

Development of a Multi-feature Smartphone App for Two Critical Workforces in Texas for Mitigating Opioid Overuse

**WRITTEN BY
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**INSTITUTE FOR
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Title: Development of a Multi-feature Smartphone App for Two Critical Workforces in Texas for Mitigating Opioid Overuse

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1.0 INTRODUCTION

Opioid Use Disorder (OUD) is a pressing public health in the United States. Sadly, nearly two-thirds of all drug overdose deaths in the U.S. have been associated with the misuse of opioids (Scholl et al., 2018). Singlehandedly, OUD resulted in more than 446 thousand deaths in the U.S between 1999 and 2018, and in 2018 in Texas, opioid overdose was attributed to 1,402 deaths. (Wilson et al., 2020; NIDA, 2020)

Literature indicates that opioid-related morbidity and mortality are significantly impacting American workplaces. The results of opioid misuse in the U.S. have been elevated workers' compensation and health insurance costs, absenteeism, and lost productivity. The National Institute for Occupational Safety and Health (NIOSH) reported that 44% of workers' compensation claims in 2017 were linked to opioids prescriptions (Harduar Morano et al., 2018).

Recent data published by the Bureau of Labor Statistics found that OUD has had a profound and significant effect on workers' health, safety, and well-being in particular industries. Industry sectors such as transportation, warehousing, construction, and healthcare have experienced higher than average opioid-related difficulties. (Bureau of Labor Statistics, 2020). In these crucial industries, opioid use and misuse accounted not only for worker lost time, but alarmingly opioid use and misuse accounted for 61% of drug-related deaths among workers (Shaw et al., 2020). The reasoning for these OUD workplace disruptions is attributable to the innate nature of these industries as these work environments have the least access to paid sick leave as compared to other industries as well as require a great deal of physical work (Dissel et al., 2016; Bunn et al., 2014).

The physical nature of transportation and warehousing, and healthcare makes industry workers vulnerable to acquired pain and injuries on the job. These health conditions often generate the need for medical services, which can include a provider recommendation for opioids. Therefore, the combination of on-the-job risk factors for injury and provider prescription recommendations increase the risk of developing OUD within these occupational groups (Shaw et al., 2020). As a result of these factors, there is a clear need to develop public health interventions for these vulnerable occupational groups to help reverse the continuing opioid crisis.

With the emergence of new smartphone technologies, health interventions do rely solely on face-to-face delivery and can be widely utilized outside the clinical settings via mobile health (mHealth) tools. Literature indicates that smartphone Apps are easily accessible that allow patients to access the required information upon request whenever necessary (Sheikh et al., 2021). The main advantages of the App are to offer multimedia features that combine texts and audiovisual information, comprehensive activation, reproducibility, and final feedback about a health issue (Malale et al., 2020). Therefore, we anticipate that a smartphone app-based behavioral mitigation strategy may be effective in significantly reducing the burden of OUD among Texas workers who are at risk of excessive opioid use or who are already addicted.

We propose to develop a multi-feature smartphone App for two critical occupational groups in Texas: 1. transportation and 2. healthcare workforces. Our primary goal is to reduce the prevalence of opioid overuse in these critical infrastructure sectors and promote the health and well-being of the employees via technology-based intervention. We believe our innovative educational public health technology will enhance the security and resilience in these two industries allowing them to continue the business in a healthier and more productive environment.

2.0 OBJECTIVES

We propose three research objectives that will help us accomplish our goal to mitigate excessive opioid use among transportation and healthcare workers, the two critical workforces vital for our homeland security. The first objective will characterize the risk of opioid use in these vulnerable occupational groups, which will be used to determine the features of the App. The second and third objectives will use machine learning technology to build the App for analyzing opioid addiction risk and mitigate the risk in individuals at risk and individuals who have already become OUD patients, respectively.

Objective 1: Identify the potential risk factors of opioid use in the Texas workforce with specific emphasis on transportation and healthcare workers.

Activity 1: Conduct an extensive literature review

- Assemble information to identify the risk factors such as injury, pain, use of medication, occupational and lifestyle stresses, depression, mood, and other triggers of uncontrolled opioid use.

Activity 2: Interview executives from these two industries

- Analyze data
- Code data
- Interpret data

Activity 3: Conduct focus groups with representatives from these two industries

- Analyze data
- Code data
- Interpret data

Objective 2: Build a multi-feature smartphone App for the Texas workforce in transportation and healthcare who are not characterized as OUD patients but vulnerable to opioid addiction.

Activity 1: Record data based on the responses from a user on various risk factors (identified by objective 1).

Activity 2: Analyze data based on the responses from a user on various risk factors using machine learning technology.

Activity 3: Develop and launch a user-friendly smartphone application that will:

- provide knowledge about OUD,
- assess the risk of the employees,
- provide a meaningful warning (educational intervention), and
- link participant with regional resources for opioid overuse prevention

Objective 3: Build a multi-feature smartphone App for the Texas workforce in transportation and healthcare to help the current OUD patients or individuals at risk of developing OUD to reverse this addiction.

Activity 1: Record data based on the responses from a user on various risk factors (identified by objective 1).

Activity 2: Analyze data based on the responses from a user on various risk factors using machine learning technology.

Activity 3: Develop and launch a user-friendly smartphone application that will:

- provide knowledge about OUD,
- assess the risk of the employees,
- provide a meaningful warning (educational intervention),
- link participant with regional resources for opioid overuse prevention

3.0 IMPACT/POTENTIAL MEMBER COMPANY BENEFIT

OUD has become a considerable challenge for the Texas workforce. In order to address this problem, we propose the creation of a multi-featured smartphone App to be created through a multi-step process. The process will begin with a detailed examination of current literature and research on OUD. SHSU faculty will seek out primary data from identified stakeholders following the literature review. Risk factors identified in either the literature review or the primary data collection will be assigned a score/weight. A supervised machine learning algorithm named logistic regression will then be used to consider each risk factor score. The sum total of these risk factors determines the overall score, which in turn establishes the individual's risk for developing OUD.

Upon completion of the algorithm, SHSU faculty will generate the interface of the App. The public face of the App will have the user complete a skip logic survey. After completing the App survey, the respondent will be assigned to one of three primary OUD risk levels (Normal, Moderate, and High) by the algorithm. The respondent will get a risk level as a report that is sharable to their

employer without exposing the details of the responses. Due to HIPAA privacy issues, data sharing will be kept limited. In addition, the App will provide a separate page that can educate and create awareness about the risk of OUD and can facilitate possible actions to mitigate it.

While this App can serve as a useful tool for combatting OUD, it is important to note that the respondent must be self-motivated to address their addiction; we carefully address that on a separate page in the App. This page functionality will allow the user to write some thoughts, things that trigger the OUD, and factors that help them abstain. This functionality also includes encouraging words to inspire upon completion of certain milestones. The impact of this App is far-reaching, affecting the health of individual workers, companies, industries, and communities. The communication of the risk of OUD to the individual worker through an App allows workers to manage their health proactively. Further, the App creates an opportunity for users to assess personal risk without jeopardizing the chance of disclosing personal health information before they are prepared to share their situation.

In addition, by targeting the transportation and warehousing, and healthcare companies, the App seeks out aiding vulnerable industries. As mentioned above, the physical nature of transportation and warehousing, and healthcare makes industry workers vulnerable to on-the-job acquired pain and injuries, which may require management through opioid. As recent experiences during the COVID-19 pandemic have confirmed, workers from the transportation and healthcare sectors are “essential” to ensure continuity of functioning for communities. By assessing the risks of OUD for the two important industries that are crucial for homeland security, our App will directly benefit the functioning and stability of Texas communities.

4.0 RESEARCH TEAM

We have assembled a team of investigators from the Computer Science and Technology and Population Health departments of Sam Houston State University to implement the proposed study by accomplishing the research objectives. The **Principal Investigator, Dr. ABM Islam**, has extensive knowledge and experience in smartphone App development and supervision. He is currently working on a project where the National Library of Virtual Manipulatives (NLVM) modules are reimaged as a smartphone App. Nonetheless, Dr. Islam is also working with Dr. Khan (Co-PI-1) in an interdisciplinary collaborative study that applies machine-learning algorithms to intervene eating disorders and other public health issues. **Dr. Khalid Khan, the Co-PI-1**, is an epidemiologist who has been doing quantitative research in public health interventions on occupational and vulnerable communities. He has applied technology-based educational intervention strategies in his research, including mobile health (mHealth). **In this project, Dr. Amanda Scarbrough is the Co-PI-2** and has extensive knowledge and experience in research on factors furthering individual and community health. Her research has been qualitative in nature, and she has over 10 years of experience creating and deploying surveys as well as analyzing data collected from vulnerable populations. In addition, Dr. Scarbrough has a great deal of experience in distributing health information to various audiences in a culturally, linguistically, and industry-specific modality.

5.0 RESEARCH PLAN

This section describes the research procedures that will be followed to accomplish our two research objectives.

5.1 Identify the Risk factors of Opioid Overuse

The SHSU team will conduct a literature review, administer focus group interviews, and create a short questionnaire survey to identify the risk factors for OUD targeting the two occupational groups of interest. Focus group interviews will be conducted in the transportation, warehousing, and healthcare industries. Interviews will be completed at the group's preference and can be done either on-site or via zoom. Focus groups will include both employees and executives and be led, coded, and interpreted by SHSU faculty. Additional (separate) focus groups will collect information from the clinicians serving vulnerable individuals at different clinics and hospitals.

The SHSU team will create a survey with multiple-choice and Likert scale questions. The survey will be created using Qualtrics and distributed via email, and will be disseminated to higher levels of executives and staff in the transportation, warehousing, healthcare industries, and clinicians serving the high-risk individuals from these two sectors. Results will be stored behind SHSU's firewall, ensuring the safety of responses.

Once the focus group and interview data are analyzed, the two Co-PIs will summarize the findings and share them with the PI of the project. The PI will then use the data to develop the multi-featured App.

5.2 Development and Design of the Smartphone App

We plan to build a smartphone app that can track work-related risk factors to be determined via objective 1. Potential risk factors include injuries, pain, mood, stress level, usage of medication, craving, and triggers. This collected data will be used for the machine learning models to predict the risk of OUD.

All responses in the App will be collected and stored in a cloud-based database. After a certain amount of usage, those collected App data will be downloaded from the cloud server. Moreover, each participant's usage and response rates will be tracked. Initially, we plan to develop an App that can be used by both iOS and Android users. iOS is the operating system for Apple devices, whereas all other device uses the Android system. iOS and Androids are different in nature and independent in-app compatibility. However, some programming languages allow cross-platform compatibility for app development. We will take advantage of this compatibility and use Kivy as a programming language to develop the App. Kivy is an open-source python library initially developed by MIT. This open-source library can run on various operating systems- Windows, Linux, iOS, Android, OS X, and Raspberry Pi. One of the most prominent Kivy features is, that the same code can run in any operating system. It is very much flexible and easy to use. The Kivy is open source, so it is free of cost, and anyone can use it. We want to develop the App available for all prospective users free of charge. A simplified Wireframe of the proposed multi-featured smartphone App is depicted in Figure 01. It is noteworthy here is additional features and functionality can be added as necessary in the future.

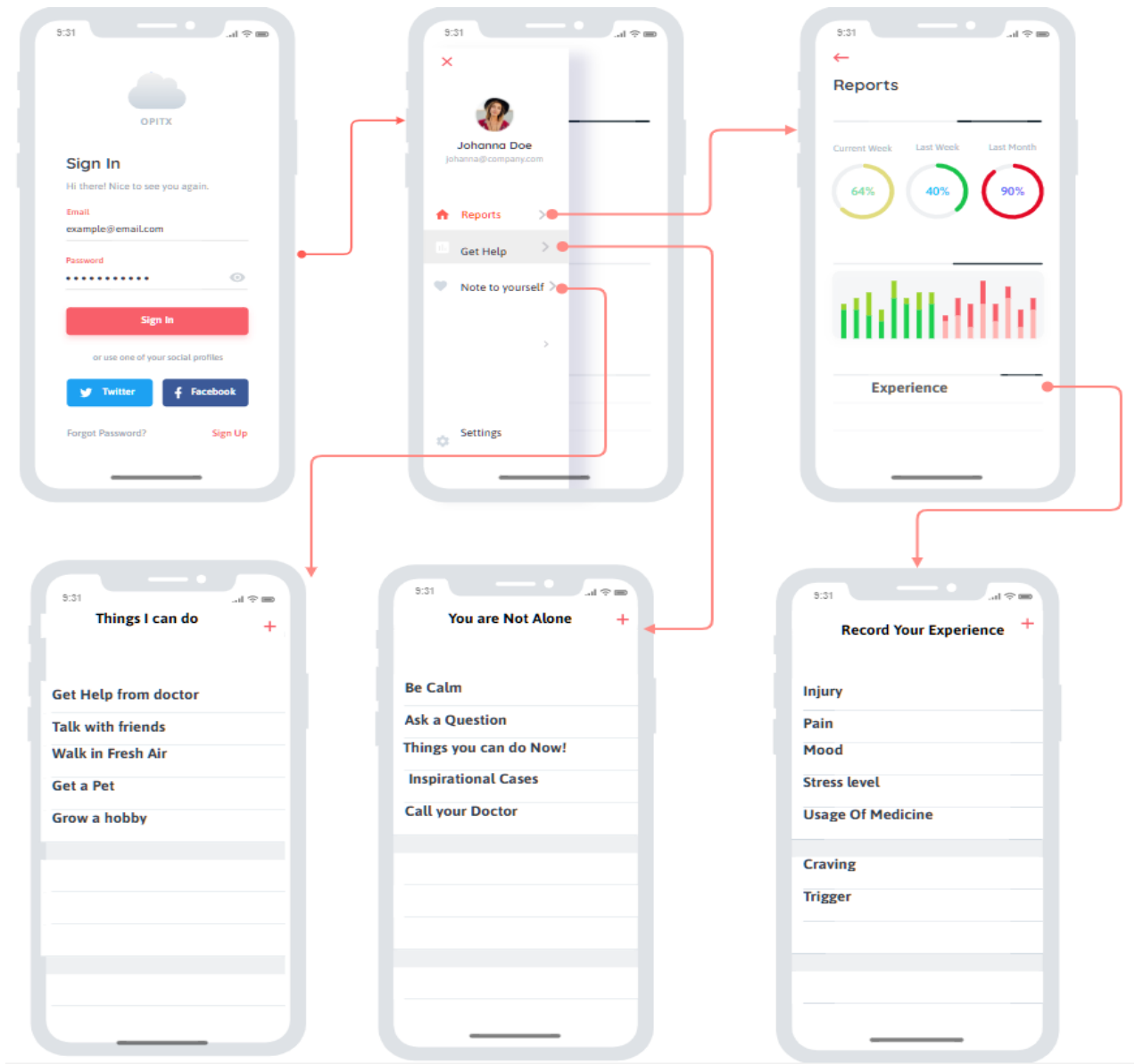


Figure 1: The wireframe of the proposed APP, a simplified description

5.2.1 Features and Navigation of the Proposed App

The App will have several functionalities, and each of the functionalities will be on a different page, as shown in Figure 1. The page and related functionality are described below:

Page Name	Homepage
Fields/ options	Sign in, Log in
Functionality	This page provides the user the functionality to sign in or log in. The fields take email addresses and passwords as a requirement. All that information is securely stored in a cloud-based database with state-of-the-art encryption to prevent data breaches.

Page Name	Option page
Fields/ options	Reports, Get help, and Note to yourself
Functionality	Reports: It generates a summary report based on user response to the experience and calculates the risk factors using Logistic Regression. Get help: It provides important information to educate the user Note to yourself: A journal to take notes and self-motivation.

Page Name	Reports
Fields/ options	Reports, Record their Experiences
Functionality	The reports page describes the overall reports for a user. On a separate page, it summarizes the weekly and monthly risk factors of OUD addiction in terms of percentage based on user responses. The color code will be used to distinguish among the various level of OUD risk factors. Experience: the user will be able to share their experience on the work factors- injury, pain, mood, stress level, usage of medicine

Page Name	Get Help (You are not Alone)
Fields/ options	Be calm, Ask a Question, Things you can do now, inspirational cases, call your doctor
Functionality	This page is designed to educate and provide insights, information, and suggestions to OUD patients. It gives various suggestions like being calm, asking a question to the community, things you can do, or in some cases, seeking help from the doctor.

Page Name	Note to yourself (Things I need to do)
Fields/ options	Get help from the doctor, talk with friends, walk in the fresh air, get a pet, grow a hobby
Functionality	It works as a personal journal. The user can write down notes about their findings, what steps they missed and what they learned to form their own experience. A user can also add some of their self-thinking suggestions here, which can be shared with their doctor during the visit

5.2.2 Feature Extraction:

All collected App data will be downloaded in a structured file format. In this file, the rows will describe the work-related risk factors, and the column will describe the level score for each factor. We plan to provide the following factors to get a response from the target group. However, any

work-related injuries need to be addressed. We like to have a Boolean response(Yes/No) for this function. The same goes for a trigger.

Moreover, other factors- pain, mood, stress level, usage of medicine, craving is also contributing factors for OUD. A scale from 1 to 10 will be used to track the level of responses. Each response will be scored in the following way, as described in Tables 1 and 2.

Table 1: Scoring for the risk factor with a Boolean response

Factors	Response	Score
Injury	Yes	1
	No	0
Trigger	Yes	1
	No	0

Table 2: Scoring of the risk factor with a response of various levels (one instance is given)

Factor	Stress Level									
Response level	1	2	3	4	5	6	7	8	9	10
Score	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

After recording all the responses and using the abovementioned scoring method, those scores will be used as an input to a Multinomial logistic regression model. The model will predict three categories- Normal, Moderate, and High Risk of OUD.

5.2.3 Machine Learning Model:

Features extracted from the previous steps will include scores from each work factor risk. These scores will determine the risk factor of OUD for an individual. The machine learning model we will use falls under the supervised machine learning category, called Logistic Regression. Logistic regression analyzes the relations between a categorical dependent variable and a set of independent variables. Among various logistic regression types, we will consider multinomial logistic regression for this project. Multinomial logistic regression is used when the dependent variable has three or more unique values. Logistic regression competes with discriminant analysis as a method for analyzing categorical-response variables. However, this logistic model will predict the probability based on the input scores, whether a respondent is at Normal, Moderate, and High risk of OUD.

6.0 TIMELINE

Task	May'22	June'22	July '22	August '22
1. Assemble information to identify the risk factors				
2. Interview executives from the transportation and healthcare industry				
3. Conduct focus groups with representatives				
4. Develop a user-friendly smartphone application				
4.1 Requirement gathering				
4.2 Build the Architecture				
4.3 Develop the Modules				
4.4 Testing				
Project Report				

7.0 BUDGET

Salaries and Benefits:

Principal Investigator (PI), Dr. ABM Rezbaul Islam, will be responsible for developing the opioid intervention App using information from the risk assessment. He will provide oversight of the entire project and coordinate collaborations between all investigators and student researchers associated with this project. His other specific tasks will include training a student researcher about App development, preparing project documents, monitoring data collection, developing databases, analyzing data, and reporting the findings of the study to the scientific community. We are requesting a three-month summer salary @ 50% effort (0.50 FTE), a total of **\$14,781** for Dr. Islam.

The Co-PI-1, Dr. Khalid Khan, will coordinate the logistics for collecting quantitative information about various risk factors (objective 1) via a structured questionnaire survey and literature review. He will analyze the data for objective 1, and then provide recommendations regarding the features of the smartphone App that the PI is going to develop. Dr. Khan will also pilot test the App on a small group of occupational workers from the transportation industry. We are requesting a two-month summer salary @ 40% effort (0.40 FTE), a total of **\$7,784**.

The Co-PI-2, Dr. Amanda Scarbrough, will coordinate the logistics for collecting qualitative information about various risk factors (objective 1) via focus groups and literature reviews. She will code and evaluate the data for objective 1, and then provide recommendations using qualitative approaches. We are requesting a two-month summer salary @ 40% effort (0.40 FTE), a total of **\$7,606** for Dr. Scarbrough.

We will hire two graduate/undergraduate student researchers to assist the PI and the Co-PIs. These students will implement the tasks outlined in objectives 1,2 and 3 under the supervision of the investigators. One student from Computer Science and another from Population Health will be involved in this project. Each student will get three months of summer salary @0.50 FTE. The budget for the students are provided below:

Student 1 (Computer Science): **\$4,800**

Student 2 (Population Health): \$4,800

The total budget for the project is: \$39,771

8.0 BIOSKETCH

PI: Dr. ABM Rezbaul Islam has a Ph.D. in Computer Science and Engineering. His research interest is focused on Artificial Intelligence, Computer Vision, and Mobile Health. He has extensive experience in object detection in images with a variety of applications. He has published several research papers on artificial intelligence-based methods for image processing. In particular, his research is focused on designing an artificial intelligence-based Convolutional Neural Network (CNN) model for medical image classification. His CNN models were successfully used to classify colonoscopy images based on severity, widely used to detect colon cancer commercially. Moreover, his research works were funded by NIH and Mayo Clinic, Minnesota. Currently, Dr. Islam is working on a machine learning approach to detect human skin in images and videos. He believes this research will help to filter out objectionable content from the web and also help law enforcement to stop women and child exploitation on the internet. Dr. Islam has been collaboratively developing a smartphone App for various areas of applications- health, national Library of Virtual Manipulatives (NVLM).

Co-PI-1: Dr. Khalid Khan is an Associate Professor of Population Health at SHSU is an epidemiologist who has expertise in developing and evaluating technology-based (e.g., computer or smartphone-App technology) public health interventions. Along with various foundation and state-funded grants, he has secured federal grants from the National Institute for Occupational Safety & Health (NIOSH) and the National Institute of Environmental Health Sciences (NIEHS) as a PI. After joining SHSU in 2020, he has received a large NIH R01 as a PI, a five-year project on the impact of environmental stressors on brain health. His research accomplishment in public health intervention has been highlighted in a newsletter published by NIEHS on its 50th anniversary. He has published many articles in peer-reviewed journals and done conference presentations involving both undergraduate and graduate students as co-authors.

Co-PI-2: Dr. Amanda Scarbrough is a tenured associate professor with the Department of Population Health at SHSU. Dr. Scarborough's primary research interests have focused on the intersection of location and community and individual health. Her research on location centers on how place affects individual and community health. The theoretical frame through which she examines this phenomenon is the Social Determinants of Health (SDOH). SDOH, or the environments in which people are born, live, learn, work, play, worship, and age, affect a wide range of health, functioning, and quality-of-life outcomes and risks. Dr. Sacrbrough's research has been funded the Texas Department of State Health Services, The Walmart Foundation and the Texas Higher Education Coordinating Board. All these grants have resulted in increased access to services and improved the health of the community. Dr. Scarbrough has several published articles and has done presentation in the area of location/geography and health. As a community-based researcher, Dr. Sacarbrough communities to be committed to improving the health of Texans.

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