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# Pothole Distress Assessment Innovation on the Surface of the Asphalt Pavement

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**Abstract**: A persistent issue in Malaysia for asphalt pavement distresses are cracks and potholes which are affecting a wide range of stakeholders, including those responsible, such as the Public Works Department (JKR) and concessionaires. The purpose of this study is to develop an application or recommendation software is at detecting distresses and making repair recommendations for cracks and potholes in asphalt pavements. The visual assessment method is carried out through the user interface system's features of user information extraction and potholes distresses, as well as by the sensory infrastructure in the background of this application system through its use. This application was built on the MIT App Inventor platform. The analysis findings will show user data, the severity of the distresses, and a proposal to repair the pavement distress to the on-site inspection officer based on the Public Works Department's (JKR) Malaysia's standard treatment methods. Pavement distress analysis using automated digital image evaluation techniques can speed up the process of obtaining analyzed data, reducing the risk of accidents and costs. Furthermore, mobile phone-based automated visual assessment methods improve the objectivity, accuracy, and consistency of pavement distress survey dataAs a nutshell, the suggested method for improving pavement distress assessment is to develop automated assessment innovations so that pavements can be improved and more efficiently evaluated, as well as to recommend appropriate repair ideas based on the severity of pavement distress.

**Keywords**: Vision-based Methods, Potholes, Pavement Analysis, Application Development, Asphalt

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## 1. Introduction

Asphalt surface pavement is subjected to a wide range of traffic levels, from two-lane rural routes to multi-lane interstate highways [1]. The maneuverability of the pavement is directly proportional to time; as time passes, the deterioration of the pavement's maneuverability accelerates. As a matter of fact, corrective measures are required to restore safety and employability capabilities. Small bowl-shaped failures on the asphalt surface can be defined as almost elliptic pavement areas that are completely or partially surrounded by dark shadows (due to depression) and have a detailed texture appearance and course (due to debris) on the road surface [2]. In cases where potholes endanger the safety and maneuverability of the pavement, pothole repair is required. One of the most important tasks in the planning of repairs and treatment of surface asphalt pavements is detecting and estimating the severity of pothole damage. Detection and estimate of the seriousness of pothole damage is one of the important tasks for the planning of repairs and treatment of asphalt pavements surfaces. Road maintenance companies need more workforce in particular for manual data collection, and plenty of working hours to carry out rough estimates of damage on the road. The proposal for improvements to the pothole distress analysis is to develop automated assessment innovations to help increase the range of pavements age through the proper repairs according to the seriousness of pavement distresses.

In this study, researcher investigate and analyze pothole using Mobile Potholes Interpreter which have been develop through this study. The aims of the proposed mobile application development study are to develop innovations in assessment and selection of treatment methods for pothole records through the concept of software applications. In addition, the study also focused on determining the severity of the potholes on the asphalt pavement surfaces.

As shown in Figure 1, Existing methods for pothole detection can be divided into vibration-based methods by Yu and Yu [3], De Zoysa et al. [4] and Eriksson et al. [3–5], 3D reconstruction-based methods by Wang [6], Chang et al. [7], Hou et al. [8], and Jiaqiu et al. [9], and vision-based methods by Koch and Brilakis [1], Jog et al. [10], Emir Buza et al.[11], Huidrom et al. [12].

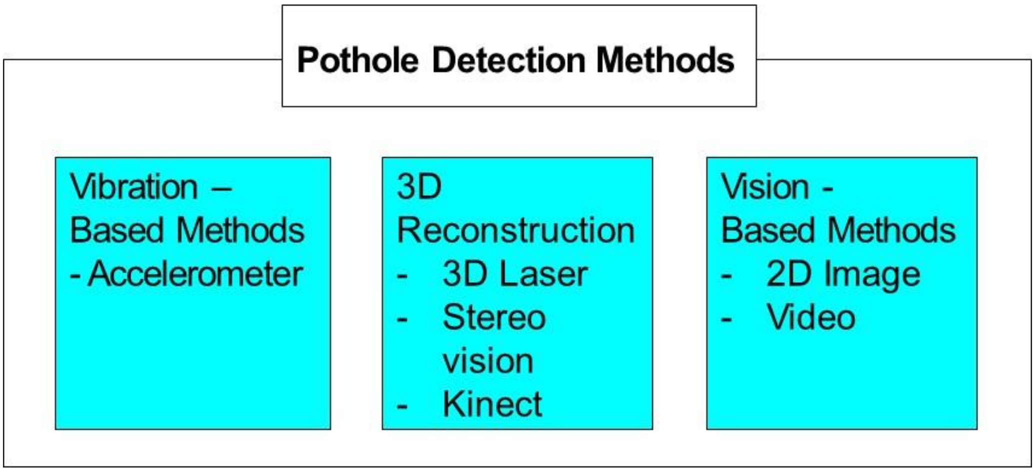


**Figure 1: Classification of pothole detection methods [13]**

## 2. Materials and Methods

The study was carried out in order to capture images of pavements distresses using an application interface through smartphone and to conduct an extraction analysis using an application that will be developed at the end of this research. This study contributes to the development of user friendly operational and cost-effective pavements analysis to manage the ongoing deterioration of the asphalt pavement structure. Furthermore, the data that will be used is based on photographic evaluations provided in the application. Furthermore, this adverb is a recommendation to use automatic processing in the evaluation of crack and potholes distress on the asphalt pavement surfaces.

### 2.1 Materials

This study uses Mit App Inventor as a platform for application development to run a simulation and data collection. App Inventor is a cloud-based tool, which means you can build apps for Android or iOS devices right on the web scan check. The development of this application was designed and formed based on own perspective and some reference from Pothole Patrol [5]. This development process has been divided into 3 stages of work flow as following as:

- Part 1: Feasibility study and Drafting Design
- Part 2: Application flow
- Part 3: Design and Simulation Process

### 2.2 Methods

Before publish the application to any platform, a lot of simulations will be run to check and confirm the validity, reliability and acceptability of the sensor and user interface which had been used in the application. An Android smartphone with camera infrastructure, GPS sensor, gyroscope system, accelerometer, and communication channel (cellular or WiFi) were required for this study. Figure 2 depicts the mechanisms to be created in the researchers' software/application proposal. This application needs the user to input data in order to determine the severity of the pothole distress. The features are extracted by the back server from the data loaded after the signal modification. The final potholes data is recorded to a customized database that users can access through reports.

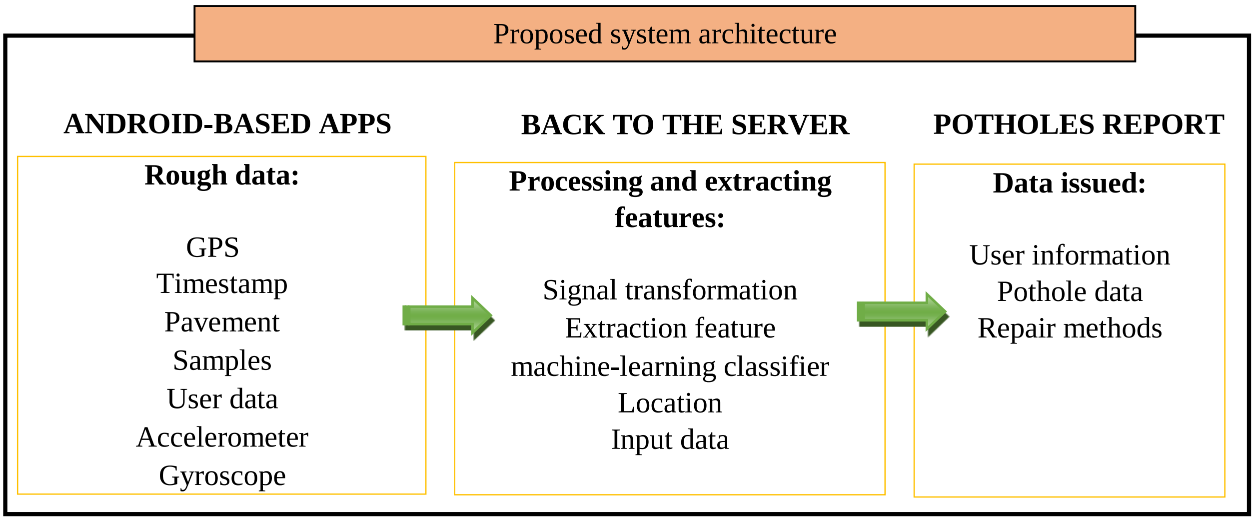


**Figure 2: Proposed system architecture**

### 2.3 Pothole Assessment Algorithm

User-centric and mobile software processes are preferred in this proposed software development methodology. The general workflow consists of four stages: (1) data acquisition, (2) data processing and feature extraction, (3) classification (as shown in Figure 2). First, data acquisition is carried out to collect image-formatted information on pavement damage. Secondly, a series of data processing methods are used to process raw data collected at the first stage, and sliding windows along with simple threshold methods are used to identify potential holes. Thirdly, different domain features are extracted from potential crater hole windows after a series of signal transformations. Finally, supervised machine-learning classifier apply for data input from users to distinguish the seriousness of road defects. The results are presented in the form of pdf reports containing user information, crater hole damage information, and pavement repair recommendations based on severity on the screen display of smartphone.

The results are presented in the form of pdf reports containing user information, potholes distress information, exact location and pavement repair recommendations based on level of seriousness. Procedures of the potholes assessment was described using algorithms in Figure 3 below.

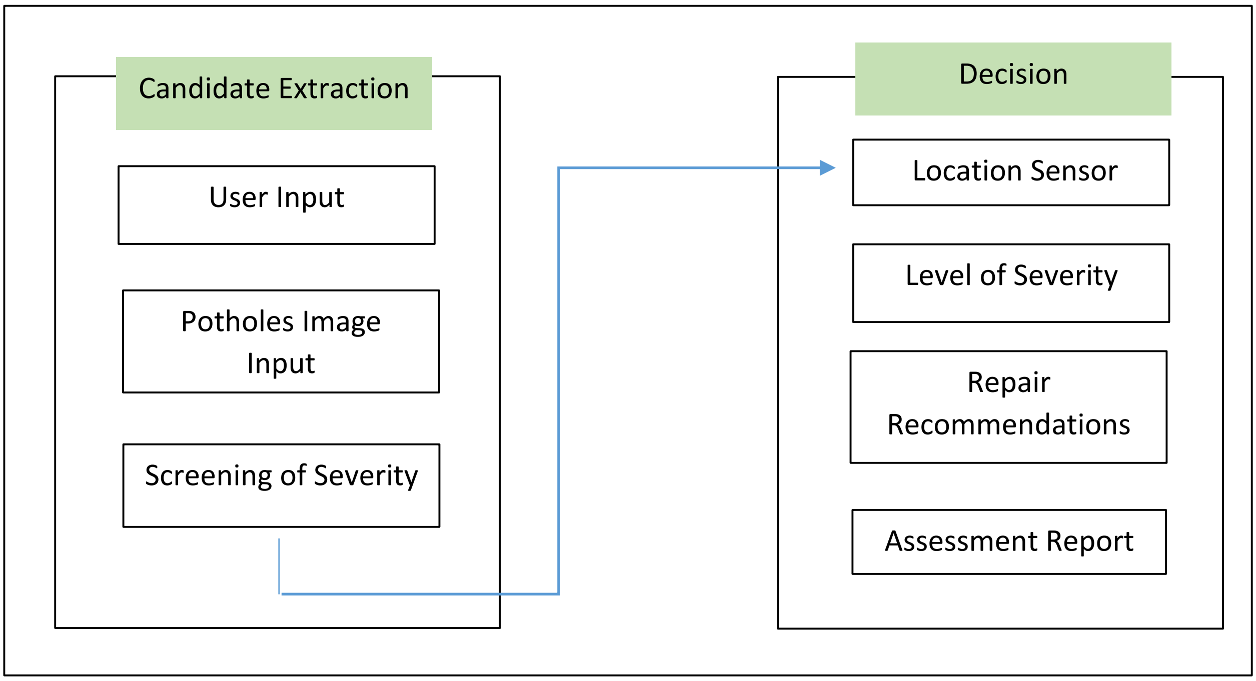


**Figure 3: Pothole assessment algorithm**

## 3. Application Development and Result

The application development and results section present data and analysis of the study. There are three stages that have been implemented in the Mobile Potholes Interpreter to classify the severity of potholes as shown in Figure 2

### 3.1 Application Development Using Mit App Inventor

Developers used Mit App Inventor software facilities to create this proposed application called "Mobile Potholes Interpreter." MIT App Inventor is a piece of software that allows designers to develop applications without having to write any code. App Inventor is a web-based app development tool that allows you to create apps for Android and iOS devices. Within the Mit App Inventor platform, users can find component references and built-in block lists as shown in Figure 4 and Figure 5.

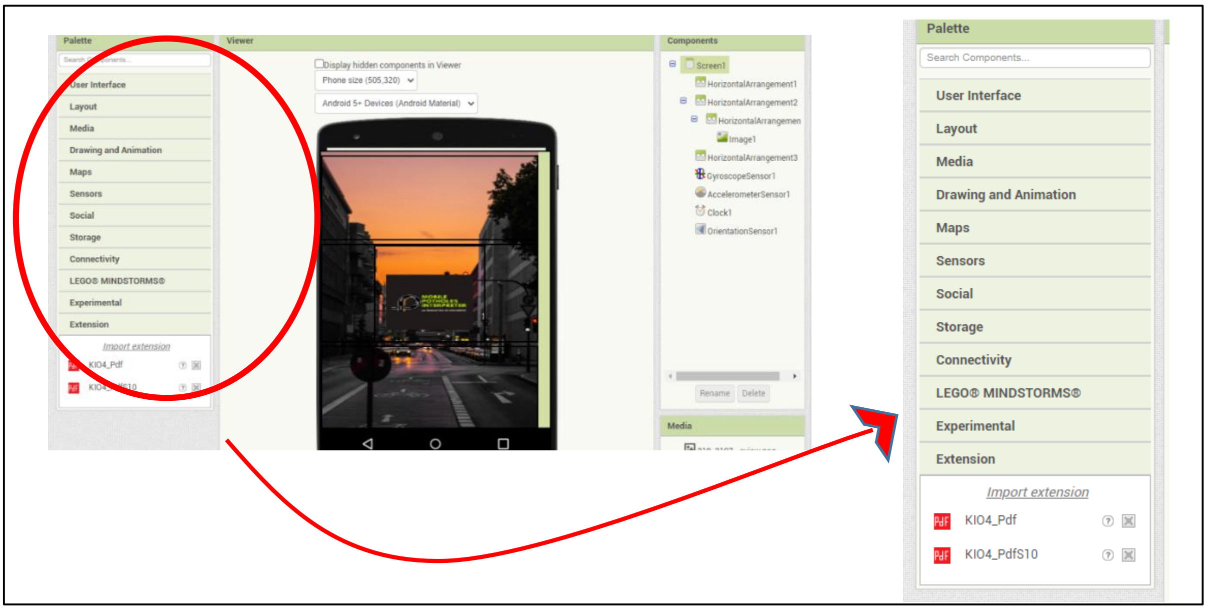


**Figure 4: Components provided by the MIT App Inventor system**


**Figure 5: Control block provided by *the* MIT App Inventor system**

### 3.2 Pothole Distress Assessment Using MIT App Inventor

The study took initiative to develop the application of this approach in order to assist engineers and concessions in conducting pothole distress assessments, as well as to improve the quality of inspections and the influence on worker safety and health. A position sensor (GPS), an accelerometer sensor, and a user-friendly surface system are all included in this mobile application. Between the user's surface and the sensor, the completeness of sensors and systems aids users in conducting more effective and seamless assessments. The first step in using the Mit App Inventor to execute an evaluation is to log in and register with the application system. The user should then keep the screen window open until it reaches the home display window (see Figure 6), where the analysis begins when the user types hit button "Potholes Assessment." To carry out the detection operation and categorization of the pothole distress severity, users should provide some data, as shown in Figure 7. Finally, documenting the display of information entered as well as the integration of sensor systems to the backup program's background infrastructure system would aid the application system in obtaining location data virtually by supplying longitude, latitude, and altitude coordinates.

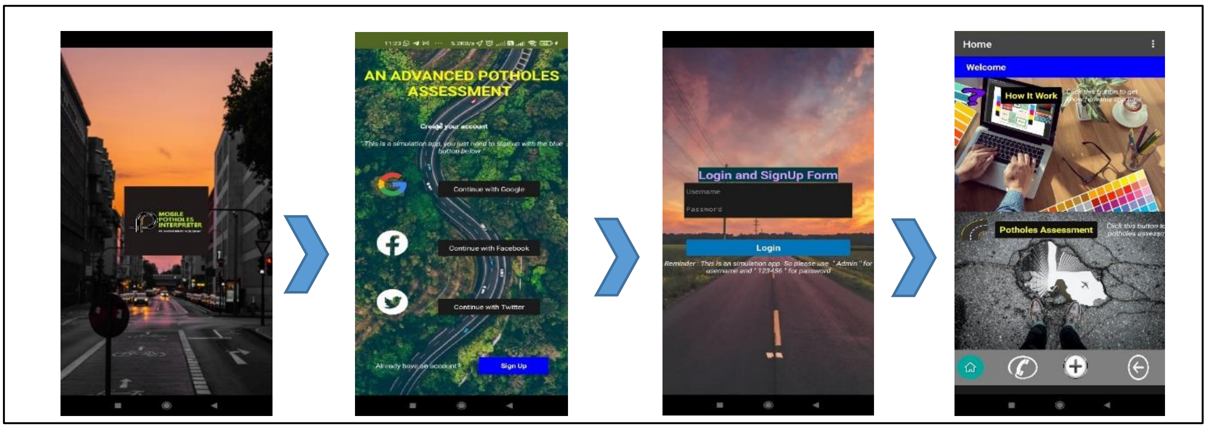


**Figure 6: Screen capture from login page to home page**

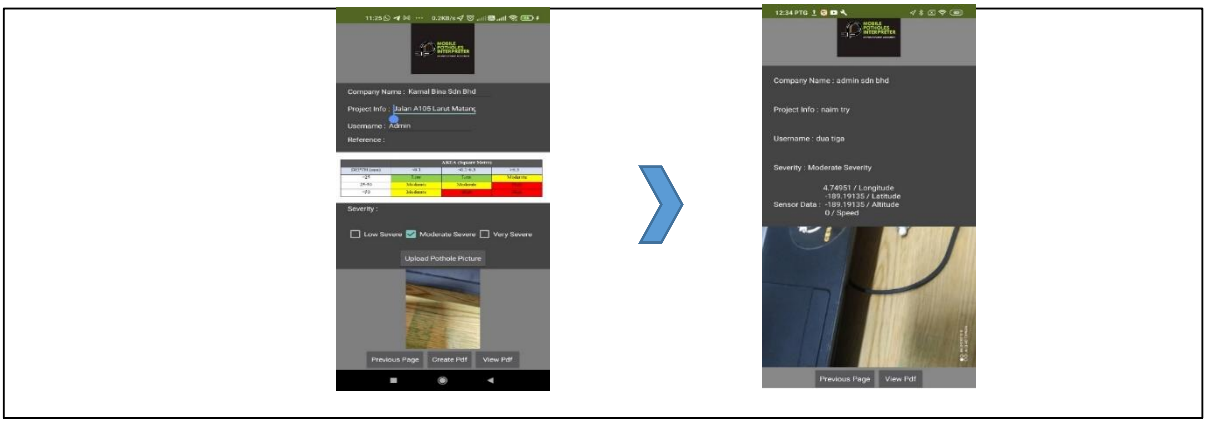


**Figure 7: Process for pothole assessment by Mobile Potholes Interpreter**

### 3.3 Result from the simulation

The report of the potholes assessment result obtained through the application simulation is shown in the Figure 8 below. Simulation of the detection method and severity of pothole distress through the proposed application was carried out on 10 images of different potholes along Jalan Tembaga Kuning, Kamunting and Federal Road F60 (Changkat Jering-Beruas).

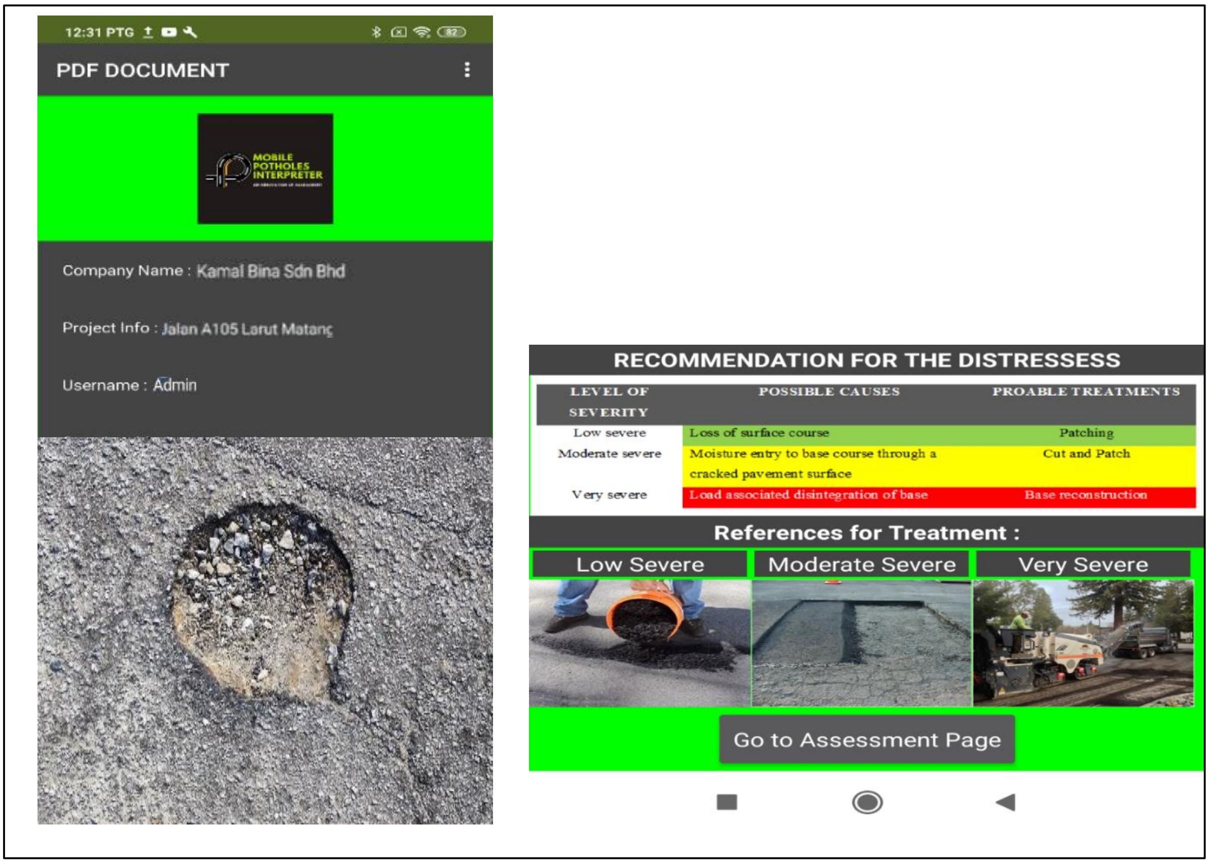


**Figure 8: Final report for the potholes assessment through Mobile Potholes Interpreter**

**Figure 9: Images of different potholes along Jalan Tembaga Kuning, Kamunting and Federal Road F60 (Changkat Jering-Beruas)**

### 3.4 Discussion

The analysis of how this proposed application algorithm is completely operational is detailed in Figure 9. The user and the server system should interact in two ways with the Mobile Potholes Interpreter. The infrastructure for connected sensor and mobile software applications is the same. It also covers user interface system-based detection algorithms and sensory feature infrastructure with limited software/software resources, as well as assessments based on real-world input data gathered with Android-based smartphones. For each distress assessed, this detection algorithm test creates appropriate rehabilitation preparation based on the Visual Inspection Manual from JKR [14].

This application's research and development is analogous to that of a system of mobile sensors, such as the Pothole Patrol [5]. Mobile Pothole Interpreters, like Pothole Patrol, have current location sensor network actions that operate with user interface systems. After feature extraction, the Potholes Patrol user interface system merely serves to record user complaints about crater hole damage and delivers no output result. Other applications for the proposed innovations of mobile pothole interpreters, on the other hand, have been able to give the impression that the process of determining pavement damage can now be revolutionized from traditional and manual concepts to automatic detection, as well as help to increase productivity, reduce costs, and avoid risk during the process of pavement damage analysis on the road. Based on the reference classification of the severity of the pothole in the manual guide for assessing the conditions of the flexible pavement surface by JKR [14], this approach allows concessionaires and on-duty inspectors to produce data on crater holes more precisely and rapidly.

Figure 10 and Figure 11 provide a comparison of the analytical process between the Mobile Potholes Interpreter and the Pothole Patrol. From these two diagrams, it can be determined that the Mobile Potholes Interpreter analysis technique is more practical and user-friendly for obtaining pavement injury analysis data. This is because, unlike the Pothole Patrol system, which only stores input data and does not provide any output data to the user after a complaint of a pothole malfunction, Distress data dissected by the Mobile Potholes Interpreter application system is shared directly and is automatically stored in the external storage of the user's smartphone.

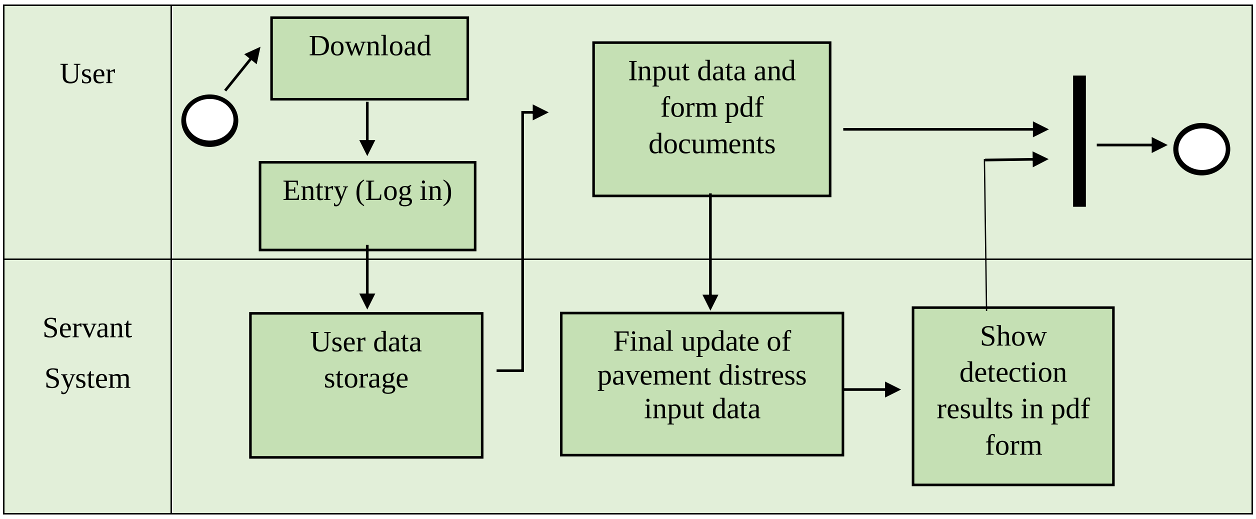


**Figure 10: Summary of *Mobile Potholes Interpreter* analysis model**

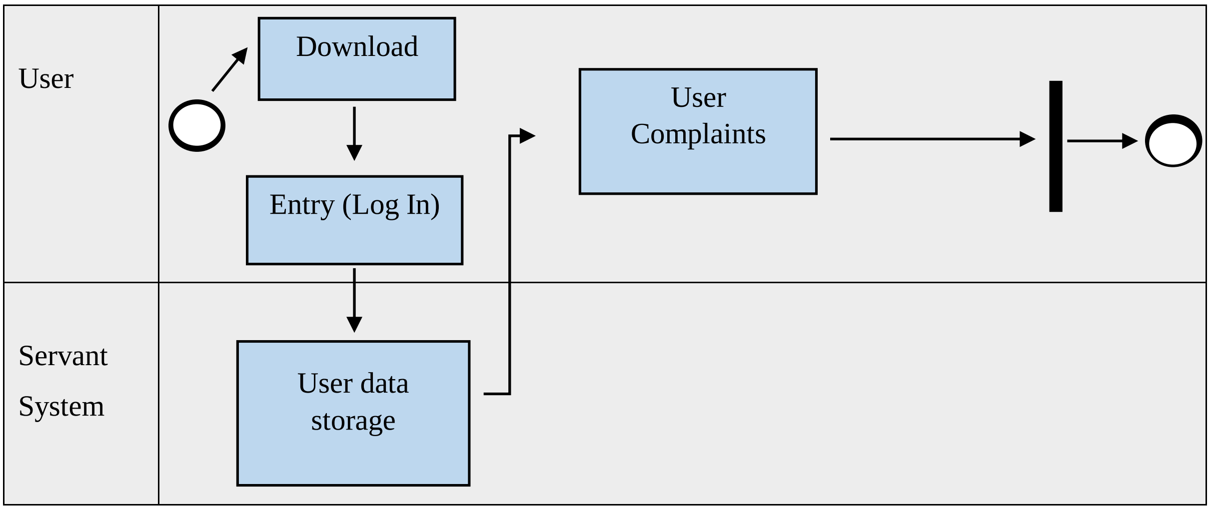


**Figure 11: Summary of Pothole Patrol model**

## 4. Conclusion

Through the concept of visual assessment through smartphones, the development of this proposal application has been developed as an innovation in assessment technology and the selection of treatment methods for pothole assessment. In the development of this application, the usage of mobile sensor infrastructure to detect and report the severity of pothole distress on road surfaces has proven to be a valuable tool. Based on simulation analysis, the Mobile Potholes Interpreter makes the greatest use of the accessibility available in the application development platform to provide visual detection, assessment, and classification of pothole rehabilitation selection. It also collects and interprets data from users and GPS sensors to determine the severity of potholes on the road surface. Furthermore, because this is the first edition of the researcher's application, it can be improved in the future in terms of analysis accuracy by adding additional sensor infrastructure. However, the robustness of this application's development is not restricted to potholes; other distresses, such as cracks and rutting, are also candidates for future research. To summarize, the invention of pothole assessment technology has been effective, and the simulations that have been conducted have ushered in a new age for the process of automatically detecting pavement distresses.

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