UMT PRESS

Journal of Sustainability Science and Management
Journal Homepage: https://jssm.umt.edu.my
eISSN: 2672-7226
DOI: http://doi.org/10.46754/jssm.2026.05.005

MOBILE APPLICATION FOR REAL TIME POSITIONING DISTRESS AT SEA

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ARTICLE INFO

Article History:
Received: 14 July 2023
Revised: 7 January 2025
Accepted: 3 December 2025
Published: 15 May 2026

Keywords:
Mobile application, search and rescue operations, usability analysis.

ABSTRACT

This study aims to design and evaluate the usability of the Real-Positioning Distress System (RPDS) application to assist coastal fishermen and small operators at sea. This Android-based mobile application was developed using the Eclipse Java IDE. The application's features and architecture have been tailored according to user preferences and the capabilities of the end-user device. A pilot study and a user satisfaction evaluation were conducted to further analyse the RPDS application's usability. Results of the pilot study show that the details of distress location and time received are accurate and efficient for all areas. Results of the user satisfaction survey indicate that respondents were satisfied with the features and operability of the RPDS application. The application also provides sufficient, intuitive functionality to accomplish the primary objective of sending a distress alert, making it a viable alternative for future mobile applications. This study concluded that an application with simple functions is desirable for end users to improve the user experience.

Introduction

Fishing has traditionally been the main occupation that provides income for communities living in coastal regions. A report published by the Malaysian Fisheries Department in 2023 indicates that there were almost 112,344 registered fishermen in Malaysia; two-thirds or about 84,629 were classified as coastal fishermen operating small boats. These coastal vessels or small boats operate only within 12 nm of the coastline (Fishery Department of Malaysia, 2023). These boats use outboard engines and are sufficient to power small vessels with a total length of 2 to 12 metres and do not, by regulation, require the installation of any communication devices such as a VHF radio (SOLAS: The International Convention for the Safety of Life at Sea, 1998). Most of the time, they communicate using personal mobile phones during emergencies to inform family members, closest friends, and the community leader.

In most emergencies, the information provided is incomplete, with the victim giving no precise location. This will cause some delays in the Search and Rescue (SAR) operation, as the message has passed through multiple parties before reaching the relevant authority. In the worst-case scenario, some emergency messages or calls will be unanswered or ignored. Practical initiatives are needed to address the issues faced by coastal fishermen and small-boat operators. Simple efforts to create a new mobile application that provides near-similar features to GMDSS or VHF radio distress buttons would effectively enhance safety at sea. A mobile phone is a device that almost everyone carries all the time. According to statistics, more than 32% of the global population, from kids to teenagers to adults has relied on mobile phones in their daily activities (Weichbroth, 2020). A mobile application could be a perfect tool for quick information gathering and sharing (Rapp & Cena, 2016; Cena *et al.*, 2018; Chen *et al.*, 2019).

Several studies on the application of location tracking via mobile phone have also been conducted recently by previous researchers (Lai *et al.*, 2010; Chandra *et al.*, 2011; Dinesh Kumar *et al.*, 2016; Mukesh Krishnan *et al.*, 2019). K3M is an example of a mobile application that allows the maritime community in Malaysia to lodge reports or request emergency assistance directly with the maritime authority. Too many features embedded in the application have been reported to cause difficulties for users and it can only be downloaded on a high-end device due to its large file size. This is beyond the needs of coastal fishermen or small-boat operators, as it is hindered by the capabilities of the devices they use and by very limited data allowances. According to previous mobile user analysis studies, most users tend to avoid complex applications for emergency use, which provides the basis for this study's design of a suitable mobile application (Green *et al.*, 2003; Swaid & Suid, 2019).

This study analyses the potential of mobile phones to enhance the safety of daily activities for coastal fishermen and boat operators. They usually require information such as navigation guidance, real-time coordination, and the transmission of a distress message. The advancement of mobile technology provides an opportunity and immediacy for supporting such information (Chen *et al.*, 2019). In particular, this study designs and develops a new mobile application called the Real-Positioning Distress System (RPDS). Through this RPDS application, the user can send a distress message to maritime authorities to receive immediate assistance.

To ensure the success of the RPDS application, this study also conducts a usability analysis involving coastal fishermen and small boat operators. Usability refers to a mobile application's ability to be used by a specified user to achieve their specific goal (Baharuddin *et al.*, 2013; Nikou & Economides, 2019). Usability is measured using a variety of components, depending on the individual (Nathan *et al.*, 2016). According to Nikou and Economides (2019), the usability of the mobile application can be demonstrated through user ratings of its interface.

Several usability standard have been introduced of either to guide the design or measure the developed application such as ISO 9241-11 model (Harrison *et al.*, 2013; Moumane *et al.*, 2016; Iqbal *et al.*, 2017; Kureerung & Ramingwong, 2019; Arthana *et al.*, 2019; Basyir *et al.*, 2019), Neilson model (Nathan *et al.*, 2016; Alturki & Gay, 2017; Muqtadiroh *et al.*, 2017), PACMAD model (Cata *et al.*, 2015; Saleh *et al.*, 2015; Alturki & Gay, 2017), ISO 9126 model (Cheikhi *et al.*, 2006; Moumane *et al.*, 2016; Paz *et al.*, 2019), and mGQM model (Hussain & Kutar, 2010b; Hussain *et al.*, 2014; Zahra *et al.*, 2017) as shown in Figure 1.

Many criteria have been studied and proposed by previous researchers. Different studies used different criteria to measure the usability of their mobile applications. This study used the ISO 9241-11 guidelines (Figure 2), which rely on three criteria: Effectiveness, efficiency, and satisfaction (Georgsson & Staggers, 2016; Nik Ahmad & Hasni, 2021). To summarise the usability criteria found in the literature, the criteria were reviewed and grouped into main and sub-criteria, as presented in Table 1. Most of the sub-criteria used different terminology, but they share a similar meaning.

For the usability analysis, the evaluation considered factors on the human side (perception or feedback based on experience with the application) and the application's performance in performing the specified task, as indicated by Mou and Zhou (2018). The criteria of efficiency and effectiveness were evaluated through the pilot test. The reliability of the application in providing location information/ distress messages was examined by comparing the data provided by the RPDS application (time and coordinates) with those from the GPS. The criteria for satisfaction were based on feature evaluations from target users. The combination of these three results is expected to indicate

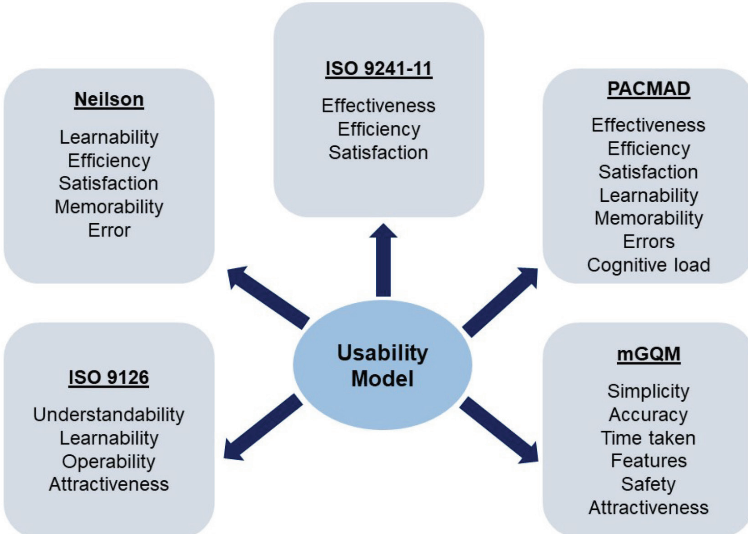


Figure 1: Usability model reported in the literatures

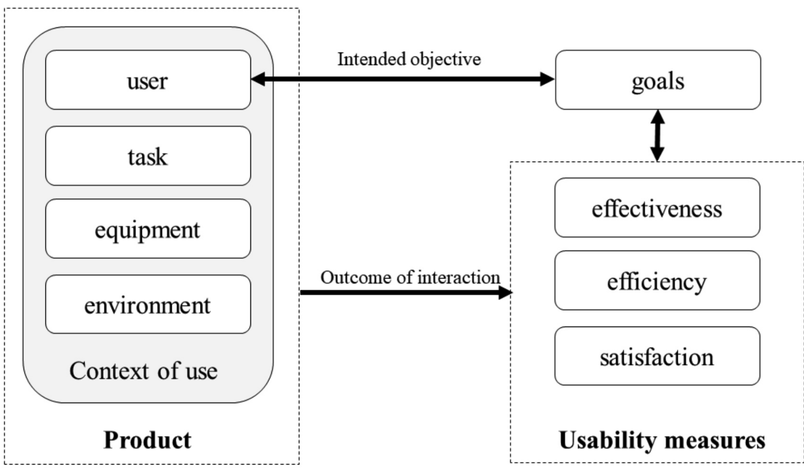


Figure 2: Usability framework according to ISO 9241-11
Source: Nik Ahmad and Hasni (2021)

the level of usability and success of the RPDS application.

The findings from this study can serve as a point of reference for future researchers, offering new perspectives for mobile application developers and usability analysts to better understand end users' specific needs. A dual-analysis approach, namely performance testing and user satisfaction feedback, conducted during the evaluation process, helps strengthen the findings and add additional value to the present study.

Methodology

The methodology of this study was divided into three phases: End-user engagement (Phase 1), application design and development (Phase 2), and usability analysis (Phase 3). Each phase is described in detail in the following section.

Table 1: Criteria selected based on ISO 9241-11

Main Criteria	Subcriteria	Description	Reference
Efficiency	▪ Interruptibility	Able to access with no interruption (signal/ advertisement)	(Saleh *et al.*, 2017)
	▪ Responsive/Timeliness/ Simultaneous	Able to provide information in a quick time	(Hussain & Kutar, 2010a; Kureerung & Ramingwong, 2019; Zali & Fadzlah, 2017)
Effectiveness	▪ Memorability	Capable of remembering all steps/features/information provided by the user	(Alturki & Gay, 2017; Elkheir & Abdul Mutalib, 2015)
	▪ Accessibility/ Findability	Easy to access and available in any medium (i.e., Google Play, App Store)	(Aggarwal *et al.*, 2019)
	▪ Accurateness/ Reliability/ Operability/ Steadiness/ Sability compliance	Able to provide accurate/ precise information required by the user (i.e., location, coordinate, direction)	(Aggarwal *et al.*, 2019; Kabir *et al.*, 2018; Zali & Fadzlah, 2017)
Satisfaction	▪ Understandability/ Readability/Simple/ Effortlessness	Easy to understand the language, features, and steps provided in the mobile apps	(Aggarwal *et al.*, 2019; Kabir *et al.*, 2018; Zali & Fadzlah, 2017)
	▪ Attractiveness/ Intuitive design & features/ Navigation/ Notification	Design/feature/interface provided in the mobile apps is attractive and self-explanatory	(Aggarwal *et al.*, 2019; Hussain & Kutar, 2010a; Kureerung & Ramingwong, 2019)
	▪ Cognitive load/ Training	Able to be used with limited skill/training	(Alturki & Gay, 2017; Kabir *et al.*, 2018; Saleh *et al.*, 2017)
	▪ Safety/Privacy/ Security	Able to keep important details of the user	(Hussain & Kutar, 2010a)

Phase 1: End-user Engagement

The RPDS application was designed to assist local fishermen and small boat operators in emergencies at sea. One of the application's goals is to ensure that features are designed in accordance with the user's preferences and capabilities. For that purpose, a session with fishermen or boat operators (as end users) in Terengganu was conducted to gather their specific preferences for the new application and to gain their perspectives on the existing applications. A 1-day engagement session was held at Universiti Malaysia Terengganu on 24 January 2020, involving 45 fishermen and small-boat operators (mean age = 48; SD = 1.672), as depicted in Figure 3.

In this study, the engagement session was divided into three main activities as depicted in Figure 4. The first activity began with a briefing on the aim, scope, and other related information to provide participants with an initial idea, knowledge, and guidance. After completing the briefing, the participant was required to complete the question form (Figure 5) for information collection, which covers the following categories: (i) participant details, (ii) device specification, (iii) issue with existing application (K3M smartphone apps), and (iv) application features and interfaces preference. This activity took about 30 minutes to complete for all participants. The session ended with a face-to-face discussion with the participant to obtain their consent for the application design and development (Szolnoki & Hoffmann, 2013; Saloniki *et al.*, 2019).

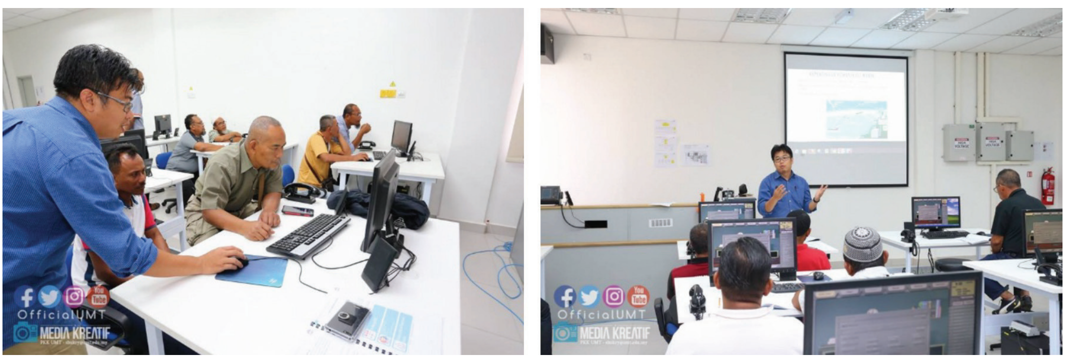


Figure 3: Engagement session
Source: Media Kreatif UMT

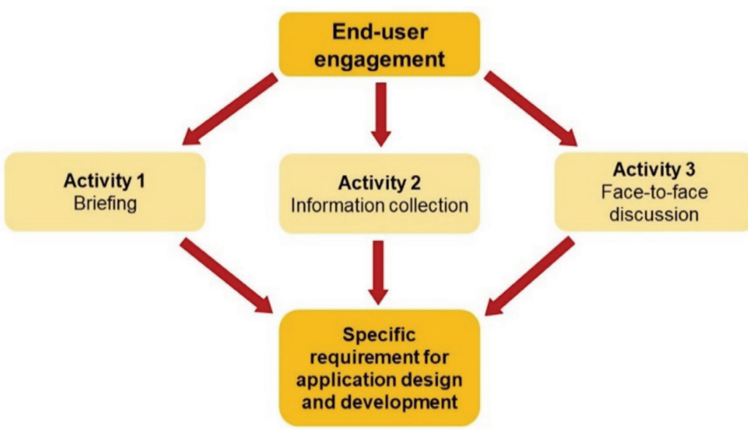
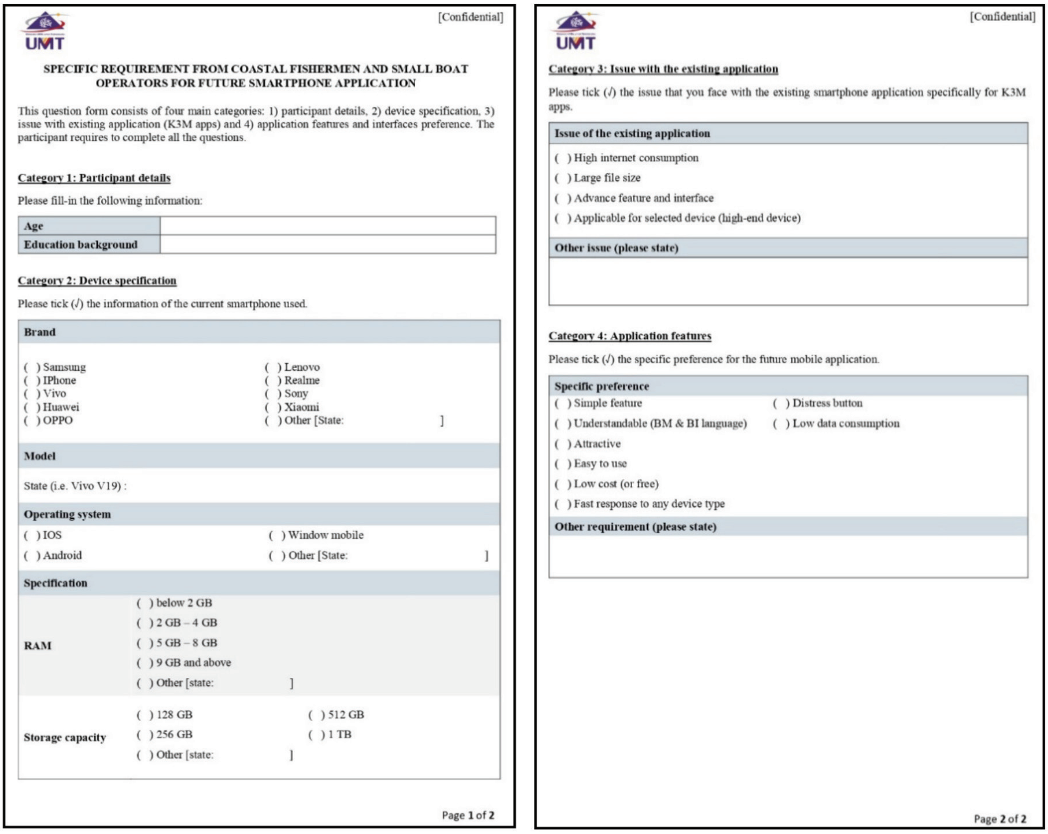


Figure 4: End-user engagement process



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SPECIFIC REQUIREMENT FROM COASTAL FISHERMEN AND SMALL BOAT OPERATORS FOR FUTURE SMARTPHONE APPLICATION

This question form consists of four main categories: 1) participant details, 2) device specification, 3) issue with existing application (K3M apps) and 4) application features and interfaces preference. The participant requires to complete all the questions.

Category 1: Participant details

Please fill-in the following information:

Age	
Education background	

Category 2: Device specification

Please tick (/) the information of the current smartphone used.

Brand		
( ) Samsung ( ) IPhone ( ) Vivo ( ) Huawei ( ) OPPO		( ) Lenovo ( ) Realme ( ) Sony ( ) Xiaomi ( ) Other [State:]
Model		
State (i.e. Vivo V19) :		
Operating system		
( ) IOS ( ) Android		( ) Window mobile ( ) Other [State:]
Specification		
RAM	( ) below 2 GB ( ) 2 GB – 4 GB ( ) 5 GB – 8 GB ( ) 9 GB and above ( ) Other [state:]	
Storage capacity	( ) 128 GB ( ) 256 GB ( ) Other [state:]	( ) 512 GB ( ) 1 TB

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Category 3: Issue with the existing application

Please tick (/) the issue that you face with the existing smartphone application specifically for K3M apps.

Issue of the existing application
( ) High internet consumption ( ) Large file size ( ) Advance feature and interface ( ) Applicable for selected device (high-end device)
Other issue (please state)

Category 4: Application features

Please tick (/) the specific preference for the future mobile application.

Specific preference	
( ) Simple feature	( ) Distress button
( ) Understandable (BM & BI language)	( ) Low data consumption
( ) Attractive	
( ) Easy to use	
( ) Low cost (or free)	
( ) Fast response to any device type	
Other requirement (please state)	

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Figure 5: Sample of question form used during engagement session

Phase 2: Application Design

The RPDS application was specifically designed for Android mobile devices to support and enhance the daily activities of coastal fishermen or small boat operators. The system uses the Firebase Realtime Database to enable seamless data integration across multiple databases without requiring SQL and to allow users to access the database in real time. This application was developed using open–source Java technology in an Eclipse-based Integrated Development Environment (IDE). Through this RPDS application, fishers and small boaters can request assistance from authorities by simply sending a distress message.

The RPDS application was developed based on four (4) main modules: Register/Login, GPS, Digital Compass, and Data Sharing. The function of each module is depicted in Figure 6 and details of each functionality is provided in Table 2. The case narratives for each module embedded in the RPDS application are summarised in Tables 3, 4, 5, and 6.

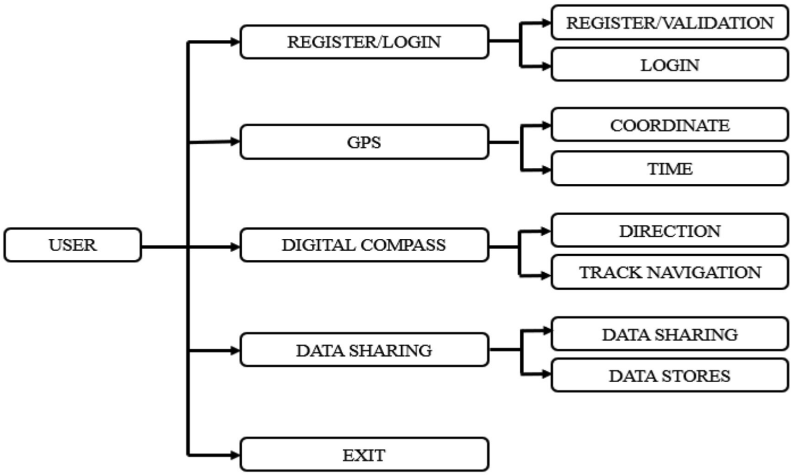


Figure 6: Functional module of the RPDS system

Table 2: Functionality of the module embedded in the RPDS application

Module	Functionality
Register/login	Provide registration of a new user and login to the application system. This interface saves all the users information in the database.
GPS module	Allow the user to identify and detect real-time location using satellite signal. The position is provided in latitude and longitude.
Data sharing	Deals with data information sharing received from the new user's information and GPS information.
Digital compass	Provide real-time heading information and enable a precise location. This module requires users to have a smartphone with a magnetometer to detect direction relative to Earth's magnetic field.

Table 3: Case narrative for registration and validation

Use Case	User Registration and Validation
Primary actor	Fishermen, boat operators
Goal in context	To access the functionality of the application
Precondition	System must be fully configured; an appropriate user ID and password must be obtained
Trigger	-
Scenario	1. The user enters the RPDS application on a smartphone. 2. User enters the username, password, and email in each field to complete the registration process. 3. The process will run and display "Success of registration". 4. Users can now log in to the function and access it using their registered account.
Exception	1. The out-user cannot access this functionality directly; see use case "User Registration and Log in" 2. If the username and password are incorrect, the system will prompt the user to re-log in.

Priority	Important priority: Everyone can access this function, but it should be available to registered users first
When available	First increment
Frequency of use	Everyday
Channel to actors	Web and mobile application with an Internet connection
Secondary actors	Firebase hosting
Open issues	1. How much does this system assure that it will not allow a hacker to access this functional website? 2. What mechanisms can we use to protect ourselves from out-users?

Table 4: Case narrative for distress

Use Case	**User Distress**
Primary actor	Fishermen, boat operators
Goal in context	To successfully send the location details to the database
Precondition	The system must be fully configured, an appropriate user ID and password must be obtained.
Trigger	To send the latitude and longitude
Scenario	1. The user enters the RPDS application on a smartphone. 2. User enters their username, password, and email in each box to run the registration process. 3. The process will run and display "Success of registration". 4. The user pushes the distress button when in a distress condition.
Exception	1. The out-user cannot access this functionality directly; see use case "User Registration and Log in" 2. The user cannot spam the button because it will cause an error.
Priority	Important priority: Everyone can access this function, but it should be available to registered users first
When available	Distress
Frequency of use	During distress
Channel to actors	Web and mobile application with an Internet connection
Secondary actors	GPS and firebase hosting
Open issues	1. How long does it take for this application to send the location of distress details to the database? 2. How accurately will this longitude and latitude be sent to the database?

Table 5: Case narrative for map

Use Case	**User Map**
Primary actor	Fishermen, boat operators
Goal in context	To view the location geographic
Precondition	The system must be fully configured, an appropriate user ID and password must be obtained

Trigger	To mark the position on the map
Scenario	1. The user enters the RPDS application on a smartphone. 2. User enters their username, password, and email in each box to run the registration process. 3. The process will run and display "Success of registration". 4. Push the button open the map. 5. Navigate our position on the map.
Exception	1. The out-user cannot access this functionality directly; see use case "User Registration and Log in"
Priority	Important priority: Everyone can access this function, but it should be available to registered users first
When available	Loss direction
Frequency of use	Every day
Channel to actors	Web and mobile application with an Internet connection
Secondary actors	Google Service
Open issues	1. How accurately does this map mark our position?

Table 6: Case narrative for digital compass

Use Case	**User Digital Compass**
Primary actor	Fishermen, boat operators
Goal in context	To navigate a position
Precondition	The system must be fully configured, an appropriate user ID and password must be obtained
Trigger	To get true direction
Scenario	1. The user enters the RPDS application on a smartphone. 2. User enters their username, password, and email in each box to run the registration process. 3. The process will run and display "Success of registration". 4. Push the button on the Digital Compass. 5. Navigate in the true direction automatically, referring to the compass needle.
Exception	1. The out-user cannot access this functionality directly; see use case "User Registration and Log in"
Priority	An important priority: Everyone can access this function, but it should be available first to registered users
When available	Loss
Frequency of use	Every day
Channel to actors	Web and mobile application with an Internet connection
Secondary actors	Motion sensors, environmental sensors, and position sensors
Open issues	1. How accurately can the needle of a compass get true direction?

Phase 3: Usability Analysis

In this study, usability is assessed against the effectiveness, efficiency, and satisfaction criteria as outlined in ISO 9241-11. According to Basyir *et al.* (2019), the levels of effectiveness, efficiency, and satisfaction were simultaneously related to users' decisions to utilise the application. For these purposes, this study used a combination of two methods to analyse the usability of the RPDS application: A pilot test and a user satisfaction evaluation. The evaluation was conducted by considering factors related to the human (perception or feedback based on experience with the application) and the application's ability to perform the specified task.

Pilot Study

A pilot study was conducted among students, lecturers, and technical staff from the maritime program to evaluate the usability and functionality of the RPDS mobile application in real-world conditions. A group of 10 members, comprising five students, three lecturers, and two technical staff was involved in this study. The study was conducted by cruising aboard the research vessel, as shown in Figure 7. The usability and functionality of the RPDS mobile application were evaluated based on transmission time and the accuracy of the server-provided position.

Before running the RPDS application, it was downloaded and installed into a real mobile phone (Android 6.0.1 – Marshmallow; CPU – Octa-4×2.0 GHz Cortex-A53). The pilot study covered two areas: First, specifically within the coastal waters of Terengganu [Figure 8 (a)] and second, around the coastal waters of Peninsular Malaysia from Langkawi through the Malacca Strait, Singapore Strait, and South China Sea [Figure 8 (b)]. All received data and the server-provided position accuracy were then identified and compared with the GPS data. The time required for the system to respond to a particular workload was also determined.

User Satisfaction Evaluation

User satisfaction was evaluated based on participants' experience and feedback when using the RPDS application. A total of 34 participants aged 20–60 years, actively involved in marine activities within the coastal waters of Terengganu volunteered to participate in this evaluation process (Figure 9). Participants were first required to download the RPDS application from the Google Play Store on their own device. Participants were first given about one hour to explore and use the application.

To assess the user's satisfaction with the RPDS application, participants were required to complete the questionnaire (Figure 10). The survey used a 5-point Likert scale to evaluate various aspects of the application, ranging from strongly disagree (1) to agree (5) strongly. This

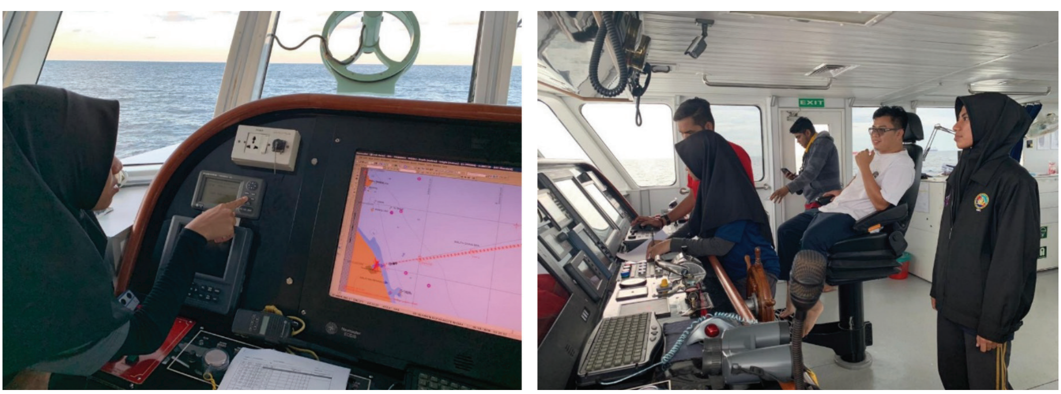
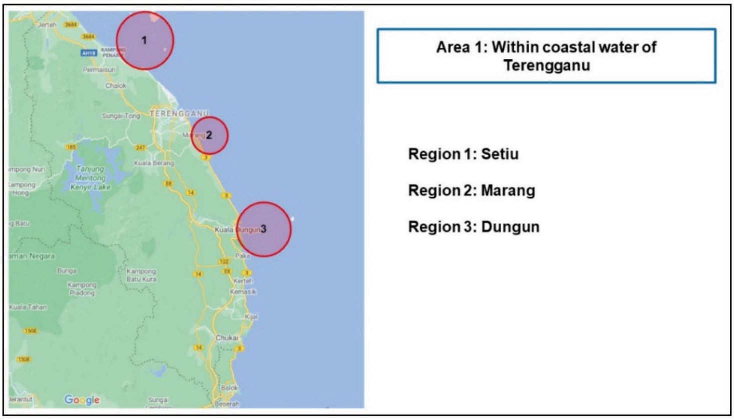
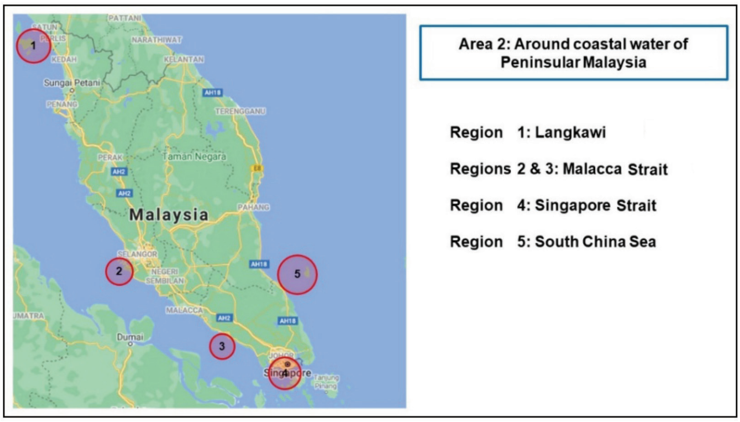


Figure 7: Sailing onboard for the performance test
Source: Captured by authors



(a)



(b)

Figure 8: Area covered during pilot study (a) within the coastal waters of Terengganu and (b) around the coastal waters of Peninsular Malaysia

Figure 9: User evaluation process
Source: Media Kreatif UMT

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MOBILE APPLICATION FOR REAL-TIME POSITIONING DISTRESS AT SEA: USER SATISFACTION SURVEY

Thank you for using RPDS mobile application! Please answer the following questions based on your experience with the app.

Please indicate how much you agree or disagree with the following statement:

Factor 1: Feature – Easily Visible

The interface, icons and text presented in the RPDS mobile application is readable, visually clear and easy to distinguish.

☐ 1 - Strongly Disagree
☐ 2 - Disagree
☐ 3 - Neutral
☐ 4 - Agree
☐ 5 - Strongly Agree

Factor 2: Task Completion – Step to Send Distress

The steps to send distress signals are intuitive and do not require additional guidance.

☐ 1 - Strongly Disagree
☐ 2 - Disagree
☐ 3 - Neutral
☐ 4 - Agree
☐ 5 - Strongly Agree

Factor 3: Usability – Battery and Data Usage

The apps use a reasonable amount of battery. The usage of data is minimal and does not affect internet connection.

☐ 1 - Strongly Disagree
☐ 2 - Disagree
☐ 3 - Neutral
☐ 4 - Agree
☐ 5 - Strongly Agree

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Factor 4: Response Time

The RPDS mobile application provides immediate feedback after submitting the distress signal.

☐ 1 - Strongly Disagree
☐ 2 - Disagree
☐ 3 - Neutral
☐ 4 - Agree
☐ 5 - Strongly Agree

Factor 5: Overall Satisfaction

Overall, the RPDS mobile application meets my expectations for distress signaling at sea.

☐ 1 - Strongly Disagree
☐ 2 - Disagree
☐ 3 - Neutral
☐ 4 - Agree
☐ 5 - Strongly Agree

Recommendation or suggestion

Please share any features, improvements, or changes you would suggest to make the RPDS mobile application more useful or user-friendly (if any).

....

....

Thank you for your feedback!

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Figure 10: Sample of user's satisfaction survey form

scale allowed participants to express their level of agreement and satisfaction with specific features and functionalities of the RPDS application. The survey included questions targeting key areas of user experience, including features, ease of use when sending distress messages, usability issues, response time, and overall satisfaction.

Results and Discussion

Specific Criteria from Fishermen or Small Boat Operators

The specific criteria for the RPDS application were obtained through a questionnaire survey conducted during an engagement session with fishermen or small-boat operators. About 45 participants who were actively engaged in marine activities in Terengganu's coastal waters agreed to complete the questionnaire. Figure 11 illustrates the demographic characteristics of the participants. Participants were divided into five age groups. The highest percentage was among those aged 41 to 50 (38%), followed by those aged 31 to 40 (21%) and 51 to 60 (19%). 13% were between 20 and 30, only 9% were 60 or older.

Among all participants, 30 (67%) had attended secondary school and 11 (24%) had attended primary school. Only 4 (9%) of them were college graduates. According to the literature, users under 55 years old with at least a secondary education had no issues with mobile technology adoption (Vicente & Lopes, 2016; Vaportzis *et al.*, 2017). They often used mobile phones for emergencies, social activities, or other routine tasks (Nasir *et al.*, 2008; Mohadisdudis & Ali, 2015; Vicente & Lopes, 2016; Seifert *et al.*, 2017; Chmielarz, 2020). This means that the fishermen or small boat operators were already familiar with and had no difficulty using a mobile application to support their daily activities; hence, developing a new application would pose no issue for them and require minimal familiarisation.

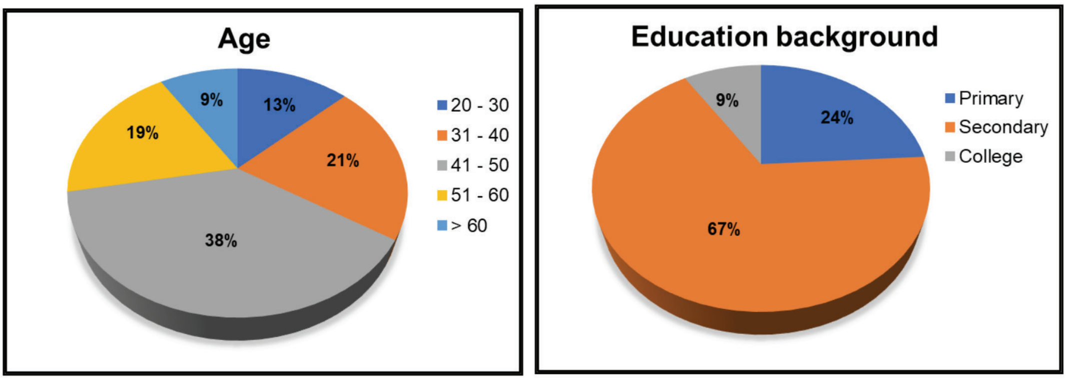


Figure 11: Participants' demographics

Figure 12 shows the brand and specification of the device used by the participants. This information was gathered to ensure the application was designed in accordance with the end-user device's capabilities. Based on the survey, the following are six brands of smartphones that the fishermen or small boat operators commonly use; these including OPPO (32%), Huawei (20%), Xiaomi (17%), Realme (14%), VIVO (9%), and Samsung (8%). As shown in Figure 12, all participants used Android-based mobile phones with 2–4GB of RAM and 32GB of storage, indicating limited device capacity and capability. The RPDS application must be designed with a simple function that achieves its main goal: Sending a distress message.

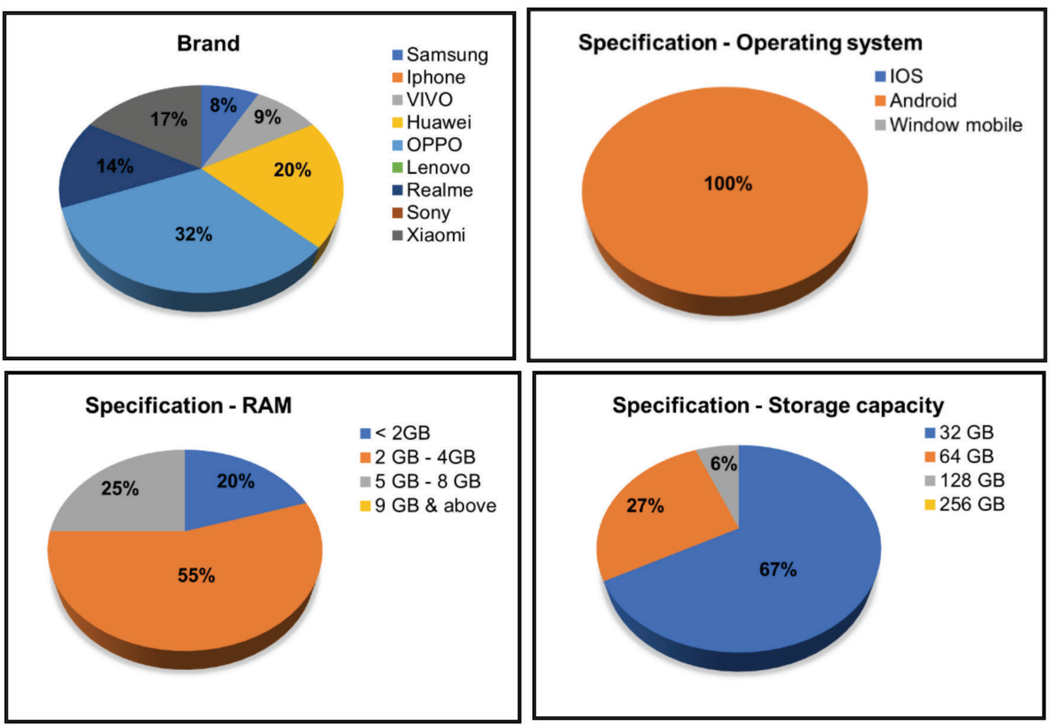
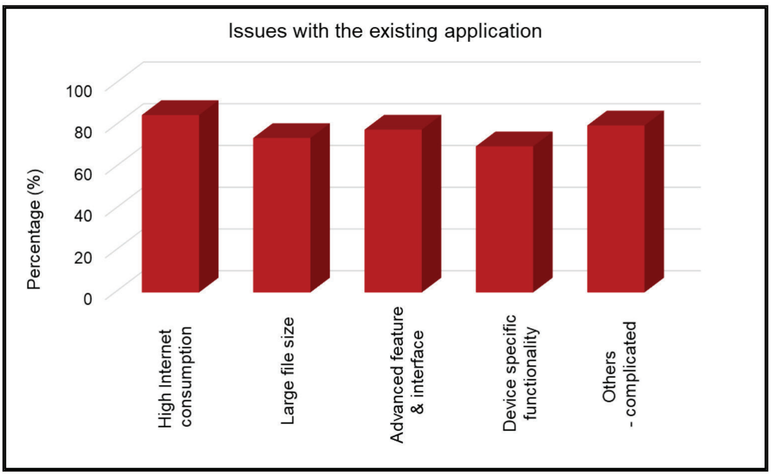


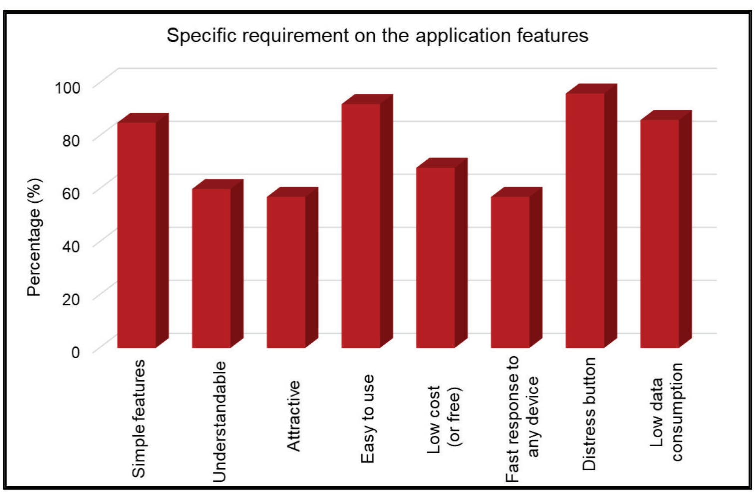
Figure 12: Device brand and specification used by the participants

An issue with the existing application was also collected, as shown in Figure 13 (a). The feedback was based on their personal experience with the application. Most of them face difficulty in using the application due to the following reasons: (i) High internet consumption, (ii) large file size, (iii) advanced feature and interface, (iv) device-specific functionality, and (v) complicated. These become the main aspect to be considered in developing a future mobile application, especially when involving this target group of study.

It is also crucial to understand the target user's specific preferences to develop a successful mobile application. As illustrated in Figure 13 (b), the fishermen or small boat operators required four main criteria for the future RPDS application, these including (i) simple feature, (ii) ease of use, (iii) distress button, and (iv) low data consumption. More than 80% of participants proposed similar criteria to support their activities at sea. Details on the design and architecture of the RPDS application are described in the subsequent section.



(a)



(b)

Figure 13: (a) Issue with the existing application and (b) specific preference on the future application feature

Features and Architecture of RPDS Application

By taking into consideration the existing issue and requirement of the target user in Section 3.1, this study suggested five interface options for the user including a register/login interface [Figure 14 (a)], a verification interface [Figure 14 (b)], a distress button interface [Figure 14 (c)], a Google Maps interface [Figure 14 (d)], and a digital compass interface [Figure 14 (e)]. Both registration/login and verification were standard interfaces in any mobile application for acquiring and securing user details. Three interfaces in Figure 14 (c–e) are special requests from the target users, which are considered the uniqueness of this RPDS application.

The RPDS mobile application fixes the user's location and transmits real-time information directly to the responsible authority with a single button press during an emergency. Figure 15 shows the architecture of the RPDS application. This application consisted of three main components. The first component is the user. Before using the application, the user

(a) Registration interface (b) Validation interface (c) GPS interface

(d) Google Maps interface (e) Digital compass interface

Figure 14: Screenshot of the interface provided in the RPDS mobile application

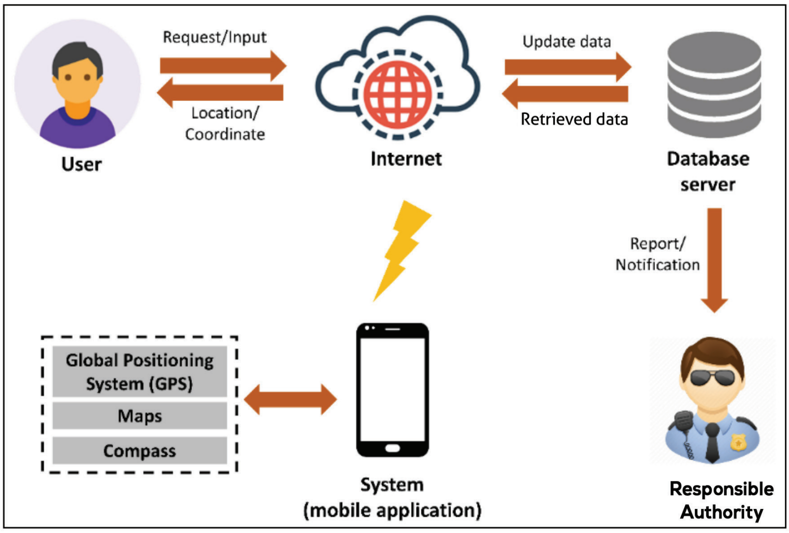


Figure 15: Architecture of RPDS application

must register in the RPDS system to create the database. Once it is created, the user can use the provided features to send/receive information, view their current location and navigate the direction. In an emergency, the user also has the option of sending an additional safety message to the server for assistance.

The second component is the database server. The RPDS application required a GPS connection to the smartphone to obtain real-time coordinates (e.g., latitude and longitude) for further processing by the application. When a distress button is pressed, the server receives the location and updates it to notify the responsible authority via messages. All the collected information is stored in the database. The third component is the authority. The authority receives the distress notification from the server and dispatches a SAR team to the specified location. All of these processes are summarised in the data flow diagram shown in Figure 16.

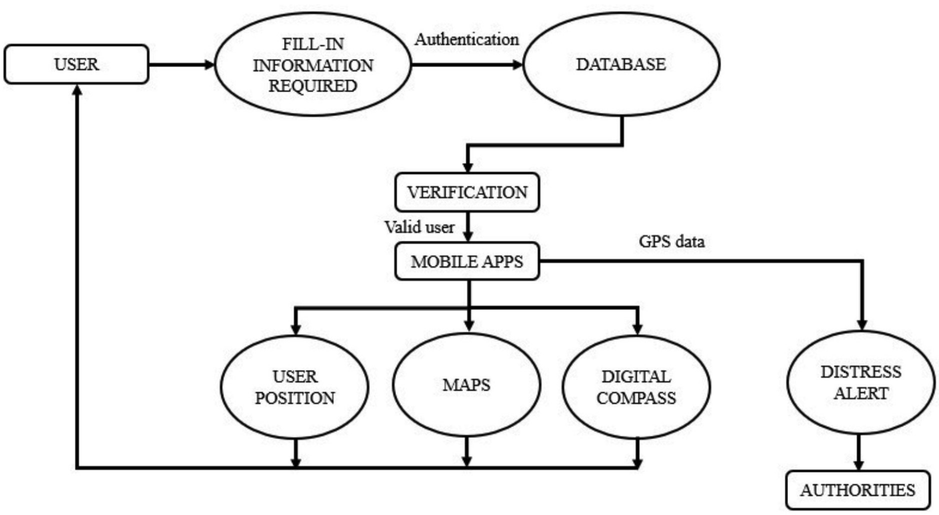


Figure 16: Data flow of RPDS application

Usability of RPDS Application

Pilot Study

To ensure the usability and functionality of the RPDS application, a pilot study was conducted in a real-world environment aboard a research vessel. The study was conducted in two areas: Area 1–specifically within the coastal waters of Terengganu and Area 2–around the coastal waters of Peninsular Malaysia, from Langkawi via the Malacca Strait, Singapore Strait, and South China Sea. All information related to the user's activities has been recorded, stored, and synchronised in the database. Three main components have been displayed in the database: Latitude, longitude, and position accuracy.

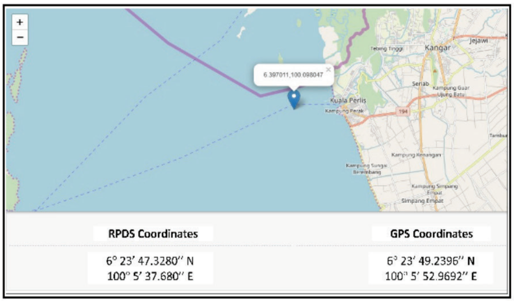
The accuracy of the position detected by the RPDS application was determined by comparing its coordinates with those from GPS. The time taken to transmit from the RPDS application was also compared with the time recorded in the database to identify delays. The results are summarised in Table 7. The comparison of positions and times from both systems was almost identical. This demonstrates and verifies that the detection system was accurate and well-functioning when tested within the coastal waters of Terengganu.

A similar pilot study on the application of RPDS was also conducted in a large area along the coastal waters of Peninsular Malaysia. Figure 17 shows the map retrieved from the RPDS application at a specific location. It also included a comparison of the coordinates obtained from the RPDS application and the GPS unit on board the vessel. The voyage took almost three days, from 31 March 2019 to 2 April 2019, to reach the final destination.

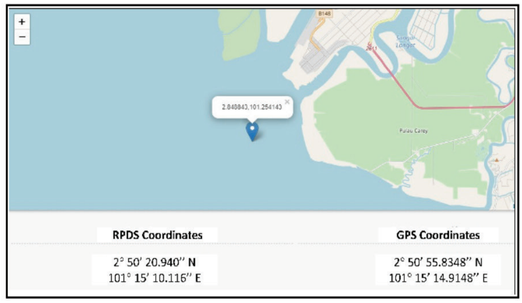
Based on the map shown in Figure 17, the system detected most locations and pinned them to the exact positions where the user was. While crossing the Singapore Strait, the location was determined, but only to a limited extent due to the signal coverage provided by certain telecommunication service providers. This might be due to the location of the Singapore Strait, which is far from the Malaysian border and is not capable of supporting the telecommunications network. The RPDS application successfully records location information. The coordinate provided was also acceptable and within the location range.

Table 7: Position and time recorded by the RPDS application and GPS during a pilot study within the coastal waters of Terengganu

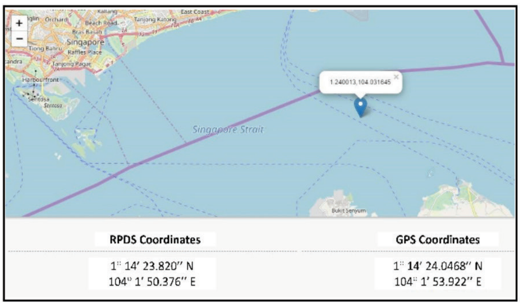
No.	RPDS Position	RPDS Time Transmit (h)	GPS Position Received	Database Time Received (h)
1	Lat: 5.395561 Long: 103.077351	0642	Lat: 5.394506 Long: 103.077001	0642
2	Lat: 5.329174 Long: 103.122032	0705	Lat: 5.329814 Long: 103.123010	0705
3	Lat: 5.274091 Long: 103.174994	0735	Lat: 5.274119 Long: 103.172009	0735
4	Lat: 5.072239 Long: 103.275342	0827	Lat: 5.072330 Long: 103.274432	0827
5	Lat: 4.859831 Long: 103.396237	0837	Lat: 5.859104 Long: 103.396110	0837
6	Lat: 4.759516 Long: 103.399676	0848	Lat: 4.750314 Long: 103.399901	0848



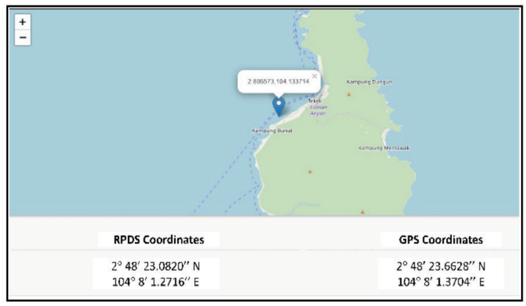
(a) Langkawi



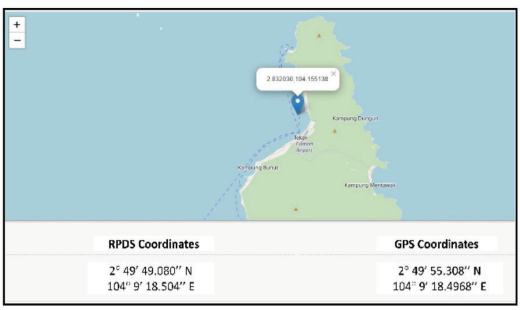
(b) Klang



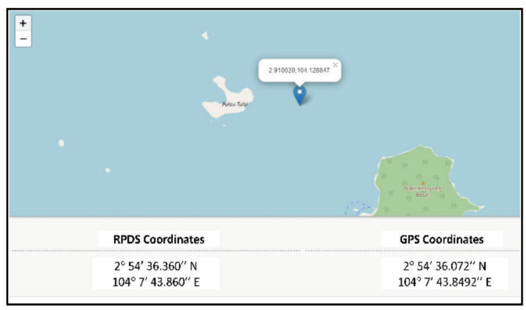
(c) Singapore Strait



(d) Tioman (Tioman Island)



(e) Kapas (Kapas Island)



(f) Kulai

Figure 17*:* Map of tracking location from RPDS application and GPS unit on board the research vessel

For further confirmation of the efficiency of the RPDS application in sending information, Table 8 summarises the time taken to transmit from the RPDS application and the time taken to receive by the database. The time transmitted and received by the database was almost identical. The time delay detected at certain locations might be due to the quality of network coverage while crossing the area. The information was successfully delivered to the database as discussed previously in Figure 17 and the position received is acceptable and within the real-time. Based on this analysis, the results indicated that the location details obtained from the RPDS application were accurate and well-functioning across all waters in Peninsular Malaysia. The interface provided in the RPDS application is easy to use, understandable, and suits the needs of fishermen and small boat operators.

Table 8: Comparison of time transmitted by RPDS application and time received by database during a pilot study along the coastal waters of Peninsular Malaysia

No.	RPDS Time Transmit (h)	Database Time Received (h)	Location
1	0915 (March, 31)	0916 (March, 31)	Langkawi
2	1517 (April, 1)	1518 (April, 1)	Klang
3	1016 (April, 2)	1018 (April, 2)	Singapore Strait
4	1941 (April, 2)	1941 (April, 2)	Tioman (Tioman Island)
5	2010 (April, 2)	2011 (April, 2)	Tioman (Kapas Island)
6	2148 (April, 2)	2148 (April, 2)	Kulai

User Satisfaction

To assess user satisfaction with the RPDS application, a set of guided questionnaires was developed and distributed to 34 respondents during a workshop. The respondents were guided through the questionnaire and given ample time to complete it correctly. The respondents were asked to rate their agreement and disagreement on a 5-Point Likert scale (5 – Strongly Agree and 1 – Strongly Disagree). The mean values and standard deviations of the responses to each statement are shown in Table 9.

The analysis of user satisfaction (Table 8) revealed that respondents were satisfied with the designed mobile application, which provides sufficient, user-friendly functions to accomplish its primary objective: Sending a distress alert. The respondent also believed that the procedure for sending the distress message was straightforward and that the application requires little training to operate. Apart from that, the application's features were easily visible and operated with minimal error. The respondents assigned the lowest rating to response time, owing to differences in phone capacity. To ascertain users' overall satisfaction, respondents were asked to rate the RPDS application. About 73% of respondents were extremely satisfied with the current state of the application. To identify the relationship between the selected factors and overall satisfaction, a multiple regression analysis was conducted, which showed that all selected variables significantly affect user satisfaction (R2 = 0.996, $p < 0.001$). The regression analysis revealed a strong correlation between feature simplicity and user satisfaction.

Conclusions

The RPDS application would be a preferable solution for fishermen or small boat operators in distress at sea, at least within the range of telephone communication. It serves as an instant distress alert to authorities and pressing a button can transmit the user's current location in real time. A pilot study and user satisfaction evaluation were conducted to ensure the usability of the RPDS application. The evaluation considered factors related to humans

Table 9: User satisfaction survey results

Question Statement (Factors of Satisfaction)	Mean	SD
Features (easily visible)	4.04	0.96
Task completion (steps to send distress)	3.85	0.88
Usability issue (heavy usage of battery and data)	3.72	0.99
Response time	3.00	1.03
Overall satisfaction	4.05	0.99

(perception or feedback based on experience with the application) and the application's ability to perform the specified task.

Based on the analysis, the RPDS application is effective and efficient in providing accurate and efficient location and time. The majority of respondents expressed satisfaction with the developed mobile application, which provides sufficient and user-friendly functions to accomplish the primary goal of sending a distress alert. The findings of this study can provide new perspectives for mobile application developers and usability analysts to better understand end users' specific preferences.

In addition, several improvements can be explored based on user feedback. The key area for improvement is the integration of offline capabilities, which allow users to continue using the mobile application even when cellular or internet coverage is unavailable. Integrating the mobile application with other existing emergency response networks could also enhance its effectiveness by providing better, coordinated assistance. These improvements would not only address the practical challenges encountered by users at sea but also elevate the function of the mobile application in enhancing maritime safety.

Acknowledgements

The authors would like to acknowledge Universiti Malaysia Terengganu for the funding given under the research grant TAPE-RG (Vot. 55136) to complete this study. Special thanks also to Research Vessel Discovery (RV-Discovery) and all experts who took part in the usability evaluation process.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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