



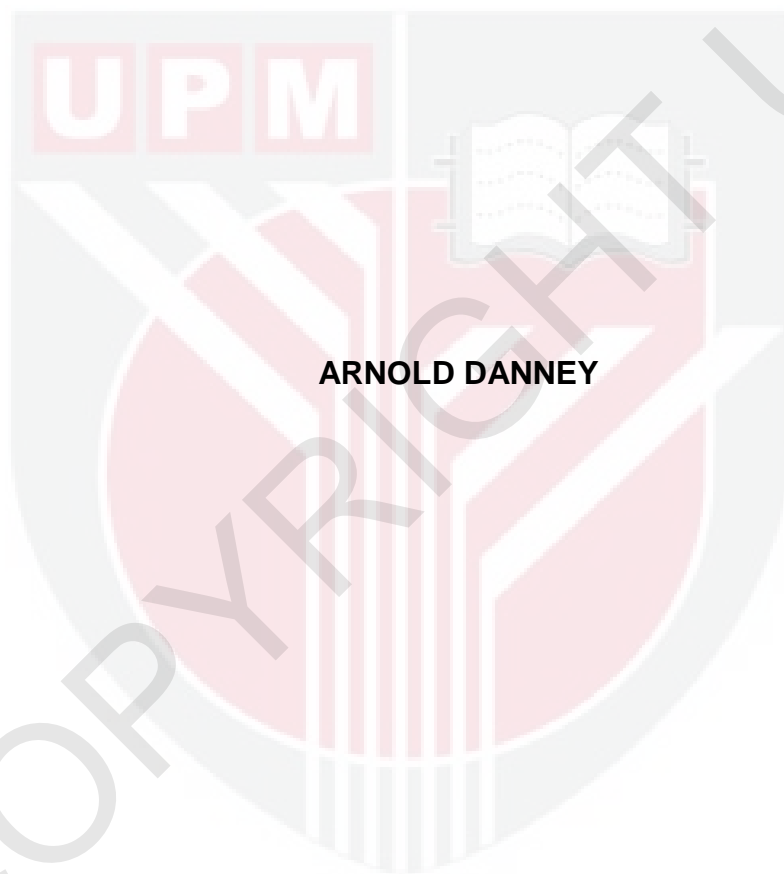
**UNIVERSITI PUTRA MALAYSIA**

***GEOGRAPHIC INFORMATION SYSTEM (GIS) BASED PLANNING  
TECHNIQUE FOR FOREST ROAD NETWORK ACCESS: CASE STUDY  
IN  
AYER HITAM FOREST RESERVE***

**ARNOLD DANNEY**

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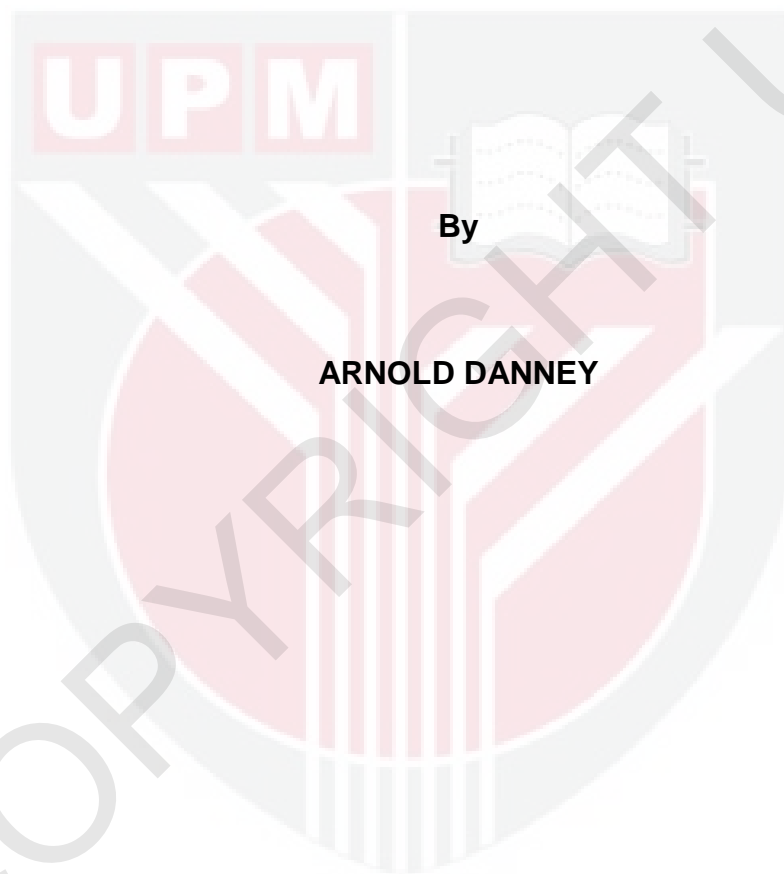


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**FACULTY OF FORESTRY  
UNIVERSITI PUTRA MALAYSIA**

**2016**

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By

**ARNOLD DANNEY**

**A Project Report Submitted in Partial Fulfillment of the Requirements  
for the Degree of Bachelor Science Forestry in the  
Faculty of Forestry  
Universiti Putra Malaysia**

**2016**

## DEDICATION

**To my beloved family,**

Dannek ak Kabey

Limah ak Buga

Also my siblings

For their overwhelming support morally and financially.

**To my supervisor,**

Who has been a constant source of knowledge and inspiration.

**To all my friends,**

For the encouragement supports and the sacrifice that you have given.

Thank you for everything

And

May God Bless All of Us

## ABSTRACT

Forest road is an important infrastructure which is required in forest development timber harvesting activities. It also helps in forest research and environmental damage protection. The forest road specification (Garis Panduan Jalan Hutan, 2010) is used as guideline for forest road planning in Peninsular Malaysia. In this study, a forest road with cost optimization was planned and designed using Geographic Information System (GIS) software, case study in Ayer Hitam Forest Reserve, Selangor. The current forest road was surveyed and tracked using Global Positioning System (GPS) device followed by data analysis in GIS software. For this study, Network Analysis method was used by using Cost Back Link Tool in GIS. This tool developed Network Algorithm which is used to determine the least costly route for forest road. The final output of this method is new forest road network plan of Ayer Hitam Forest Reserve which is generated from the Network Analysis. Results of the study showed the new generated forest road plan has better road network access with least cost construction compare to the current forest road network of AHFR. The road design approach could be applied for planning of forest road in other locations in Peninsular Malaysia.

## ABSTRAK

Jalan Hutan adalah infrastruktur penting yang diperlukan dalam pembangunan hutan dan aktiviti pengusahaan hutan. Ia juga membantu dalam aktiviti penyelidikan dan perlindungan kemusnahan alam sekitar. Spesifikasi jalan hutan (Garis Panduan Jalan Hutan, 2010) digunakan sebagai panduan dalam perancangan jalan hutan di Semenanjung Malaysia. Dalam kajian ini, jalan hutan bersama kos yang optimum telah dirancang dan direka menggunakan perisian Sistem Maklumat Geografi (GIS), kajian kes di Hutan Simpan Ayer Hitam, Selangor. Jalan hutan semasa telah diukur dan dikesan menggunakan peranti Sistem Kedudukan Global (GPS) diikuti dengan analisis data dalam perisian GIS). Untuk kajian ini, kaedah analisis rangkaian telah digunakan dengan menggunakan Cost Back Link Tool dalam GIS. Alat ini membina algoritma rangkaian yang digunakan untuk menentukan laluan yang paling murah untuk jalan hutan. Hasil akhir kajian ini adalah pelan baru untuk rangkaian jalan hutan di Hutan Simpan Ayer Hitam yang terhasil daripada analisis rangkaian. Keputusan kajian ini menunjukkan pelan jalan hutan yang baru dihasilkan mempunyai akses rangkaian jalan yang lebih baik dengan kos pembinaan yang menjimatkan berbanding dengan rangkaian jalan hutan semasa HSAH. Pendekatan bagi rekabentuk jalan hutan ini boleh diaplikasi untuk perancangan mana-mana jalan hutan di Semenanjung Malaysia.

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Last but not least, I would like to express my deepest gratitude to all my family members who always give me full support, contributions and sacrifices throughout the course of my study.

## APPROVAL SHEET

I certify that this research project report entitled Geographic Information System (GIS) Based Planning Technique for Forest Road Network Access: Case Study in Ayer Hitam Forest Reserve by Arnold Danney has been examined and approved as a partial fulfillment of the requirements for the degree of Bachelor of Forestry Science in Faculty of Forestry, Universiti Putra Malaysia.

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Prof. Dr. Mohamed Zakaria Bin Hussin  
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Universiti Putra Malaysia

Date: 21<sup>st</sup> June 2016



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## LIST OF ABBREVIATIONS

AHFR	Ayer Hitam Forest Reserve
DTM	Data Terrain Model
ESRI	Environmental System Research Institute
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GPS	Global Positioning System
JPSM	Jabatan Perhutanan Semenanjung Malaysia
MUS	Malayan Uniform System
SMS	Selective Management System
SE	Super Exit

# CHAPTER 1

## INTRODUCTION

### 1.1 Background

The demand in forest and forest products nowadays is increasing in parallel with economic developments of societies (Acar & Eroglu, 2001). Malaysia also has no exception in this issue as Malaysia is one of the developed countries that require timber product for source of revenue (FAO, 2011) and for local use in many sectors. Hence, to make timber product available, efficient design for forest road planning and forest transportation is being complicated problems (Contreras et al., 2008). Forest road planning has important portion of total cost among all the forestry activities (Greulich, 2003).

Forest roads are essential structures in forest lands to provide access for management, harvesting, transportation, protection, and recreation activities. The forest road construction and maintenance are important to be considered not only to minimize negative impact on the environment, but also the safety of users. The construction of the forest road should be carried out with close observation to economic aspect and also consideration of the topographic difficulty (Silva et al., 2016). The presence of the forest road allowing better forest access and transportation, thus gives a consistent impact in lowering cost for overall harvesting operation (Pellegrini, 2012).

At the present time, the modern technique using GIS (Geographic Information System) and GPS (Global Positioning System) technologies is more effective to reduce time consumed in forest road planning and construction (Rogers, 2005). In addition, these technologies capable to locate and stimulate forest road with specified standards considering the steep slope in order to reduce the costs of construction and maintenance (Sakai, 2012). These techniques only spend a little cost and time in field reconnaissance followed by generating map using computer.

The latest technology in GIS such as the usage of drone and satellite imagery, and advance analysis has become easier through efficient data management and more comprehensive analysis of criteria (Salah et al., 2000). A couple of studies on using GIS and GPS technologies in forest road planning and design have been conducted by researchers such as Dahlin & Fredricksson (1995), Tan (1999), Akay & Sessions (2005), Abdi et al., (2009), and Pellegrini (2012). In Malaysia itself, several researches on forest road planning and design using GIS and GPS technologies have been reported by researchers, including Kamaruzaman (1991), Khali (2001), Hasmadi & Kamaruzaman (2008), Hasmadi & Norizah (2010), and Norizah & Chung (2014).

## 1.2 Problem Statement

The forest road design and construction process is the most expensive and time consuming portion of a harvest operations plan. The design of forest road network access critically affects the orderly flow of logs and transportation costs (Cavalli, 2010). It is not surprising that so many road design tool and optimization models have been built to assist the development of forest road planning and construction. A good location planning of forest road access will not only ensure the efficiency of its construction and maintenance works, but also increase the productivity of the operations. For a least cost of forest road construction and maintenance, information on costs factors needs to be detail and taken into account during the forest road planning.

The primary problem of the forest road construction in Malaysia is the typical road planning and designs are still based on traditional plotting on the ground with costs factors are less considered. Cost optimization in road planning is important at the present time as existing road from first rotation of timber harvesting operation could reduce the overall operational costs of second rotation of timber harvesting. Hence, this study was out to plan forest roads with costs optimization by using network analysis.



### 1.3 Objectives of the Study

The aim of this study is to plan the road network access at least costs by using GIS technology. To be specific, the objectives outlined for this study are:

- I. To design the forest road access plan in Ayer Hitam Forest Reserve in terms of costs optimization by using Network Analysis.
- II. To compare forest road design generated from Network Analysis with current forest road network in AHFR.



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