FIRE EXTINGUISHER LOCATOR WITH BUILT-IN INSTRUCTION EXPERT (FELIX)

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ABSTRACT

The persistent rise in fire-related incidents poses a serious threat to public safety, especially in communities with limited access to emergency resources. Inadequate access to fire extinguishers and widespread unfamiliarity with their proper use during emergencies remain critical concerns. These gaps in fire safety preparedness often lead to delayed response times and preventable escalation of incidents. To assess the impact of integrating real-time location tracking and instructional guidance in fire safety, this study utilized the Research and Development design (R&D) to develop the Fire Extinguisher Locator with Instruction Expert (FELIX), a mobile application designed to enhance preparedness. FELIX combines two features: a GPS-based extinguisher locator and an embedded instruction system that guides users on proper usage. Testing was conducted using two smartphone brands, utilizing performance indicators such as accuracy, precision, recall, and F1-score. It involved 100 trials per device, evaluating consistency in locating fire extinguishers and providing correct instructions, followed by data collection using a confusion matrix. Results indicated a perfect recall rate for both devices, with Device 1 achieving slightly higher accuracy (0.72) and F1-score (0.84) compared to Device 2 (0.69 and 0.82). While the app's digital tools enhanced user awareness and response time, variations in smartphone hardware slightly affected location accuracy. Findings affirm the application as a dependable and innovative fire safety tool. This study underscores the potential of mobile-based technologies like FELIX in addressing long-standing gaps in emergency preparedness. The researchers recommend further development in this domain to support safer, more resilient communities.

Keywords: Fire safety preparedness, Mobile application, GPS, Fire incidents, Fire extinguisher, Location tracker, Fire extinguisher locator

INTRODUCTION

Fires, when left unchecked, can be the most unforgiving phenomena. As the second grows, so does the probability of the fire claiming not just properties, but innocent lives. Between 1993 and 2020, fire-related incidents claimed around 401,000 lives annually. As a result, this is deemed to be one of the pressing global issues, with most cases occurring in buildings and establishments (Murray et al., 1996; Brushlinsky, 2020; Zhang, 2023).

On a global scale, the Chinese Ministry of Public Security documented numerous major

incidents for about 202,299 fire cases in buildings, in 2012 alone; this concerning fact led to 3,410 fatalities and extremely severe injuries (Mi et al., 2020). In the Philippines, fire incidents have risen alarmingly, with 5,764 cases recorded from January 1 to April 2, 2024, resulting in 120 fatalities and 352 injuries (Caliwan, 2024). Additionally, fire incidents from Davao City demonstrated the ever-growing fire risk, as reports have recorded 716 incidents from January to October 2024, which is a 28.85% increase over the same period in 2023.

Since fire originates from a wide range of sources, different types of fire extinguishers were developed in order to combat a particular class of fire effectively. In the hands of a trained individual, fire extinguishers are great tools that can be used as the first line of defense to protect people and property from the early stages of fire. While preventive measures such as fire risk assessments and fire monitoring systems are implemented (Shokouhi et al., 2019), this course of action often fails to address a profound factor: the accessibility and usability of firefighting equipment during emergencies. Studies have shown that despite the use of proper firefighting equipment, a lack of confidence or familiarity with handling such equipment often prevents people from effectively using them, which aligns with data from a study conducted in Nigeria, in which only 35.2% of employees knew how to use a fire extinguisher, 41.9% were aware of their locations within the facility, and only 34.5% demonstrated a solid understanding on fire safety (Ukegbu et al., 2022).

Moreover, strategically placed fire extinguishers will allow individuals to access them quickly, which will significantly increase the chance of containing the fire in its early stages (Tongthong et al., 2023). Without the proper placement and visibility, even the most effective fire extinguisher will become useless in an emergency (O'Connor, 2023). With this, non-compliance still remains an ongoing issue. In a study conducted at a healthcare facility in Abia State, Nigeria, only 11 out of 27 buildings that were surveyed had fire extinguishers available (Ukegbu et al., 2022). Similarly, a study conducted in Osun State, Nigeria in 2021 revealed that 75% of residential buildings lacked fire extinguishers (Valentine, 2021). Additionally, a study in Tarlac City found that although 45.45% of households had firefighting equipment readily available, a larger proportion (63.64%) do not have access to fire extinguishers, hence they do not know how to properly use one (Acosta, 2024).

To help mitigate this pressing issue, the researchers conducted a study. They developed a mobile application that locates the nearest fire extinguishers and effectively instructs even those with no knowledge of how to use the equipment — all with an overarching pursuit to reduce fire-related disasters and save lives.

OBJECTIVE OF THE STUDY

This study aims to develop the FELIX application – a tool for locating and identifying fire extinguishers. To ensure that the application is ready for public use, the researchers established the following specific objectives:

1. The study will assess the performance of its core features, including the Fire Extinguisher Locator and the Instructional Guide.
2. The study will evaluate the accuracy of the Fire Extinguisher Locator functionality across different brands and models of smartphones
3. The study shall examine whether the use of the FELIX application significantly improves the response time and accuracy of individuals in locating and using fire extinguishers during fire emergencies.

MATERIALS AND METHODS

The study utilized the Research and Development design (R&D), which aims to expand the current knowledge by experimentation and examination of scientific information in order to create an innovative product (Gutterman, 2023).

This approach will use any available information on advancements in technology and fire safety measures.

The mobile application was tested on the 3rd floor of an educational institution in Davao City, Philippines. The researchers chose this location due to heavy foot traffic on that specific floor level since a diverse population of students, teachers, and staff alike is situated here.

To cross-check the compatibility between devices, the application was tested using two different phone brands. The data collection involved two stages: (1) a trial phase of the application's user interface and (2) prototype testing to evaluate functionality and performance. During the trial phase, the data focused on evaluating the features and usability of the application, ensuring that all core components like the fire extinguisher locator, instructional guide, and mapping system are present and functional, and assessing whether the application accurately identifies the location of the nearest fire extinguisher and provides the user with correct information on how to use it. Moreover, to gauge the performance, the study utilized two research instruments: the FELIX Performance and Usability Testing Instrument and the Confusion Matrix dataset.

The FELIX Performance and Usability Testing Instrument is a checklist and evaluation tool that assesses the core functionalities of the application's interface. Furthermore, the Confusion Matrix Dataset was developed through a series of 200 test trials with 100 trials conducted per device. This dataset aimed to identify the false positives by comparing the predicted outcomes generated by the 'FELIX' app with the actual outcomes.

Following the data collection, the Confusion Matrix was used to analyze the application's predictive accuracy by comparing the actual outcome to the predicted outcome (Sathyanarayanan & Roopashri Tantri, 2024). This instrument measured how well the application performs in correctly identifying the nearest fire extinguisher and providing information such as fire type, manufacturer name, and expiration date, and showed a clear comparison of the application's effectiveness versus the intended outcome.

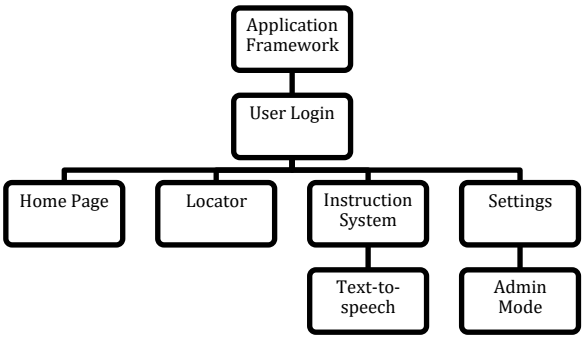

Figure 1. Organizational Chart of the Application's Framework

The application framework includes a user login system, which leads to four main features: the home page, the locator, the instructional guide, and the settings. The Home Page acts as the main screen, which talks about the purpose of the application and its features. The locator helps users find the nearest fire extinguishers using GPS technology. In addition, an Instruction system was placed in order to give the users visual guidance on how to properly use the fire extinguisher, further enhancing fire safety. Lastly, in the settings menu, an admin mode was implemented in order to add, remove or change the information and location of the fire extinguishers whenever a fire extinguisher is replaced or has changed locations.

Figure 2. Application Layout

Upon launching the application, the Felix logo will appear on the screen along with a "Get Started" button. After tapping the button, users are directed to an introductory page that provides a brief description of the application. They are then taken to the main interface, which includes essential elements such as the Home Page, Locator, Instructions Page, and Settings, with the instructions page featuring both visual and audio guides, and the settings including access to admin mode.

To develop this application, the researchers used Flutter, an open-source UI toolkit developed by Google, which allows developers to build high-performance Android applications from a single codebase. In this study, the platform used the Dart programming language as the coding system for creating the application.

RESULTS AND DISCUSSION

In this section, the results gathered from the data collection are presented. The outcome of the testing done across different devices will be analyzed to evaluate the performance of the application. The results will highlight the application's reliability in locating fire extinguishers and delivering instructions effectively.

1. FELIX Functionalities and Response

To ensure that FELIX functions effectively across different mobile platforms, the researchers conducted a comprehensive testing phase focusing on its core features. The evaluation used a usability checklist to systematically verify the presence and performance of each function. The test was conducted on two commonly used Android devices, with the aim of identifying whether all intended features worked consistently across brands. The focus was on critical components such as the extinguisher locator, instructional modules, emergency tips, and user interface responsiveness.

FELIX Checklist (both devices)

Table 1

FELIX Checklist (both devices)

	Criteria	Yes	No
Features of FELIX			
1	Real-time location tracking of fire extinguishers.	[✓]	[ ]
2	Intuitive user interface for quick navigation.	[✓]	[ ]
3	Compatibility with emergency protocols (e.g., alarm systems)	[✓]	[ ]
4	Integration with mobile or desktop applications	[✓]	[ ]
5	Alerts about safe distances, proper handling, and types of fires suitable for the extinguisher.	[✓]	[ ]
6	Detailed guide for using the extinguisher effectively.	[✓]	[ ]
7	Step-by-step guidance to reach the extinguisher during an emergency.	[✓]	[ ]
Usability of App Features			
8	The app interface is visually appealing and user-friendly.	[✓]	[ ]
9	Buttons, icons, menus, and options are well-labeled, logically organized, and easy to navigate.	[✓]	[ ]
10	The app offers helpful tips or pop-up guides to assist users in navigating features when needed.	[✓]	[ ]
11	The font size and style enhance readability and overall user experience.	[✓]	[ ]
12	Emergency features are intuitively designed so users can access them easily, even without prior training.	[✓]	[ ]
13	A reliable and user-friendly mapping system ensures easy navigation to fire extinguishers.	[✓]	[ ]
Reliability of Fire Extinguisher Locator			
14	The search feature identified extinguishers in my vicinity.	[✓]	[ ]
15	The real-time locator displayed the nearest fire extinguisher accurately.	[✓]	[ ]
16	The app ensures precise and real-time updates for fire extinguisher locations.	[✓]	[ ]
17	The GPS functionality is robust, ensuring reliable performance indoors and in multi-story buildings.	[✓]	[ ]

As shown in Table 1, all 17 features listed in the usability instrument were successfully executed and marked "Yes" on both devices. This outcome confirms that FELIX was fully functional during every test trial, demonstrating strong platform compatibility. No failures or inconsistencies were observed, reinforcing the application's reliability and readiness for real-world use regardless of hardware differences.

Fire Extinguisher Locator. Based on the results of the FELIX application, the locator feature effectively helps users identify the nearest fire extinguisher through a built-in mapping system. This aligns with the study of Chen et al. (2021), which highlights how recent technologies such as the Global Positioning System (GPS) have been used to improve emergency response and situational awareness. Furthermore, TongThong et al. (2023) emphasized the importance of proper placement and visibility of fire extinguishers for early fire control, as these standards are often overlooked. In line with this, the FELIX application has shown its efficiency in helping users locate nearby fire extinguishers within their vicinity, especially in urgent situations where quick response is critical.

Instructional Guide. The FELIX app's instructional guide provides a visual and audio-assisted demonstration on how to use different types of fire extinguishers. Based on this feature, it aligns with the findings of FasterCapital (2024), which emphasized the growing role of mobile applications in enhancing public situational awareness. By integrating this guide, FELIX supports users by offering accessible, real-time assistance during critical situations.

2. FELIX Reliability and Accuracy

To assess the reliability and accuracy of FELIX, the researchers conducted 100 test trials on two smartphone brands. These trials aimed to evaluate the app's overall performance in detecting fire extinguishers and ensuring consistent functionality across different devices.

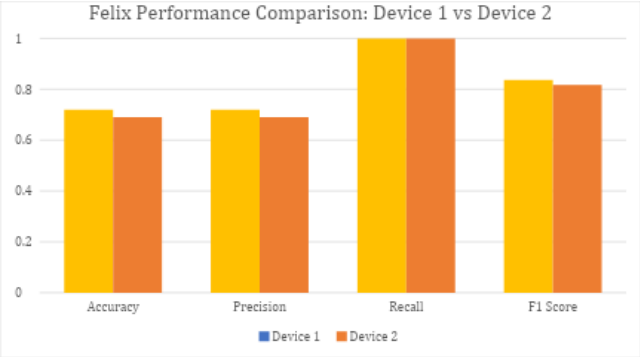

Figure 3. FELIX Performance Comparison

For both Accuracy and Precision, Figure 1 shows that Device 2 achieved a score of 0.69, while Device 2 scored 0.72. Out of the two smartphone brands, Device 1 is more likely to identify the location of the two nearest fire extinguishers at the same time. Hence, the findings suggest that the difference in scores of the two models is possibly due to the different sensors used. This supports previous studies that across different phone brands, the accuracy of its sensors varies greatly; this variability stems from the difference in hardware, operating systems, and software implementations (Kuhlmann et al., 2020). Despite this fact, both devices showed strong and dependable results based on accuracy and precision.

3. FELIX Performance Metric

Table 2
FELIX Performance Metric

Metric	Device 1	Device 2
Accuracy	0.72	0.69
Precision	0.72	0.69
Recall	1	1
F1 Score	0.837209302	0.816568047

The Table above shows that both devices achieved:

- *Perfect recall (1.00) – all fire extinguishers were detected.*
- *Slightly higher accuracy and precision with Device 1 (72%) compared to Device 2 (69%).*
- *F1 Score also favors Device 1 slightly (0.84 vs 0.82), indicating better balance between precision and recall.*

The recall scores across the two smartphone brands are a perfect (1.00), suggesting that the application detected all fire extinguishers within its area. The consistent 100% recall rate reflects FELIX's reliability in identifying extinguishers in real-time. This addresses the long-standing issue in fire safety systems where critical firefighting equipment is often absent or inaccessible (Babatunde et al., 2020; Satrio et al., 2021). In contrast, FELIX enhances accessibility by using a visual display via mobile phones, solving the problem of poor visibility and location awareness—issues commonly noted in both public and private buildings (Tongthong et al., 2023).

4. Response Time and Accuracy of Individuals

The findings showed that FELIX could significantly enhance the response time of individuals and accurately locate a fire extinguisher during emergencies. The locator feature of the application can successfully locate a fire extinguisher around its premises, even when hidden in obscure places. However, some individuals are still unfamiliar with the proper use of fire extinguishers, resulting in delays in suppressing fire in its early stages (Parry et al., 2022; Tongthong et al., 2023). The instructional guide of FELIX provides users with step-by-step directions in the form of images and shows them the right type of extinguishers to use in fires, preventing the fire from becoming a major hazard (Abdullahi, 2023).

CONCLUSIONS

Based on the study conducted, the researchers conclude that the FELIX application is a reliable and effective tool for enhancing fire safety preparedness. With its fire extinguisher locator feature and instructional guide, FELIX not only improves access to firefighting tools but also supports better emergency response in buildings. The application's consistent performance across different smartphone brands highlights its potential for widespread use in diverse settings, including hospitals, offices, and residential areas. These results suggest that mobile technology plays a crucial role in bridging gaps in traditional fire safety measures. Overall, FELIX represents a promising advancement in fire safety and emergency preparedness, making it a valuable tool for public use whenever and wherever.

RECOMMENDATIONS

The development and experimentation process of the "FELIX" mobile application encountered numerous setbacks. With minimal financial resources, a limited timeframe, and a restricted testing environment, the researchers were not able to expand the application to its fullest potential. Therefore, in consideration of the limitations the study has faced, it is noteworthy to acknowledge that the project remains in its developmental and testing phases. At this stage, the application and hardware components are open for further improvement and enhancement. Improvements that could be explored and implemented include the refinement of the tracking system through better coding integration, redesigning the user interface and layout for clearer usability, and establishing a more stable and scalable server system to support real-time data updates and cloud connectivity. These upgrades would allow FELIX to function more reliably and efficiently, especially when deployed in larger or more complex environments:

1. To ensure compatibility with iOS devices. The application should cater to users of

Apple devices, enabling them to download the mobile application from the App Store.

2. To evaluate user acceptability. FELIX should be deployed to a small but diverse group of users, including individuals of varying ages, technical competencies, and backgrounds, in order to assess user interaction, identify usability issues, detect accessibility barriers, and determine potential improvements.
3. To develop a smart monitoring and maintenance system. The system should monitor each fire extinguisher's pressure and expiration date through a simple application interface and prompt users to discontinue use once the extinguisher has expired.
4. To enhance tracking and location monitoring. A functional prototype of a physical tracking device should be developed and attached to each fire extinguisher, integrating Bluetooth Low Energy (BLE) technology to enable real-time location tracking.
5. To integrate an AI-powered instructional voice system. FELIX should incorporate an intelligent feature that guides users step-by-step during emergencies, adapts rapidly to conditions, detects the type of fire, and delivers clear, multilingual instructions through voice or visual prompts to improve response in critical situations.
6. To implement a performance rating system. Users should be provided with the capability to evaluate the application's effectiveness, accessibility, and overall functionality.

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AUTHORS' PROFILE

Ken Vleo L. Miro was a student at Lyceum of the Philippines University – Davao and the lead researcher behind FELIX. With a strong passion for technological expansion, particularly in mobile app development, he explores how everyday devices like smartphones can become powerful tools for safety, awareness, and emergency response. His ultimate goal is to develop technology that is not only convenient but also addresses significant societal issues—creating solutions that are practical, impactful, and rooted in the needs of the community.

Francheska Beatrix Alexia B. Young was a student at Lyceum of the Philippines University – Davao. Her interests lie in the intersection of safety, technology, and human behavior. Through her involvement in the development of FELIX, she aims to explore how digital tools can improve not

only emergency responses but also individuals' sense of preparedness and confidence during disasters.

Lensam Mae S. Silbano was a student at Lyceum of the Philippines – Davao. She is passionate about science, public service, and the pursuit of meaningful knowledge. Her academic journey reflects responsibility, adaptability, and leadership—traits she continues to strengthen through her involvement in writing, research, and STEM-related initiatives. With a strong interest in technology and a heart for service, she aspires to apply her skills in scientific inquiry and communication to promote safety, raise awareness, and foster innovation in both local communities and broader society.

Zakia Nia Angelie J. Barnal was a student at Lyceum of the Philippines University – Davao, with a deep interest in design, innovation, and real-world problem-solving. As one of the student researchers and developers behind FELIX, she is passionate about using technology to create safer, more informed communities. Through this project, she continues to explore how digital tools can not only support emergency response but also build confidence and readiness in everyday users.

Rhina May L. Fonellera, LPT is the Junior College Coordinator at the Lyceum of the Philippines University Davao with a Bachelor of Secondary Education Major in Mathematics and ongoing studies in Mathematics Teaching. She is passionate about guiding young researchers in developing critical thinking and academic integrity through meaningful, research-based learning experiences. Her work reflects a strong commitment to fostering a culture of inquiry, excellence, and lifelong learning among students.

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