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MRSI: Mobile Road Safety Information Application using Crowdsourcing

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ABSTRACT

Road deterioration poses a significant challenge for all. Enhancing road security and minimizing accidents necessitates an effective, dependable tool to assist road users, particularly in UNIMAS and Kota Samarahan. Presently, a gap exists as there is no intuitive application available to offer and report on road traffic information. The development of an app to communicate road conditions and safety is therefore essential. With the growing preference for smartphones over traditional desktops or notebooks, leveraging these devices for rapid dissemination and notification about road status and safety proves to be a more time-efficient and convenient method. Test results indicate that over 70% of users found the application to be user-friendly with stable functionality. Additionally, the app provides real-time traffic condition updates.

1. Introduction

Roads are the primary means of transportation for most people these days. All individuals desire to go on lengthy travels, parents want to go to work, college students and universities want to attend lectures, and high school students want to attend lessons. An application system, which is the term for those programs or services that are hosted on a server and can be accessed through a mobile app, is used to describe this system. As a result, these applications may be accessed through any Android mobile device, from anywhere in the world. Research on traffic patterns and behavior has increasingly turned to crowdsourcing as a valuable tool for gathering real-time data. Crowdsourcing allows for the collection of vast amounts of data from a diverse range of sources, providing a comprehensive view of traffic conditions. One of the key benefits of crowdsourcing in traffic research is the ability to access data from various geographical locations, making it possible to analyze traffic patterns on a broader scale [1]. Furthermore, crowdsourcing also enables researchers to gather data on specific aspects of traffic, such as congestion, accidents and road closures, which can be used to develop more targeted and effective traffic management strategies. This approach has proven to be particularly useful in urban areas where traffic congestion is a major issue [2]. In addition to traditional research methods, crowdsourcing offers a cost-effective and efficient way to collect data, making it a valuable tool for traffic research. With the increasing availability of smartphone

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technology and GPS devices, individuals can contribute to traffic data collection effortlessly, providing researchers with a rich source of real-time information [3]. The use of crowdsourced data in traffic research has the potential to significantly enhance our understanding of traffic dynamics and inform the development of innovative solutions to complex traffic problems.

Crowdsourcing is the process of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community, rather than from traditional employees or suppliers. The process of crowdsourcing is often used to subdivide tedious work and has occurred successfully offline. It combines the efforts of numerous self-identified volunteers or part-time workers, where each contributor of their own initiative adds a small portion to the greater result. The term "crowdsourcing" is a blended of "crowd" and "outsourcing"; it is distinguished from outsourcing in that the work comes from an undefined public rather than being commissioned from a specific, named group [4]. Mobile crowdsourcing refers to the process of collecting data or information from a large number of people through their mobile devices. In the context of road traffic, this refers to collecting real-time data on traffic conditions, congestion, accidents, and road closures from people on the road. Some examples of mobile crowdsourcing for road traffic include Waze, a navigation app that uses user-generated data to provide real-time traffic updates, and INRIX, a traffic analytics company that provides real-time traffic information [5].

The problem regarding the traffic condition is very critical especially during peak time in Kota Samarahan area. The people might not know the condition of the road safety, for example, if there is any accident occur in real-time. They only get to know the situation once they are in the situation. Some more, the people do not have specific platform or application that can help them to notify them in case there is any accidents occur in certain location of the road. The installation of sensors on the roadways, which is excessively expensive, is one issue with existing systems for gathering traffic data.

In order to give "crowdsourced" collective knowledge about road structure in UNIMAS and Kota Samarahan, this study describes the design and development of a Mobile Safety Information Application (MSRI) employing crowdsourcing that captures and analyses public views of safety. A mobile crowdsourcing app that gives users of the roads a platform to report any unfavourable conditions of the road infrastructure quickly and easily. The presentation of "crowdsourced" safety perception data *via* social media on interactive mobile applications will make drivers more attentive.

2. Literature Review

While crowdsourcing has provided valuable data for traffic research, it also comes with its own set of challenges. One of the main issues is the quality and reliability of the data collected. Since crowdsourced data is contributed by a wide range of individuals, there is a potential for inaccuracies or biases in the information provided [6]. Researchers must carefully consider methods for validating and cross-referencing the crowdsourced data to ensure its accuracy and reliability [7]. Another challenge is the potential for privacy concerns and data protection issues when collecting information from individuals. This is particularly pertinent when using location-based data from smartphones and other GPS devices. Researchers must navigate the ethical considerations surrounding the collection and use of personal data, ensuring that privacy rights are respected, and data security measures are in place to protect sensitive information [8]. Moreover, the diverse nature of crowdsourced data presents a challenge in standardizing the information collected. Different reporting formats, data structures, and levels of detail can make it difficult to consolidate and analyze the data effectively. Researchers are exploring methods to standardize crowdsourced data to ensure its compatibility and

usefulness for traffic analysis [9]. Another obstacle in crowdsourcing traffic research is the need to incentivize and engage individuals to contribute their data consistently. Researchers are exploring strategies to motivate and sustain participation in crowdsourcing initiatives, addressing factors such as user incentives, user experience, and platform design to encourage continued engagement. Furthermore, integrating crowdsourced data into existing traffic management and transportation systems can be a technical challenge [10]. As traffic research continues to leverage the power of crowdsourcing, overcoming these challenges will be essential in maximizing the value of crowdsourced data and harnessing its potential to revolutionize our understanding of traffic dynamics and inform the development of effective solutions. Developing and implementing best practices is crucial for addressing the challenges associated with crowdsourcing in traffic research. Researchers have identified several strategies to enhance the quality, reliability and usability of crowdsourced data for traffic analysis. By adopting these best practices, the potential of crowdsourcing in revolutionizing traffic research can be fully realized. To address concerns about the quality and reliability of crowdsourced data, researchers have developed robust validation methods. Utilizing machine learning algorithms and data filtering techniques, it is possible to identify and address inaccuracies or biases in the collected data. By implementing rigorous data validation processes, researchers can ensure that the crowdsourced data meets the necessary standards for reliability and accuracy [11].

2.1 Standardization of Crowdsourced Data

Standardizing the format and structure of crowdsourced data is essential for effective analysis. Efforts are underway to develop common data schemas and protocols that enable seamless integration of crowdsourced data into existing traffic management systems. By standardizing the reporting formats and data structures, researchers aim to streamline the process of consolidating and analyzing crowdsourced information. In addition to the technical challenges, ethical considerations are important in crowdsourcing traffic research. Researchers must ensure that the collection and use of personal data from individuals are conducted in a manner that respects privacy rights and adheres to data protection regulations. It is crucial to establish robust data security measures to safeguard sensitive information and guarantee that individuals' privacy is protected. In addition to the technical and practical aspects of crowdsourcing in traffic research, it is crucial to delve into the ethical considerations that underpin such initiatives. The ethical dimension encompasses the responsibility of researchers and organizations to prioritize the well-being and rights of individuals who contribute their data to these crowdsourcing efforts [12]. Moreover, transparency in data collection practices is vital to build trust with participants. Researchers should provide clear information about how the data will be used, who will have access to it, and how it will be protected. This transparency can encourage individuals to feel more comfortable contributing their data to crowdsourcing initiatives [13]. Motivating individuals to consistently contribute their data is a critical aspect of successful crowdsourcing in traffic research. Researchers are exploring various incentive structures, such as gamification, rewards and recognition programs, to encourage continued participation. Additionally, improving user experience and making the data contribution process user-friendly can enhance engagement and retention of participants. Creating a seamless and intuitive process for individuals to contribute their data, coupled with meaningful incentives, can boost participation in crowdsourcing efforts and ensure a steady stream of valuable data for traffic research. To encourage consistent participation in crowdsourcing initiatives, researchers are exploring innovative approaches to engage and incentivize contributors. This includes designing user-friendly platforms, providing real-time feedback to contributors, and offering incentives such as

rewards or recognition for active participation. By prioritizing user experience and community engagement, researchers aim to cultivate a sustainable and committed network of contributors for ongoing data collection [14]. Addressing the technical challenges of integrating crowdsourced data into existing traffic management and transportation systems is a key priority. Researchers are collaborating with technology experts to develop seamless integration frameworks that facilitate the real-time utilization of crowdsourced data for traffic monitoring and decision-making. Furthermore, the dynamic integration of crowdsourced data enables the implementation of adaptive traffic control measures, such as rerouting strategies and signal optimization, to mitigate congestion and improve overall traffic flow. This real-time approach to traffic management not only enhances efficiency but also contributes to reducing environmental impacts associated with prolonged congestion and idling vehicles [15].

2.2 Limitations and Challenges

While crowdsourcing presents numerous benefits for traffic research, there are also limitations and challenges that need to be considered. One of the primary concerns is the quality and accuracy of the data collected through crowdsourcing platforms. Since the data is contributed by individuals from diverse backgrounds and with varying levels of expertise, ensuring its reliability can be a challenge [16]. Moreover, there may be issues related to data privacy and security when collecting information from mobile devices and GPS technologies. It is crucial to address these concerns to safeguard the privacy of individuals while still harnessing the potential of crowdsourced data. Another challenge is related to the representativeness of the data. While crowdsourcing allows for data collection from various geographical locations, there may still be areas that are underrepresented, leading to potential biases in the analysis. Addressing these biases and ensuring comprehensive coverage of diverse regions is essential for drawing accurate conclusions from the crowdsourced data [17]. Despite these challenges, the use of crowdsourcing in traffic research holds immense potential for revolutionizing the way we understand and manage traffic. By acknowledging and addressing the limitations, researchers can work towards maximizing the benefits of crowdsourced data while mitigating its drawbacks. To address concerns related to the quality and reliability of crowdsourced data, researchers have begun to explore the application of advanced technologies for data validation and quality assurance. Leveraging the power of artificial intelligence and machine learning algorithms, it is possible to develop automated processes for identifying and addressing inaccuracies or biases in the collected data. By integrating these technologies into the validation methods, researchers can significantly enhance the reliability and accuracy of crowdsourced data for traffic analysis. As the field of traffic research continues to evolve, the seamless integration of crowdsourced data into existing traffic management systems has become a key focus area. Researchers are now exploring dynamic integration frameworks that enable real-time utilization of crowdsourced data for traffic monitoring and decision-making. By leveraging advanced data processing and visualization tools, it becomes feasible to ensure that crowdsourced data serves as a vital component of modern traffic management strategies, providing valuable insights and support for informed decision-making in real time [18]. As the field of traffic research continues to evolve, there is a growing recognition of the need for innovation and collaboration to address the complex challenges of urban mobility. Researchers, urban planners, and policymakers are coming together to explore innovative solutions that prioritize sustainability, safety, and efficiency in urban transportation systems. The integration of crowdsourced data and advanced analytics not only facilitates the identification of traffic patterns and trends but also supports the development of sustainable urban mobility strategies.

By collaborating with experts in urban planning and environmental studies, researchers can leverage crowdsourced data to inform the design of pedestrian-friendly infrastructure, public transit routes, and cycling networks, promoting multi-modal and environmentally conscious urban mobility options [19,20]. The ongoing advancements in crowdsourcing, data validation, and real-time integration are reshaping the landscape of traffic research and management. By embracing innovation and interdisciplinary collaborations, researchers are paving the way for comprehensive and sustainable approaches to urban mobility and traffic control. The continued dedication to addressing challenges and maximizing the potential of crowdsourced data holds the promise of revolutionizing how we understand and manage traffic dynamics, ultimately contributing to the development of efficient and sustainable urban transportation systems. From Table 1, there are four existing application and one proposed application which is MRSI. All the application are free to download, install and use *via* the Google play store.

Table 1
Comparison between existing system and proposed application

Features	Stormpins	Plus Expressway	Waze	TomTom GPS Navigation Traffic	The Proposed MRSI
Location Function	/	/	/	/	/
GPS function	/	/	/	/	/
Easy to use (user interface)		/		/	/
Google Map	/	/	/	/	/
Login Required	/				/
Mobile crowdsourced	/		/		/
Free Application	/	/	/	/	/
Android platform	/	/	/	/	/

3. Methodology

The methodology that are going to be adopted to develop mobile applications for MRSI using Crowdsourcing is Agile Development Life Cycle (ADLC) model because it always been use across the mobile development industries. Agile development technique offers opportunities to examine a project's direction as it progresses through its lifespan using a regular work schedule. In an agile view, every part of development such as requirement, design, and another phase are constantly return throughout the lifecycle. The effects of this way deal greatly reduce both development cost and time market [13]. The MRSI system requirement are characterized in however much detail as possible. We review on a similar system of MRSI and review on related software development life cycle and also get the data by meeting or interview various numbers of users representing all the departments or aspects of the current system. The development phase includes planning, user requirement gathering, implementation and user testing phases. The initial design of the new system is transformed into a first prototype. This system is often scaled down and serves as a representation of the final product's qualities. Figure 1 shows the MRSI's use case diagram and activity diagram as part of the UML design for this mobile crowdsourcing application.

An interview is the method to gather feedback and information from user from various background. The interview was held to collect data about the current mobile application system on how they contribute to the road safety and how interaction between mobile application and the user.

An interview was conducted to students that facing the traffic jammed and people who had involve into road accident for the data gathering process. A few selected interviewed individuals will be discussed in this section regarding the need to have the mobile application related to road traffic

and safety, the road surface, track, or poorly maintained road safety structure are to blame for the accident. The respondent also eager to participate and to be able to able to use the crowdsourcing mobile application, which increases road user safety and awareness.

The development is evaluated in the same way from the first prototype. The former steps are iterated as many times as necessary, until the developer is fulfilled that the prototype represented the final product before presenting the application to the client. Tables 2 and 3 shows the specification for the hardware and software in developing this mobile crowdsourcing application. The final system is thoroughly evaluated and tested from client. The client will try and review the application. At this stage, the system needs client acceptance to release the system. If client say no the phase will recycle the process until client accept the system.

Table 2
Hardware specification

Items	Specification
Operating System	Windows 7 and above
Installed Memory (RAM)	4.00 GB
System type	64-bit Operating System
Android Mobile	4.4 and above

Table 3
Software specification

Items	Programming languages/Platforms
Programming languages and GUI design	Google Maps API, C programming, C++, Html, Java, ionic, html5, CSS, Sass
Database	Firebase
Operating System	Windows 7 and above
Text Editor	Microsoft Visual Studio
Design	Android Studio Development (Android SDK), Java SE Development kit (JDK), Android Development Tools (ADT) Android Virtual Device (AVD)

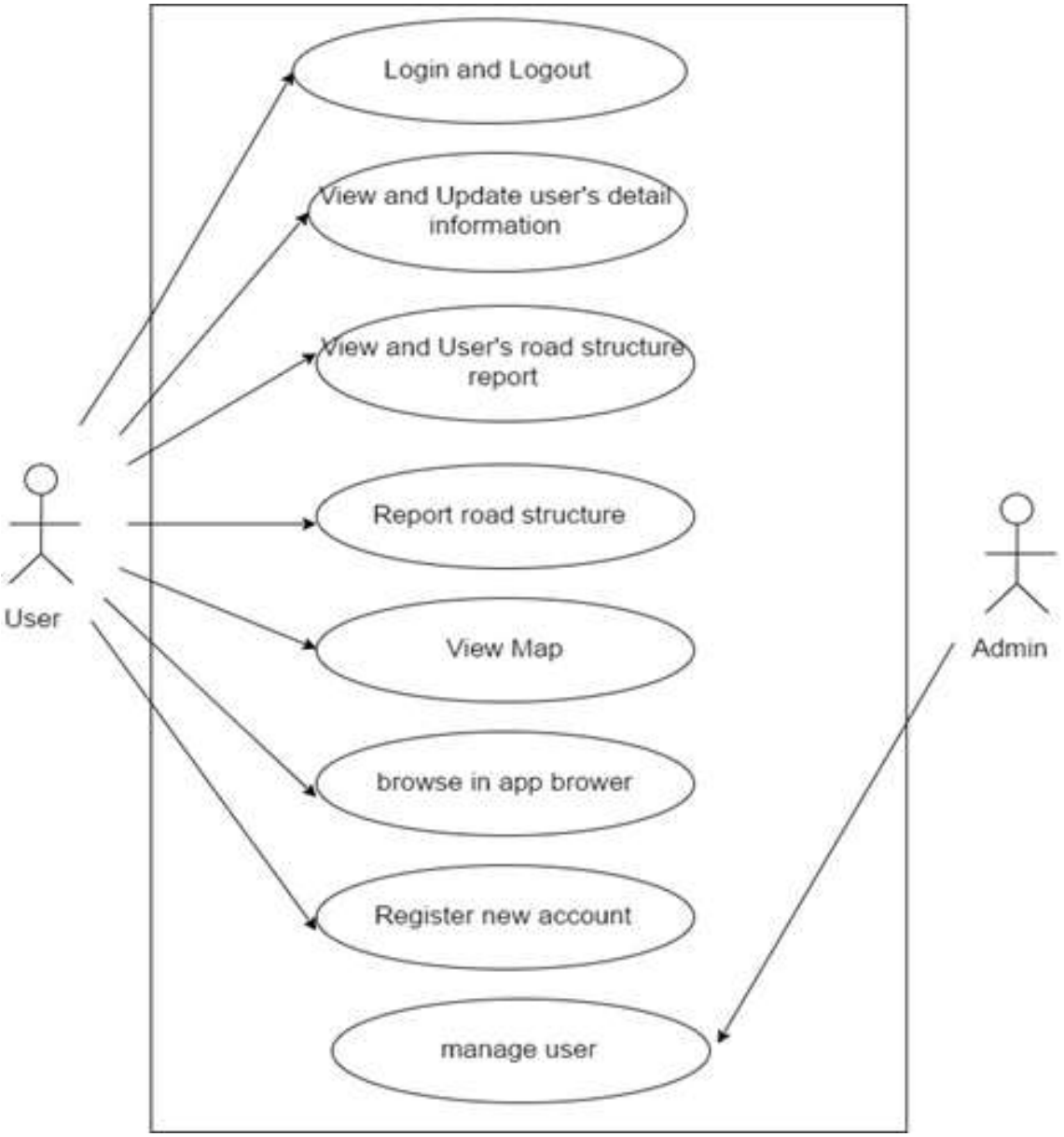

Fig. 1. The MRSI use case diagram

4. Results

This section describes the user interface of the proposed MRSI. It also includes how the implementation is the proses where the realization of the requirement and the design into a real executional program through programming. The implementation consists of two perspectives which are physical implementation and logical implementation. Physical implementation is where the interface is being develop and the logical implementation is the functionality of the system.

Figure 2 shows the login and registration page. It will display the user's location on a map as well. The user can pan and zoom the map. Users must enter the location and comment in the popup template that appears after clicking the save button at the top of the page (Figure 4), which will store the data to the Firebase database. Figure 3 shows the report of each different users. It shows the location the comment and the user first name. These situation shows where the crowdsourcing occur. Different user shares the information at one place. When a user clicks the button at the top left of the page, they are taken to the in-app browser, as shown in Figure 5, which is already linked

to the Cahya Mata Sarawak website. By doing so, the users can get the phone number of the company. Cahya Mata Sarawak is company of the construction and road maintenance.

4.1 MRSI System Testing

The final and most crucial step in making sure the built application satisfies the requirement is testing. Error detection is the process of testing. Testing plays a crucial part in guaranteeing the system's reliability and quality. The outcomes of testing are also applied later on in maintenance. The goal of testing is frequently to establish that a software is functional by proving that it is error-free. The primary goal of the testing phases is to find any potential faults in the programme. Hence, executing a programme with the goal of identifying mistakes is the process of testing.

4.2 Testing Objective

Finding errors in a system or software is the primary goal of testing. A good test case is one that has a strong chance of detecting the problem. The test version of the project is displayed in the following table. The information is in Table 5 because this is the project's initial testing.

Fig. 2. Login page and registration page

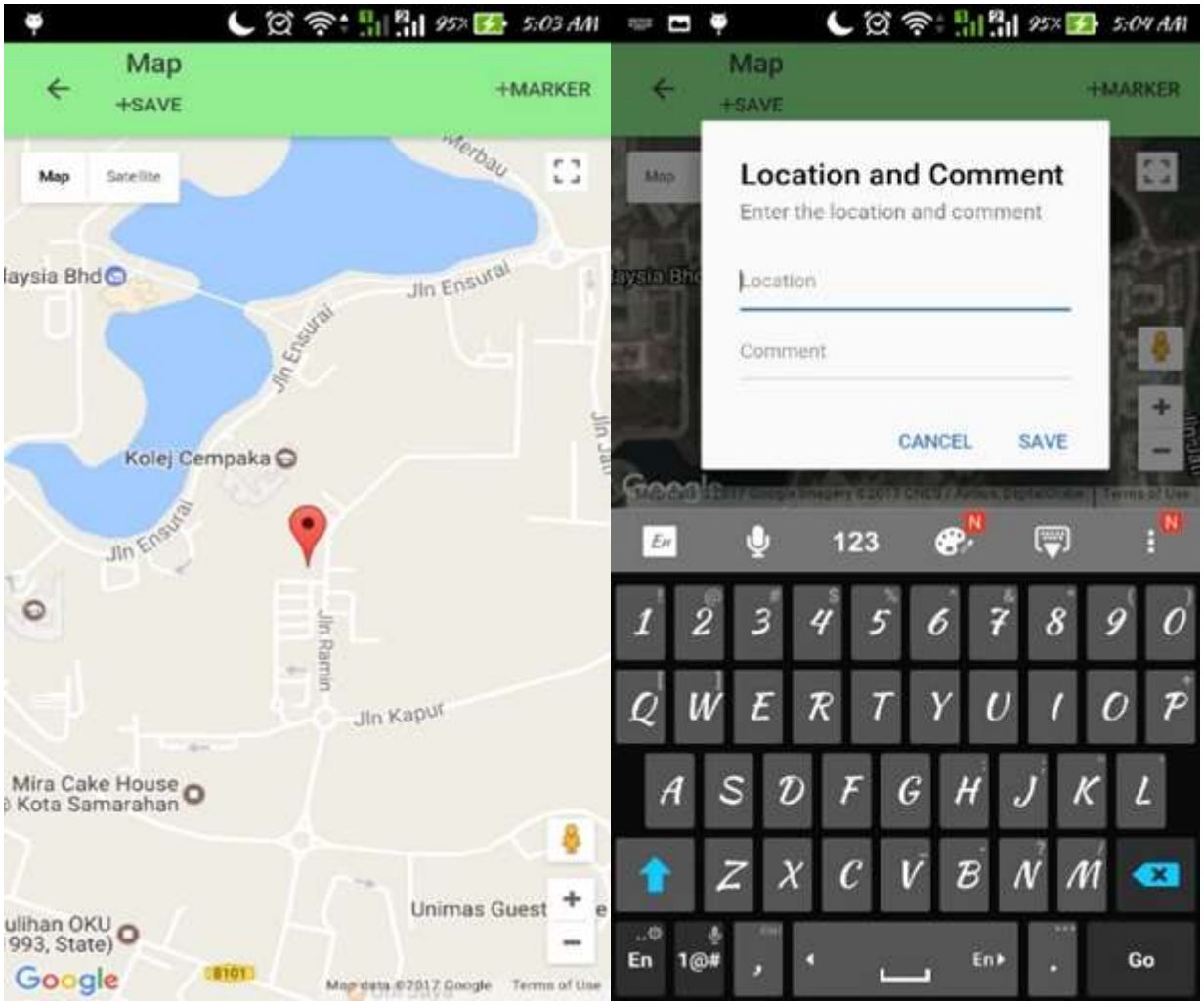

Fig. 3. Map and geolocation and save location and comment

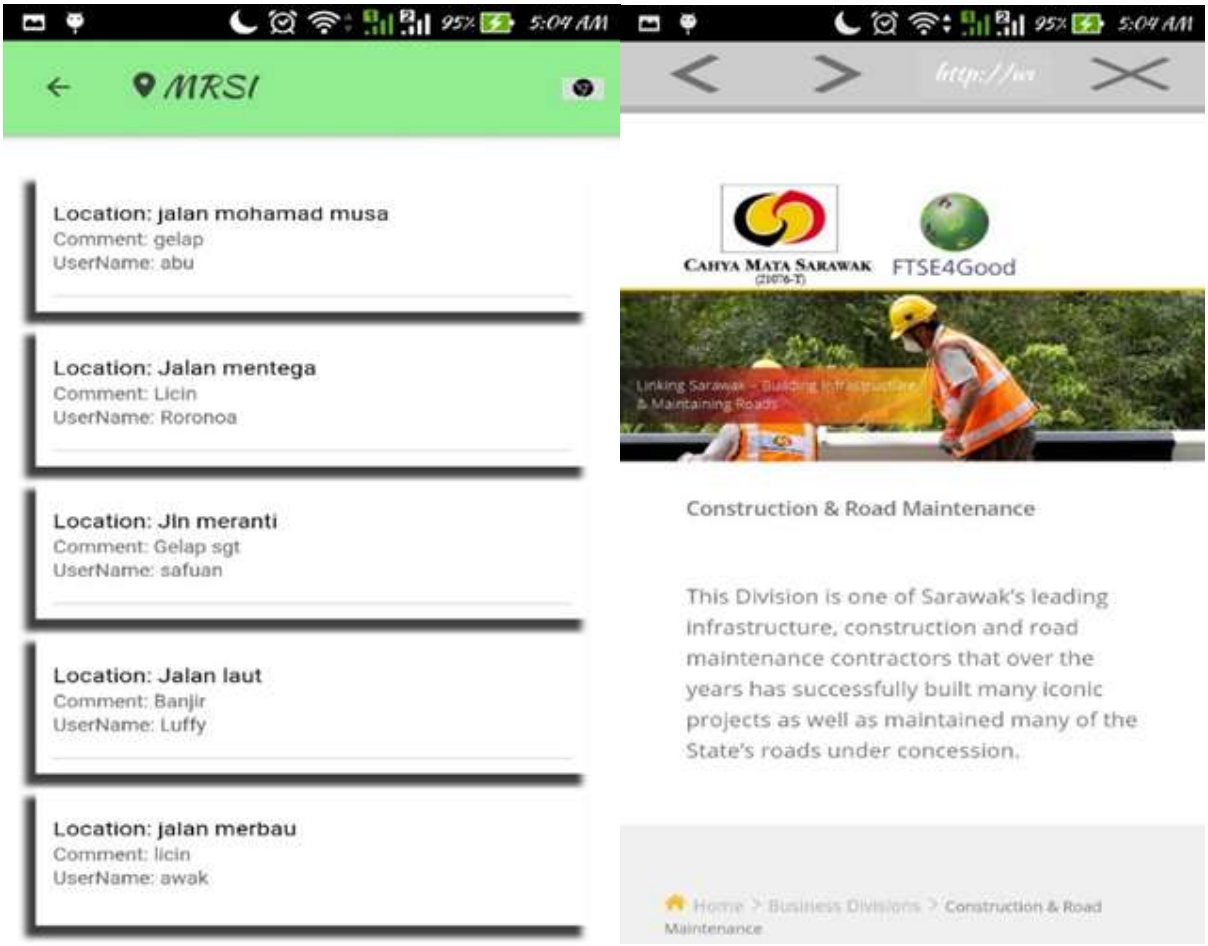

Fig. 4. Reports and in-app browser

4.2.1 Functionality rate

The functionality of MRSI application is divided into seven main functions which are registration, login, manage user profile, view map, save location and comment, view reports and view in app browser. There are 30 users that have been testing the mobile application. The results of this functionality rate are analysed and illustrated in a bar chart as shown in Figures 5 to 12.

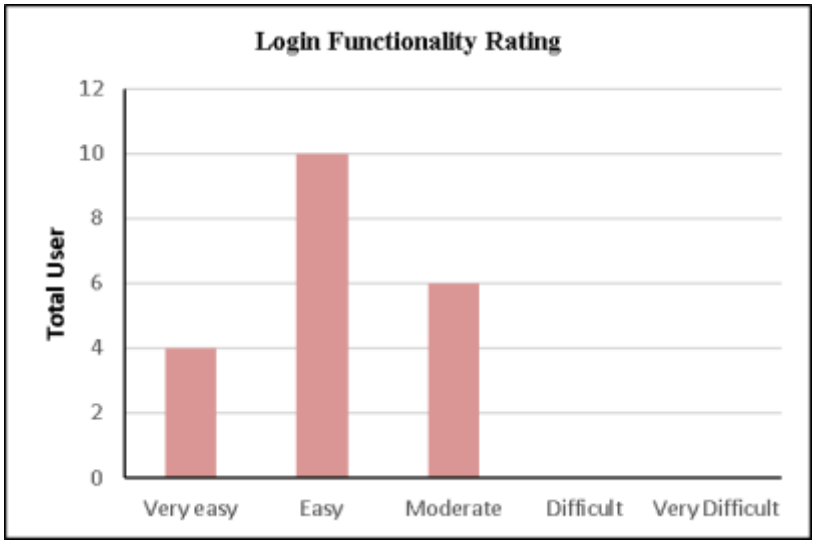

Fig. 5. Login functionality rating by user

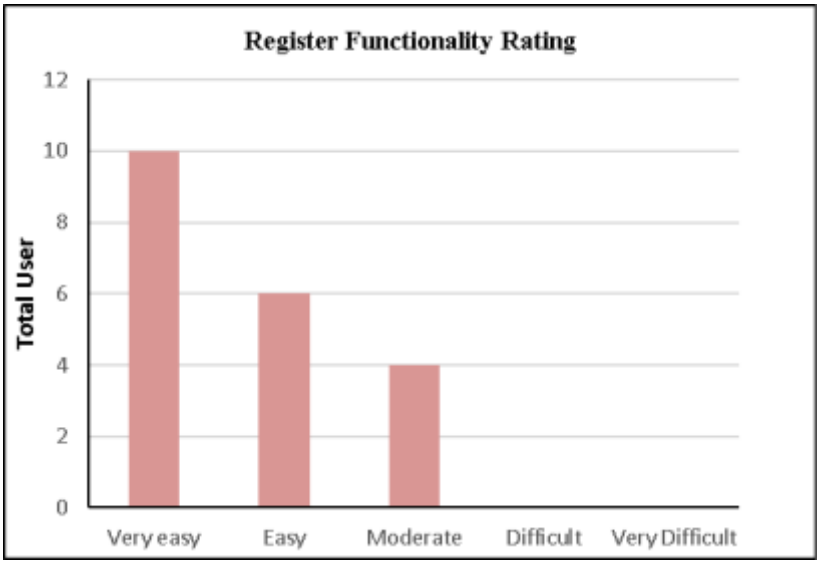

Fig. 6. Register functionality rating by user

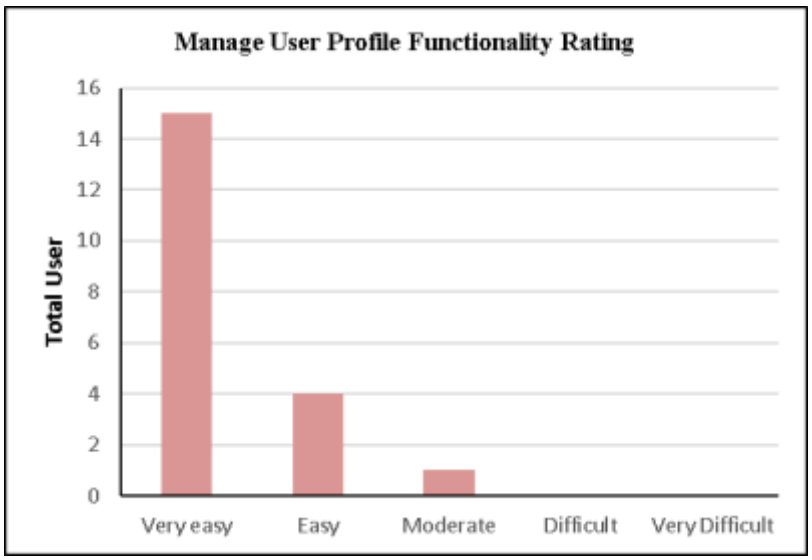

Fig. 7. Manage user profile functionality rating by user

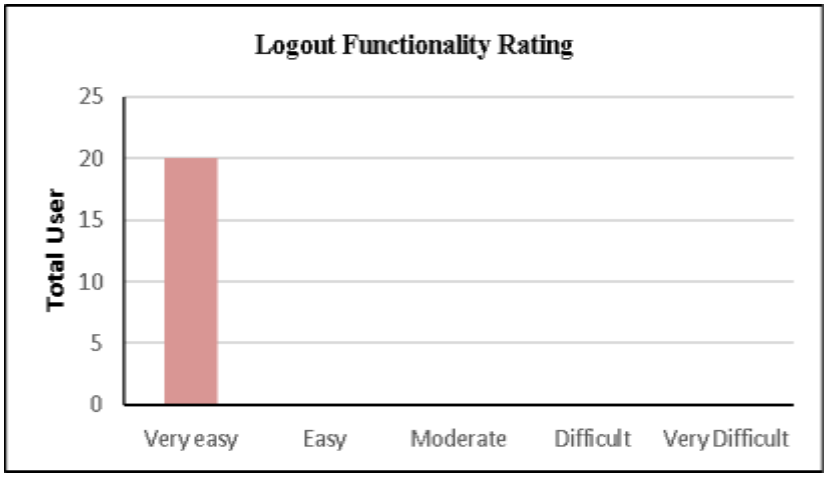

Fig. 8. Logout functionality rating by user

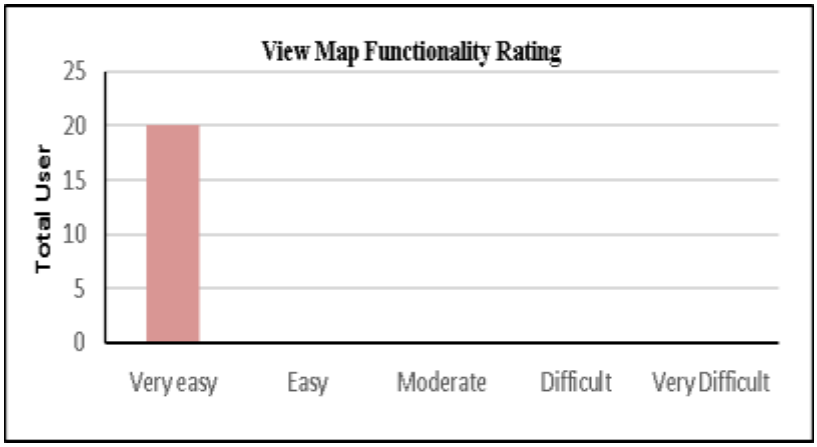

Fig. 9. View map functionality rating by user

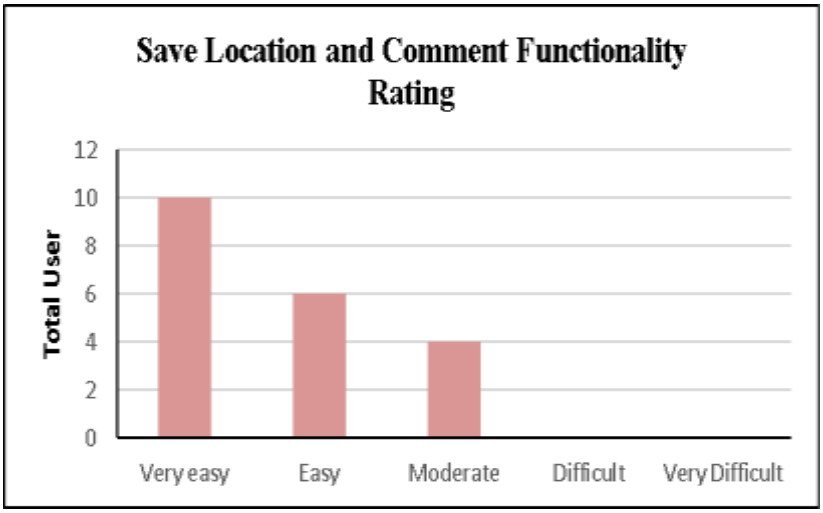

Fig. 10. Save location and comment functionality rating by user

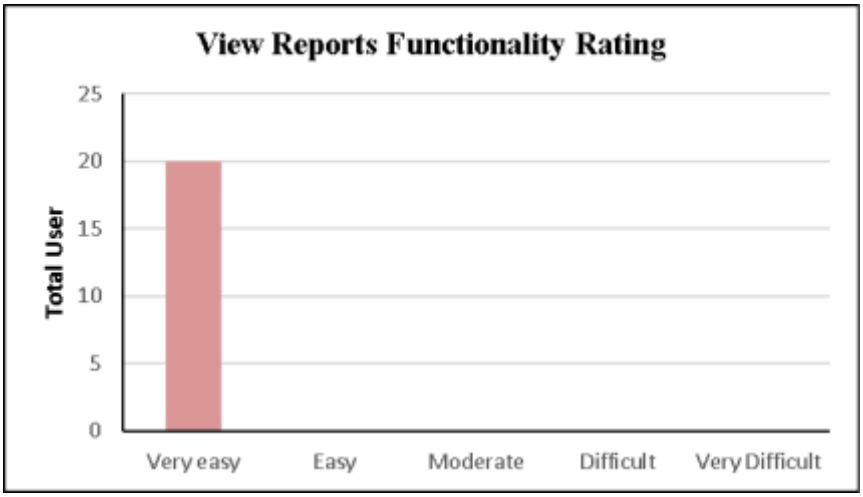

Fig. 11. View reports functionality rating by user

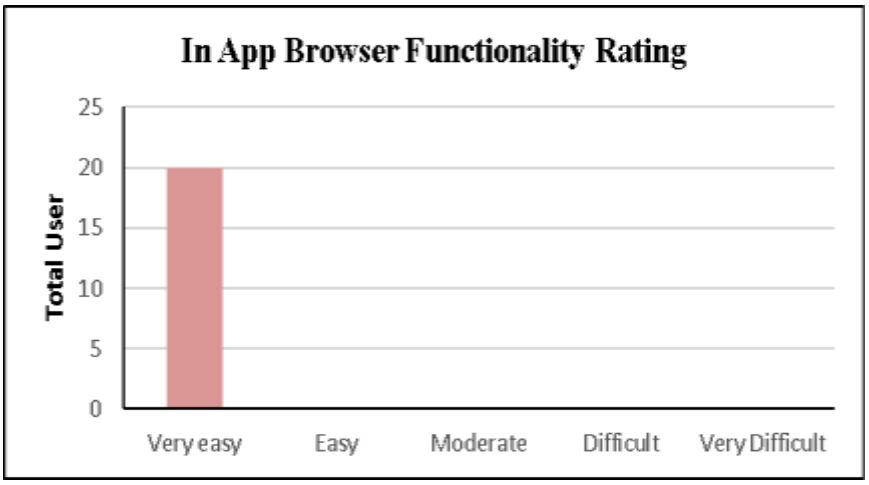

Fig. 12. In app browser functionality rating by user

4.3 MRSI Interface Design Rate

Figure 13 shows the results taken from tested users regarding the user-friendliness of MRSI application interface design, 70% of tested user agreed that MRSI has very good interface in terms of user-friendliness.

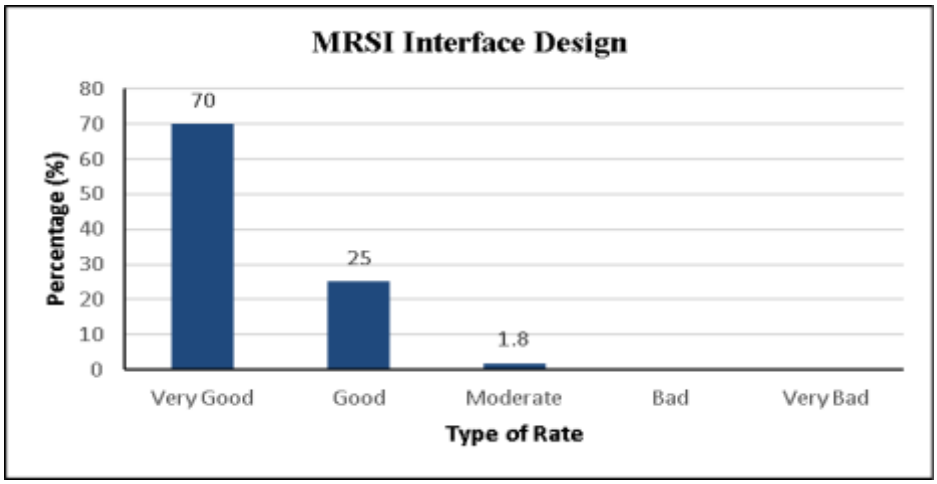

Fig. 13. Rate of MRSI Interface Design based on user-friendliness

4.4 Understandability of Application

Figure 14 shows the result from questionnaire distributed in measuring if tested users understand the main purpose of developed project. From the bar chart below, 100% from tested user understand the purpose of MRSI.

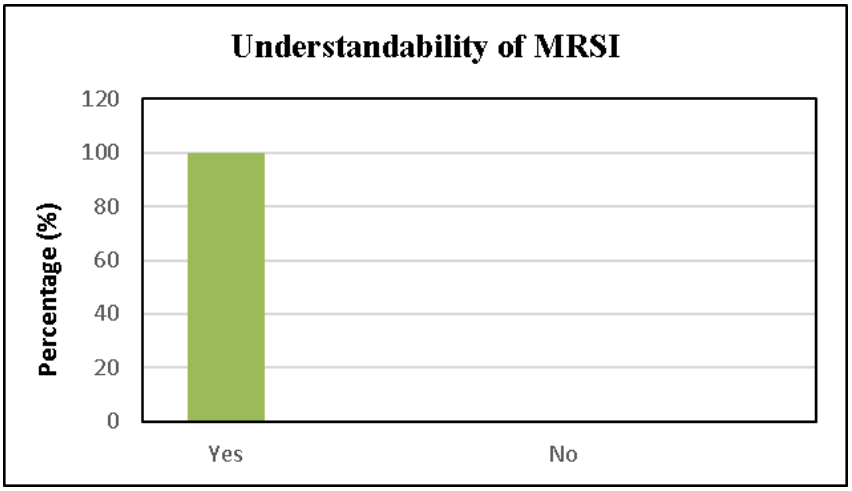

Fig. 14. Response from users on understandability of MRSI application

5. Conclusions

The MRSI is one of the mobile applications that is based on crowdsource to give information about road traffic condition on the spot. Based on its analysis and its test plans, all the functional and non-functional of MRSI shows a promising result and a stable application as well as easy to be used. Mobile crowdsourcing has been known to be a cost-effective technique to give information in real-time. However, there is still a room for improvement as some of the limitations in MRSI current applications, such as only allow to share one location. Any new location adding in will overwrite or replace the previous location. Incorporating multilingual elements into the application is essential for future work, especially to accommodate both locals and foreigners who might use the application while traveling [24]. Furthermore, the use of IoT-based technology in this development will be highly suitable for aiding in accident prevention [25].

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