

Development of FRAMES (Fatigue Risk Assessment with Medical Advise) Application: Self-Assessment Application for Pilots

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Abstract

Introduction: Pilots have job characteristics that are at risk of causing fatigue. Since fatigue is not a disease, it is important to manage the risk factors. We developed a self-assessment application to manage the fatigue risk for pilots, including physical activity and sleeping difficulties. This application aims to increase pilots' awareness as one of the health maintenance measures.

Methods: The application was developed in collaboration with Garuda Indonesia Training Centre (GITC) to ensure suitable educational content for pilots. The users were asked to fill in data inquiring about their flight characteristics, the Checklist Individual Strength-20 for fatigue screening, General Physical Activity Questionnaire for physical activity, and Jenkins Sleep Scale for sleep difficulties. Afterward, a recommendation will be given based on the received input.

Results: The application was able to screen fatigue risks, physical activities, and sleeping difficulties, and provide recommendations based on the questionnaire that was filled in, all adjusted to the user's work characteristics. The finalized version was then available for download as an Android-based application for the pilots in GITC.

Conclusion: The FRAMES is an Android-based self-assessment application for pilots. With the use of this application, hopefully, fatigue can be detected early in pilots, hence counteract measures may be implemented sooner to mitigate fatigue.

Keyword: pilots, fatigue, risk

Abstrak

Latar Belakang: Pilot memiliki karakteristik pekerjaan dengan risiko kelelahan atau fatigue. Mengingat fatigue bukan merupakan diagnosis penyakit, penting untuk mengatasi faktor risikonya. Peneliti mengembangkan suatu aplikasi self-assessment untuk menangani risiko kelelahan pada pilot termasuk menangani aspek aktifitas fisik dan kesulitan tidur. Aplikasi ini bertujuan untuk meningkatkan kesadaran pilot sebagai salah satu langkah memelihara kesehatan.

Metode: Aplikasi ini dikembangkan dengan Garuda Indonesia Training Center (GITC) untuk memastikan isi materi edukatif untuk pilot. Pengguna diminta untuk mengisi data tentang karakteristik flight, Ceklis Individual Strength-20 untuk skrining fatigue, General Physical Activity Questionnaire untuk aktifitas fisik umum dan Jenkins Sleep Scale untuk mengetahui kesulitan tidur. Rekomendasi akan diberikan berdasarkan data yang dimasukkan pengguna.

Hasil: Aplikasi ini dapat melakukan skrining risiko fatigue, aktifitas fisik dan kesulitan tidur serta memberikan rekomendasi berdasarkan kuesioner, yang telah disesuaikan dengan karakteristik pekerjaan pengguna. Versi terbaru dari aplikasi ini dapat diunduh melalui Android dan tersedia untuk pilot di GITC.

Simpulan: FRAMES adalah aplikasi evaluasi diri berbasis Android untuk pilot yang dapat digunakan untuk mendeteksi dini kelelahan atau fatigue pada pilot, sehingga dapat membantu mengukur dan secara cepat memitigasi risiko kelelahan.

Kata kunci: pilot, kelelahan, fatigue, risiko

Background

Fatigue is defined as a physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member's alertness and ability to safely operate an aircraft or perform safety-related duties.¹ Pilots have job characteristics that are at risk of causing fatigue. These characteristics include sleep loss due to early morning flights or night flights, extended wakefulness, circadian phase, and workload.² Since fatigue is not a disease, it is important to manage the risk factors. The management of fatigue needs collaboration from stakeholders in the aviation industry.

International Civil Aviation Organization (ICAO) recommends Fatigue Risk Management System (FRMS) to its contracting states. ICAO defines FRMS as a data-driven means of continuously monitoring and maintaining fatigue-related safety risks, based upon scientific principles and knowledge as well as operational experience that aims to ensure relevant personnel is performing at adequate levels of alertness.³ In 2019, the research team composed a practical guidebook for managing fatigue in pilots. The book contains a practical guide to managing fatigue through physical activity, physical exercise, and sleep arrangement.

As a continuation of the book, the research team developed a fatigue management application for pilots with physical activity and sleep patterns. The application is self-assessment, which can be accessed directly by pilots. The application consists of a fatigue screening section, physical activity level, and sleep quality assessment. Pilots will receive recommendations based on their physical activity level and sleep quality based on the assessment. This application aims to increase pilots' awareness and is one of the health maintenance measures.

Methods

The FRAMES (Fatigue Risk Assessment with Medical Advise) application was developed for eleven months from June 2020 to May 2021 in collaboration with Garuda Indonesia Training Centre (GITC). The research team chose to collaborate with GITC because as a Learning and Development Unit the research team

can obtain input about educational content suitable for pilots for the development of self-assessment fatigue management applications.

The application development consisted of several steps. First, the application content material was prepared through various literature reviews and discussions among the research team, sports medicine and occupational medicine experts, and pilots. It was then determined that the data required for assessment are flight characteristics, questionnaires for fatigue screening, physical activity, and sleep habits, also the type of education or recommendation provided to the user. The flight characteristics information required includes total flight hours, license, rank, aircraft type, and rating. The questionnaires that are to be used for fatigue screening, physical activity, and sleep habits are the Checklist Individual Strength-20 (CIS-20), General Physical Activity Questionnaire (GPAQ), and Jenkins Sleep Scale, respectively. The recommendations consist of advice on physical activities, exercises, and sleeping strategies based on the user's questionnaire data and adjusted to the user's work or flight characteristics.

The CIS-20 questionnaire has 20 items that can portray fatigue in four domains: subjective experiences and reduction in motivation, activity, and concentration. The respondents are asked to determine from a Likert scale of 1 ("Yes, that is true") to 7 ("No, that is not true") of the 20 items based on the past 2 weeks. A total score of 76 indicates the respondent has chronic fatigue. The research team chose this questionnaire as compared to the Samn-Perelli Fatigue Scale which is usually used to assess fatigue in pilots at the time when they fill in the questionnaire and does not capture fatigue during daily conditions. Whereas compared to another fatigue assessment questionnaire, the Fatigue severity scale which also assesses fatigue in daily situations, the CIS-20 has a higher internal consistency and test-retest reliability (0,84–0,95 and 0,74–0,86 vs 0,88 and 0,84, respectively).^{4,5}

The GPAQ consists of 16 questions that collect information on physical activities in three domains: activities at work, travel to and from places, and recreational activities. The levels of physical activity are categorized as low, moderate, and high by equations of the filled-in items. The Jenkins Sleep Scale is a 4-item questionnaire used to screen sleeping difficulties, where it addresses difficulties in falling asleep, frequency of awakenings during the night, trouble remaining asleep, and subjective feelings of fatigue and sleepiness despite

a typical night's rest. The questions are determined by a Likert-type scale from 0 ("not at all") to 5 ("22-31 days"). If the total score is more than 4, the respondent has sleeping difficulties.^{6,7}

Second, after the preparation of the content material, the research team created a logic flow for the application. The initial stage of the flow is for the user to input personal data which consists of name, date of birth, and address, followed by input of work or flight characteristics as informed above. Every month the user will be notified to update the work characteristic data based on their previous flight duties. Afterward, the user will be asked to fill in the CIS-20 questionnaire, GPAQ, and Jenkins Sleep Scale. Once all the data is filled in, the application will then calculate the total score from the CIS-20 questionnaire, where based on the score, recommendations or educational content will appear for the user.

Third, the research team discussed with the application developer team the content and logic flow of the application. The developer then created a dummy application or prototype for trial use by the research team.

Fourth, for the application trial, the research team asked a group of pilots from GITC to try the dummy application for user interface and content feedback. The trial was performed twice – initial and post-feedback improvements.

Finally, after the second trial, the developer team finalized the application, which was then demonstrated to the GITC pilots involved in the previous trials. The research and application developer team also provides a manual e-book for this application.

Result

We performed two trials to ensure that the feedback received could improve the application. From the first trial, we received feedback mostly about the application's appearance, user interface, questionnaire, and recommendation content, which includes education regarding the use of sleeping pills. The developer team then made improvements to the app based on the feedback and tested the improved app in the second trial. Feedback from the second trial emphasized more on the technicalities of the application, such as data input options, language options, and application appearance.

After two trials with the prototype, the research and application developer team managed to finalize the application. The application was able to screen fatigue risks, physical activities, and sleeping difficulties, and provide recommendations based on the questionnaire that was filled in, all adjusted to the user's work characteristics. The finalized version was then available for download as an Android-based application for the pilots in GITC.

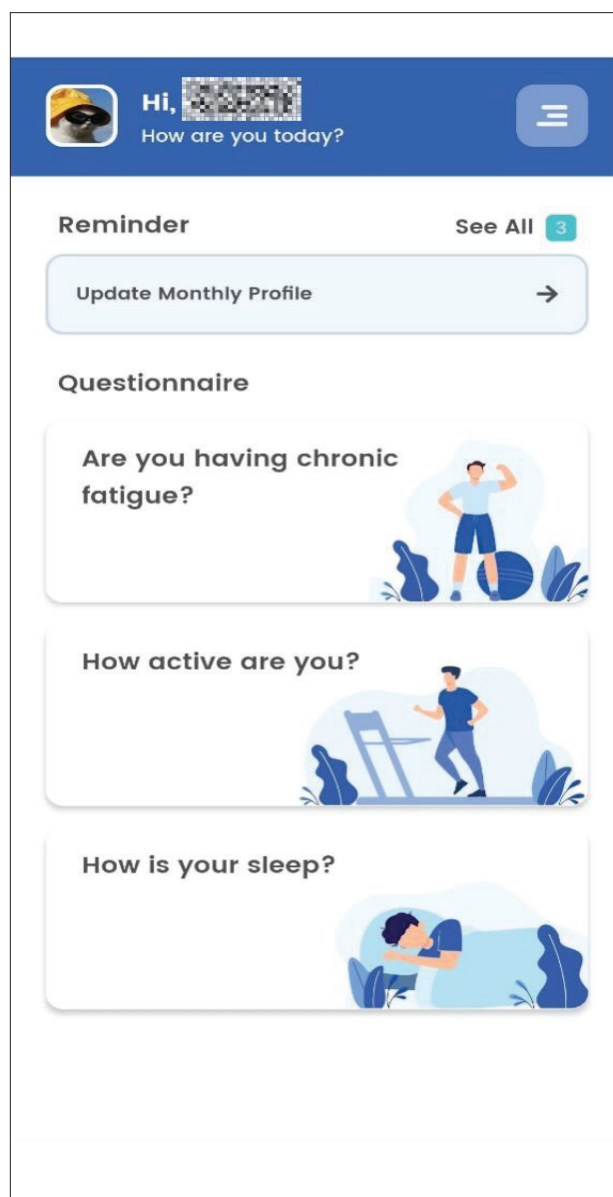


Figure 1. FRAMES Application Main Screen

Discussion

The FRAMES is an Android-based self-assessment application for pilots with a fixed-wing type rating. It consists of several parts: registration, data verification, filling in questionnaires for fatigue screening, physical activity, sleeping difficulties, and recommendations according to the pilot's fatigue status. The advice given is recommendations on physical activities and exercises (which includes the type, intensity, time, and frequency), and sleep strategies that are adjusted to the user's work or flight characteristics. In this application, pilots can also submit information when experiencing microsleep events while performing flight duties. Pilots can fill out the CIS-20R fatigue screening questionnaire, GPAQ, and Jenkins Sleeping Scale in the application every 30 days, which will provide a new recommendation based on the latest information input. Hopefully, with the use of this application, fatigue can be detected early in pilots, hence counteract measures may be implemented sooner to ensure optimal performance during flight.

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