ALERTNESS AND FATIGUE REPORTING SYSTEM

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U.P. OPEN UNIVERSITY
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Acceptance Page

This thesis titled Alertness and Fatigue Reporting System is hereby accepted by te Faculty of Information and Communication Studies, U.P. Open University, in partial fulfillment of the requirements for the degree Master of Information Systems.

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Biographical Sketch

The proponent has been in the IT industry for over a decade, serving the first half as an IT Practitioner for a National Government Agency and the latter half in a private IT company. Technology used is mainly in Microsoft and Web Technologies. This project is the first mobile application project handled by the proponent and hosted in Google Cloud Platform. The scope of work done in this project is technology architecture, development, and implementation. The ideation process was done with the help of the thesis adviser.

Acknowledgment

All thanks to my family and friends who supported me during the preparation of this thesis in one way or another. Sincere thanks to the representatives of the airline company who is the partner of the proponent during the initial conceptualization.

Special thanks to the faculty and members of the U.P. Open University Faculty of Information Communication Studies, especially to the adviser and the Advisory Committee.

Dedicated to:

Parents and siblings.

Abstract

Even before the pandemic, employers look for ways to get insights on people's engagement and mindfulness at work. The same is much needed now, given that the economy is still recovering, the quarantine and the fight against the pandemic is ongoing.

With the little interaction that employees have in person, it is more timely to have an application such as the one proposed here, to reach out to employees and listen to how they have been doing so far. Released in a form of mobile application, end-users can report their

Leveraging the offering of the cloud infrastructure, employers can get real-time information and be able to get better inputs for decision making.

Table of contents

CHAPTER I

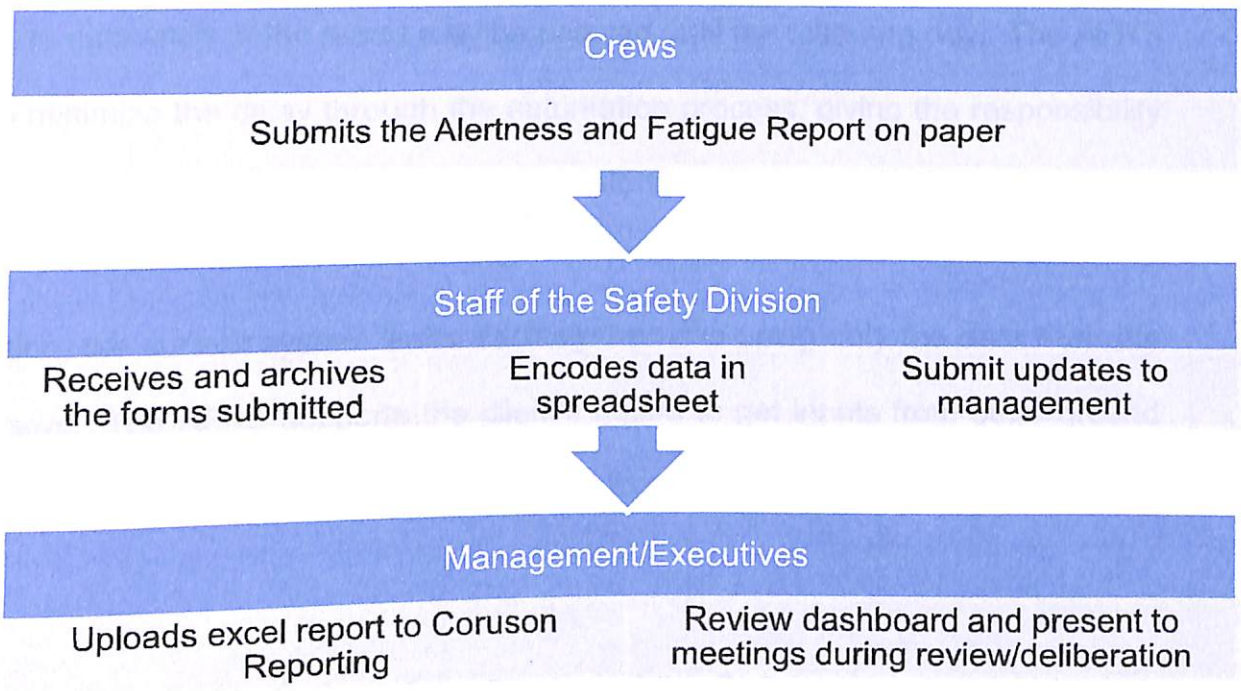
INTRODUCTION

Fatigue has many definitions but the focus of this study refers to the term 'fatigue' as the state of exhaustion an individual encounters at any given time due to factors such as extensive labor, lack of sleep, or stress. Based on the data gathered by the ICAO, IATA, and IFALPA, lack of sleep highly contributes to increased fatigue levels[1]. The same is mentioned in the study conducted in 2003 (Caldwell et.al), that sleepiness is the key factor for fatigue[2].

In the Philippines, the airline industries must comply with implementing Flight Risk Management System (FRMS). Companies have the prerogative to choose whether to adapt the FRMS recommended by ICAO, utilize related enterprise solution to monitor and track flight risks, such as Coruson Reporting System[3], or develop an in-house solution tailored for the company needs.

The client has adapted a hybrid approach. Tracking the alertness and fatigue of crew members are reported in paper-based form and once encoded, the users upload the records to Coruson Reporting which then offers dashboards for executives.

Figure 1. Existing process for Fatigue Risk Management System



SOURCE: *Personal communication, email message on November 5, 2019*

Objectives

The study focuses on the opportunity of helping the client to realize the value it could get in **automating the alertness and fatigue report** by getting the report directly from the end-users, and letting the employees track their own personal experience. The Figure 1 in the previous section shows that the report submitted by the employees are visible only to the Managers and Executives. Through the AFRS, the employees are given an overview of how they have been doing for the week. Users will be able to track their average daily score, and get insights on what is their top factor for their increased fatigue level.

In the current situation, the flight crews and the back-office staff have different shift, hence the data entry of the report may be delayed until the following day. The AFRS aims to minimize the delay through the automation process, giving the responsibility of data entry to the flight crews, baggage operators, and other ground personnel.

In addition, the current system limits tracking the risks using only the data from the flight crews. The AFRS supports the client's desire to get inputs from other ground personnel to get a more holistic view of the company's flight safety risks.

Limitation of the Study and the Software

The first phase of the AFRS application is available only as an Android app. This OS is selected as MVP due to the 83% of the market[4] are using android devices compared to others. The same code base can be used for Apple handhelds, however, additional configurations and a development machine in MacOS are needed to fully create a package compatible with Apple. Testing and Release in iOS is out of scope.

The Firebase Realtime Database libraries and packages used for AFRS are not yet supporting the web interface. There is no clear timeline from Firebase product owners on when this could be released to the general public, hence the web version is also being declared as out of scope.

The project rollout methodology will be done using APK packages, sharable links will be provided to select target users. The same link is shared to some of the client

employees for testing purposes. The AFRS android app is not available in Google Play Store.

The license used to host the Firebase Realtime Database is limited only to a 90-day trial period which will by July 2021. Data will still be available, however, additional updates cannot be done unless the plan is upgraded to a pay-as-you-go or an annual subscription. Refer to deployment risks section for more details about the upgrade recommendations.

Authentication process supported by the application is limited to Google Sign-in. In case client wants to change the sign in process, this will be considered as an enhancement.

Integration to other systems such as HR, Coruson Reporting, and other office application are not supported. In case the client desires to fully implement the project, a separate work plan will be created to tailor to the needs of the client, update the schema as necessary, and add more features such as integration to existing systems. Sample computation is documented in the Annexes section, to give an overview on operational cost.

The Daily Alertness Average Score is aggregated based on the report submission date and time. In edge case scenarios when users in overnight shift submits a new entry past 12 midnight, the latest submission will be used in computing the average for the current date or the day the entry is made. Reports are also limited to query using the

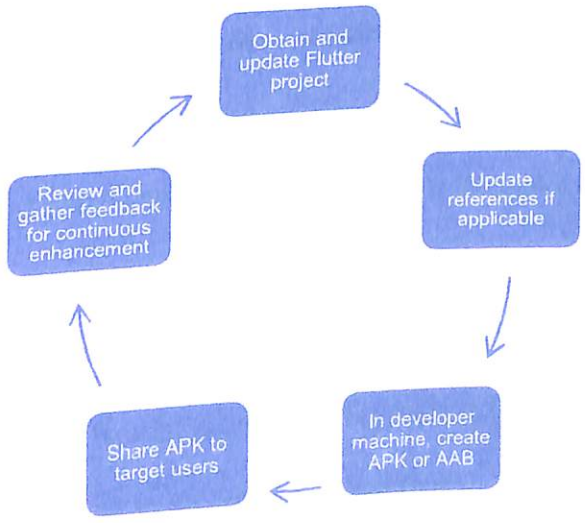
last 50 submissions per user, regardless of the date. Custom range filter is not part of the MVP.

Deployment Plan

This section is intended to discuss how the application is currently setup for distribution. Since the application is not uploaded in Google Play, the APK installers for the project are available in this link (https://drive.google.com/drive/folders/1EqjlY8ANrEbBssL4zg3h_Bsbso21x1Bv?usp=sharing).

If the source code project is updated, a separate build of Android App Bundle or APKs need to be generated again. Instructions on how to prepare the package are available online. Refer to the link in Annexes section for details.

Figure 2. Development Lifecycle



It is highly recommended that the client hosts and continuously publish updates in Google Play. This will help the distribution to target users easier to manage. The organization will need to pay a one-time fee of $25 to activate a Google Developer Account. Once activated, the organization can publish succeeding updates, and other apps using the same account.

Deployment Risks

The software development tools used to create and compile the android package are open source. However, the license used to develop the database featured in this document is a 90-day trial license. After July 2021, all transactions are halted until the proponent agrees to upgrade to a paid subscription plan.

Options for upgrade are Spark Plan and Blaze Plan. Spark Plan is free and highly recommended when developing free applications for students/educational purposes. This has monthly quota for accessing Realtime Database, with only 100 connections per month, 1GB data for the entire database and 10GB/month downloads. User authentication feature is also limited to 10k verification requests/month. Once quota is reached, subsequent connections are postponed to prevent incurring additional costs.

Another alternative is to setup account using Blaze Plan, a pay-as-you-go pricing model. With Blaze Plan, the offerings for Realtime Database is similar with the Free plan and once quota is reached, rather than denying subsequent requests, cost will be incurred to the owner's billing account. A sample is additional cost of $5 for every

GB that exceeds the quota. And for authentication, in excess of 10k verifications per month, a fee of $0.06/verification per day is incurred.

The project was created using personal Google account, hence direct transfer of the project from one organization to another is not feasible without the help of official Google Support representative.

It is recommended that prior to the full roll-out of the application in the company, the client avails a plan under its own Google Cloud Platform account, Firebase Account, and the Realtime Database. Regenerate the json file needed by the app to connect to Google's Application Programming Interfaces (APIs). Lastly, the client will need to recreate the application bundle to be able to use the new environment configuration.

CHAPTER II

REVIEW OF RELATED LITERATURE

In this chapter, selected application with similarity of purpose are highlighted, to provide additional information on what the client currently uses, and the available alternatives.

The Coruson Systems of Ideagen

Coruson is an enterprise level application for safety management with focus on aviation and railway industries. Ideagen has expanded its market reach to multiple locations, up by 500% since they have started, thus reaching out to more and more customers to date.

Coruson offers its clients a centralized view on safety management data which can be modelled and visualized to aid decision makers. This application is currently being used by the client for keeping the historical data of the Alertness and Fatigue Report. In addition, Coruson also offers Incident Management, Audit Management, Corrective and Preventive Action (CAPA), and Reporting/Analytics.

Headspace for Work[5]

Headspace Inc. is a U.S. based company offering courses on meditation and mindfulness. They are committed to integrating data collected from mindfulness

meditation with their clinical research. They aim to use modern science in measuring and reaching the goal of improved health all over the world, starting with their clients.

The company offers courses available in mobile apps which can be availed in different subscription plans. Headspace for work is specially designed to cater to the need of a customer organization.

Outsystems

Outsystems[6] offers an enterprise workspace for creating a single codebase project which can be deployed to mobile and web platforms. The development of custom applications are driven by creating models, workflows and interfaces which can be further extended using custom code.

Outsystems offers a computer-based set of courses to help onboard customer's IT personnel to the technology. Alternatively, an instructor-led course offered in Singapore and US can be taken to take a deeper understanding on how the platform can help companies accelerate business solutions and realize value fast.

Custom built apps

Creating a custom app helps companies design it in a way that is tailored for the need and culture in the workplace, and the data is managed by the company. With the

technologies sited below, the proponent aims to give a high level overview on what the client will need to jumpstart their custom app.

Firebase Projects.[7] It helps manage the Realtime Database, Authentication Integration, and project related application, starting with the android package created for AFRS. The Firebase account recommends to consolidate apps that work together, like web and mobile applications which caters to the same group of customers or managing the same set of data. Firebase is a container for Google Cloud Project and offers additional features such as Crash Analytics, Realtime Database, and Machine Learning among others.

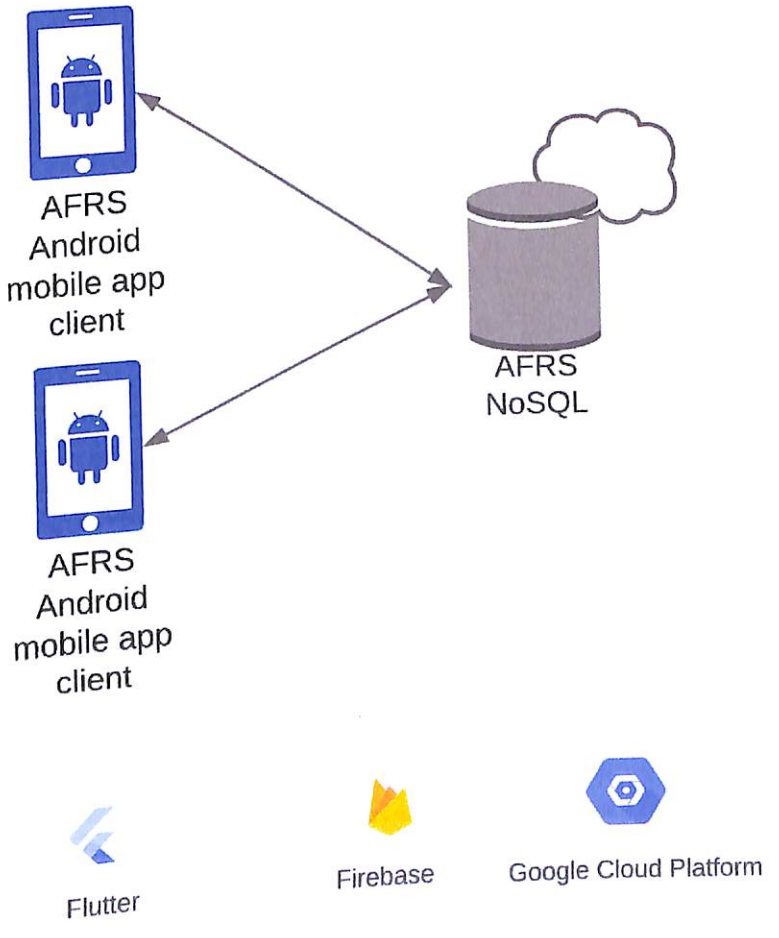
Flutter[8] is an open source toolkit for cross platform development. Flutter is developed by Google for mobile UI framework. A single codebase can be used to implement the feature in android, iOS, and web platforms.

CHAPTER III

DESIGN AND METHODOLOGY

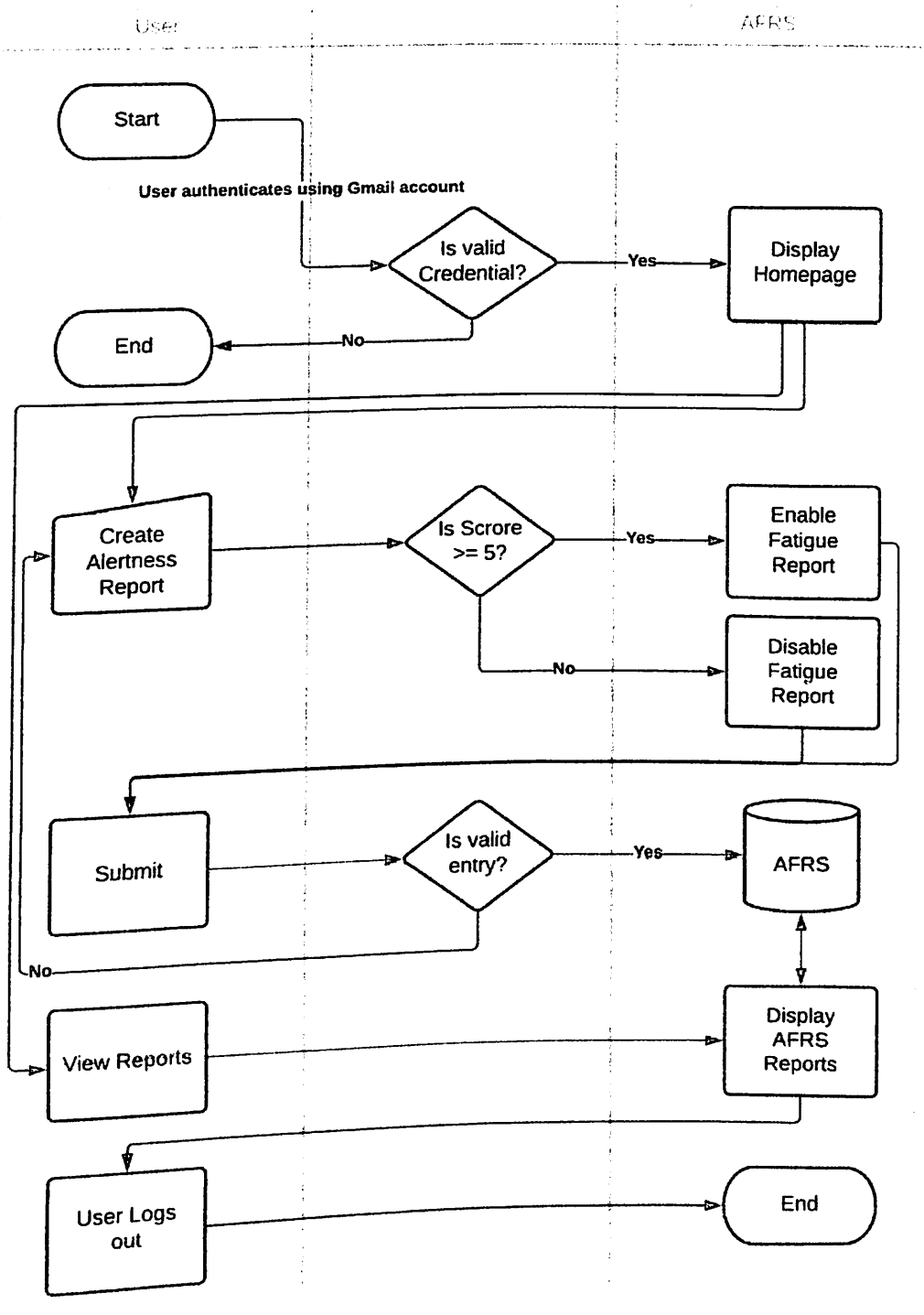
The AFRS app is installed in the end-users' handheld device. Users must login using their valid Google Account in order to access the data hosted in the private cloud similar to illustration below.

Figure 3. AFRS Architecture



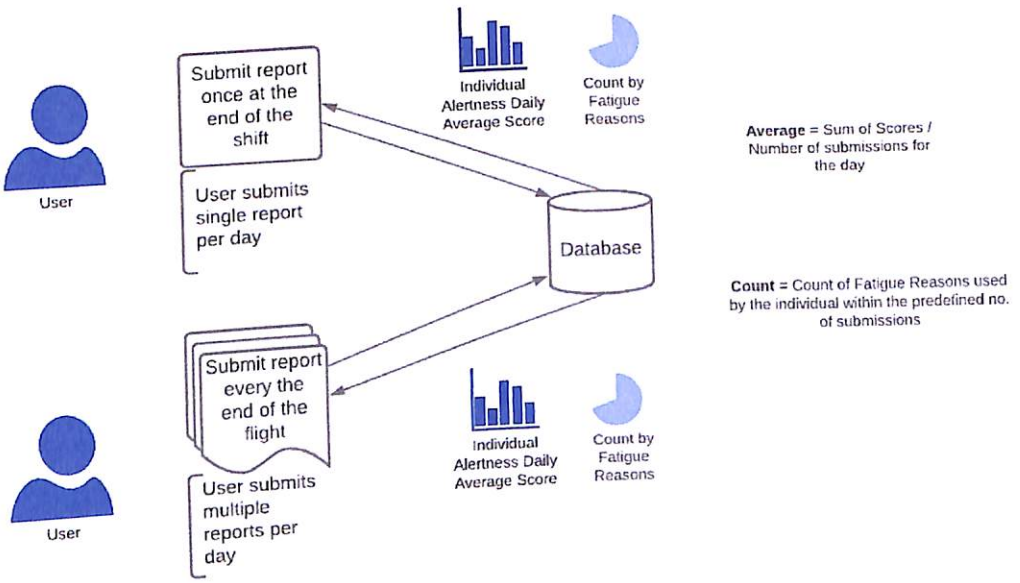
How the application works internally is guided by the data flow illustrated below. Only users with valid credentials can submit new entries, and view the report analytics.

Figure 4. AFRS Data Flow



The reports viewed by the users are queried in the database every time the report page is opened. The scope of metrics included in the graphs are narrowed down to individual level, thus report of first user is not included in computing average score of the second user. For cases when users are submitting multiple reports on a given day, i.e., flight crews reporting every end of flight, the average daily score is computed and derived score is displayed in the report.

Figure 5. Conceptual Flow



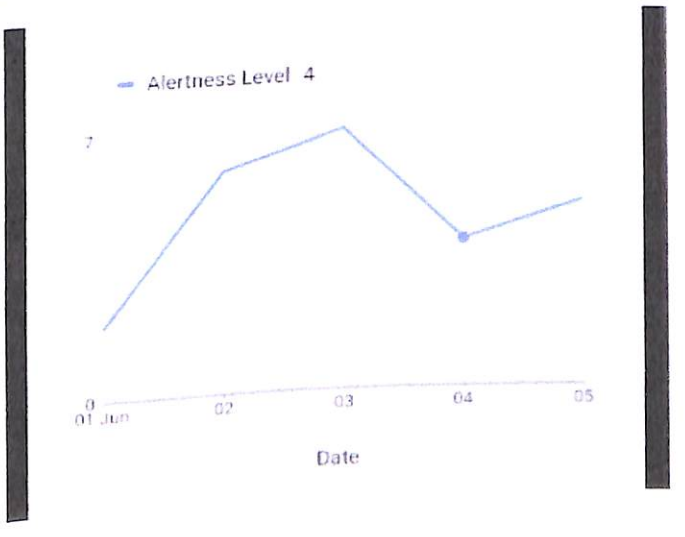
CHAPTER IV

RESULTS AND DISCUSSIONS

The AFRS offered a way for the end users to submit alertness report and fatigue report directly from individual's mobile devices. The bottleneck experienced in submitting the paper-form, and having another staff to encode the data has been managed.

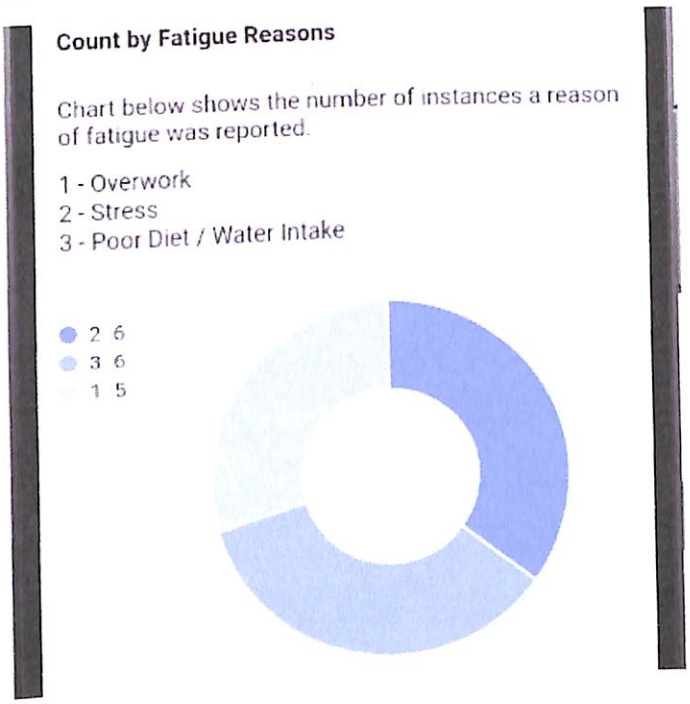
Each user was provided with his/her own dashboard where the data about the last date and alertness score submitted is displayed. The data presented to the users through the Time Series Line Graph provided the opportunity to personally track the daily average level of alertness.

Figure 6. Daily Average Alertness Level



Presented together with the pie chart for Count by Fatigue Reason, user was able to associate what contributed to the rise in fatigue he/she experienced. The aggregates were recalculated after the users submitted the fatigue report.

Figure 7. Top contributor for rise in fatigue level



With the centralized database, the data submitted by the users, such as flight crews, guest officers, and ground personnel were stored together. This served as a preliminary step in analyzing the risks in safety operations in a comprehensive manner.

The old setup focused on the level of alertness between flight crews and pilots, because they interacted with the customers/travelers most of the time. After the MVP, discussions is expected to be conducted by the company to further review the results collected from other groups (ground personnel) and how their actions also helps the company manage or minimize the operational risks.

CHAPTER V

CONCLUSION

The AFRS MVP version is able to show to the client how it would help the organization when alertness and fatigue report were collected from the individuals through the mobile application, compared to the old approach.

Enabling users to personally track submissions, daily average alertness scores, and common fatigue causes help in raising awareness on what factors contributes to an individual's fatigue triggers.

The MVP version is a good start, but the client still needs additional features/enhancements before rolling out the application to a wider number of users. The organization would also need to approve the budget required to continue enhancing the application, as well as the hosting requirement of the app.

REFERENCES

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[4] Sanchez, M. J. (November 2020). Market share of mobile operating systems in the Philippines from September 2019 to September 2020. Retrieved from https://www.statista.com/statistics/931129/philippines-mobile-os-share/

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[6] Outsystems Platform retrieved from https://www.outsystems.com on 30 April, 2021

[7] Firebase Projects retrieved from https://firebase.google.com/docs/projects/learn-more on 30 April, 2021

[8] Flutter 2.2 retrieved from https://medium.com/flutter/announcing-flutter-2-2-at-google-i-o-2021-92f0fcbd7ef9 on 20 May, 2021

[9] How to setup firebase and flutter. (June 2021). Retrieved from https://firebase.google.com/docs/flutter/setup

ANNEX A

AFRS Source Code. A digital copy stored in a CD is provided together with this document. Alternatively, private Github repository is in https://github.com/misyelgarcia/AFRS_FLUTTER_APP/tree/master. Send email to littlemitchgarcia@gmail.com for access request.

AFRS APK Installer. A digital copy is stored in a CD provided together with this document. Alternatively, the android APK is downloadable from this link (https://drive.google.com/drive/folders/1EqjIY8ANrEbBssL4zg3h_Bsbso21x1Bv?usp=sharing).

In case the reader desires to utilize their own subscription, a guide on how to setup new firebase project is available on the web[9]. Update the package references and rebuild the project. Reinstall the application to re-point the application to the new project.

ANNEX B

User Interface Design

The series of the illustrations below are the AFRS MVP version.

Figure 8. Login Screen

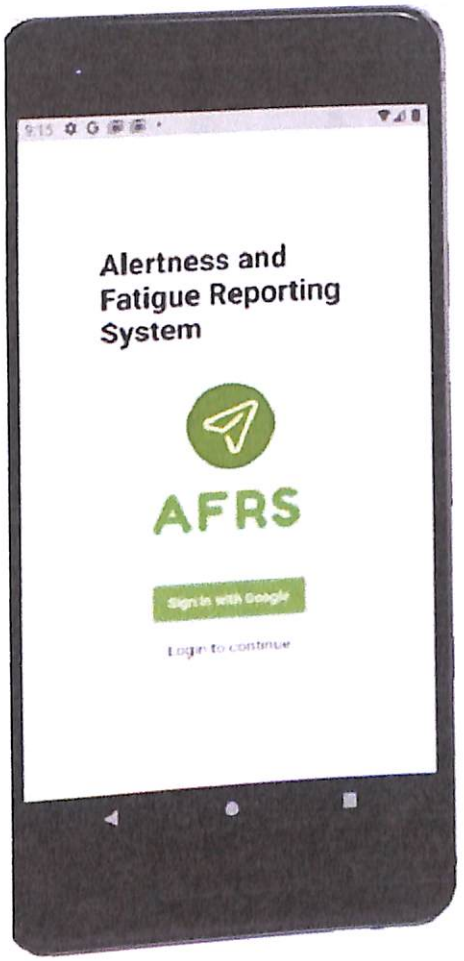


Figure 9. Home Screen

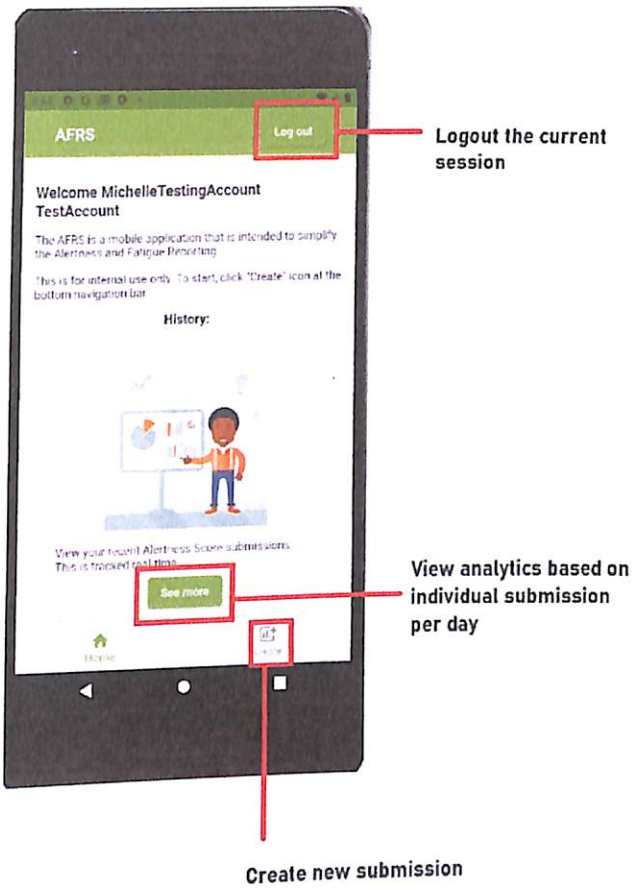


Figure 10. Create Alertness Report Screen

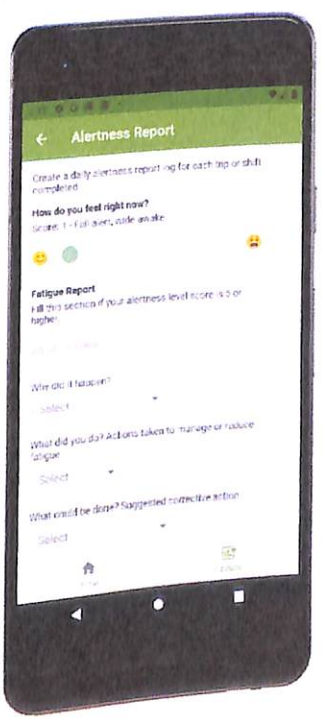


Figure 11. Create Fatigue Report

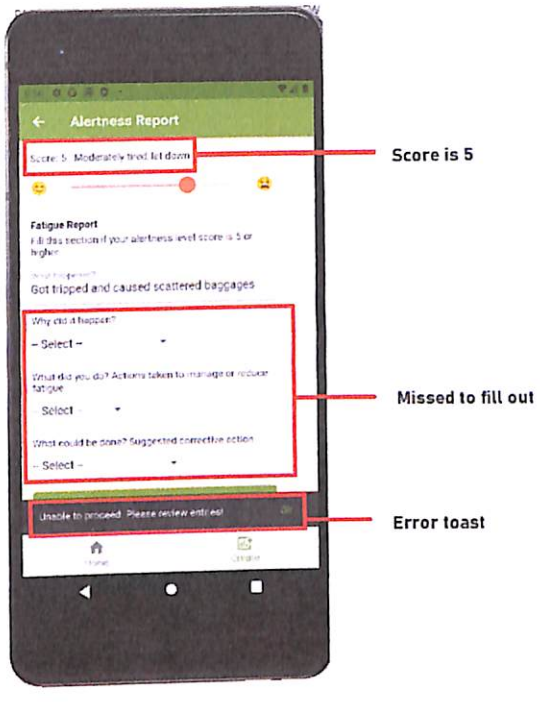


Figure 12. View Daily Average Alertness Level

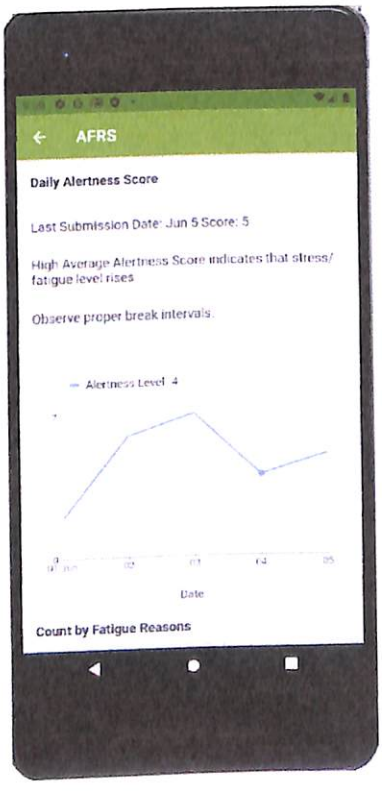
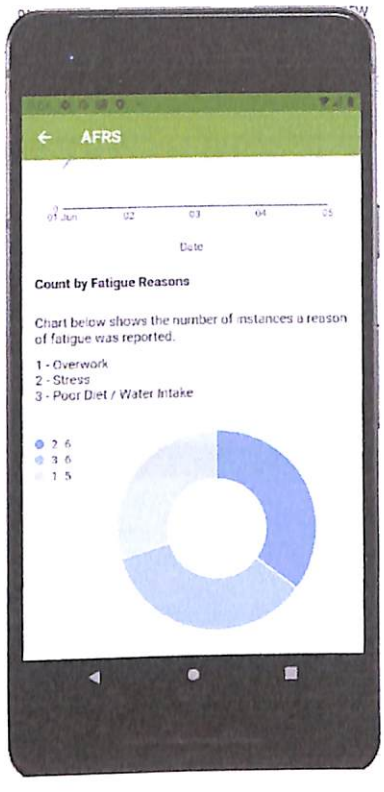


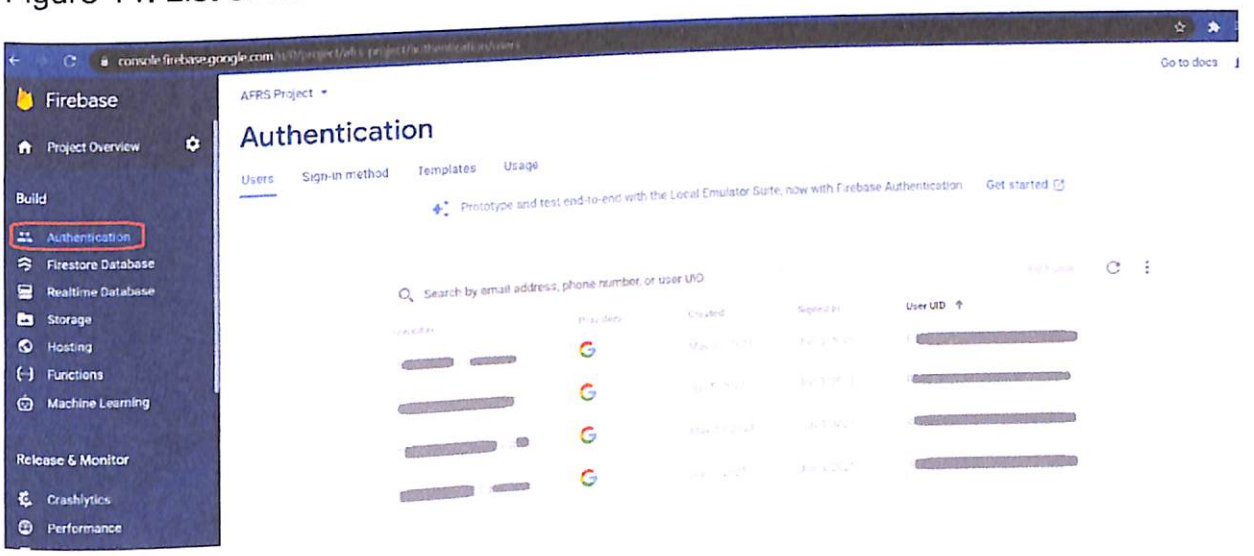
Figure 13. Top Reasons for Fatigue



Authentication

The Firebase Project offers integration with Google Sign-in Services. User Access Roster can be viewed and managed in the project's Authentication module. The data displayed have been redacted to observe user privacy.

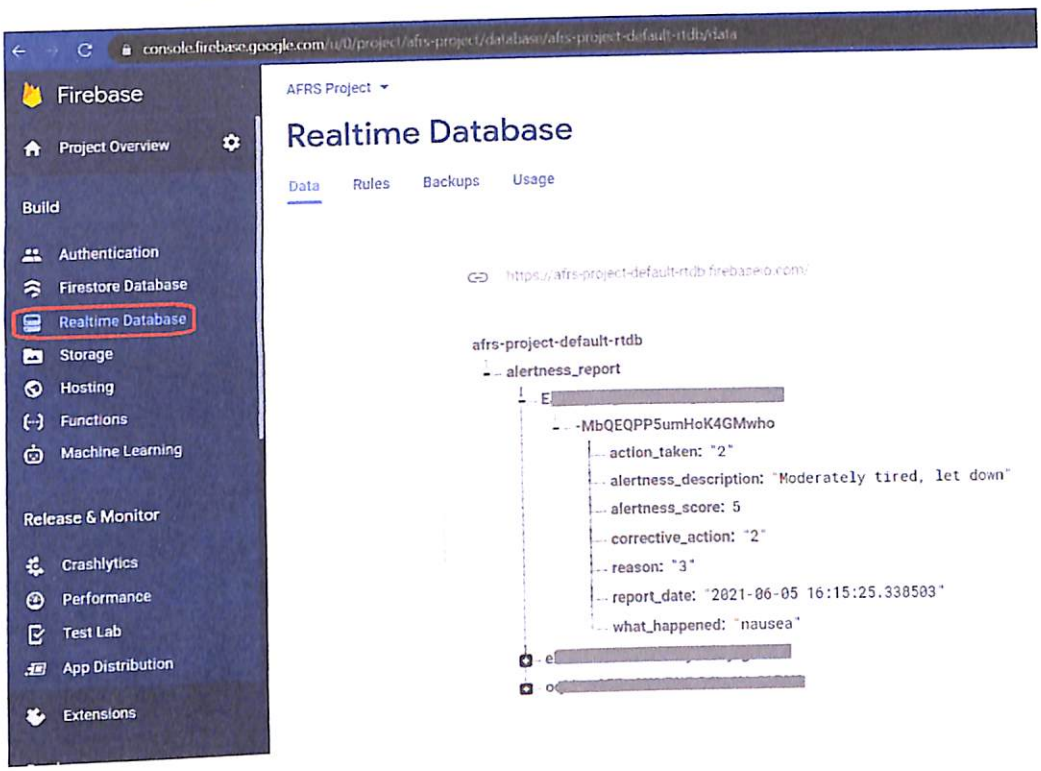
Figure 14. List of Users



Alertness Report Schema Structure

The AFRS hosted in Firebase Realtime Database is a NoSQL database. The structure of saving data are grouped per individual users and each submissions were assigned with unique keys.

Figure 15. AFRS Database



ANNEX C

System Specifications

Listed below are the hardware and software requirements needed by the client to maintain and update the package.

For mobile application development / maintenance, the following are the minimum system requirement of the development environment:

Item	Requirement
Hard Drive Capacity	250GB or higher
Processor	Intel Core i5 or higher
Memory	12GB or higher
Operating System	Windows/Linux/MacOS
Development Tools	Android Studio IDE Flutter and Dart packages
Database	Firebase Realtime Database
Hosting	Google Cloud Platform

Maintenance plan for the software

The AFRS MVP application was developed under the free trial plan of Google Cloud Platform (with $300 credits valid for 90 days). Alternative for upgrades are Spark Plan (Free but with Quota), and Blaze Plan (Pay-as-you-go pricing model).

For enterprise systems, the estimated hosting cost of the firebase project is $1000 per month using the following features

Service	Range	Cost
Realtime Database	41GB storage (or 820 M messages) Free for the first 1GB (about 20 M messages)	$200
	210 GB transferred (4,200 M messages) Free for the first 10GB (about 200 M messages)	$200
Phone Auth	20,000 verifications Free for the first 10,000 verifications	$600
Total		$1000

Hosting for Google Play and Apple Store

Developer License for Google Play Developers and Apple Store Developer have the following prices.

Platform	No. of Users	Cost
Apple Developer Membership License	1	$99/year
Google Developer License (One time fee)	1	$25
Total		$124