QUARRY RESOURCE PLANNING FOR THE STATES OF SELANGOR, TERENGGANU, KELANTAN, SABAH AND SARAWAK: A GENERAL OVERVIEW & THE STATISTICAL MODELLING FOR DEMAND OF AGGREGATES

Zulkifli Ab-Ghani-Hilmi, Sa'diah Sahat, Hajar Mohamad and Saharani Abdul Rashid
Faculty of Information Technology & Quantitative Sciences, Universiti Teknologi MARA Pahang
Zulkifli Ab-Ghani-Hilmi@pahang.uitm.edu.my

ABSTRACT

Quarrying is an important economic activity since infrastructure and industrial development led to a continuing demand for rock aggregates in the country. Under the Eighth Malaysian Plan (2001-2005), the construction sector is expected to grow at an annual rate of 6.7%. However, the government and the society are increasingly sensitive on safety and environmental issues related to exploitation of rock materials. The government, through the Department of Minerals and Geoscience Malaysia, commissioned a mining consultant firm to conduct studies and prepare reports on quarry resource planning for every state in the country. The primary objective of the project is to identify policies and strategies for the sustainable development of the quarrying industry in view of the economic interest, social and safety considerations, impact on environment and conservation of natural resources.

INTRODUCTION

The quarrying industry needs to be planned and administered properly for the purpose of a sustainable development of the industry. This means that un-renewable resources (i.e rock materials) should be planned and controlled in a proper and systematic manner for the current and future needs. Every state should develop a 'Quarry Resource Planning' for an orderly development of the industry and avoiding waste of the rock material. The Malaysian Government through the Department of Minerals and Geoscience Malaysia, commissioned selected mining consultant firm to conduct studies and prepare reports on quarry resource planning for every state in the country.

The first report was for the State of Perak and it was completed during the Sixth Malaysian Plan (1995). During the Seventh Malaysian Plan, reports for Johor, Negeri Sembilan and Pahang were completed (1998-2000). The project continues under the Eighth Malaysian Plan for Selangor, Terengganu and Kelantan (2002-2003) with an approved budget of RM816,250 and at present the project continues for the State of Sabah (RM332,797) and Sarawak.

The main consultant firm for the States of Selangor, Terengganu and Kelantan was Osborne and Chappel. Currently, SBA Consultants Sdn Bhd is handling the project for Sabah and Sarawak. Unit of Research, Development and Commercialization of UiTM Pahang (used to be Bureau of Research & Consultancy) represented by four lecturers from the Applied Statistics SIG group was appointed on the statistical aspect of the project such as designing the questionnaire as an instrument to gather information from the quarry operators, analyzing the data collected; and the major consultation is to determine a statistical demand model used for forecasting the future consumption of aggregates in each state based on the current demand and supply.

Before the project proceeds in each state, representatives from the relevant government agencies (Federal and State) such as the Public Works Department, State Economic Planning Unit, Land and Survey Department, Department of Agriculture, Department of Environment, Town Councils, Department of Minerals and Geoscience, Statistics Department, the Quarrying Companies Association, etc. were gathered for a briefing on the quarry resource planning. The purpose of the briefing is to get their cooperation in providing data, plans and guidance during the preparation of the report. For every state, two meetings are held to go over the draft report before it is amended and accepted. The final report will be handed over to each state government and as such, the information is still considered to be confidential. The expectation is that the State Governments, the relevant department and agencies, quarry companies or individuals interested in the quarrying industry will find the report and its recommendation useful in improving the quarry industry.

SCOPE OF THE QUARRY RESOURCE PLANNING STUDY AND REPORT

The report on the quarry resource planning for each state consists of the following pages and chapters:

Table of Contents
List of Tables
List of Figures
List of Plates – photographs of the quarry sites
List of Appendices
General Abbreviations
Glossary
Acknowledgement

Executive Summary
It gives the general overview of the important findings and information available in the report.

Chapter 1: OBJECTIVE

This chapter contains a list of objectives and the approach adopted for the rock resource study such as reviewing the geological information in order to determine potential rock resources and potential quarry sites, reviewing of legislations and government procedures affecting the quarry industry, etc.

Chapter 2: PROFILE OF STATE

This chapter describes a general background of the state and specific profiles such as topography and drainage, land use, population and labour force, and economic activities.

Chapter 3: GEOLOGICAL FEATURES

This chapter gives information on the rock type distribution in each state such as sedimentary rocks, granitic rocks, unconsolidated sediments, etc. with maps obtained from the Mineral and Geoscience Department.

Chapter 4: USES OF ROCKS

This chapter describes the commercial uses of granite, sandstone, volcanic rocks, limestone/marble and river gravel.

Chapter 5: GOVERNMENT PROCEDURES

This chapter discusses laws and government procedures applicable to the quarrying industry such as Land (Quarry) Rules 1997, Mining Ordinance 1960, Mineral Development Act 1994, Environmental Quality Act 1974, National Land Code 1965, Factories and Machinery Act 1967, Occupational Safety and Health Act 1994, Explosives Act 1957, National Forestry Act 1984, Town and Country Planning Act 1976, Land Conservation Act, etc. It also discusses the fee/royalty for removal of rock materials.

Chapter 6: QUARRYING ACTIVITIES

This chapter gives an overview of the quarry industry in terms of their location, production, quarrying rights, management and workforce. Then, quarrying activities in each district is detailed. Quarrying method for production of aggregates from quarry development, drilling and blasting, excavation and haulage, crushing and screening and transporting crushed rocks to customers are explained.

Chapter 7: INFRASTRUCTURE

Existing and proposed infrastructure are discussed in this chapter with focus on transportation system (road, sea, air and railway) and utilities (electricity and water supply).

Chapter 8: FUTURE GROWTH AREAS

This chapter discusses the development policy, spatial development of the state, and future pattern of land use, economic activities and growth areas by districts.

Chapter 9: RESOURCES

Potential rock resources (i.e rock materials suitable for use as road and construction aggregates) and potential quarry locations according to districts are highlighted in this chapter. Detailed maps of the potential quarry locations are included.

Chapter 10: SUPPLY AND DEMAND

This chapter takes a look at past production of aggregates, analyse consumption trend and attempts to predict future demand of aggregates by taking into consideration important economic activities, infrastructure development and population growth. Statistical models presented in this chapter could serve as a guide for forecasting future demands.

Chapter 11: ISSUES

The issues facing the quarrying industry are discussed under the following subtopics:
Government Policy on Rock Resources, Regulation of Quarrying Activities, Quarry Land and Rock Removing License; Safeguarding of Rock Resources; Collection of Royalty/fees; Explosive Handling, Storage and Use; Occupational Safety and Health; Optimizing the Usage of Rock Resources; Recycling of Rock Products; Management and Workforce; Quarrying Below Ground Level; Environmental Aspects of Quarrying; Rehabilitation Aspects of Quarry Land; and Financial Incentives for the Quarrying Industry.

Chapter 12: RECOMMENDATION

This chapter outlines recommendations on rock resource planning and strategy from the consultant group, particularly to resolve issues stated in Chapter 11.

Appendices
References and Bibliography

STATISTICAL MODELLING FOR DEMAND OF AGGREGATES

Methods in Forecasting Demand of Aggregates
The three methods that have been used in some quarrying resource planning are as follows:

(I) Direct Usage Method
This method was introduced by Robert M. Whelan from the Oregon Department of Geology and Mineral Industry in 1995. An aggregate usage factor has to be determined. It is the amount of aggregates consumed for a given unit of construction. Then, a forecast of all economic activities in a certain year that uses aggregates (for example, the number of kilometres of new roads, the number of residential housing, etc) is produced. The overall demand for aggregates is obtained by summing all of the demand forecast for each economic activity. The disadvantage of this method is that accurate usage factors are difficult to obtain. It is more of a quantity survey approach rather than a statistical model.

(II) Time Series Method
Some previous studies on the forecast of demand for aggregates have relied on a time-series approach that is based on historical data. Usually, the trend equation is determined, whereby forecast is made by projecting the long term trend into the future. This method was used by the Denver Metro Area, United States of America using aggregate production from 1960 to 1985 and forecast was made until 2010. New South Wales, Australia geological survey has also adopted this approach.

(III) Simple/Multiple Regression
Another approach is the multiple regression method that involves the determining of a model equation that relates the demand of aggregates with general economic factors such as the gross domestic product,

population, road and building constructions, etc. Using stepwise procedure, only variables that are highly correlated with the aggregate demand will be included in the regression model. At the same time, the assumptions of the residuals being normally distributed with equal variance and independent are approximately satisfied. Some examples of the demand model using the regression technique are the British Columbia Model (1980), Ontario Model (1992), Lower Mainland of British Columbia Model (1996-2021), and Planning for the Supply of Aggregates in England (1992).

Basically, the Applied Statistics SIG team has adopted the Simple/Multiple Regression and Time Series Method in building a statistical demand model for quarry aggregates for the States of Selangor, Terengganu and Kelantan. All analysis has been done using SPSS Version 11/12 and Excel. As for the Sabah report, which is now in progress, we are also considering the direct usage method if availability of data permits.

Due to the confidentiality of the information gathered and the rights of the main consultant firm and our client as the owner of the data, we are unable to give detailed information of our methodology and findings. Nevertheless, a 'make-up' summary of the models obtained for the State of Terengganu and a summary of remaining reserves, potential resources and life span of aggregate quarries in Terengganu are shown in the next two tables as an example.

Table 1 : Remaining Reserves, Potential Resources and Life Span of Aggregate Quarries in Terengganu

Analysis	Time Series Analysis	Multiple Linear Regression	Simple Linear Regression
Model	Demand =Trend x Seasonal Index where Trend = 575,761.8 + 13,672.4(time)	Demand = $3.055 + 0.30X_1 + 1.03X_2$ where X_1= km of new roads X_2= no. of terraced houses	Demand =171.5 +1.692X where X = population size
R^2-Value (explanatory power)	0.97 for the trend line	0.85	0.65
Total demand (2002-2010)	26,977,822 tonnes	27,041,000 tonnes	25,164,000 tonnes
Average annual demand for the next 9 years	2,997,536 tonnes	3,004,556 tonnes	2,796,000 tonnes
Life-Years of current resources	>60 years	>70 years	>100 years
Comments	Even though it has a high explanatory power, this model is obtained based on monthly records from 2001 to 2002. Perhaps, a better picture of the movement of the demand over time could be obtained if there were records of aggregate demand for at least the last 5 years. Nevertheless, the model is useful to predict quarterly demand in a certain year in the future.	A model with a reasonably high R^2-value. The advantage of this model is that it relates demand with macro-economic indicators that are relevant to demand of aggregates such as building and road constructions, GDP population, etc. Based on the present economic activities in the state, this is the most recommended model.	The explanatory power of the model is moderate. The advantage of this model is that population size is not sensitive to changes in government policies and external pressures. It may be used for a longer period of time compared to the other models.

* Actual figures have been modified

The table below shows a summary of Remaining Reserves (million tonnes), Potential Resources (million tonnes) and Life Span of Aggregate Quarries in Terengganu.

Table 2 : Remaining Reserves, Potential Resources and Life Span of Aggregate Quarries in Terengganu

District	Remaining Reserve in Existing Quarries			Potential Resource in Neighbourhood of Existing Quarries		Potential Resource in New Areas	
	No of Quarries	Million Tonnes	Life-Years	Million Tonnes	Life-Years	Million Tonnes	Life-Years
Besut	1	15.0	>100	30.0	>200	90	>200
Setiu	-	-	-	-	-	90	>100
Hulu Terengganu	2	10.7	15	40.0	52	100	>100
Kuala Terengganu	4	33.5	50	60.0	98	90	>100
Marang	2	8.5	50	-	-	90	>200
Dungun	3	40.5	59	30.0	54	100	>100
Kemaman	2	58	>100	30.0	44	70	>100
Total	14	166.2	57	190.0	66	630	>200

* changes have been made to the original data

LIMITATIONS

The adequacy of the models in predicting the annual demand of aggregates does not imply the validity of the model. Although the models are adequate in forecasting future consumption of aggregates, it may not be valid if there are extreme changes in the government policies regarding the overall development of the state. All the data involved in developing the model are based on current policies and development of the state. If the pattern of development highlighted by the government does not change, the models are adequate and valid to be used in the forecasting.

The regression and time series analysis in this study rely on historical data. One of the drawbacks in using data from the past is that, it is more suitable for short rather than long term forecasting. Over longer period, changes in government, changes in economic policy, external pressures, and other factors make historical data less suitable. In this study, forecast of aggregate demand is performed until the year 2010.

CONCLUSION

One of the positive things about the consultation project is that it has enabled the lecturers involved to bridge the gap between theory and practice. As academicians, we are used to textbook data that were constructed perfectly to fulfill a certain statistical technique. This is not so with real-world data. Some modifications of the statistical technique (to be specific, regression analysis) have to be made to accommodate the 'not so perfect data'. The consultation work has given the lecturers involved the opportunity to contribute their expertise in a project that would be beneficial to one of the economic activities and to the nation as a whole. Apart from the other consultant members from Osborne & Chappel, SBA Consultants and the technical committee from the Department of Minerals and Geoscience who have become our close friends, we are also making new acquaintances as the project moves on to the various states. Last but not least, it is hoped that the consultation work is a small step on our part in promoting linkages and academic interactions between UiTM with industries and other government bodies, which is one of the strategies towards a World Class University

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