ELECTRONIC FIELD DATA COLLECTION SYSTEM FOR HIGHWAY INSPECTION MAINTENANCE

NOR HUSNA BINTI MOHD GHAZALEE

A project report submitted in partial fulfilment of the

requirement for the award of the degree of

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Special dedicated to
my supportive parents,
my beloved husband and
my precious son.

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May Allah bless all of you.

ABSTRACT

Compared to traditional maintenance inspection with paper sheets, electronic maintenance data collection can improve maintenance data management. The traditional process of collecting highway inspection data is based on paper sheets where the records are to be filed manually. The inspection in paper based is hard to be used whereby the inspector need to take out pen from his pocket to write up the inspection data manually, measure the length in critical condition such as slope and also need to bring camera to take the photos. Therefore, an Electronic Field Data Collection System (EFDCS) has been approached in this research for helping the inspectors to collect and record the field inspection data. The system uses a Tablet PC as a device to collect and record the inspection data. The objectives of this study are to review the current practice of field inspection process in highway maintenance; to develop a prototype of Electronic Field Data Collection System (EFDCS) for highway inspection maintenance by using the technology of Tablet PC and to address the potential and limitation of Electronic Field Data Collection System (EFDCS) in highway inspection maintenance. Data were collected from Malaysian Highway Authority (MHA) and Senai Desaru Expressway Berhad (SDE) by means of interviews and structured interview questionnaires. The prototype of Electronic Field Data Collection System (EFDCS) was developed by using two type of Android application software; D^{3}atadroid and Smart Measure. The finding showed that the Electronic Field Data Collection System (EFDCS) has a great potential in field inspection maintenance as the system able to increase the accuracy of collecting field data, reduce the tools and equipment of inspection, prevent duplication of data, eliminate re-entry of data and speed up the inspection time.

ABSTRAK

Berbanding dengan pemeriksaan penyelenggaraan tradisional dengan helaian kertas, pengumpulan data penyenggaraan elektronik boleh meningkatkan penyelenggaraan pengurusan data. Proses tradisional mengumpul data pemeriksaan lebuh raya adalah berdasarkan lembaran kertas di mana rekod yang akan difailkan secara manual. Penggunaan kertas ketika menjalankan activiti pemeriksaan adalah sukar dimana pemeriksa perlu mengambil pen dari sakunya untuk menulis data pemeriksaan secara manual, mengukur panjang dalam keadaan kritikal seperti cerun dan perlu membawa kamera untuk mengambil gambar. Oleh itu, 'Electronic Field Data Collection System' (EFDCS) telah didatangi dalam penyelidikan ini untuk membantu pemeriksa untuk mengumpul dan merekodkan data pemeriksaan. Sistem ini menggunakan Tablet PC sebagai alat untuk mengumpul dan merekodkan data pemeriksaan. Objektif kajian ini adalah untuk mengkaji semula amalan semasa proses pemeriksaan bidang dalam penyenggaraan lebuh raya; untuk membangunkan prototaip 'Electronic Field Data Collection System' (EFDCS) untuk pemeriksaan penyelenggaraan lebuh raya dengan menggunakan teknologi PC Tablet dan bagi menangani potensi dan batasan 'Electronic Field Data Collection System' (EFDCS) dalam penyelenggaraan pemeriksaan lebuh raya. Data yang dikumpul daripada Lembaga Lebuhraya Malaysia (LLM) dan Senai Desaru Expressway Berhad (SDE) melalui temu bual dan soal selidik temuduga berstruktur. Prototaip 'Electronic Field Data Collection System' (EFDCS) telah dibangunkan dengan menggunakan dua jenis perisian aplikasi Android; 'D3atadroid' dan 'Smart Measure'. Hasil daripada kajian tersebut menunjukkan bahawa 'Electronic Field Data Collection System' (EFDCS) mempunyai potensi yang besar dalam bidang pemeriksaan penyelenggaraan yang dapat meningkatkan ketepatan mengumpul data bidang,

mengurangkan peralatan pemeriksaan, mengelakkan pertindihan data, menghapuskan semula kemasukan data dan mempercepatkan masa pemeriksaan.

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LIST OF ABBREVIATIONS

ABBREVIATION		FULLNAME
D3	-	D^3atadroid
EFDCS	-	Electronic Field Data Collection System
EMS	-	Expressway Management System
GIS	-	Geographical Information System
GPS	-	Geographical Positioning System
MHA	-	Ministry of Highway Authority
PDA	-	Personal Digital Assistance
SDE	-	Senai-Desaru Expressway
SM	-	Smart Measure

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Compared to traditional maintenance inspection with paper based approach, electronic inspection system can improve the maintenance data collection and record. The traditional process of a highway inspection data is based on paper sheets where the records are to be filed manually.

In regard to this situation, Electronic Field Data Collection System (EFDCS) would be approached in this research for helping the inspectors to collect and record the field inspection data of highway maintenance. The system can greatly improve the effectiveness and efficiency of the inspection activity. Electronic Field Data Collection System (EFDCS) uses a technology of portable computer whereby it able to mobile the information here and there as the nature of field inspection is to move from one site to other sites. Therefore, there are new technologies available that use portable computers for collecting and recording the field data inspection. One of the technologies is Tablet PC which is likely to familiar in this 2000'an. It is varies in several brand such I-Pad by Apple and Galaxy Tab by Samsung.

The purpose of this research is to complement the traditional paper based highway inspection process with an electronic based inspection to carry out the inspection process by increasing the accuracy of collecting field data, maintaining a good record keeping, prevent duplicate data, eliminate re-entry data and reduce the inspection time. To achieve this research the Electronic Field Data Collection System (EFDCS) is developed by using a Tablet PC whereby android application software is used as tools for field inspection of highway maintenance. The system also generates a detailed inspection report together with the checklist and site measurement, GPS and photos of defect.

1.2 Problem Statement

Highway inspection is one of the most important highway maintenance activities in order to identify the highway conditions as well as traffic condition. Inspections are performed to understand, evaluate, assessed and judge the highway conditions so that the roads can be maintained and repaired in good condition for the traffic and road environment.

The physical highways that need to be inspected cover pavement, drainage, slope, bridge and tunnel. The requirement to carry out the inspection normally refers on the maintenance inspection guideline procedure by Malaysian Highway Authority (MHA). Slope inspection for example needs to check debris from drainage channels and slope surface in every 6 months. In this situation, paper based inspection is hard to be used whereby the inspector need to take out pen from his pocket to write up the inspection data, measure the length of slope and also need to bring camera to take the photos. Thus, in every inspection the inspector has to bring these items; checklist sheet, pen, camera and tape as well. If one of them is missing, they cannot proceed for the inspection.

At present, the Senai Desaru Expressway Berhad (SDE) has developed the integrated Expressway Maintenance System called EMS which consists of asset of highway, inventory, maintenance regime and application of GIS in future. The system operated in web-based platform where the internet applications are utilises. The system cannot be accessed if the internet is not available. Preliminary observation show that the system does not focus on the field inspection whereby the inspectors have to key in the inspection data into the system once he is back from the field inspection. In directly, re-entry work is happen. The inspector may have flexibility on time and place to key in the data as the system is internet basis. They can work on the data entry after office hour at home or any other places.

On the other hand, maintenance highway inspection is an operation that requires a lot of man-hours. Traditionally the maintenance data has been collected with paper sheets, and if information systems have been used for maintenance data management, inspection records have been fed manually to databases. Mobile applications are needed for electronic collection of maintenance data, and as well for other field tasks of distribution utilities as described by Janne *et al, (*2007).

In order to enhance the effectiveness and the quality of field data collection in highway maintenance, the Electronic Field Data Collection System (EFDCS) based on the Tablet PC is designed to enable collect and record field data, take photos and do the site measurement by using one tool only. The proposed system will simplify the existing process and acts saving tool for collecting and reporting highway inspection data. Furthermore, mobile inspection is easy to carry and suitable to handle in any situation.

1.3 Aim and Objectives

The aim of this study is to develop an Electronic Field Data Collection System (EFDCS) for highway inspection maintenance in order to collect and record the field data. To achieve this aim, the following objectives have been set;

i. To review the current practice of field inspection process in highway maintenance

ii. To develop an Electronic Field Data Collection System (EFDCS) prototype for highway inspection maintenance by using the technology of Tablet PC.

iii. To address the potential and limitation of Electronic Field Data Collection System (EFDCS) in highway maintenance.

1.4 Scope of Study

This study is limited to data collection and record activities for field inspection maintenance activities undertaken throughout the province on the Senai Desaru Expressway, Malaysia. The scope of study will focus on the development of Electronic Field Data Collection System (EFDCS) by using the technology of Tablet PC and Android application software.

1.5 Research Methodology

In general, the following methodology has been adopted in order to achieve the objectives and *Figure 1.1* showed the flow chart of the research methodology;

i. In order to achieve the first objective is to review the current practice of field inspection process in highway maintenance, the method for acquisition data will be obtaining from Ministry of Highway Authority (MHA), Senai Desaru Expressway Berhad (SDE) and some interviews among them will be conducted.

ii. The second objective which is to develop a prototype of electronic field inspection for highway maintenance by using the technology of Tablet PC, D^{3}atadroid and Smart Measure application software will be chosen to develop the database system.

iii. To achieve the final objective which is to address the potential and limitation of electronic field inspection, the method to acquire data is by giving the structure interview questionnaires and evaluation questionnaires to the inspectors and other related person and support by literature research from previous thesis which had been carried out before.

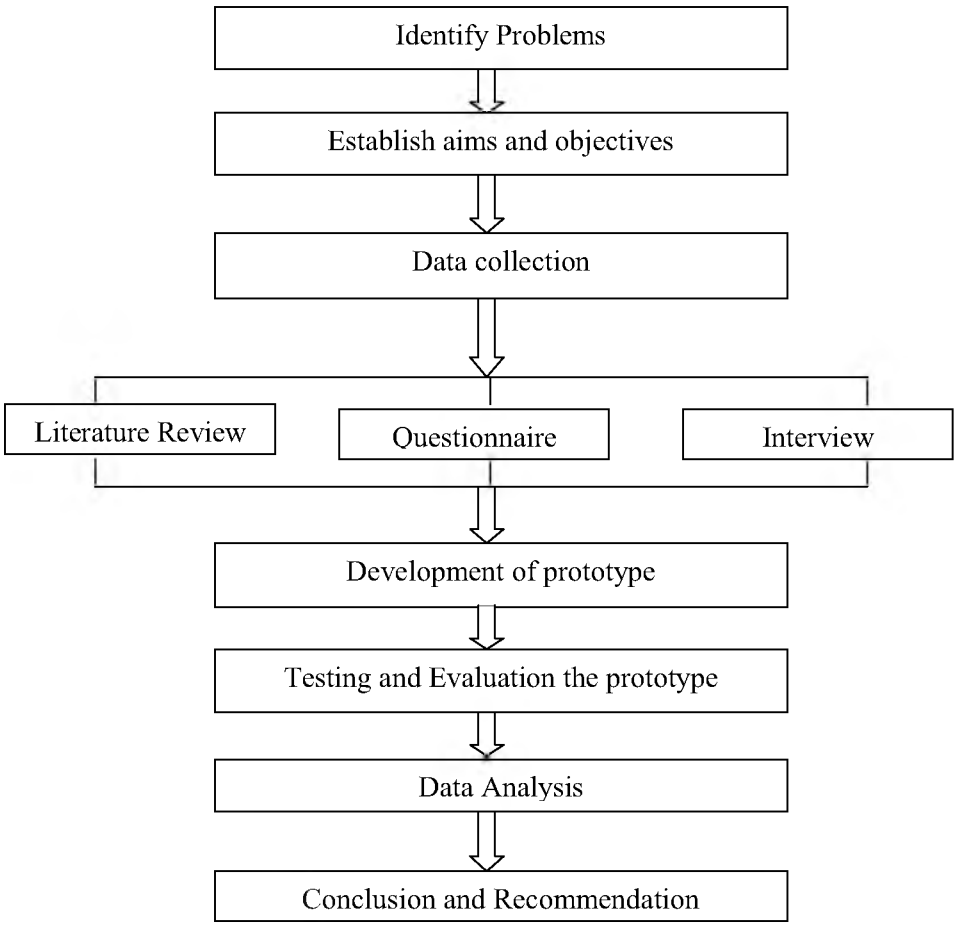

Figure 1.1: Chart of the research methodology

1.6 Summary of the Chapters

The study has been outlined to seven (7) chapters. The explanation of each chapter is as following;

1.6.1 Chapter 1 : Introduction

Chapter 1 describes the overall intention of the study. It also explains the problems statement, objectives, the scope of study and the brief methodology adopted for the study.

1.6.2 Chapter 2: Literature Review

Chapter 2 is a literature review on the background of research related to the environment of highway inspection in Malaysia, electronic record keeping and the tools selection for data collection.

1.6.3 Chapter 3: Methodology

Chapter 3 describes in detail the methodologies of study to achieve the objectives. This includes methodology for data collection and data analysis for questionnaire and interview with expert panels.

1.6.4 Chapter 4: Data Analysis

Chapter 4 will show the collection of data obtained from the questionnaire and interview by expert panels.

1.6.5 Chapter 5: Electronic Field Data Collection System for Highway Inspection Maintenance

Chapter 5 discuss in details the development of Electronic Field Data Collection System prototype by using Android application software's named D^{3}atadroid and Smart Measure. The structure and the environment of the developed prototype will be described in this section. The application method of the program also will be discussed.

1.6.6 Chapter 6: Evaluation of the Prototype

Chapter 6 will discuss the evaluation of the prototype of electronic field inspection and also includes the aim and objectives of the evaluation, methodology, results and discussions on the overall evaluation process.

1.6.7 Conclusion and Recommendation

Chapter 7 concludes the overall study on the subject and evaluate whether the objectives of the study are met. Recommendations for future studies are also suggested.