Faculty of Engineering

DEVELOPMENT OF PROTOTYPE WEB-BASED EDUCATIONAL

SYSTEM FOR LOW VOLUME RURAL ROAD DESIGN

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Bachelor of Engineering with Honors
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This declaration is made on the 14 day of June 2019.

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This Final Year Project report which entitled **"Development of Prototype Web-Based Educational System for Low Volume Rural Road Design"** was prepared by Nur Ardilla binti Shazali as a partial KNS 4254 Final Year Project course fulfilment for the Degree of Bachelor in Civil Engineering is hereby read and approved by:

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RON ALDRINO CHAN @ RON BUKING   DATE

(Final Year Project Supervisor)

DEVELOPMENT OF PROTOYPE WEB-BASED EDUCATIONAL

SYSTEM ON LOW VOLUME RURAL ROAD DESIGN

NUR ARDILLA BINTI SHAZALI

Report is submitted to
Faculty of Engineering, University Malaysia Sarawak
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Dedicated to my beloved parents, who always bestow me sustainable motivations and

encouragements

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ABSTRACT

Road design is very closely related to the use of authorities' guidelines to meet the needs and ensure safe and economical roads are constructed. However, calculation provided in guidelines usually involved complex and complicated formulae that require more time. Therefore, a Prototype Web-Based Educational System for Designing Low Volume Rural Roads (LVRRs) was developed. The main objective of this study is the developing prototype of a web-based expert system to determine the appropriate design and solutions for flexible pavement. This system is a knowledge-based system which may assist or use as reference by novice engineers, technicians, students and other potential users who interested in studying pavement design. The proposed system contains a knowledge base, descriptions and solutions which is shown as draft calculation and uses the latest manual based on the 1st Edition of Guidelines of the Design Low Volume Rural Road by JKR Research Centre for the prototype. In this research, there are two (2) kind of information collected which are primary data and secondary data which is standard guideline and questionnaire respectively. Questionnaire was used to assist in verifying and validating the system. There are two phases in collecting the responses from targeted populations. The first phase evaluation was done during Workshop on New Guidelines of Low Volume Rural Road by JKR to validate the web-based system is needed. Then, questionnaire for second phase evaluation is distributed by online (Google Form) to experts to verify and validate the system. Tabulation of analysis of results is evaluated using Microsoft Excel and Analysis of Variance (ANOVA). The results obtained shows that the web-based system very much important as a tool for references and comparison.

ABSTRAK

Rekabentuk jalan sangat berkait rapat dengan penggunaan garis panduan pihak berkuasa untuk memenuhi keperluan dan memastikan jalan yang berkos rendah dibina. Akan tetapi, langkah pengiraan yang disediakan dalam garis panduan selalunya melibatkan perumusan yang kompleks dan rumit yang memakan masa yang banyak. Oleh itu, Prototaip Sistem Pendidikan Berasaskan Web untuk Rekabentuk Jalan Luar Bandar telah dibangunkan. Objektif utama kajian ini adalah untuk membangunkan prototaip sistem pakar berasaskan web untuk menentukan rekabentuk yang sesuai dan penyelesaian untuk turapan fleksibel. Sistem ini adalah satu sistem berasaskan pengetahuan yang boleh membantu atau digunakan sebagai bahan rujukan oleh jurutera muda, juruteknik, para pelajar dan pengguna lain yang berminat untuk belajar tentang rekabentuk jalan. Sistem yang dicadangkan ini mengandungi asas pengetahuan, deskripsi dan penyelesaian yang ditunjukkan sebagai pengiraan draf berpandukan Garis Panduan Merekabentuk Jalan Luar Bandar edisi pertama yang dihasilkan oleh Jabatan Kerja Raya (JKR). Dalam kajian ini, terdapat dua jenis maklumat digunakan iaitu data primer dan data sekunder. Data primer yang digunakan ialah garis panduan manakala data sekunder ialah soal selidik. Kajian soal selidik dipilih untuk membantu dalam mengesahkan sistem ini. Terdapat dua fasa untuk mengumpul respon daripada penduduk sasaran. Fasa pertama dilakukan di bengkel tentang garis panduan baru untuk merekabentuk jalan luar bandar oleh pihak JKR untuk mengesahkan keperluan sistem tersebut pada masa kini. Soal selidik untuk fasa kedua telah diedarkan melalui atas talian (borang Google) kepada pakar untuk mengesahkan sistem ini. Tabulasi analisis keputusan soal selidik dinilai menggunakan Microsoft Excel dan analisis varians. Keputusan yang didapati menunjukkan bahawa sistem berasaskan web amatlah penting sebagai alat rujukan dan untuk perbandingan.

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LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
ANOVA	Analysis of Variance
CBR	California Bearing Ratio
CSS	Cascading Style Sheet
HPU	Highway Planning Unit
HTML	Hypertext Markup Language
JKR	Jabatan Kerja Raya
LEF	Lane Distribution Factor
LVRRs	Low Volume Rural Roads
REAM	Roads of Engineering Association Malaysia
UNEPSA	Union of National European Paediatric Societies and Associations
UNIMAS	Universiti Malaysia Sarawak

CHAPTER 1

INTRODUCTION

1.1   General

Rural infrastructure is a major development priority due to social and environmental benefits. According to the Ministry of Infrastructure and Communication and Public Works Department of Sarawak in 2014, Sarawak still requires about 9253 kilometers of rural roads to connect existing kampongs to the main roads by upgrading existing or construction access roads. Providing rural road connectivity is important to enhance economic development especially for agriculture as well as social benefits with easier access to kampongs facilities such as hospitals, schools, and others. Moreover, time to travel from one place to another place can be saved because of the better and maybe shorter routes.

Designing roads should be simplified yet still economically feasible. However, the process of designing rural road is problematic since engineers need to refer to guidelines and standards provided by relevant authorities to get exact data and precise steps of calculation. Meticulous works are needed which required more time to complete a design as rural roads designed must be safe to be used by road users.

Prototype Web-Based Educational System for Designing Low Volume Rural Road (LVRR) is a knowledge-based system produced for novice engineers, technicians, students and other potential users who interested in studying pavement design. Guideline used in producing this prototype system is the 1st Edition of Guidelines for The Design of Low-Volume Rural Roads (LVRRs) from Jabatan Kerja Raya (JKR) Sarawak Research Centre in collaboration with Universiti Malaysia Sarawak (UNIMAS). The guidelines fit all requirements of existing Roads of Engineering Association (REAM) and Arahan

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Teknik for JKR R1 and R2 road standards. The web-based system will provide reference and guidance for all targeted users especially students. There is a quiz section filled with questions related to road field and some related information that can improve users' knowledge on pavement design.

1.2   Problem Statement

Road design is very closely related to the use of authorities' guidelines to meet the needs and ensure safe and economical roads are constructed. However, calculation provided in guidelines usually involved complex and complicated formulae that require more time. Also, the information in guidelines are difficult for the understanding of readers because there are plenty of figures, tables, graphs and others that need to be referred. Thus, the reader may confuse to use which graphs or tables to get the data for each parameter needed. Then, other situations commonly faced by students where lack of availability of data related to low volume rural road pavement design on Internet and other search engine causing students having difficulties in getting guidelines information.

1.3   Objectives

The aim of this research is to develop a prototype web-based educational system for the pavement design on low volume rural. The proposed system contains a knowledge base, descriptions and solutions which is shown as draft calculation. In arrange to attain the point of this research, the objectives are set as follow;

- To identify and validate the need for the proposed system through literature review and a questionnaire survey with engineers.

- To develop a prototype web-based educational system for pavement design on low volume rural roads (LVRR) that contains a knowledge base which incorporate the acquired knowledge in the forms of rules, compiling each data, formulae and options related in designing rural roads which contributes in easier calculations process and better understanding for each design options provided.

- To verify and validate the developed prototype web-based educational system through testing and user feedback.

1.4 Scope of Study

This study focuses on developing a prototype web-based educational system that can be used for students and young engineers to design, gain knowledge and information regarding pavement design for low volume rural roads. The system concerned only on the flexible pavement design and uses the latest manual based on the 1st Edition of Guidelines of the Design Low Volume Rural Road by JKR Research Centre. This study excludes the pavement design using American Association of State Highway and Transportation Officials (AASHTO) procedures.

1.5 Significant of Study

The present study covers the preliminary of development of a prototype web-based educational system for pavement design to be used by potential users such as engineers, students, technicians and others as references and basic understanding as well as the concept of pavement design. Furthermore, the system can assist users in pavement design in a short period of time which can be accessed by everyone with an Internet connection.

1.6 Thesis Structure

Chapter 1 includes a general description of the study, issues and objectives that need to be achieved at the end of the study. Moreover, scope, significant and thesis structure also furtherly explained.

Chapter 2 presents literature reviews regarding components of this study. The literature includes past researches related to low volume rural roads, web-based system, questionnaires survey and verification and validation of expert system are presented in this chapter.

Chapter 3 touches on methods used to complete this study. Methods used involve data collection method, guidelines used, details of every data and formulae used for calculation and explanation of the web-system. The questionnaire survey sample is also attached in this chapter as well as a method of verification and validation of the prototype system.

Chapter 4 discussed the Results and Discussion which presents the result and analysis of the questionnaire which is clarified with several graphs and charts.

Chapter 5 presents the conclusion for the study comprising achievements of the objectives and some recommendations for future studies.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

A literature review is depicted as use of ideas in the writing to justify the specific way to deal with the topic, the choice of techniques and ventures to conduct and confirmation that the latest research brings some newest ideas for improvement (Hart as cited by Levy & Ellis, 2006). This chapter will furtherly explain fundamental knowledge of components in low volume rural road design in various countries and methods to conduct and validate the research.

2.2   Low Volume Rural Roads

Based on "A Guide on Geometric Design of Roads, REAM – GL 2/2002", the rural roads are classified into six (6) groups of the design standards; R6, R5, R4, R3, R2 & R1. Moreover, general functions of rural roads are branched into five (5) groups such as Expressway, Highway, Primary Road, Secondary Road and Minor Road as shown in Table 2.1 below. However, only R1 and R2 standards are applicable for the category of Minor Road which structure the basic network within a land scheme, serve mainly local traffic with less trip length with no access control. Projected ADT for R1 and R2 are less than 150 vehicles per day and from 150 to 1000 vehicles per day respectively.

Table 2.1 Rural Road Classes in Malaysia

CHARACTERISTICS OF RURAL ROAD (BASED ON DESIGN VOLUME OF TRAFFIC)					GEOMETRIC STANDARD	LEVEL OF SERVICE (LOS)	PROJECTED ADT (VEHICLE/DAY)
EXPRESSWAY	HIGHWAY	PRIMARY ROAD	SECONDARY ROAD	HIGH VOLUME	R6	C	ALL TRAFFIC VOLUME
					R5	C	>10,000
				MEDIUM VOLUME	R4	D	3,000 – 10,000
					R3	D	1,000 – 3,000
			MINOR ROAD	LOW VOLUME	R2	E	150 – 1,000
LOW VOLUME →					R1	E	< 150

Source: REAM – GL 2/2002

Design of flexible pavement comprising different layers such as sub-grade, sub-base, base and wearing course. The pavement structure made from favourable quality materials transfer forces coming from traffic loads in order to make sure the foundation of pavement is protected from overloading and structure must be safe for all road users (JKR, 2015). Figure 2.1 shows function of road pavement in transferring loads. Materials used for pavement of Low Volume Rural Road (LVRR) such as bitumen, crushed and natural aggregates or stabilised soils and thickness for every layer of pavement can be determined

through few main factors; expected traffic loading, location availability of local materials and cost. Common pavement cross section of a LVRR can be referred from Figure 2.2.
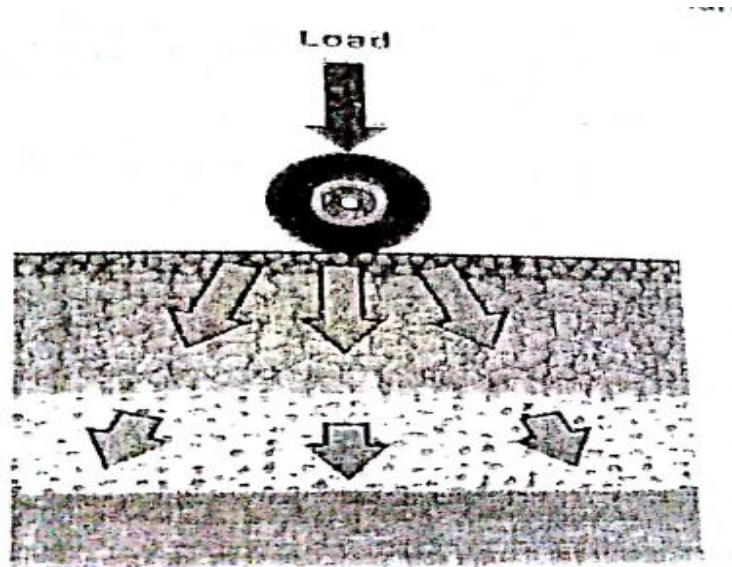

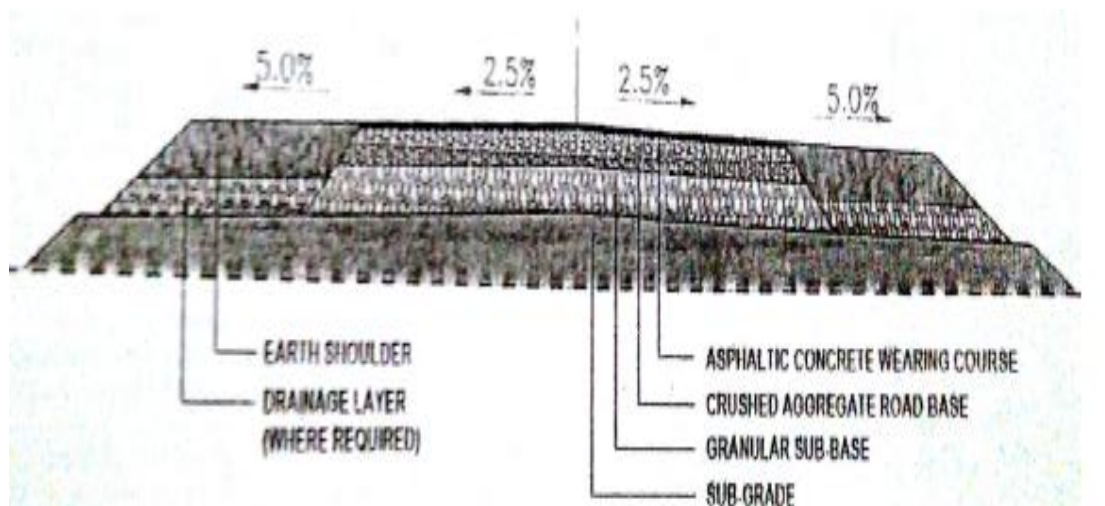Figure 2.1 Function of Road Pavement in Transferring Loads (JKR, 2015)

Figure 2.2 Typical Pavement Cross Section of a Low Volume Rural Road (JKR, 2015)

2.2.1 LVRR in Other Countries

About eighty-five (85) percent of 33.8 million kilometres of roads in this world are classified as low volume rural road with average traffic of below 1000 vehicles per day. Fifty-nine (95) percent of these roads belong to USA, China, India, Brazil, Japan, Canada, France and Russia (Bhandari, 2013). Table 2.2 below discussed some features of rural roads in different countries.

Table 2.2 Description of Rural Roads in Different Countries

No.	Country	Description
1	China	• Nearly 3.7 million kilometres comprise rural roads • Builds 381,000 kilometres of rural roads annually
2	India	• 2.7 million kilometres are rural roads
3	Sri Lanka	• Roads' are classified as National, Provincial, Urban and Rural • About 65,000 kilometres of local authority roads in both urban sectors (5,000 kilometres) and in rural sectors (60,000 kilometres)
4	Ethiopia	• Has three types of road institutions: i. Federal Roads Authority – Federal roads ii. Regional Roads Authority – Regional roads iii. Woreda Rural Roads Office – Community roads
5	Kenya	• Has 100,800 kilometres unclassified rural roads (11,500 kilometres are paved and rest are unpaved • Categorized as National (A, B & C) and Rural (D & E)

Source: Bhandari, 2013