EVALUATION OF RECREATION-USE IMPACTS IN RELATION TO PHYSICAL FACTORS ALONG GUNUNG DATOK TRAIL, NEGERI SEMBILAN, MALAYSIA

NOOR JALILAH BINTI JUMAAT

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By

NOOR JALILAH BINTI JUMAAT

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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October 2013

Chairman : Assoc. Prof Abdullah Mohd, PhD
Faculty : Forestry

As one of the most popular recreational settings in Malaysia, Gunung Datok Recreational Forest has experienced many physical changes along its primary hiking trail, which has been developed for the purpose of mountain climbing. The excessive use of the trail has led to deterioration of soils. In addressing this issue, the aim of this study is to evaluate the recreation-use impacts related to physical factors along Gunung Datok Trail. The present research also attempts to determine the relationships between recreational use and its impactsfor the purpose of resource management. A six-month study (July to December 2010) was conducted using an integrated method: track problem assessment method and trail condition classes. Seventeen point samplings were determined using the track problem assessment method where predefined problems were detected based on the expansion of trail width, soil compaction, trail depth, and soil erosion. Subsequently, all the sampling points were categorised using trail condition class survey method.

In the first part of this study, the current physical conditions of Gunung Datok Trail were monitored. Measurements of the trail width, depth, compaction, and soil erosion were taken at every point sampling. The study found that the minimum length of trail width was 1.10 meters at point sampling 15, while the widest trail was found at point sampling 3 with a length of 4.70 meters. For trail depth, point sampling 16 was identified as the deepest trail with 1.23 meters, while the shallowest trail was at point sampling 1 with only 0.48 meters. This study discovered that point samplings 1, 6, and 7 had the highest degree of soil compaction with 4.83 g/cm^2. Meanwhile, for soil erosion, point sampling 3 accumulated the

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largest amount of soil loss with 4.63 m^2. Overall, point sampling 3 was identified as the most degraded area, where it showed the most visible changes as compared with the other point samplings.

The second part of this study focused on determining the physical factors which contributed significantly to the recreation-use impacts along the trail. Four attributes were selected as the physical factors: slope gradient, soil texture, rainfall intensity and amount of use. Soil texture was identified through particle-size analysis using pipette method, while slope gradient was measured using a clinometer. Data on rainfall intensity and number of visitors for each month of the study were gathered from the Meteorology Department of Malaysia and Gunung Datok Coorperation Berhad respectively. For data analysis, Pearson correlation and regression analysis were used to examine the strength of relationship between the physical factors and recreation-use impacts. The results revealed that soil texture and slope gradient hadcontribute to the erosion process and expansion of trail. From the regression models, slope gradient was found to be the highest explanatory predictor for soil erosion (R^2 = .053), while soil texture showed the highest R^2 value for trail width with 4.4%. Nevertheless, both factors were found to be the major predictors for all the recreation-use impact indicators. Even though rainfall and amount of use were not found to significantly influence the impacts, both factors were considered as the supporting factors.

In the third part of this study, seventeen point samplings were categorised using trail condition classes. At the end of the study, the results showed that 17.6% (three point samplings) were classified as moderately damaged trail, 64.7% (eleven point samplings) were highly damaged, and three point samplings (17.6%) were detected as hotspot areas. The hotspot areas (point samplings 3, 7, and 14) require immediate mitigation actions to avoid further degradation. Overall, Gunung Datok Trail was categorised as Class III out of four classes, which indicates it is a highly damaged trail. Therefore, the whole trail requires continuous observation and maintenance; priority should be given to the highly damaged areas.

In conclusion, Gunung Datok Trail needs immediate mitigation actions, especially in the hotspot areas. Points with steep slope gradient require extra attention from the park management to ensure sufficient preventive measures for users' safety. Besides, a continuous monitoring programme needs to be implemented by the park management to minimise future trail degradation.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PERKAITAN DI ANTARA IMPAK AKTIVITI REKREASI DAN FAKTOR-FAKTOR FIZIKAL DI SEPANJANG TREK HUTAN DI GUNUNG DATOK, NEGERI SEMBILAN, MALAYSIA

Oleh

NOOR JALILAH BINTI JUMAAT
Oktober 2013

Pengerusi : Prof. Madya Abdullah Mohd, PhD
Fakulti : Perhutanan

Hutan Rekreasi Gunung Datok merupakan salah satu kawasan rekreasi yang popular di Malaysia. Peningkatan jumlah pengunjung sejak beberapa tahun kebelakangan ini telah menyumbang kepada perubahan fizikal di sepanjang trek hutan seperti pelebaran dan pendalaman trek, kepadatan tanah, dan hakisan tanah. Satu kajian telah dijalankan di sepanjang trek Gunung Datok bagi mengenalpasti dan menangani isu tersebut. Matlamat kajian ini adalah untuk menilai kesan penggunaan trek hutan akibat daripada aktiviti rekreasi yang dipengaruhi oleh beberapa faktor fizikal di sepanjang trek Gunung Datok. Selain itu, kajian ini juga bertujuan untuk mengenalpasti perkaitan di antara penggunaan rekreasi dan impak negatif bagi tujuan pengurusan sumber alam semulajadi di kawasan tersebut. Kajian ini telah dijalankan selama enam bulan (bermula Julai sehingga Disember 2010) dengan menggunakan kaedah bersepadu di mana kaedah pengecaman kawasan bermasalah dan pengkelasan keadaan kawasan telah digunakan. Sebanyak tujuh belas titik persempelan telah ditentukan menggunakan kaedah pengecaman kawasan bermasalah berdasarkan kepada pelebaran dan pendalaman trek, kepadatan tanah, dan hakisan tanah. Kemudian, kesemua titik persempelan dikategorikan mengikut keadaan fizikal trek tersebut.

Kajian ini terdiri daripada tiga bahagian. Di bahagian pertama, keadaan fizikal persekitaran trek Gunung Datok telah dipantau. Pengukuran lebar dan kedalaman trek, kepadatan tanah dan hakisan tanah telah dijalankan di setiap titik persempelan. Hasil pengukuran mendapati bahawa panjang minimum bagi lebar trek adalah 1.10 meter (titik persempelan 15), manakala lebar trek paling besar telah dikenalpasti di titik persempelan 3

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(4.70 meter). Bagi kedalaman trek hutan, titik persempelan 16 telah di kenalpasti sebagai trek paling dalam dengan ukuran 1.23 meter manakala titik persempelan 1 mempunyai kedalaman trek paling minimum iaitu hanya 0.48 meter. Kajian ini juga mendapati titik persempelan 1, 6, dan 7 mempunyai kepadatan tanah yang tertinggi iaitu 4.83 g/cm^2. Sementara itu, bagi hakisan tanah, titik persempelan 3 telah mengalami proses hakisan tanah yang paling besar di mana ia telah kehilangan tanah sebanyak 4.63 meter persegi. Secara keseluruhannya, titik persempelan 3 telah dikenalpasti sebagai kawasan yang paling teruk di mana ia menunjukkan perubahan yang amat ketara berbanding dengan titik persempelan yang lain.

Bahagian kedua kajian ini tertumpu kepada penentuan faktor-faktor fizikal yang telah menyumbang kepada impak rekreasi di sepanjang trek Gunung Datok. Empat aspek telah dipilih sebagai faktor fizikal iaitu kecerunan trek, tekstur tanah, keamatan hujan, dan jumlah penggunaan. Tekstur tanah telah dikenalpasti melalui analisis saiz tanah menggunakan kaedah pipet, manakala kecerunan trek telah diukur menggunakan clinometer. Data bagi keamatan hujan dan jumlah pengunjung bagi setiap bulan telah diperoleh daripada Jabatan Meterologi Malaysia dan Koperasi Gunung Datok Berhad. Untuk analisis data, Korelasi Pearson dan analisis regresi telah digunakan untuk mengenalpasti perkaitan dan kekuatan hubungan di antara faktor fizikal dan kesan penggunaan rekreasi. Keputusan yang diperoleh mendapati bahawa tekstur tanah dan kecerunan trek adalah merupakan faktor utama, terutamanya kepada hakisan tanah dan pelebaran trek. Dari model regresi, kecerunan trek telah menjadi penyumbang utama kepada proses hakisan tanah (R^2= 0.053), manakala tekstur tanah menunjukkan perkaitan yang tertinggi dengan pelebaran trek iaitu R^2 = 4.4%. Walaupun keamatan hujan dan jumplah pengunjung didapati tidak mempengaruhi impak dengan ketara, kedua-dua faktor tersebut didapati masih menyumbang kepada impak negatif dan dikira sebagai faktor yang menyokong.

Di bahagian ketiga kajian menunjukkan pengkelasan kesemua titik persempelan mengikut keadaan trek tersebut. Keputusan menunjukkan bahawa 17.6% (3 titik persempelan) dikelaskan sebagai sederhana rosak, 64.7% (11 titik persempelan) sebagai sangat rosak, dan tiga titik persempelan (17.6%) sebagai kawasan panas. Kawasan-kawasan panas (titik persempelan 3,7, dan 14) memerlukan tindakan pemulihan yang segera bagi mengelakkan keadaan menjadi semakin teruk. Secara keseluruhannya, trek Gunung Datok telah dikategorikan sebagai Kelas III yang menunjukkan ia adalah trek yang sangat rosak. Oleh itu,

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keseluruhan trek ini memerlukan pemerhatian dan penyelenggaraan yang berterusan, yang mana keutamaan harus diberikan kepada kawasan-kawasan yang sangat rosak.

Kesimpulannya, trek Gunung Datok memerlukan tindakan mitigasi yang segera, terutamanya di kawasan hotspot. Kawasan dengan kecerunan yang tinggi memerlukan pemerhatian yang lebih daripada pihak pengurusan taman. Ini bagi memastikan keselamatan pengguna ketika berekreasi. Selain itu, program pemantauan secara berterusan mesti dilaksanakan bagi meminimakan impak negatif terhadap trek hutan di masa akan datang.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CSA	Cross-sectional Area
FDPM	Forestry Department of Peninsular Malaysia
LAC	Limit of Acceptable Change
PRF	Permanent Reserve Forest
PS	Point Sampling

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CHAPTER ONE

INTRODUCTION

This chapter generally describes the forest recreation in Malaysia by focusing on changes and the impacts resulting from recreation use that have occurred on the hiking trails in the forest. It explains the issues and problems related to the study as well as objectives and justification of the study.

1.0 Forest recreation : An overview

Nature always offers extraordinary appeals to nature lovers for many reasons. The adventure, beautiful sceneries, peaceful and relaxing surrounding or even new knowledge are some of the extraordinary appeals. Hence, natural places have attracted much attention of people from all walks of life, where they sought for countryside, retreats and natural environments for recreation and leisure purposes. Popular natural places favoured by most recreationists include state parks, national parks, and recreational forests or wilderness areas. Recreational forest is part of Permanent Forest Reserve where its primary objective is to conserve the natural resource besides providing opportunities for recreational activities. Therefore, physical development within the forests is minimised; building or construction works are limited to small concentrated sites, and the natural resources are protected for the enjoyment of visitors (Douglass, 2000; Brockman and Merriam, 1979). Malaysia is endowed with approximately 20 million hectares of forested area or 59.5% of its total land area, which provides economic and social benefits to the people of this nation. Forest recreation is an example of social benefit derived from the existence of natural forest. The amenity forest established under the Forest Act 1984 (Subsection 10(1) h) consists of small natural areas mostly within forest reserves. Amenity forest provided opportunities for forest recreation or ecotourism activities. These amenity forests are developed with the main objective of conserving adequate forest areas for recreation, ecotourism, and for promoting public awareness in forestry for its environmental and social services (FDPM, 1993). Figure 1 shows the number of amenity forests owned by each state in Malaysia.

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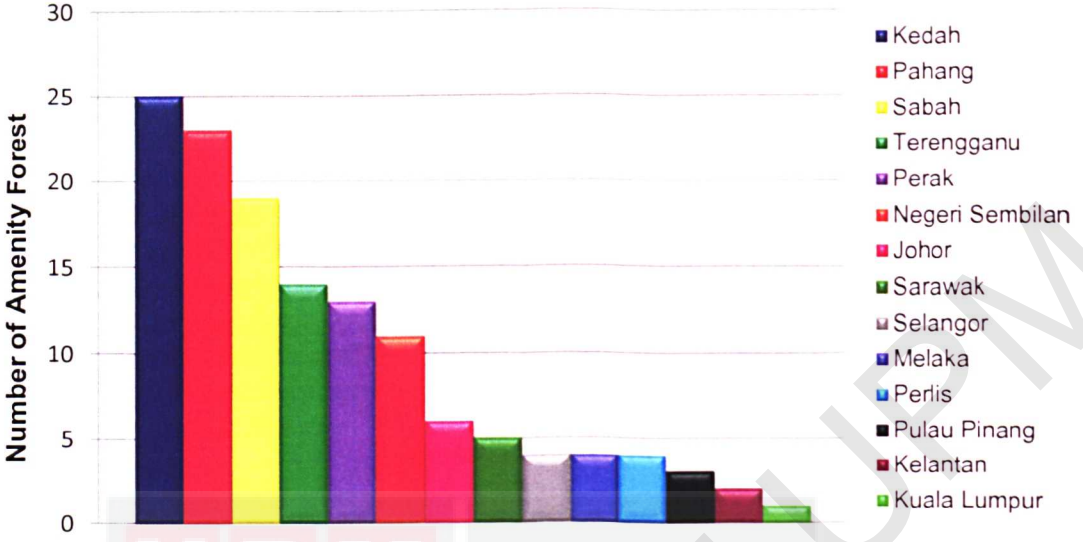

Figure 1: Amenity forest in Malaysia
(Source: Forestry Department of Peninsular Malaysia, Forestry Department of Sarawak, and Forestry Department of Sabah, 2010)

The total area of amenity forests in Malaysia is approximately 50,000 hectares; Kedah has the highest number with 25 amenity forests. Meanwhile, Kuala Lumpur the federal territory has only one amenity forest, which is the Bukit Nanas Forest Reserve or forest eco-park. Apart from being a conservation area, amenity forests are also well-known places for conducting research and educational studies among students and academicians. The natural environment provides ideal places for visitors to relax, to escape from busy lifestyle and to release stress from work. It is also suitable for public to appreciate environment and enjoy many recreational opportunities such as hiking, picnicking, camping in forest settings (FDPM, 1993). Hence, forest recreation provides a lot of benefits to the visitors. According to Brockman and Merriam (1979), forest recreation offers excellent opportunities for health and leisure-time pursuits, which can expand an individual's horizons. Recreation in natural settings such as forest may initiate development of physical skills as well as intellectual and cultural interests. In other words, forest recreation activities may help visitors to improve their individual personality and social relationships.

In Malaysia, forest recreation has emerged as a popular recreational activity. The number of visitor arrivals in natural and forest areas has been increasing throughout the years. For example, Gunung Datok Recreational Forest has been receiving a large number of visitors annually since 2007 (Gunung Datok Rembau Corporation Berhad, 2011). Obviously, this trend of visitation is a good sign for the ecotourism sector where such increased number of visitors generates

more revenue for ecotourism operators, and visitors benefit in terms of social life. However, recreational activities may also cause serious impacts on the ecological environments. Natural attractions such as mountains and waterfalls in some of the existing recreational forests draw many recreationists and as a result will increase the use of the resources and ultimately caused increasing needs for more recreational facilities. Therefore, continuous physical activities exert certain degree of pressure on the forest resources, which may cause undesirable physical changes to many aspects of forest including the condition of soil, health of vegetation, water quality, and even the habitats of wild animals. Forest recreation activities such as camping, jungle trekking and mountain climbing, wildlife observation, swimming and picnicking are often associated with negative impacts on the natural resources (Hammit and Cole, 1998).

Soil erosion along trails is the most significant form of negative impact resulting from many recreational forests. Moreover, impacts such as severe soil erosion and exposed roots are visually intrusive and can reduce the aesthetics and functional value of the recreational settings. A study conducted by Roggenbuck *et al*. (1993) showed that the impacts on natural resources were noticed by the visitors, and the impacts can degrade the quality of recreational experiences and satisfaction among visitors. Impacts such as deep ruts and excessive muddiness increased the difficulty of moving and compromised the safety of visitors (Marion and Leung, 2001). These excessive trail-related impacts on the vegetation, soil, and wildlife or water quality could represent an unacceptable departure from the natural condition and processes.

The primary concern of recreation resource managers is the undesirable change in the ecological environmental conditions (Hammit and Cole, 1998). Therefore, trail impact assessment is important, which can provide valuable information for the management. The conditions of trails must be assessed in order to identify the location, type and extent of trail resource impacts (Marion and Leung, 2001). There are three general types of trail impact assessments: trail inventory, trail condition, and trail maintenance (Marion, 1994). These types of assessments provide useful data or information about the following items: general planning, estimation of costs for materials and staff, and actions that should be taken by the management to protect the natural resources and provide satisfaction to the visitors.

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1.1 Problem statement

Gunung Datok Recreational Forest is a popular recreational forest among recreationists and ecotourists; it is patronised by both the local Malaysians and foreigners. The trend of visits can be observed by the increasing number of hikers who climbed the mountain (Table 1). They used forest trails as their main avenues for recreational activities, such as hiking, camping, bird watching and wildlife observation. Forest trails also served as access to jungle trekking and mountain climbing as these activities were the most popular adventures among the visitors (Hammit and Cole, 1998; Douglass, 1975).

Table 1: Trend of hikers climbing Gunung Datok Recreational Forest, Negeri Sembilan

Year	Number of Hikers
2007	9,000
2008	10,000
2009	12,753
2010	12,846
Until 31st March 2011	4,094

(Source: Gunung Datok Rembau Corporation Berhad, 2011)

Visitors to Gunung Datok Recreational Forest used mainly one primary trail, which had been developed for the purpose of mountain climbing activity. Therefore, when this trail was excessively used, pressure induced by the trail usage caused a greater extent of deterioration of natural resources especially soil and vegetation as compared with wildlife and water (Liddle, 1997). These damages could have occurred due to trampling activities, behaviour of the visitors, and influence of other physical factors such as rainfall intensity and topography (Marion and Leung, 2001; Hammit and Cole, 1998; Liddle, 1997). Recreation impacts such as trail widening, soil erosion, excessive root exposure, and diminishing of ground vegetation were clearly seen along Gunung Datok Trail. In fact, increasing number of visitors has led to the worsening of these problems. It is important for the management of Gunung Datok Recreational Forest to observe the trend of the number of visitors using the resources, so that they will have better ideas to implement the right actions in order to mitigate the environmental damages. The widespread damages may reduce the recreational experience and satisfaction of the visitors. If no appropriate management actions are taken or no management control procedures are introduced, the situation may worsen to such a degree that it will be difficult to rehabilitate the area (Leung and Marion, 2000). Therefore,

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this study is needed to evaluate the current conditions of the natural resources as well as its utilisation and physical factors that contribute to the recreation-use impacts. The findings of this study will be useful to the management for implementing future action to mitigate the recreational use impacts. Moreover, the study may also help in early detection of problems so that appropriate management measures can be implemented to prevent more serious problems at the later stage. In addition, the data collected can provide specific information to the management in relation to the current conditions and status of resources for monitoring purpose to control the number of hikers.

1.2 Objective of the Study

The main objective of this study is to evaluate the recreation-use impact related to selected physical factors along Gunung Datok Trail, Negeri Sembilan and to determine the recreational use and impact relationships for resource management use.

Specific Objectives

The specific objectives of this study are:

a. To quantify the recreation-use impacts that occurred on soils along Gunung Datok Trail due to the recreational activities.
b. To examine the selected physical factors use as indicators which contribute significantly to the recreation-use impacts along Gunung Datok Trail.
c. To determine trail condition classes for Gunung Datok Trail.

1.3 Justification of the Study

Malaysia has a number of amenity forests that offer great recreational opportunities, which are frequented by many recreationists. Therefore, it is important to conduct a research on the recreation-use impacts, the results of which may help the relevant authorities to manage the natural resources in a systematic and sustainable manner. In addition, the monitoring programme also helps to evaluate the success or failure of the resource protection measures in Malaysia. In addition, the study of relationships between specific impacts and use of forest facilities may provide useful information for the management to take appropriate action in order to conserve the national recreational forests.

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1.4 Definition of Key Terms

a. Physical factors

Certain physical factors influence the quality of recreation that can be developed in an area. These factors limit the possible types of developments on a given site (Douglass, 1975). These developments may give rise to negative impacts as a result of recreation activities, especially on forest trails and areas used as campsites (Olive and Marion, 2009; Leung and Marion, 2000; Hammit and Cole, 1998). Under certain conditions, the physical factors may increase the degree of impacts particularly in problematic areas. For example, heavy visitor traffic may trigger excessive muddiness on trails during rainy season, which can worsen trail widening problem.

Physical factors that affect trail resource impacts are divided into two main types: use-related factor and environmental factor, both of which can be changed through management action (Marion and Leung, 2001). Use-related factors comprise amount of use, type of use, and user behaviours; environmental factors include vegetation, soil type, topography, and climate. In this study, four attributes have been selected from the two types of physical factors. They include one use-related factor, which is amount of use; and three environmental factors, which are soil texture, slope gradient, and amount of rainfall. These four attributes are categorised as physical factors that can influence trail resource impacts.

b. Recreation-use impacts

The goal of recreation ecology is to understand the causes of impacts and to explore effective ways to mitigate impacts, in order to preserve wilderness resources and provide enjoyable recreation experiences. The term impact refers to any undesirable visitor-related biophysical change of natural resources (Leung and Marion, 2000; Liddle, 1997). The common recreation impacts are trail widening, excessive muddiness, root exposure, reduction in ground vegetation, soil erosion, and soil compaction. The occurrence of these impacts may affect the recreational satisfaction of the visitors.

In this study, the term 'recreation-use impacts' is used to describe the condition of Gunung Datok Trail. Four types of impacts were identified: trail width, trail depth, soil compaction, and soil erosion. Each of them was measured using standard and scientific methods.

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c. Recreational activities

Recreation can be defined as an activity that offers a contrast to work-related activities and that offers the possibility of constructive, restorative, and pleasurable benefits (Hammit and Cole, 1998). It is needed to provide satisfaction in some way, where it is an essential element of human biology and psychology that may improve an individual's personality and social relationships (Torkildsen, 2005). Basically, recreational activities are carried out outside daily routine with no time limitations either in indoor or outdoor settings. Common examples of recreation activities are camping, hiking, mountain climbing, picnicking, and bird watching.

d. Temporal trend

Temporal trend refers to a series of occurrences throughout the time. In recreation ecology, the temporal trends are important, which illustrate the trends of the impacts of recreation in particular places such as trails and campsites (Cole, 2004). This information can help the management to conserve the resources by preventing them from further degradation.

1.5 Organisation of the Thesis

This thesis consists of six chapters. Chapter 1 introduces the background of the study, problem statement, and description of the objectives as well as the justification of the study. Definitions of terms used in this study are listed at the end of this chapter. Chapter 2 reviews relevant literature related to this study, including topics such as recreation ecology, recreation-use impact on forest trail, physical factors affecting trail degradation, scientific methods used in recreation impacts study, and types of trail assessment as well as monitoring approaches. Chapter 3 further elaborates on the research frameworks including study area, data collection procedures, and statistical analysis conducted in the study. In Chapter 4, major findings of the study are interpreted and discussions are presented in Chapter 5. Chapter 6 concludes the thesis with a brief summary of the study; recommendations are also made at the end of the chapter.

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