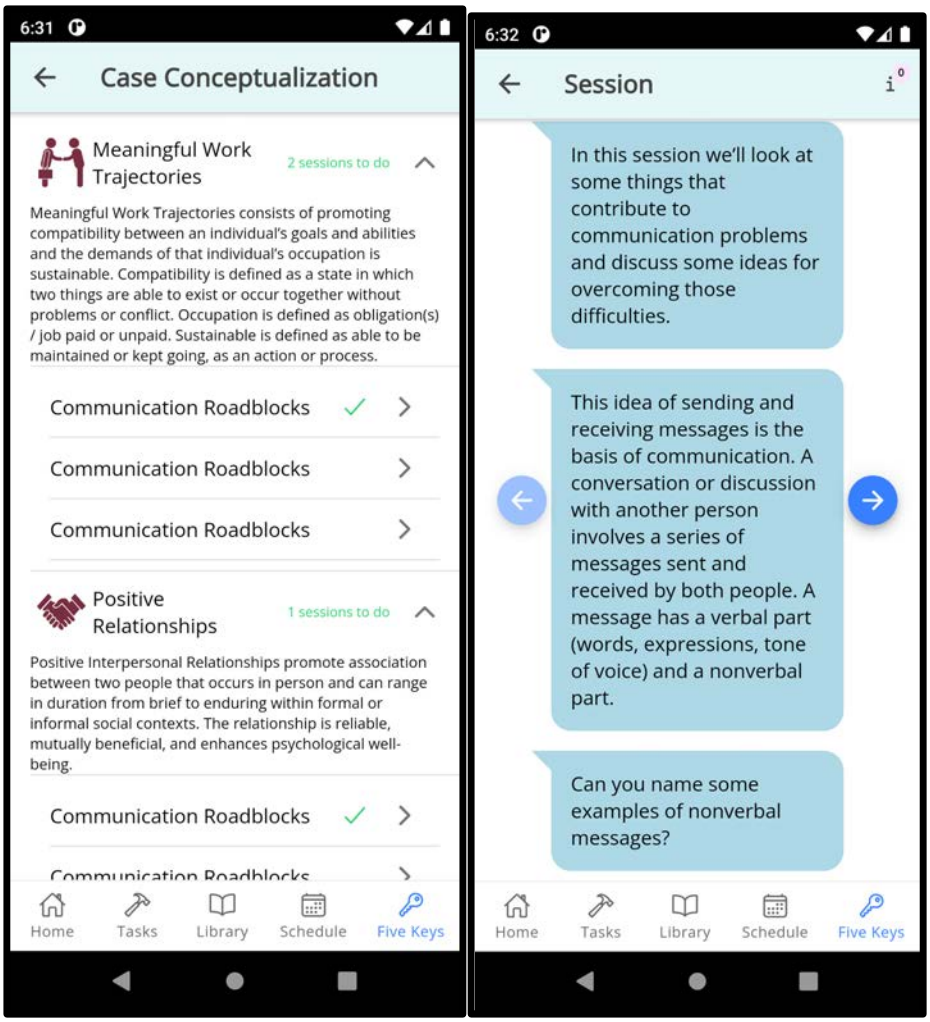

Figure 6. The participant can overview the sessions they have yet to complete (left) and participate in sessions alongside an automated chatbot (right).

HEALTH

The Health app uses a link with an external smartwatch to track the participant's vital signs throughout their participation. Tracking the vital signs of participants using the smartwatch has twofold benefits. First, two of the keys (Healthy Thinking Patterns and Effective Coping Strategies) involve users learning to manage their psychological and physiological responses to both acute and long-term stress. Indicators of effective stress management, such as blood pressure and heart rate, are collected by the health subsystem and evaluated internally by the system's metrics. Then, these evaluations are fed to the gamification system as criteria for completing game

tasks. Second, the GOALS app can provide resources and can alert emergency-response services when the participant is experiencing moments of acute stress or danger. By monitoring vital signs for significant short-term differences, the Health subsystem can identify the onset of an acute situation and provide quick access to appropriate resources.

There are two types of notifications recently added and supported by the app:

Activities Reminder: Introducing our app's daily activity log update notification feature that ensures users maintain a comprehensive record of their daily activities. We recognize the value of tracking progress and capturing daily insights, so we have introduced this convenient reminder system. Users will receive regular notifications prompting them to update their daily activity log within the app. Whether it is recording time spent with friends or family, going to work, or completing a simple workout, our notifications serve as a gentle nudge to maintain an accurate and meaningful log. By staying consistent with the daily activity log update, users can gain valuable self-awareness, track patterns, and make informed decisions to enhance their productivity and personal growth.

1) **Stress Level Reminder:** Our app's daily stress survey completion notification feature encourages users to provide valuable feedback about their day-to-day stress levels. We hope to help mitigate participants experiencing high stress levels, so we have implemented this helpful reminder system. Users will receive periodic notifications asking them whether they rate their overall stress level as “None,” “Low,” “Medium,” or “High”. By participating in the survey, we can track trends in users' stress levels and correlate them with the rest of the data to determine potential stress indicators and mitigate or prevent them.

GAMIFICATION

The gamification system coordinates the previously described GOALS into the core interaction loop of the app. In this loop, tasks are drawn from the 5-Key methodology, are monitored for completion using the appropriate subsystem, and then are recognized as completed so that the user may receive points and advancement within the game. After each loop, additional tasks are issued either automatically or at the behest of a case manager.

Implementation of the 5-Key Model

The gamification system relies on a core loop to engage users – first, they are given tasks drawn from the 5-Key methodology. The corresponding subsystem monitors the user's behavior for task completion. Then, finally, the completion is verified and rewarded within the gamification system.

The 5-Keys relate to these monitoring subsystems as follows:

- **Healthy thinking patterns** are verified through a combination of the library, health, and prompt subsystems. By having users participate in the cultivation of healthy thinking patterns and then by verifying the bio-indicators of lower stress via heart rate and blood pressure, verifiable progress can be made along this key.
- **Meaningful work trajectories** are monitored through the job subsystem and by existing frameworks in the regularly scheduled corrections meetings. The job subsystem creates the initial contact between a parolee and an applicable job opening. Then the regular meetings ensure both maintenance of professional behavior and ongoing discussion around the participants' satisfaction with their employment situation.

- **Effective coping strategies** are monitored through the same systems surrounding healthy thinking patterns - the library, health, and prompt subsystems. The feedback mechanisms are the same between the two systems. Still, the difference in focus between psychological upkeep and acute stress management results in different tasks being issued between the two keys.
- **Positive social engagement and positive relationships do not correspond to a subsystem of the GOALS app, as the subjects'** social interactions are not directly monitored. Instead, conversations between the participant and their assigned case manager give said case manager information, which they use to subjectively evaluate the participant's progress in this key.

The following table consolidates the relationships between the 5-Keys and the associated GOALS subsystems.

Key	Evaluation method	Monitoring Subsystem
Healthy Thinking Patterns	Direct	Library & Health
Meaningful Work Trajectories	Direct	Job
Effective Coping Strategies	Direct	Library & Health
Positive Social Engagement	Indirect	N/A
Positive Relationship	Indirect	N/A

The 5-Keys of Reentry are interconnected in terms of subject matter but can be pursued independently by the user. For instance, becoming integrated with one's community and integrating into one's workplace are separate pursuits, even though progress in one area can benefit the other in practice.

In implementation, this pursuit of multiple independent objectives maps neatly onto the Rubber Band model's perquisite for simultaneous parallel advancement. Using each key as a category, we can tune the degree to which progress at different points in the process is incentivized. All the while, the total number of points is preserved due to normalization, so total gamification

progress remains a viable metric for dispensing behavior-based rewards.

Since each of the 5-Keys has a set number of tasks to complete, we can determine the percentage completion for each category and use that percentage as the metric for performance in each key. From there, applying a linear evaluation function results in a dynamically rebalancing allocation of point incentives. This hyper-parameter was chosen for its ease of explanation, given the necessity for lay people on both the backend and front end to understand the adjustment algorithm in troubleshooting and maintenance.

Rewards within the SMS4CS system are given out for two criteria. The first is a set of cosmetic, non-tangible rewards given out through the Vista system (see Figure 7). The second is a track of rewards that is rewarded, one by one, as a reward for total system progress.

Figure 7. The Vista system. These screenshots show a user selecting the level of their car asset. Assets for the yard, friends, and house tracks are visible in the background. Specifically, the yard asset has a glowing icon, indicating to the user that they have unclaimed points that they can redeem and further advance towards a level up.

DASHBOARD

In addition to the GOALS app for the participant, the Dashboard system is designed to

empower case managers to monitor and analyze a large amount of data produced by participants and identified by the SMS4CS (Support and Monitoring System for Community Supervision). The objective of the Dashboard system is intended to allow case managers to oversee the participants' progress on their 5-Key activities, assign and track appointments, and explore their day-to-day data from the app.

For this goal, the dashboard system enables case managers to access a large amount of data produced by participants and identified by the SMS4CS via multiple user interfaces. The dashboard is also designed to give the case manager clear insight into critical patterns and impactful factors related to participants' activity data collected by the GOALS app. Particularly, the system provides a suite of exploration and analysis tools for understanding the large aggregation of collected data in the SMS4CS system. This will assist officers and case managers in better exploring and understanding the activity patterns of single or multiple participants. The interconnected visualizations also facilitate the identification of spatial and temporal information concerning participants' daily activities in terms of the 5-Keys and health status, thereby encouraging positive behaviors among JII.

Specifically, the Dashboard system is separated into distinct views and user interfaces designed to streamline their management and exploration of participant data (see Figures 8 – 13).

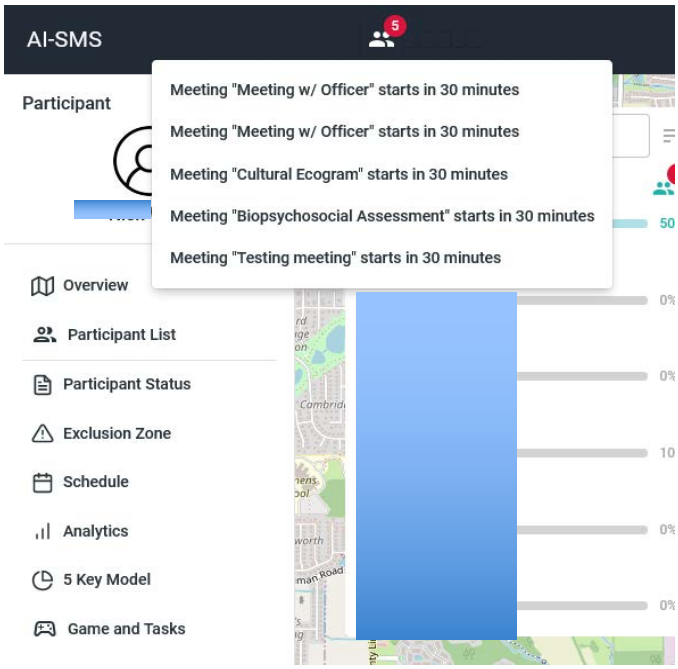

Figure 8. The overview screen, shown upon login (a). Active alerts are shown with a high-saturation red. Associated UI elements can expand into alert lists (b).

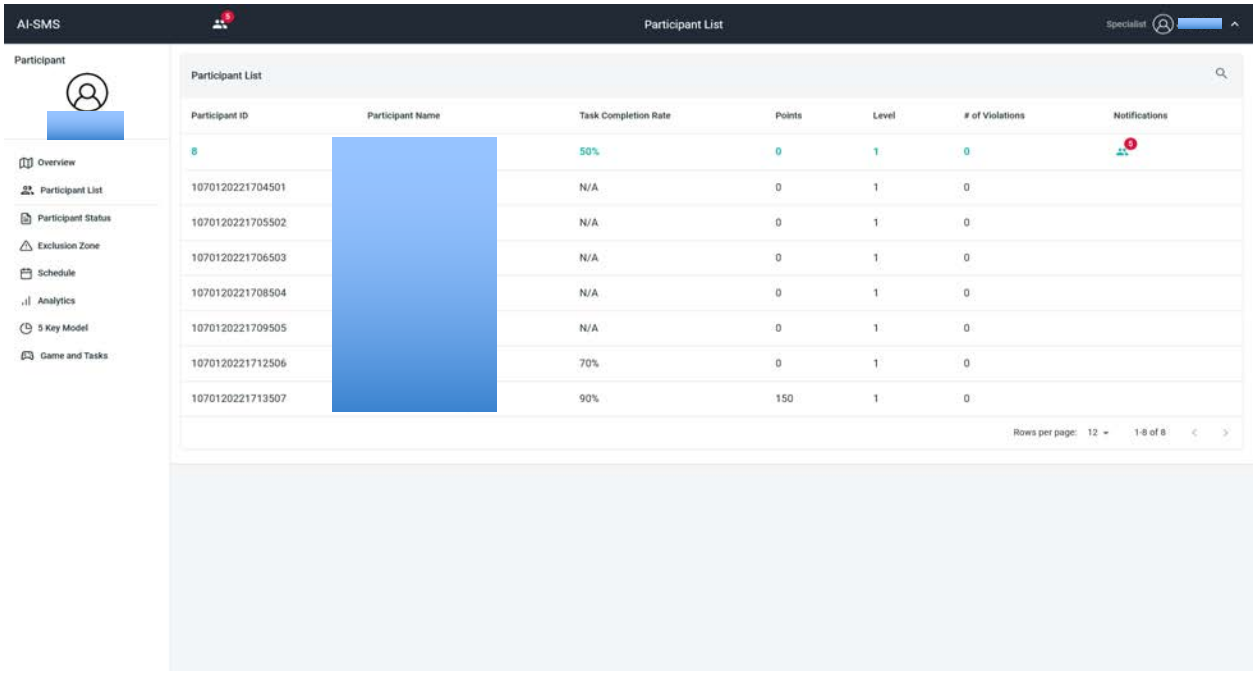

Figure 9. The participant view presents the list of participants under a case manager's responsibility.

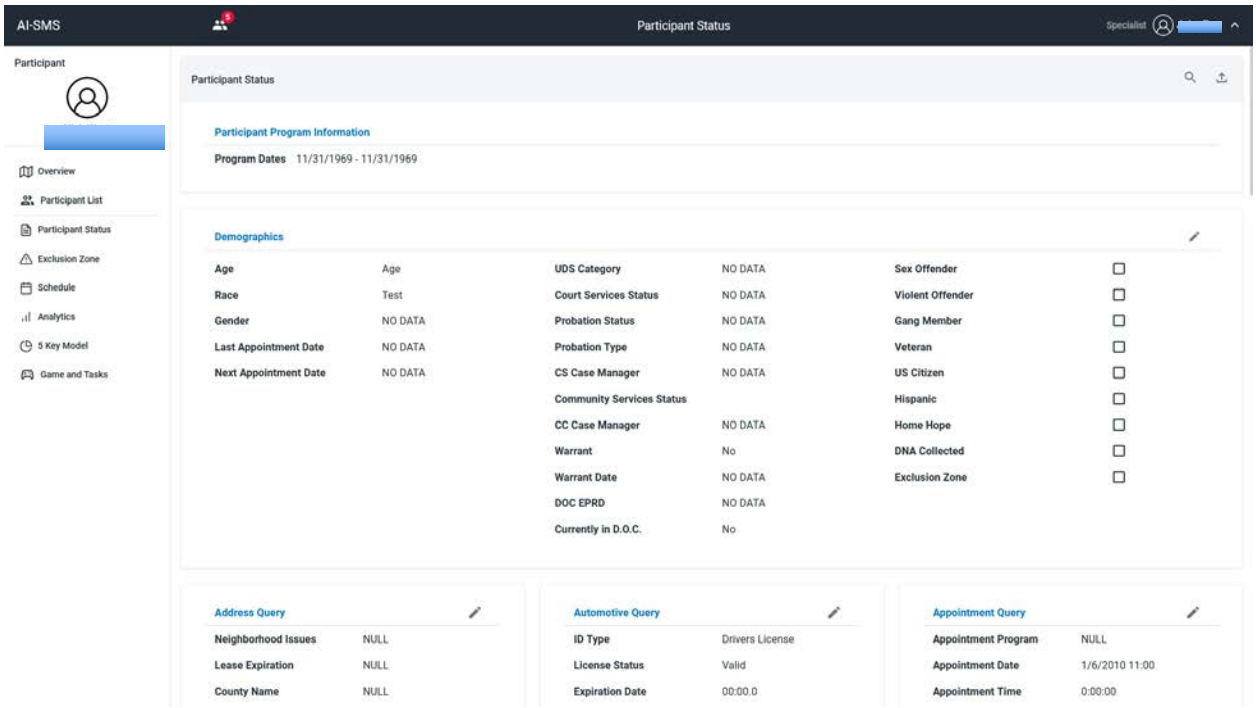

Figure 10. The Participant Status view provides in-depth information on a single JII.

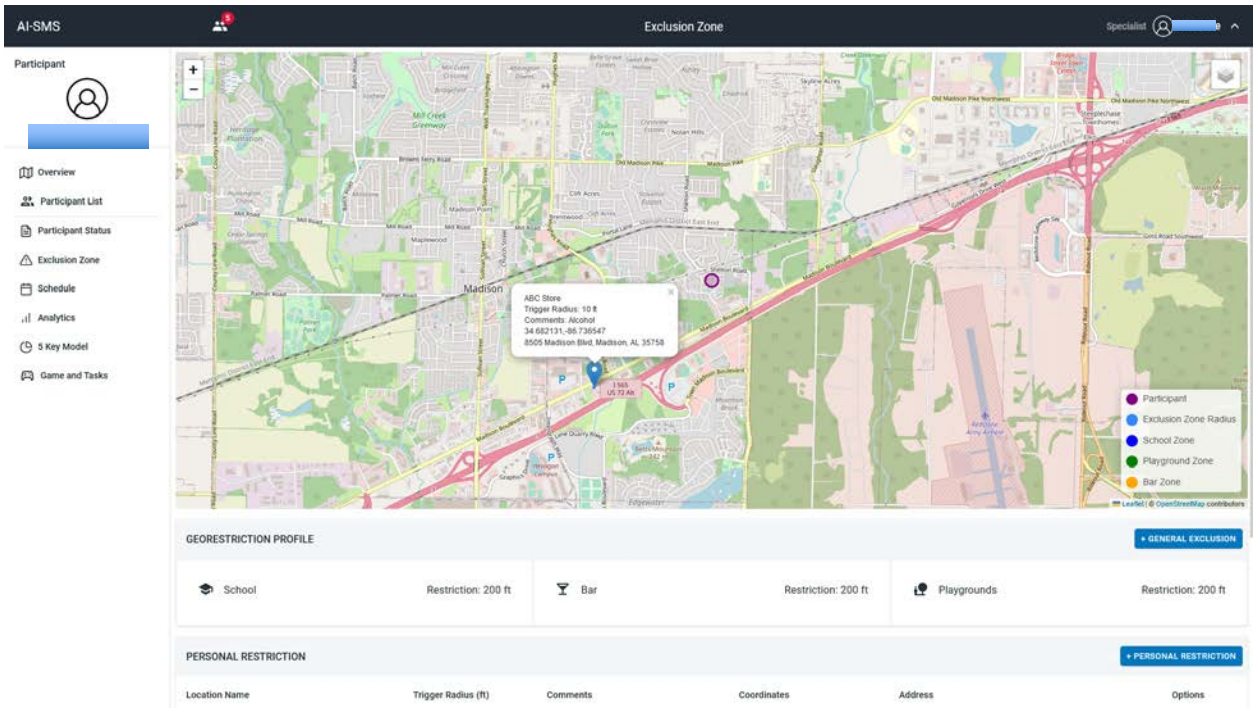

Figure 11. The Exclusion Zone view uses the participant's geolocation data to ensure restricted areas are not entered.

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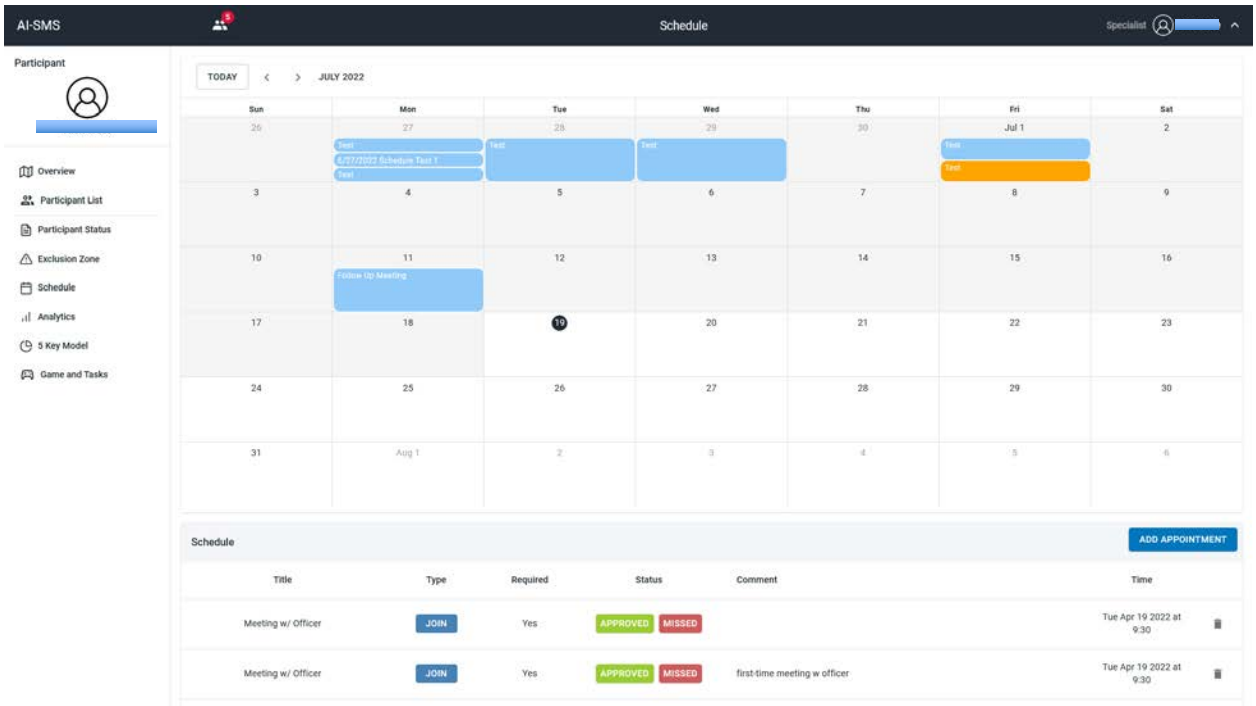

Figure 12. The Dashboard includes a schedule view similar the GOALS apps, where events are itemized as both lists and regions of a calendar.

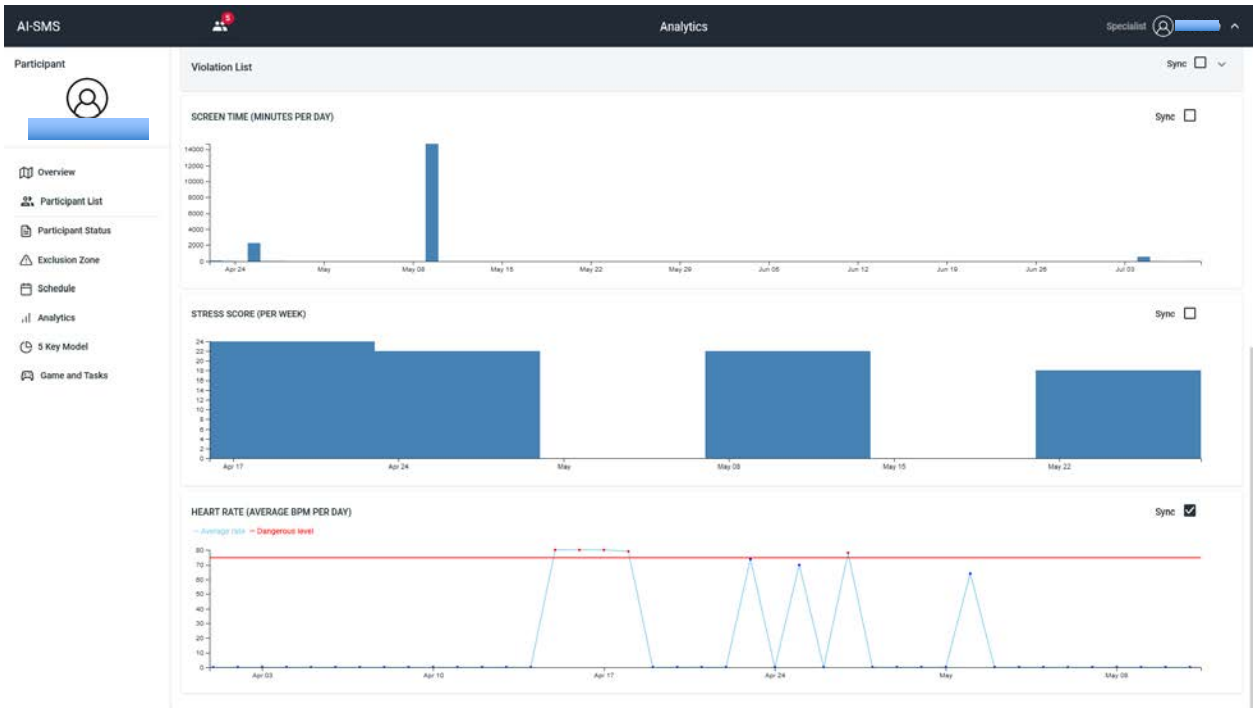

Figure 13. Various views are stacked vertically within the Analytics screen and placed below the map visualization. Top to bottom: Screen time, stress score, heart rate.

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- The **Overview view** shows the list of participants managed by the currently logged-in case worker, along with a map of their locations and exclusions.
- The **Participant List view** shows a more robust table of participants managed by the case worker, features several columns showing different information about the participants, and allows the case worker to select the participant that they would like to manage in the rest of the dashboard.
- The **Participant Status view** allows the case worker to view, upload, and edit participant information based on several files received when registering the user for the program.
- The **Exclusion Zone view** shows the general and personal exclusions for the selected participants and allows for creating new personal exclusion locations.
- The **Schedule view** contains a calendar of appointments and a table of appointments. There is also a menu that allows for the creation of new appointments.
- The **Analytics view** shows several data visualizations regarding the participant, such as violation counts over time, heart rates, and screen time, as well as a map featuring locations relevant to the participant, such as exclusion zones and violation locations.
- The **5-Key Model view** allows the case manager to set up new assessments and sessions relating to aspects of the 5-Key model for the participant.
- The **Game and Tasks view** visualizes the participant's game score statistics, the list of tasks created for the participant, and visualizations of analytics relating to those tasks. A list of rewards the participant can redeem or has redeemed for doing tasks in this view.

The intended use of the dashboard is to make monitoring participants easier for case

managers, who typically manage about 50-60 participants at any given time. Each participant has, on average, a 90-day enrollment in the community corrections program, which is determined by a judge (moderate or high-risk participants may be accorded a longer enrollment period).

To identify the design requirements of the dashboard, we had three meetings with case managers from the Tippecanoe County Community Corrections (TCCC) to learn more about their tasks and requirements. We then incorporated their stated needs and requirements into designing and building our dashboard system design.

CHATBOT

When a participant uses the GOALS APP that we have discussed above, they can complete the sessions and primary assessments through an available chat system. The chat system allows participants to finish the assigned tasks at their own pace and on their own time, while freeing up time for the supervisory staff for other more pressing tasks. The current chat system integrated into the SMS4CS application, though interactive, is not intelligent. The workflow for the current chat system integrated into the SMS4CS app is shown in Figure 14.

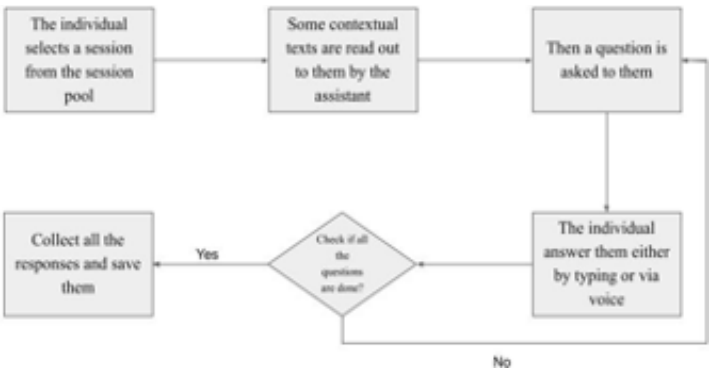

Figure 14: Workflow

When a participant starts a session, a brief introduction about the session is displayed in the form of **statements**, followed by **questions**. Both statements and questions have context related to the session topic. A response provided by a participant is considered valid if it is in context of both the statements and the questions of the session. In the above figure, note that initially, some contextual texts (**statements**) are read out by the Chat system (or printed out), which is predefined and stored in our system. Next, one or more questions are asked of the participant by the Chat system (again predefined and stored questions), and the participant is expected to respond to each question. Note that after the question, the participant's response is stored and then either the next question is asked (again pre-stored) or the next contextual pre- stored text is read out. Thus, the current chat system assumes that the responses the participants give are always in context to the statement and questions put forward by the chat system. However, in real world situations, this is seldom the case. For example, a participant might unintentionally type something not in context of the statement and/or the questions. However, the aforementioned chat system will fail to respond to such a scenario and will simply store the plausibly wrong answer and move on. We have worked on a second iteration of the chat system, which we call the AI enabled chat system, to fix this problem.

The AI enabled chat system, as the name implies, uses Artificial Intelligence (AI) to determine whether the response from the participant is in context of the statement and questions posed by the chat system. If they are, then the normal flow of the chat is maintained, and the next statement and question is presented to the participant. However, if this is not the case (that is the response is not in context or gibberish), then the chat system responds accordingly using auto AI generated texts to prompt the user to correct their response to make the recorded response relevant and useful to the participant and their supervisors going ahead. A sample session from the AI-enabled chat system would be as shown below (Figure 15):

Figure 15: Chat System

We have used a custom-built dataset to train and test the AI enabled chat system, which has been implemented using state of the art AI algorithms in the realm of natural language processing (NLP). Our implementation uses only open-source software and our custom-built dataset and hence does not involve any proprietary information or licenses. Also, note that the AI powered chat system is a product of research and not integrated into the central SMS4CS system. We plan to publish this work as a peer reviewed paper.

Ambient Noise Fingerprinting

To support the original goal of the SMS4CS system, which was to help social integration and reduce recidivism of justice involved individuals (JII), the ambient noise fingerprinting system was conceived. However, due to the constraints imposed on the final deliverable, the ambient noise fingerprinting system was never integrated into the main deliverable branch of the SMS4CS

application. This system currently stands as a standalone research project, which will be published in a peer reviewed venue for public dissipation of scientific knowledge on the problem of identifying the nature of a given location from background noise signatures.

Ambient noise, as the name suggests, refers to the background noise spectrum at any given location. Humans are very good at identifying the nature of the location at which a background spectrum recording is done. Thus, for example, if a person is shown the recording from a railway station, they will be able to identify the location as being a railway station with high confidence. The situation is similar with parts or grocery supermarkets. However, this same task is complicated when posed to an automated system.

For this project, our goal was to build an automated AI enabled system that would be able to identify the nature of a location from background noise (sounds) recorded from that location. We used a neural network-based model for our implementation. Succinctly, we used a convolutional neural network that worked with spectrograms of the ambient noise signatures and classified the associated location into various categories like supermarkets, grocery stores, railway stations, parks, etc. Since we were unable to integrate this system into the SMS4CS app, we used custom built datasets created by the students along with freely available public datasets for our implementation. We used the publicly available data for training and our custom data for testing in a transfer learning setting. As mentioned, the results will be published in a peer reviewed publication.

Results and findings

The technology was seamlessly integrated into a functional community corrections environment, with no disruptions or reported interruptions to the day-to-day operations of the Tippecanoe County Community Corrections (TCCC). The technology enrollment process for participants (N = 35) and device setup achieved a remarkable 100% success rate. Over approximately 4 months during the testing phase with TCCC, there were no reported help desk requests for technical assistance.

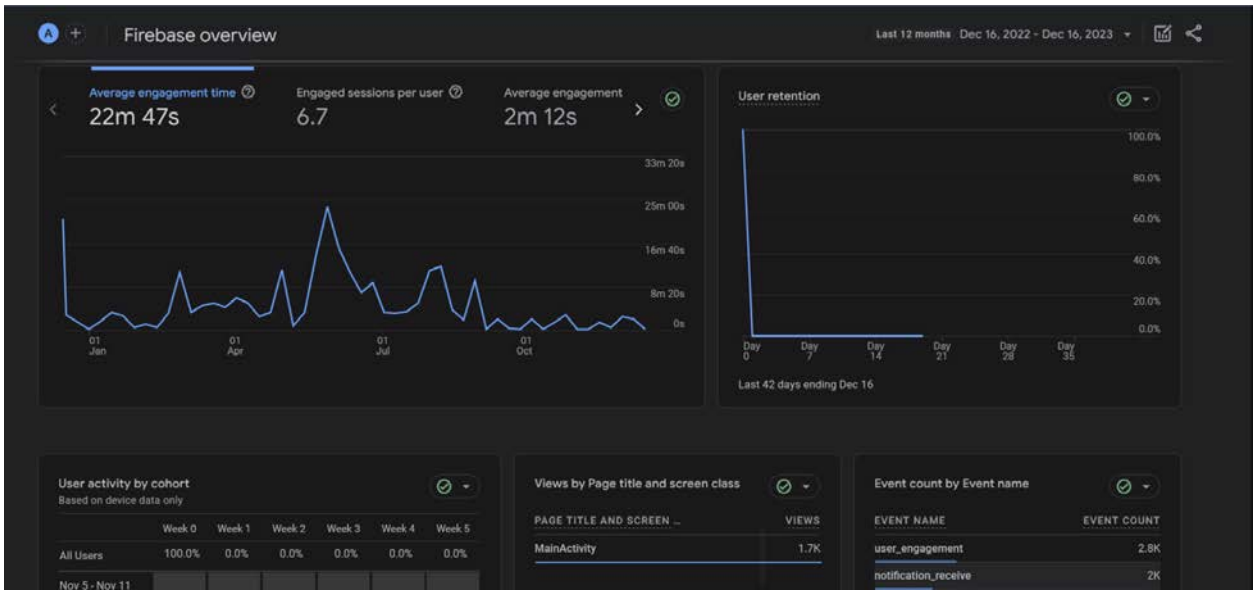

Figure 16: User Activity logs and engagement with the system

The figure above shows an average 22-minute engagement time of the app by users over the duration of the study period. In addition, anonymous usage data was collected regarding what pages users visited and how often they visited those pages. The usage data

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was used to provide users with a better user experience on the pages they were visiting the most often, as a means to maintain overall engagement time in the app. Over the study period, user feedback and engagement were used to identify and fix approximately 20 different bugs across our GOALS App, Health App, Backend, and Dashboard (see Figures 16-18).

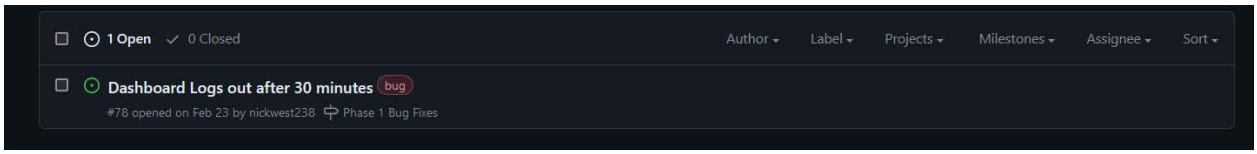

Figure 16: Dashboard Bugs

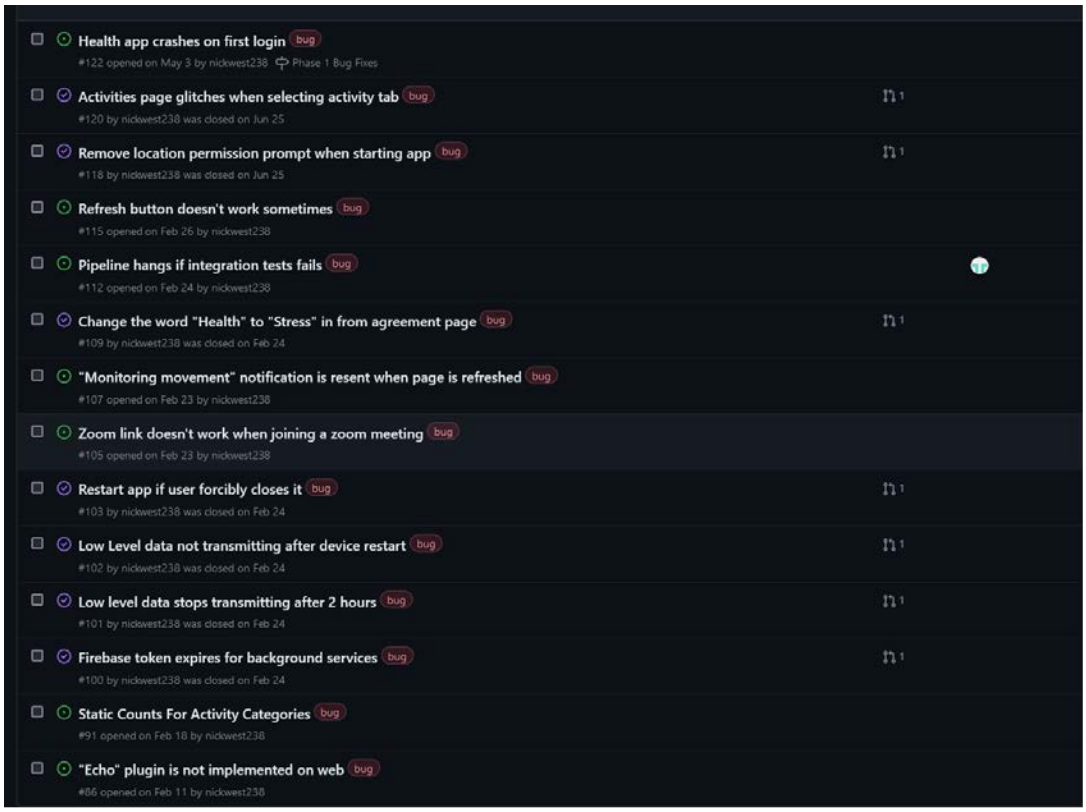

Figure 17: Health App Bugs

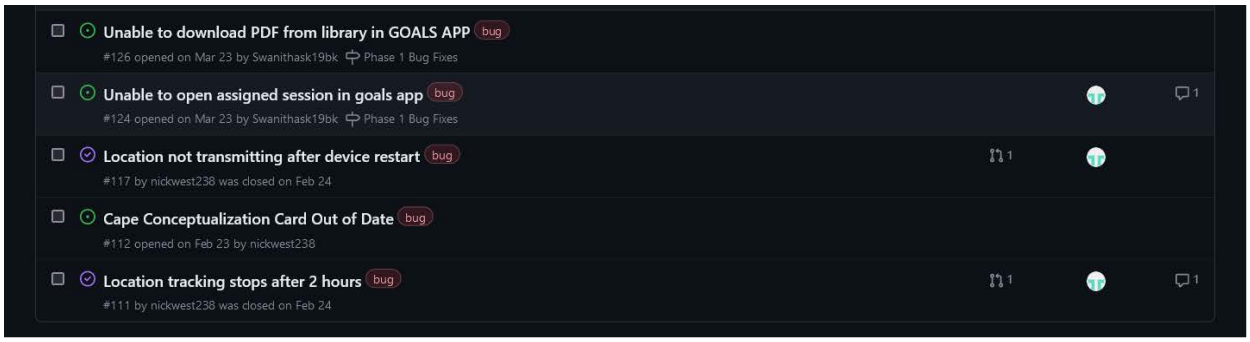

Figure 18: GOALS App Bugs

These results demonstrate the technical and operational feasibility of developing and deploying an automated system (SMS4CS) capable of effectively facilitating the implementation of innovative intervention approaches, such as the 5-Key model.

Additionally, we analyzed the needs and challenges faced by JIIs and case managers. The U.S. criminal justice system is currently overwhelmed with a large number of JIIs, including those convicted of crimes, arrested, or released from prison. This situation strains the system's limited resources, making it challenging for case managers to provide effective rehabilitation opportunities. Factors contributing to this issue include mass incarceration, high rates of recidivism, and the lack of suitable management solutions for JIIs. Additionally, the field of managing JIIs is notably understaffed. While automated data capture methods exist, they often fail to address JIIs' privacy concerns and do not present information in a way that allows case managers to manage large numbers of JIIs efficiently and effectively.

To address these problems and challenges by both JII and case managers, we implemented, tested, and deployed three interfaces—the GOALS (Gaining Occupational and Life Skills) smartphone app, the gamification system, and the dashboard web app. The user base of the system is split by these different interfaces that have been developed in the overall system. Using these interfaces, JIIs, and case managers can interact with SMS4CS.

- We tested and observed that the GOALS app successfully operates, allowing users to interact with the SMS4CS system via their smartphones. This interaction provides access to tasks, assessments, sessions, and meetings assigned by the case manager through the SMS4CS Dashboard system.
- We noted that the gamification system successfully integrates the aforementioned GOALS into the app's core interaction loop. In this loop, tasks, derived from the 5-Key model, are monitored for completion through the relevant subsystems. Upon completion, users receive points and progress in the game. New tasks are then issued, either automatically or at the discretion of a case manager/specialist.
- The Dashboard web application was developed for case managers to oversee, analyze, and engage with JII cases under their supervision. Our testing confirmed that all activities of users using GOALS and the gamification system are trackable and visualizable on the Dashboard system. The primary function of GOALS is the assignment of tasks, integral to the gamification system. These tasks, issued by case managers and fulfilled by JII, are tracked by SMS4CS subsystems. It's important to note that the Dashboard is equipped with features for both case managers and supervisory officers, and in different implementations, specific features may be disabled to align with authorized roles.

Limitations

1) The first limitation pertains to the compatibility of the developed applications, which are currently designed exclusively for mobile phones running the Android operating system and smartwatches running WEAR OS. Furthermore, an adequate data plan (e.g., 10 GB) is required to enable seamless data collection and synchronization with the backend system.
2) The second limitation arises from a protocol constraint that prevented any analysis of data related to the applications' effectiveness in enhancing the successful reintegration of Justice-Involved Individuals (JII) into the community. Consequently, key outcomes such as reduced rates of recidivism and improved overall integration into the community could not be assessed.
3) Additionally, the approved study protocol restricted access to the developed dashboard system to a research team member acting as a case manager. As a result, feedback from Tippecanoe County Community Corrections (TCCC) case managers regarding the automated systems, particularly the Dashboard, was not obtainable.

Artifacts

List of Products

Conference Presentation:

1. Nicholas Diliberti, Haeyong Chung, Yansi Keim, Marc Rogers, Umit Karabiyik, Sudhir Aggarwal, Tathagata Mukherjee, and Carrie Pettus. (2023, July). Supporting and Motivating Re-integration of Justice-Involved Individuals Through Dynamic Gamification.

Presented at International Conference on Human-Computer Interaction, Copenhagen, Denmark.

Journal Articles

1. Hutchinson, S.; Mirza, M.M.; West, N.; Karabiyik, U.; Rogers, M.K.; Mukherjee, T.; Aggarwal, S.; Chung, H.; Pettus-Davis, C. Investigating Wearable Fitness Applications: Data Privacy and Digital Forensics Analysis on Android. *Appl. Sci.* **2022**, *12*, 9747. https://doi.org/10.3390/app12199747

2. Nicholas Diliberti, Haeyong Chung, Yansi Keim, Marc Rogers, Umit Karabiyik, Sudhir Aggarwal, Tathagata Mukherjee, and Carrie Pettus. 2023. Supporting and Motivating Re-integration of Justice-Involved Individuals Through Dynamic Gamification. In Human-Computer Interaction: Thematic Area, HCI 2023, Held as Part of the 25th HCI International Conference, HCII 2023, Copenhagen, Denmark, July 23–28, 2023, Proceedings, Part IV. Springer-Verlag, Berlin, Heidelberg, 258–275. https://doi.org/10.1007/978-3-031-35572-1_18

Pending Manuscripts

1. Sai Swanitha Kedeboyina, Pushwitha Krishnappa, Sudhir Aggarwal, Tathagata Mukherjee, Marcus Rogers, Haeyong Chung, Umit Karabiyik, Design and Implementation of an Ai based Intelligent Chatbot System for Interventions with Justice involved Individuals in the Criminal Justice Ecosystem, Pending submission to conference/journal.
2. Pushwitha Krisnappa, Vishal Perekadan, Shiva Guralla, Sudhir Aggarwal, Tathagata Mukherjee, Marcus Rogers, Haeyong Chung, Umit Karabiyik, A Transfer Learning Approach for Ambient Noise Fingerprinting for Location Identification, Pending submission to conference/journal.

3. Md. Shamim Shiraj, Sudhir Aggarwal, Tathagata Mukherjee, Marcus Rogers, Haeyong Chung, Umit Karabiyik, A Semi-Supervised Approach for Speaker Segmentation and Audio Extraction, Pending submission to conference/journal.

Technology Archived

Rogers, M. K., Karabiyik, U., Aggarwal, S., Mukherjee, T., Pettus, C., Chung, H. (2023). AI Enabled Community Supervision for Criminal Justice Services. Purdue University Research Repository. doi:10.4231/CE0C-WR64

Data sets generated

As this research focused on technology, no data sets were created. The code developed for the technology 1) Backend, 2) GOALS, 3) HEALTH, and 4) DASHBOARD has been made available via PURR (see previous section).

Dissemination activities

1. Pettus, C. & West, N. (May 2023) *AI-Enabled Support Services for Individuals Under Community Corrections Supervision*. National Institute of Justice National Research Conference. Arlington, VA.
2. By Brannon Green, former AAAS Fellow; Christopher Rigano, Senior Computer Scientist, NIJ , "Specialized Smartphones Could Keep Released Persons on Track for Successful Reentry ," April 20, 2020, nij.ojp.gov: https://nij.ojp.gov/topics/articles/specialized-smartphones-could-keep-released-persons-track-successful-reentry.

3. Purdue News Service. (2020). *Artificial intelligence examines best ways to keep parolees from recommitting crimes*. Retrieved January 1, 2024, from https://www.purdue.edu/newsroom/releases/2020/Q3/artificial-intelligence-examines-best-ways-to-keep-parolees-from-recommitting-crimes.html
4. Steele, J. (2019, October 22). *AI system being developed under $1.9 million grant to help parolees integrate into society*. The University of Alabama in Huntsville. https://www.uah.edu/news/news/ai-system-being-developed-under-one-point-million-grant-to-help-parolees-integrate-into-society