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Quality Of Life Sustainability Using Geographic Information System (Gis): A Case Study From East-Coast Of Peninsular Malaysia

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Abstract: Malaysia is a developing nation and moving forward to achieve sustainability in term of economics and social indicators. Malaysia's Quality of Life (QOL) report defines QOL as an encompassing personal advancement, a healthy lifestyle, access and freedom to pursue knowledge and attaining a standard of living. Study on QOL is gaining interest from variety of discipline and becoming an important indicator for policy evaluation, rating for places, urban planning and management. In this study GIS is employed to analyze the QOL in East Coast of Peninsular Malaysia. Basically, GIS is a user-friendly interface developed to enhance the presentation of the study. This study used secondary data and aims to identify the dynamic interface of QOL using GIS approach. Through this study, five components been demonstrated, namely education, health, employment, industry and transportation; and communication which attained under specific indicators in each cases. An ordinary least square, spatial autocorrelation and Geographically Weighted Regression (GWR) was applied to explore the relationship between QOL and the independent components. The findings of this study show that, industrial, transportation and communication contributed the highest volume to QOL. Meanwhile, the employment component contributes with lover volume of scores. In general, the findings of this study clearly indicate GIS as an important and dynamic tool to analyze socioeconomic and it's able to illustrate socioeconomic sustainability with statistical values and illustrate using maps.

Key words: Quality of life; Geographic Information System, Geographically Weighted Regression

INTRODUCTION

The study on Quality of life (QOL) is gaining interest from a variety of discipline such as planning, geography, economics, sociology, political science, psychology, behavioral medicine, marketing and management and is becoming an important tool for policy evaluation, rating for places, urban planning and management (George and Bearon, 1980; Lin *et al.*, 2009). There are various concepts concerning QOL can be found in literature, such as health urban environmental quality, quality of place, residential perception and satisfaction and sustainability. Based on, Malaysian Quality of Life Report (2004), QOL is defined as *'encompassing personal advancements, a healthy lifestyle, access and freedom to pursue knowledge and attaining a standard of living'*. It also fulfills the basic and psychological needs of the individual to achieve a level of social well-being compatible with the nation's aspirations. QOL also can describe as changes by which an entire social system moves away from an unsatisfactory condition of life towards a better situation of life. The definition of QOL is depending on the individual and area of application. For example, for a town planner it might represent facilities and green spaces, but clinical terms concerned only with evaluation those aspects that are affected by disease or treatment for disease (Fayers and Machin, 2000). QOL is also part of social science concepts, which is used in everyday life and have become a part of the cultural and political vocabulary (Wadembere, 2001; Rosilawati, *et al*. 2006; Elmahdi and Afify, 2007). QOL also can describe as expression of degree of satisfaction or dissatisfaction felt by people with various aspects of their life (Abrams, 1973). On the other hand, McCall (1975) assumed QOL as necessary conditions for satisfaction and happiness. In general, Geographic Information System (GIS) is a technological tool for making intelligent decisions and concern with data related to geographic scales. Information is the extraction of specific and meaningful information while system as being a data manager. GIS also can be referred as computer-based system which used to capture, store, edit, and display and analyze geographically referenced data. GIS has emerged as a new era of presenting socio-economic data. Since its setting up and use in the early 1990's, GIS development has gone further by incorporating statistical data within its analytical functions. GIS also present data spatially and to display graphs for each spatial data displayed. GIS not only used as a mapping tool but also able to display data spatially base on time frame. In the last thirty years or so, it has become possible to put these models inside computer and more complicated models into smaller computer every year. However, these computer models, along with the tools for analyzing them, make up a GIS (Ormsby *et al.*, 2004).

According to Malczewski (2004) GIS is a tool for the input, storage and retrieval, manipulation and analysis and output of spatial data. GIS in technology perspective identifying four components of the system such as data

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input, data storage and management, data manipulation and analysis and data output. Chang (2007) describes GIS as a system that divided into four components such as computer system, GIS software, brain ware and infrastructure. Nowadays, researchers define GIS as a powerful computerizes system with in-build database management component. According to Burrough (1998), GIS is a powerful set of tool for collecting, storing retrieving, transforming and displaying spatial data from the real world. Smith *et al.* (1987) explain that GIS is a database system in which most of the data are spatially indexed and upon which a set procedures operated in order to answer queries about spatial entities in the database. However, some people describes GIS has more than a computer system. On the other hand, Chakroborty and Sahoo (2007) defined GIS as information system in order to support decision making for planning and management of activities like natural resources and environmental management, transportation and telecommunication utilities, commerce and business affairs, services and administrative management.

QOL appears to be a broader concept and meaning and this provides some reasonable meaning for QOL such as happiness, confidence and life fulfillment. Comprehensive standard for determining QOL is the social well-being enjoyed by people, communities and their society (Bach and Rioux, 1996). The concept of quality always changes rather than fixed towards non-quality at one point in time. There is assumption that when people given choice and wants' to move the quality of their lives toward excellence stage in future. Norris *et al.* (2006) compare four multivariable strategies and analyzed the skewed Health Related Quality Of Life (HRQOL) outcome data. The HRQOL data is based on Seattle Angina Questionnaire, a disease specific quality of life and symptom rating scale was collected. The first model used linear regression; the second and third models used logistic regression with two cut points and the fourth used ordinal regression. However the combination results from four different models have produced more stable parameter estimates with smaller confidence interval widths. Li and Weng (2007) have developed a methodology for integration of remote sensing and census data within a GIS framework to assess the QOL. In this particular case, socioeconomic variables such as population density, income, poverty, employment rate, education level and house characteristic has been used to analyze the level of QOL. Finally, regression model has been applied to estimate the QOL based on selected environmental and socioeconomic variables.

In term of socioeconomic studies, Fortheringham *et al.* (2002) has describe GWR as a local spatial statistical method used to analyze spatial non-stationary and measure the relationship among variables differs from location to location. There is another research by Himmelberger *et al.* (2009) indicate that there is a positive relationship between green vegetation land cover and wealthy socioeconomic condition in urban area. This research used GWR to explore spatial variation in the relationship between socioeconomic and green vegetation land cover across urban, suburban and rural area with census 2000 data. OLS and GWR results were compared based on Akaike Information Criterion (AIC) and the lower value of AIC indicate a closer fit to the data. GWR is specifies separate regression model at each observation points, thus enabling unique coefficients to be estimated at each location. Meanwhile, Rosilawati *et al.* (2006) describes the capabilities of GIS application in analyzing socioeconomics data. Databases were developed for spatial and attributed data. Both types of data were combined and analyzed using GIS. Generally, the main purpose of this paper is to develop a QOL index and analyst QOL in Terengganu, Kelantan and Pahang using GIS approach.

Methodology:

This study employs secondary data for entire period of 1990 and 2010. The data were used to analyst QOL based on Ordinary Least Square (OLS),, spatial autocorrelation and Geographically Weighted Regression (GWR) estimation techniques. All estimation was conducted using ArcGIS software. The method of this paper focused on five main steps. In this case, education, industry, employment, health and transportation and communication related data was collected as a first step. This study focused on five main steps, which are education, industry, employment, health and transportation and communication. Figure 2 illustrates the overall framework of this study.

The standard score of each indicator for each year have to calculate as a first step of QOL index calculation. The standard score show the units of standard deviation above or below the mean value. After that, observation continued by subtracting the mean with the base year value and dividing by the standard deviation. The formula of standard score is shown as in equation (1):

$$Z = \frac{Iy_i - Iy_0}{\sigma} \tag{1}$$

Where;

Iy_i - Value of indicators in year i
Iy_0 - Value of indicators in base year
σ - Standard deviation of data series
Z - Standard score

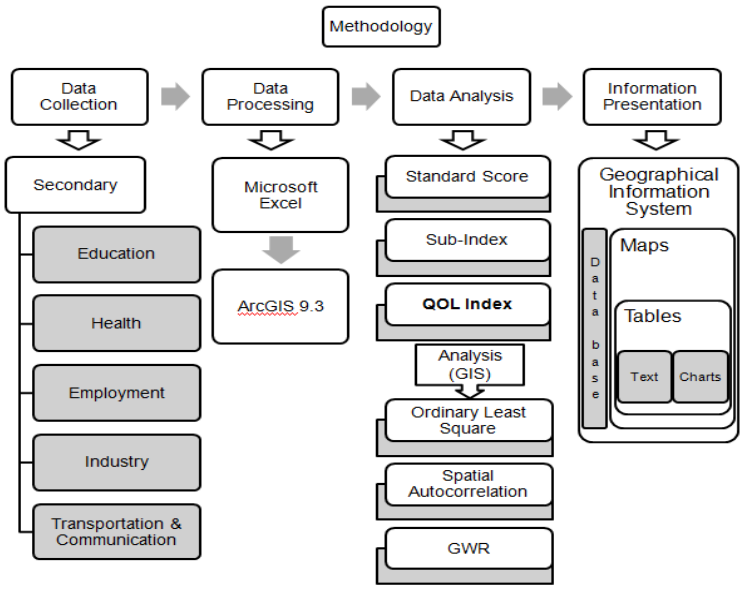


Fig. 2: *Research Framework*

The following step is calculating the sub-index for each year. All indicator chosen in this analysis were assigned a positive signs with imply that an increase in the numerical value denote improving conditions. All positive indicators should be multiplying the standard score by 10 and adding 100, as shown in equation (2):

$$\text{Sub} - \text{Index}\ (S_i) = 100 + (Z*10) \tag{2}$$

The third step is obtaining the index of each area in each year and forth step is calculating QOL index of each component by averaging the sub-indices of the indicators. These three steps repeated for each component to find out QOL index in East Coast of Peninsular Malaysia. The index calculation formula is as shown in equation (3):

$$\text{QOL Indexes} = \frac{\sum S_i}{n} \tag{3}$$

Where;
QOL - Quality of life indexes
S_i - Sub-indices of indicators
n - Number of indicators

In this study, we used Ordinary Least Square (OLS), spatial autocorrelation and GWR to explore the association of QOL. Most of researchers are aware of the limitation in analyst spatial data used global regression techniques, such as OLS regression, which generating global output and ignoring the spatial relationship between variable (Huang and Leung, 2002). Regression is the most important tool to understand the relationship among two or more variables and therefore, this study was conducted to predict the ability of education, health, transportation and communication, industry and employment in explaining the behavior of QOL.

RESULTS AND DISCUSSION

The estimation QOL indexes in this study are eventually separated to 5 categories of indexes such as education, health, employment, industrial and transportation and communication. The education index in Terengganu state had increased rapidly from merely 0.84% in year 1990 to 14.27% in year 2010. However, education index for Pahang state then further expanded to 14.04% in year 2010 from 1.09% in year 1990; and Kelantan also have upward trend on education index from 0.03% to 12.55% from the year 1990 and to 2010. Moreover, the provision of health services has improved in East Coast of Peninsular Malaysia. Health index in this research focus on hospitals and medical personnel and all the data's on government and private hospitals are included in view of increasing role in the provision of medical care. Employment index for Terengganu, Pahang and Kelantan increased slightly from the year 1990 to 2010. Based on Malaysian Economy Report in year 2010, the Malaysian government has focused on efficiency towards providing a group of technically trained workers

as a means to increase the human resources of the country. While, industry index result clearly shows that the Terengganu industry development improved than Pahang and Kelantan. There had been increases of 27.63% for Terengganu, 25.85% for Pahang and 24.50% for Kelantan from the year 1990 to 2010. Malaysian telecommunication sector has undergone significant structural transformation following privatization, deregulation and liberalization in the past decade. The services of communication sector range from voice and data communications to Internet, broadband, global management service, payphones and various multimedia solutions. For the state of Kelantan, Terengganu and Pahang, the transportation and communication index is in normal mode and not much increased for entire period of this study.

The use of spatial autocorrelation tool is to measures spatial autocorrelation based on both feature locations and feature value simultaneously. Other than that, the attribute values being analysis using Spatial Autocorrelation are self correlated and the correlation is attributing to be geographic ordering of the objects. This tool also evaluates whether the pattern of QOL expressed is clustered, dispersed or random and the result from this analysis are always interpreted within the context of its null hypothesis. The result of Moran's I for the OLS residual for the year 1990, 2000 and 2010 is 0.03, 0.04 and 0.10 respectively with 10% significant level. More importantly, the spatial autocorrelation tools result on the model residuals shows random spatial pattern for the year 1990, 2000 and 2010. Table 1 shows Moran's statistics, standardized Z-score and probability value.

Table 1: Summary of Spatial Autocorrelation

	Spatial Autocorrelation Report		
	1990	2000	2010
Moran's index	0.03	0.04	0.10
Z-score	0.55 (0.08)***	0.44 (0.06)***	0.39 (0.07)***

Note: *** indicates significant level at 10% and figures in ( ) refers to p-value

The OLS in ArcGIS 9.3 for global regression is adapted initially in this research to assess QOL in Terengganu, Pahang and Kelantan. Basically, the Moran's statistics is used to examine any existing spatial autocorrelation for residuals of five components used in this study. In order to observe results intuitively, residuals of models are displayed in ArcGIS by year 1990 and 2010. The residuals results from GWR are much lower than OLS residuals. Thus the GWR models give much better fits to data, even accounting for added model complexity and number of parameters. Table 2 shows summary of GWR estimation results.

Table 1: Summary of Geographically Weighted Regression

	Panel 1: Year 1990				
	Residual Squares	δ-value	AIC value	R^2	Adj. R^2
Education	114.32	3.57	66.42	0.82	0.80
Health	219.60	4.94	73.60	0.66	0.62
Employment	443.99	7.03	81.34	0.31	0.24
Industry	100.02	3.34	64.94	0.85	0.83
Transportation and Communication	163.24	4.26	70.33	0.75	0.72
	Panel 2: Year 2010				
Education	97.79	3.30	64.70	0.83	0.82
Health	104.94	3.42	65.47	0.82	0.80
Employment	64.28	7.92	83.97	0.42	0.40
Industry	67.29	2.74	60.59	0.89	0.87
Transportation and Communication	138.04	3.92	68.49	0.77	0.74

The employment index in Terengganu recorded the highest value of residual in 1990 and 2010. The employment creation mainly contributed by manufacturing sectors, particularly the electronics, transportation, and petroleum products, agriculture, construction, subsectors as well as the education and health services sectors, real estate, renting and business. The labor force participation rate of male and female in Terengganu state slightly increase in year 2010 at 47.9% male and 40.1% female, respectively. In terms of educational attainment of labor force, there is an increase in secondary and tertiary education, but decrease in primary and no formal education aspects. This factor clearly pictured there was also awareness among employers regarding the education as indicated by the increasing number of secondary and tertiary education. Figure 2 illustrates the GWR output features for the year 1990, 2000 and 2010.

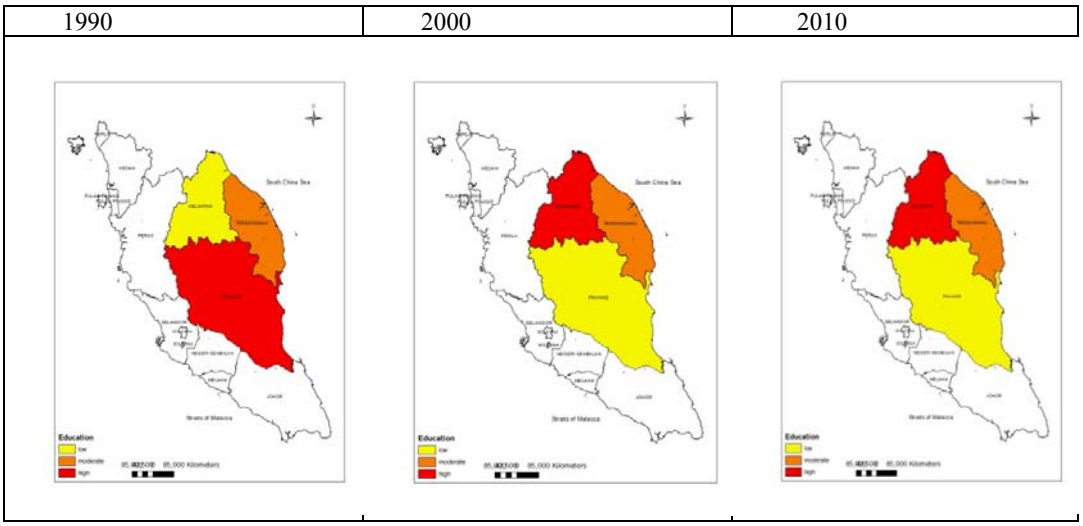


Fig. 2(a): *GWR mappings for the State of Kelantan, Terengganu and Pahang (Education index)*

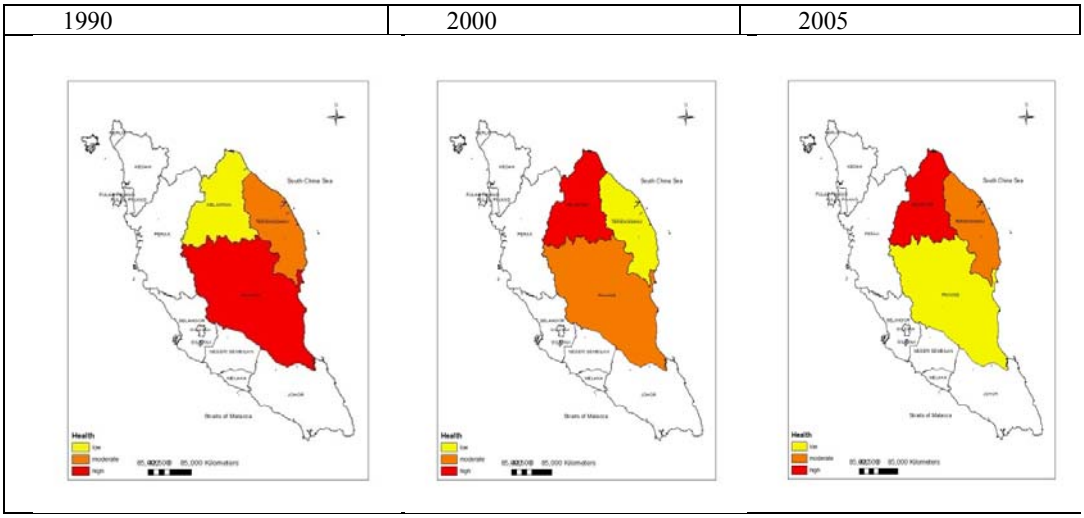


Fig. 2(b): *GWR mappings for the State of Kelantan, Terengganu and Pahang (Health index)*

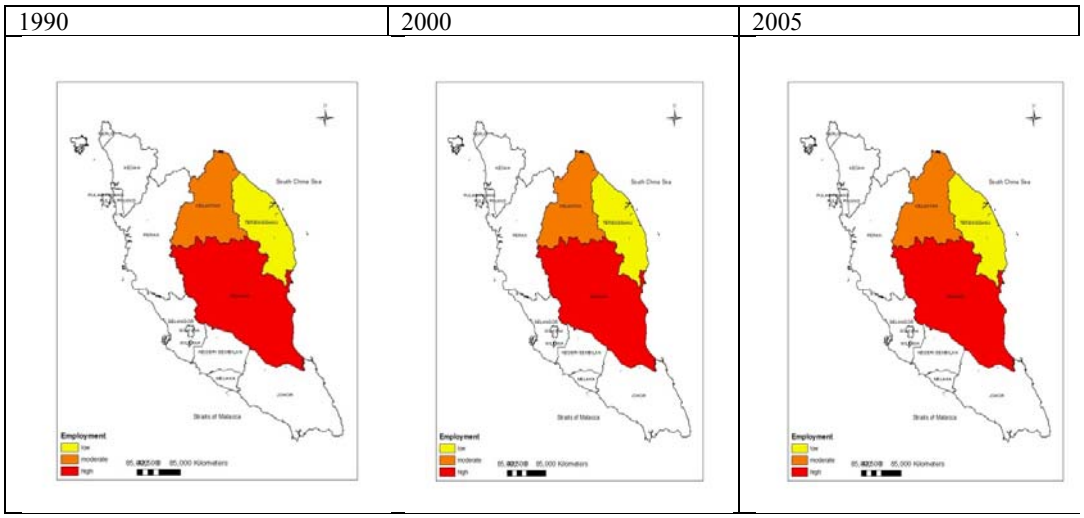


Fig. 2(c): *GWR mappings for the State of Kelantan, Terengganu and Pahang (Employment index)*

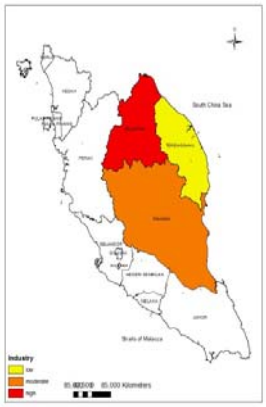
1990	2000	2005
		

Fig. 2(d): *GWR mappings for the State of Kelantan, Terengganu and Pahang (Industry index)*

1990	2000	2005
		

Fig. 2(e): *GWR mappings for the State of Kelantan, Terengganu and Pahang (Transportation and Communication)*

Subsequently, industry sector also one of the component to measure QOL. In this case, the results indicate that industries are the main element with crucial impact on QOL in East Coast of Peninsular Malaysia. On the other hand, employments give less impact on QOL. Furthermore the QOL index shows that QOL in Terengganu state better than Pahang and Kelantan. The improvement in QOL of population at Terengganu, Pahang and Kelantan reflected the overall achievement of socioeconomic of East Coast of Peninsular Malaysia. Based on QOL index, study area of this research registered significant improvements in living standards and QOL, as reflected by the five selected components. The positive coefficients for each explanatory variable reflect strength of explanatory variable has with the dependent variable. In this case, the larger improvement in education, health, employment, industry and transportation and communication, the larger changes in QOL in East Coast of Peninsular Malaysia. Furthermore the entire explanatory variable statistically significant and had a valid relationship with the dependent variable. GWR as part of a broader research area in local modeling provides those interpreted in spatial data analysis and the local relationships to be measured and mapped. Moreover the GWR use to model the dependent variables to predict the independent variables to identify the factors that contribute to dependent variable outcomes. Then, GWR also help to examine the consistency and relationships between the dependent variable and each explanatory variable across the study area. In this case, the GWR results indicated a strong correlation between all explanatory variables with the QOL, which means that the QOL is likely to continue increase in East Cost of Peninsular Malaysia with supported by education,

health, employment, industry and transportation and communication. However the industry component is highly contributed to QOL and at the same time employment give less impact on QOL.

Conclusion:

The findings of this study show that, industrial, transportation and communication indicators has contributes the highest value to QOL; and employment indicator contribute the lover volume of scores. It was concluded that the evaluation of the QOL in East Coast of Peninsular Malaysia is entirely affected by many factors, depending on the different aspects of life such as education, health, employment, industry and transportation and communication. In general, this finding clearly indicates GIS as an important tool to analyze socioeconomic indicator in order to indentify the nature of sustainable development in East Coast of Peninsular Malaysia. Unlike, previous studies that measure primarily on broad range of location with selected time period but selected location over different time periods are included in the analysis. The results of this study show that the GWR is very valuable tool for exploration socioeconomic research. In future, this type of research approach might be a valuable tool for social science researchers.

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