

Development of HIRARC Application for Civil Engineering Occupational Safety and Health

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Abstract

The construction industry in Malaysia faces various occupational safety and health (OSH) risks, especially in academic environments like universities. This project focuses on developing a mobile application based on the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method, specifically for civil engineering activities at Universiti Tun Hussein Onn Malaysia (UTHM). The main goal is to help users easily identify and report risks in places like offices and lecture halls. The app was developed using open-source tools and involved interviews with safety officers to ensure the design meets real needs. The result is a functional prototype that can assist in improving safety awareness and preventive actions. This paper explains the development steps, key features of the application, and how it supports risk management in a practical and accessible way.

1. Introduction

Occupational safety and health (OSH) have become critical areas of concern in the Malaysian construction sector due to the increasing number of incidents and risks [1]. At the university level, civil engineering activities are also exposed to similar hazards [2], particularly in office and teaching environments. However, the use of digital tools to support safety procedures is still limited [3]. To address this, the research aimed to develop a mobile application using the HIRARC method. The goal was to make it easier for users such as lecturers and staff to perform hazard identification, assess risks, and suggest controls. The app was designed for use in locations like administrative offices, staff rooms, and classrooms within UTHM Pagoh Campus. By integrating technology with standard safety frameworks, the application aims to strengthen awareness and proactive safety practices.

2. Methodology

This study applied a qualitative research approach to understand how a mobile HIRARC application could be developed and implemented for civil engineering safety in a university setting. The research was carried out in several stages: stakeholder consultation, data collection, analysis, application design, development, and testing. The main setting was Universiti Tun Hussein Onn Malaysia (UTHM), focusing on office-based workspaces such as administrative offices, lecturers' rooms, and classrooms.

2.1 Stakeholder Engagement

Key stakeholders involved in this research included safety officers [4]s from the Department of Occupational Safety and Health (DOSH) [5] and representatives from the university's Occupational Safety and Health Education (OSHE) unit. These stakeholders were selected based on their experience in workplace safety and risk assessment procedures. Their feedback played an important role in shaping the application's functions.

2.2 Data Collection and Analysis

Data was collected using semi-structured interviews with the selected stakeholders. The interview questions were designed to explore common safety challenges, user needs, and expectations from a mobile HIRARC tool. A pilot interview was also conducted with a civil engineering lecturer to validate the relevance of the questions. All responses were analyzed using thematic content analysis [6] to identify major patterns and user requirements.

2.3 Application Design and Development

The design phase involved creating digital mockups and storyboards using Canva to visualize the application's layout and interface. These visuals helped guide the programming phase, which was done using Flutter and Android Studio [7]. The development process followed standard UI/UX principles [8] to ensure the app was simple, responsive, and suitable for use in non-technical environments. Features included hazard reporting, risk scoring [9], and recommendation of control actions.

2.4 Testing and Validation

The application was tested in several stages. Unit testing was done to check the core features, followed by system testing to ensure the app worked smoothly across different devices. User feedback was collected through informal testing with selected staff and students. Based on their feedback, minor improvements were made to the interface and function flow. This testing phase ensured the app was usable and ready for practical adoption.

3. Result and Discussion

Based on an interview with Mr. Md Yazid bin Hj. Taib, a safety officer [4], the implementation of the HIRARC process typically follows six major steps: hazard identification, risk assessment, risk control, control implementation, review, and documentation.

During hazard identification, users observe the working environment and identify activities or conditions that may pose risks. Each hazard is assessed based on likelihood and severity to determine the level of risk. The control step includes reviewing existing measures and planning new controls if necessary. Implementation involves applying these controls and checking their effectiveness. Lastly, the entire process is documented and reported to all relevant stakeholders.

3.1 Challenges in HIRARC Implementation

Several challenges were reported by Mr. Taib regarding the practical use of HIRARC. These include limited knowledge or experience among users [10], which makes it difficult to assess and manage risks accurately. Resource constraints, such as time and manpower, also limit the execution of comprehensive safety assessments. Furthermore, the complexity of the work environment, where multiple hazards may exist at once, makes it hard to conduct clear and complete risk evaluations.

3.2 Key Features for a HIRARC Application

The feedback gathered suggested several features that are critical for a successful HIRARC mobile application. First, a user-friendly interface [10] is essential to ensure that users from various backgrounds can easily interact with the system. Second, the app should include guided steps to help users perform assessments, including clear instructions for each stage of HIRARC. Third, it must have a strong reporting function that allows users to generate and share detailed reports quickly and accurately.

3.3 Interface Overview and Functions

The application was built using Flutter, with a clean and intuitive layout. **Fig. 1** represents the main components of the app interface.

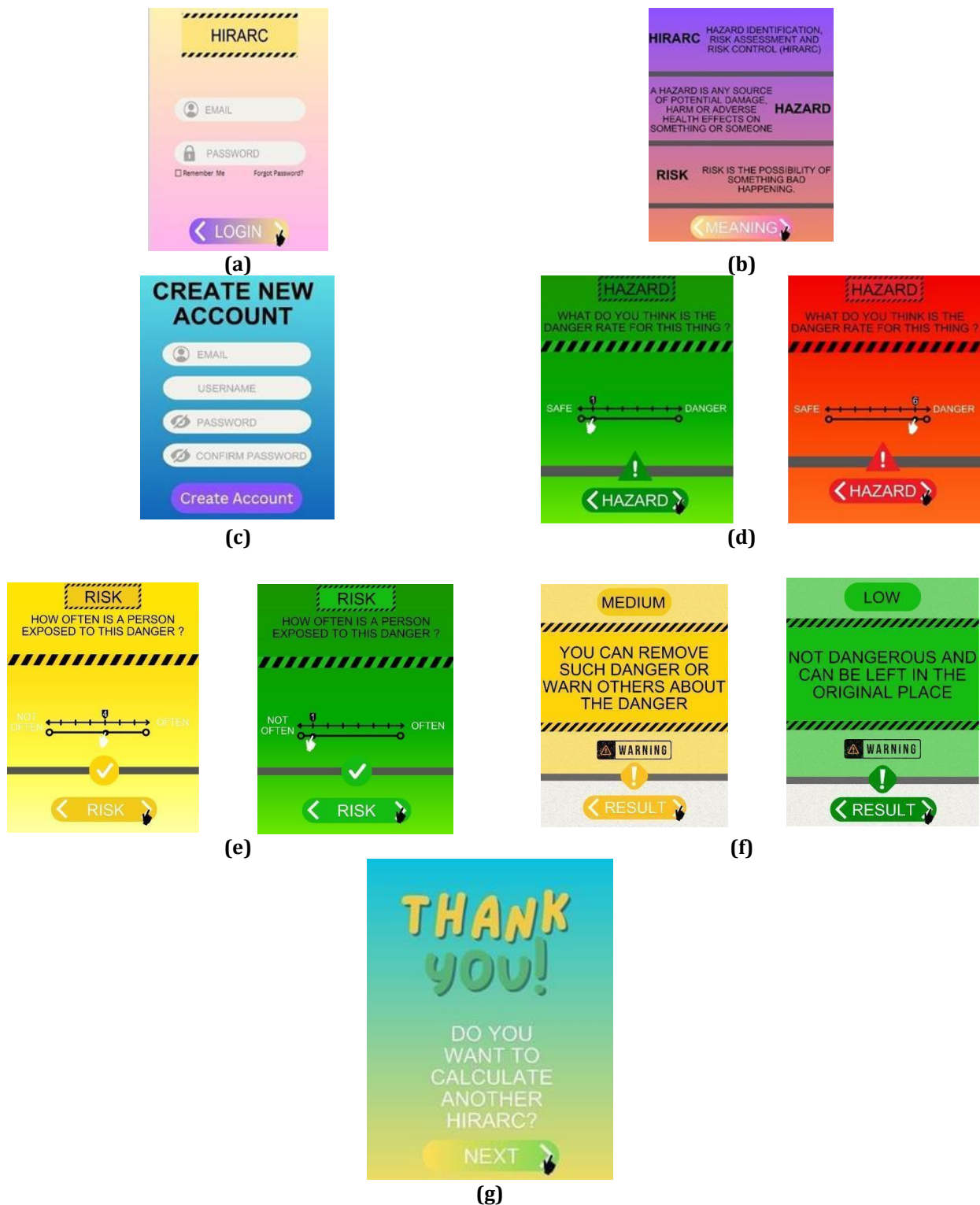


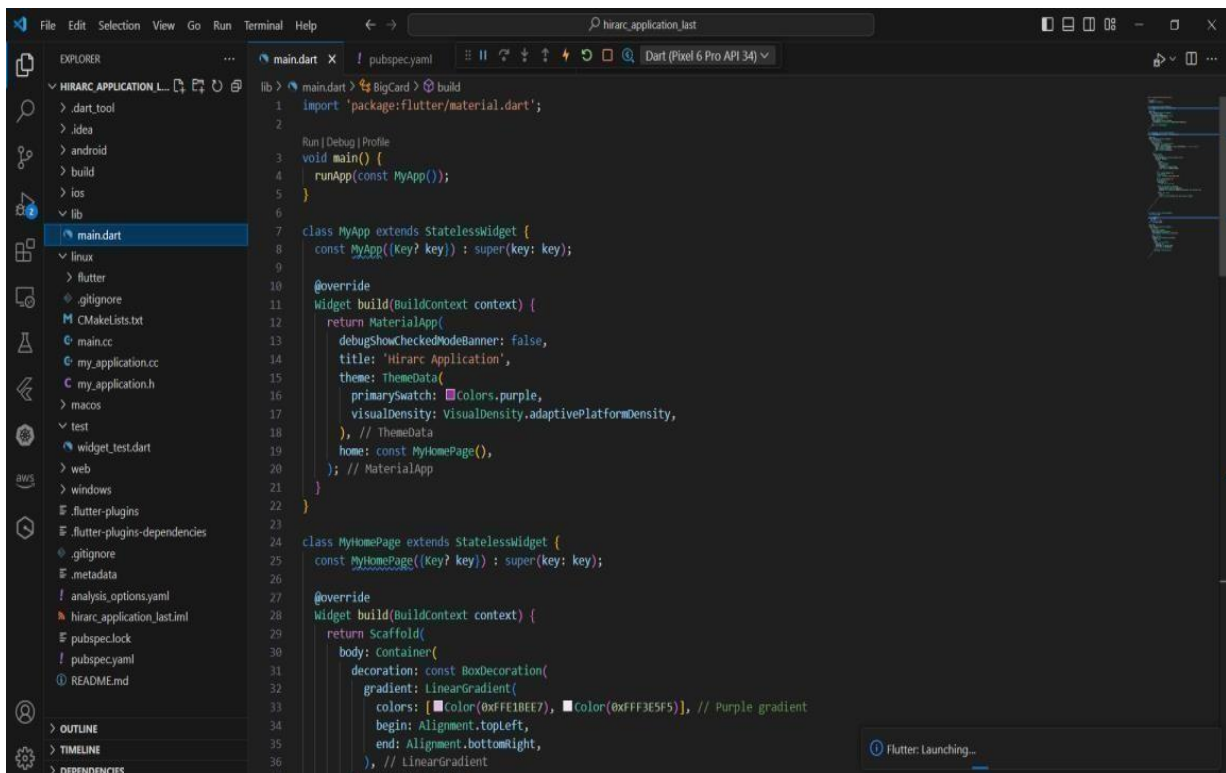
Fig. 1 (a) Login screen where users enter email and password, (b) account creation interface for new users, (c) homepage showing information about HIRARC, (d) hazard measurement slider, (e) risk measurement input screen, (f) risk matrix output grid and (g) final screen with submission and feedback message.

Each of these screens was designed to help users complete the HIRARC process in a clear and structured manner. The sequence begins from the login and input interfaces, followed by steps for assessing hazard severity and likelihood, and ends with the display of risk level and recommended actions. The interface uses distinct colours

and labels to indicate the severity of risks, which helps users to make informed decisions based on the system's output.

3.4 Application Interface Development and Output

The development of the HIRARC application was carried out using Flutter in the Android Studio environment. The source code structure was organized with proper widget design and UI elements, as shown in **Fig. 2**.



```

lib > main.dart > BigCard > build
1 import 'package:flutter/material.dart';
2
3 Run | Debug | Profile
4 void main() {
5   runApp(const MyApp());
6 }
7
8 class MyApp extends StatelessWidget {
9   const MyApp({Key? key}) : super(key: key);
10
11   @override
12   Widget build(BuildContext context) {
13     return MaterialApp(
14       debugShowCheckedModeBanner: false,
15       title: 'Hirarc Application',
16       theme: ThemeData(
17         primarySwatch: Colors.purple,
18         visualDensity: VisualDensity.adaptivePlatformDensity,
19       ), // ThemeData
20       home: const MyHomePage(),
21     ); // MaterialApp
22   }
23 }
24
25 class MyHomePage extends StatelessWidget {
26   const MyHomePage({Key? key}) : super(key: key);
27
28   @override
29   Widget build(BuildContext context) {
30     return Scaffold(
31       body: Container(
32         decoration: const BoxDecoration(
33           gradient: LinearGradient(
34             colors: [Color(0xFFE1BEE7), Color(0xFF3E5F5)], // Purple gradient
35             begin: Alignment.topLeft,
36             end: Alignment.bottomRight,
37           ), // LinearGradient

```

Fig. 2 Screenshot of Flutter source code in Android Studio

The application was then compiled and tested on mobile devices to ensure usability, interface responsiveness, and logical flow from hazard input to risk output. The screenshots below illustrate the complete HIRARC process on the mobile interface, from login to final recommendation output as shown in **Fig. 3**.

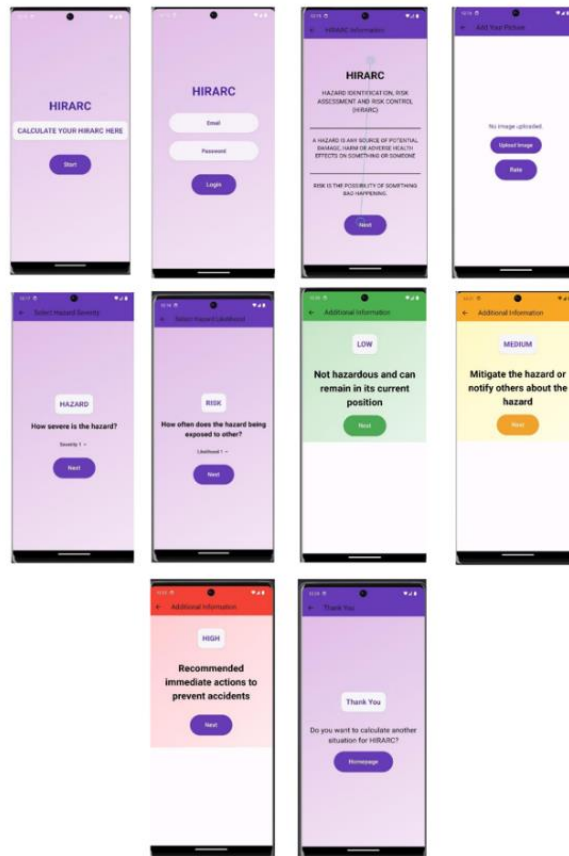


Fig. 3 Sequence of user interface on mobile application

4. Conclusion

This project successfully developed a mobile application based on the HIRARC method to support occupational safety and health practices in civil engineering environments at UTHM. By combining input from safety officer [6]s and academic staff, the app was tailored to fit real-world scenarios in university offices and lecture spaces. The key features such as hazard reporting, risk scoring [11], and guided assessments made the tool useful and practical for non-technical users.

While the prototype worked well during initial testing, several improvements are suggested. These include adding automated scoring algorithms, cloud-based data storage, and integration with institutional safety databases [12]. Future work should also focus on expanding the app's use to other engineering domains and testing its performance in more complex environments like laboratories or construction sites.

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Conflict of Interest

The authors declare no conflict of interest in the publication of this paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Mohamad Azim Mohammad Azmi, Shahiron Shahidan and Mohamad Syamir Senin.; **data collection:** Muhammad Hakim Mohamad Tahir, Haziq Adlan Md Hatta, Mohamad Arif Haqimi Mohamad Mahran; **analysis and interpretation of results:** : Mohamad Azim Mohammad Azmi, Shahiron Shahidan and Mohamad Syamir Senin; **draft manuscript preparation:** : Mohamad Azim Mohammad Azmi, Shahiron Shahidan and Mohamad Syamir Senin. All authors reviewed the results and approved the final version of the manuscript.

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