View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Universiti Teknologi Malaysia Institutional Repository
The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLII-4/W16, 2019
6th International Conference on Geomatics and Geospatial Technology (GGT 2019), 1–3 October 2019, Kuala Lumpur, Malaysia

A STRUCTURAL MODEL OF ENTERPRISE GIS REQUIREMENT FOR JOHOR BAHRU CITY COUNCIL

Nurul Syazwani Samsudin[1], Azman Ariffin[1*], Uznir Ujang[1], Z. Tarmidi[1], Affendi Ahamad[2]

[1] Department of Geoinformation, Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia, 81310 Johor, Malaysia - syazwanisamsudin53@gmail.com, azmanariffin@utm.my, mduznir@utm.my, zakritarmidi@utm.my, affendi@mbjb.gov.my

[2] Johor Bahru City Council, Peti Surat 232, Jalan Dato Onn, 80720 Johor Bahru, Johor, Malaysia - affendi@mbjb.gov.my

KEY WORDS: GIS, Municipal applications, Enterprise solution, Structural modelling, Urban management

ABSTRACT:

The city council has been using rapid information technology (IT), especially geographical information system (GIS) to improve their performance. Most initiatives in IT applications, including GIS, are limited to individuals of each department rather than supporting a comprehensive operating institution. Even though GIS is now increasingly popular, implementation of an enterprise system is low compared to developed countries. Lack of awareness on the importance of geospatial data, capability of GIS and GIS application are the reasons for the low implementation rate. In this study, the collection of information is based on the requirements of MBJB (Johor Bahru City Council) in the development of the structural model of Enterprise GIS which covers five departments. Enterprise GIS can help the council in their day-to-day management of their activities especially spatial data sharing to provide the better services to the public. The analysis is based on five categories which are data, organisation information, work information, technology information and process. Following that, analysis using four partial least squares structural equation modeling (PLS-SEM) based empirical studies was carried out to examine Enterprise GIS requirement. Data analysis was carried out using Software Packages SmartPLS. Structural model was constructed which showed the value of relationship between independent and dependent variables. The highest value was found to be the organization information.

1. INTRODUCTION

1.1 Background

Local councils are government bodies responsible for the management of an area under its administration. The functions of the local council include planning and monitoring of development, licensing, property mapping and more. The council should not only obtain data but also manage, analyse and share all forms of GIS information across relevant departments in carrying out their tasks.

Although the use of GIS has become increasingly popular, the implementation of GIS as an enterprise system is still low compared to other developed countries. This is due to lack of awareness of what GIS can do, how it should be used and the importance of geospatial data. Without the implementation of an enterprise system for GIS, data sharing between departments are not able to be facilitated. In other words, a shared central coordination or administration of GIS data, database, and standards between departments is not available. Consequently, each department uses individual GIS for their own purposes in making decisions which leads to redundant data and wastage of working hours. Due to the many factors that lead to poorly implemented enterprise GIS in local level, structural model analysis of Enterprise GIS required should be proposed. (Lennox 2012).

1.2 Problem Statement

Most local authorities have been using GIS technology for some time. GIS usually begins with a single project which caters for a specific purpose such as providing public maps for general use. The potential of GIS is not fully exploited in most local governments because of lack of awareness on what GIS can do and how it should be used. GIS supports all spatial decisions but this application has been plagued by high cost and low rate of implementation success especially in extended organisation (Samadzadegan et al. 2001). Local governments use a lot of digital data to make decisions. Therefore, the effectiveness of controlling and using GIS can benefit departments in managing the database easily for the purpose of sharing data.

There is also the issue of redundancy where various departments in the local council which have the same type of record keeping or data individually. This reflects inefficiency because the same data are collected and stored by different departments to be used according to their individual requirements. Therefore, sharing of data in between departments is significant in managing spatial data and non-spatial data. Although, each department has its own system, application and database where half of them are not compatible with other departments (Chen, Zobel, and Verspoor 2017), but the same data can be used by different departments via data sharing to be used in their respective applications. For example, the data required by the city planning department is only available and can be obtained from the valuation department. This information can also help the planning department to make decision. If the data is in another format that is not the same as in the Planning department, this may hinder the decision-making process. Conversely, if the obtained data has some of the same data types as in the planning department, it will also cause data redundancy.

This paper attempts to identify the requirements of enterprise level GIS and develop the structural model of Enterprise GIS requirements for local authorities. The methodology is explained in Section 2, followed by the results and analysis in Section 3 and conclusion in Section 4.

2. METHODOLOGY

There are several phases involved in this study which includes questionnaire design and pilot testing, data (information) collection in MBJB and data analysis. Figure 1 depicts the methodology flowchart of this study.

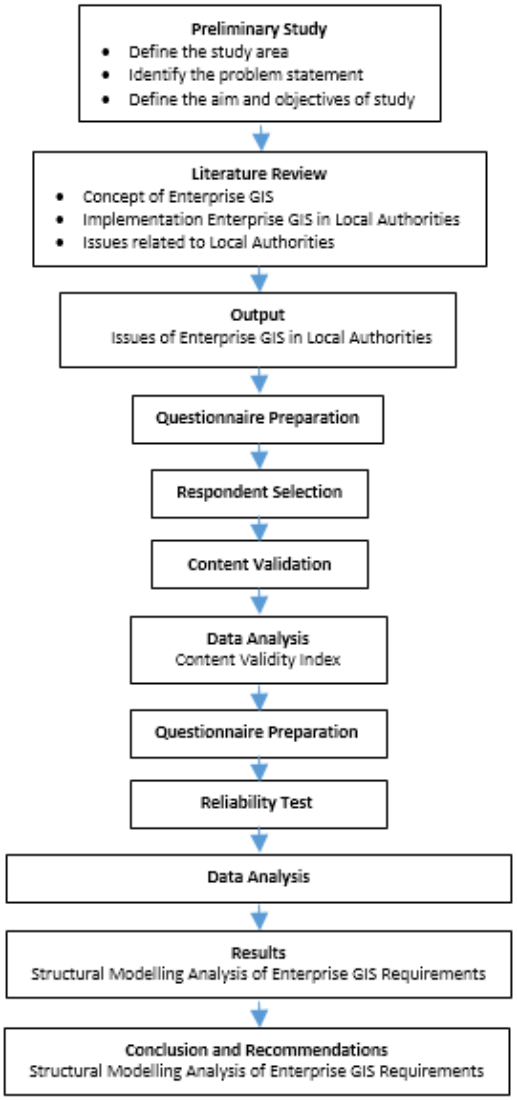

Figure 1. The methodology flowchart of study

The flowchart in Figure 1 explains the methodology of the study. The first phase is preliminary study that identifies the research problem and reviews related literature.

The second phase is questionnaire design where the questionnaire is designed based on the requirements to develop an Enterprise GIS framework. This phase also involved the reliability method/pilot testing which is often overlooked but extremely important part of the research process. It helps to detect potential problems in the questionnaire such as whether the questions asked are intelligible to the targeted sample, and to ensure that the questionnaire used in the study is reliable and valid measures of the constructs of interest.

The third phase is collection of information through questionnaire form and interview. The interview questions were prepared beforehand based on the need to fulfill the main goal of the study. The questionnaire form was used to collect specific information based on the activities of each department in a function that can be linked to GIS.

The last phase is data analysis where the information collected is divided into functions, data, hardware, software, and other related information. By dividing the information into several categories, it will be easier to understand the structure of the responses from the survey. In this study, data was analysed using qualitative and quantitative analysis.

2.1 Questionnaire Design

The questionnaire was designed based on the requirements to develop Enterprise GIS for city council. Reliability test was conducted on member of targeted population.

The randomly selected respondents for the reliability test were 20 persons from various department in MBJB. The result of the reliabity test shows that the translated measures have achieved an acceptable value (>0.70) (see Table 1). Table 1 given below is the Reliability Statistics Table which provides the value for Cronbach alpha which in this case is 0.874 and reflects high reliability of the measuring instrument. Furthermore, it indicates high level internal consistency with respect to the specific sample.

The Cronbach's alpha is equal to 0.874 > 0.7. It can be concluded that the scale used to measure is reliable.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.874	.942	41

Table 1. Result for cronbach alpha using SPSS software

Reliability values between 0.70 and 0.80 are considered to be "respectable" while those between 0.80 and 0.90 are deemed "very good" (Ni Riordain et al. 2011).

The target population for this study was the staffs in MBJB. There are between 34 to 55 staff members in each department of MBJB. The samples of the population involved 20 experts and 28 staffs from different knowledge backgrounds which made up a total of 48 respondents and reaped a 37.8% response rate. For instance, based on sample size table with the population size 200 and confidence level of 95%, a study should get 132 sample size. Nonetheless, a response rate of 20% is considered as a good response rate, while a 30% response rate is considered to be very good. (Union 2016).

2.2 Information Collection

Data was collected from survey respondents or survey involving some staff with experience in GIS. The questionnaire consisted of five sections: A, B, C, D and E; where part A is the respondent's information, part B is organisational information, part C is role of each department, part D is about the data used, part E is information technology involving hardware and software and finally, part F is the process.

The instrument is structured in a modified Likert fashion, on a 5 - point scale, between (5) "strongly agree", (4) "agree", (3) "neutral", (2) "disagree", and (1) "strongly disagree".

2.3 Development of Structural Model

When the decision is made to implement GIS for companies, several requirements must be evaluated to further strengthen the need for an Enterprise GIS in the organization. A comprehensive literature review has been conducted to identify resource-related factors and develop structural models. Figure 2 shows the structural model indicating relationship between Benefits of Enterprise GIS and the requirement for Enterprise GIS which is organisation information, task information, technology information, data and process.

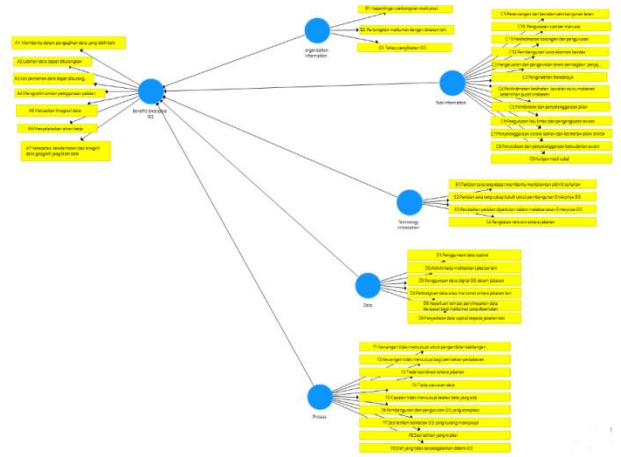

Figure 2. Structural Model between benefits of Enterprise GIS and the requirement for Enterprise GIS

Data analysis was carried out using SmartPLS software package. Partial Least Square (PLS) of Structural Equation Modeling (SEM) approach as the graphical equivalent of a mathematical representation of relationship between dependent variable to explanatory variable was adopted for data analysis, as common methods of data analysis do not give insight of underlying relationships between various factors (Hair, J.F, et al ,2014). From the PLS-SEM method, a structural model was constructed to show the value of relationship between independent and dependent variables. From the structural model value, the needs for an Enterprise GIS can be analysed.

3. RESULTS AND ANALYSIS

3.1 Structural Model Results

The structural model also called as the inner model in PLS comprises of benefits of Enterprise GIS, data, organization information, technology information and the process. Figure 3 shows the relationship between variables and Table 2 shows the summary of the Structural Model.

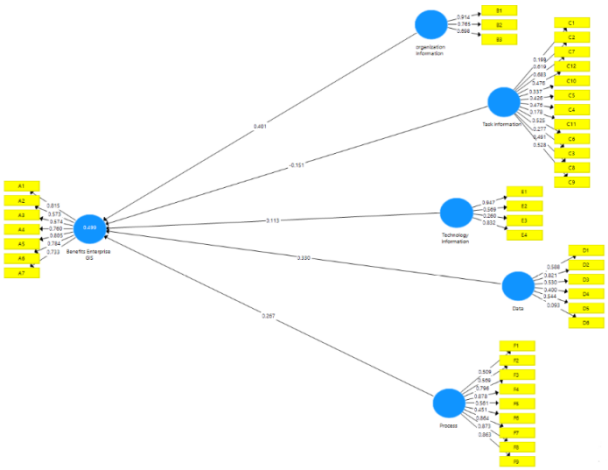

Figure 3. Structural Model Results with value relationship

Relationship	Path Coefficient	p-value	Supported
Data > Benefits Enterprise GIS	0.371	0.015	Supported •Positive Relationship
Organization Information > Benefits Enterprise GIS	0.455	0.000	Supported •Positive Relationship
Technology Information > Benefits Enterprise GIS	0.113	0.036	Supported •Positive Relationship
Process > Benefits Enterprise GIS	0.267	0.041	Supported •Positive Relationship
Task Information > Benefits Enterprise GIS	-0.151	0.210	Not Supported •Negative Relationship

Table 2. Summary of the Structural Model

Structural relationships can be assessed by testing the explained variance on endogenous latent variable which is Enterprise GIS benefits by calculating R^2 of the endogenous latent variable and path coefficient also termed as beta (β) values of each path in the model. The results of structural Model are shown in Figure 2. According to (J. Cohen,et al,2003) R^2 of endogenous is assessed as substantial at the value of 0.26, moderate at value of 0.13 and weak at value of 0.02. From Figure 3 it is perceived that R^2 of the endogenous latent variable (benefits of Enterprise GIS) is 0.499 which is higher than the cut-off value and hence the model lies at satisfactory level. In assessing the path coefficient, beta value of all structural paths is compared, the higher the path coefficient, the significant effect on endogenous latent variable.

3.1.1 Data

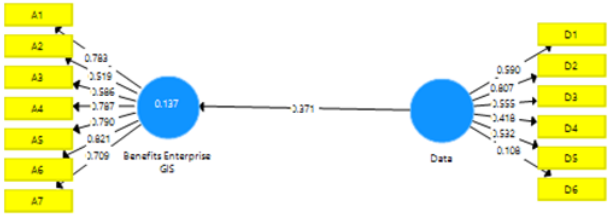

Figure 4. PLS SEM conceptual model for data

Figure 4 shows that there is a positive relationship between data and Enterprise GIS benefits which is the path coefficient 0.371 and the p-value is 0.015. The value of path coefficient supported the Enterprise GIS. Based on indicator value, the high value was D2 (Work activities) which can conclude that the questionnaire was tested on a pilot sample of members of the target population that the sharing data or information between department is high. And also data frequently used in MBJB is spatial data.

3.1.2 Organisation Information

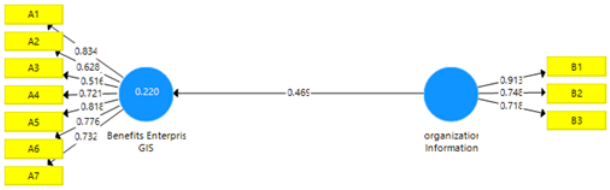

Figure 5. PLS SEM conceptual model for Organization Information

From figure 5, it can be concluded that organisation information has higher value. The indicator values show that the sharing of information is important in daily routine of work and the organisation is involved in sharing of data/information with other departments. Figure 5 also shows that the value of B3 (Usage of GIS) is lowest. This is because the existing GIS involvement in the organisation is still low.

3.1.3 Technology Information

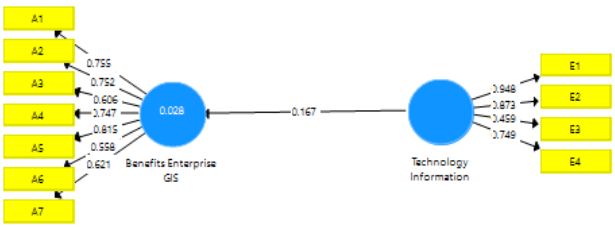

Figure 6. PLS SEM conceptual model for Technology Information

Technology information consists of hardware and software used in MBJB. Technology information can also be described as software used to assist in carrying out daily activities and whether there is a communication network which is technically within their department. Based on figure 6, the path coefficient for technology information to benefits Enterprise GIS is 0.167. The lowest value which is 0.499 can determined where digital communication network between the departments is still lacking even though they require the sharing of data between departments. From this result, we can conclude that the technology information needs to be improved and communication networks is required within the organisation.

3.1.4 Task Information

Figure 7 shows the relationship between task information and benefits Enterprise GIS is negative. We can conclude that work functions performed by several departments involve Enterprise GIS. From this value it can support that an Enterprise GIS is required at municipalities.

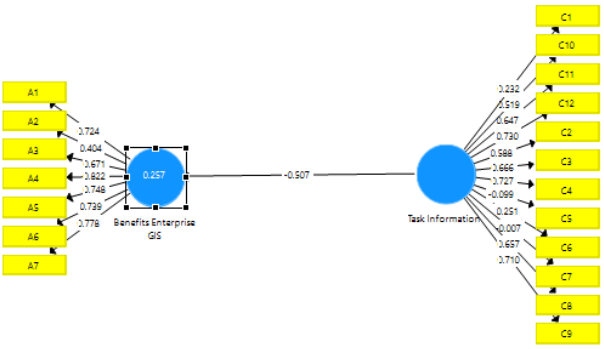

Figure 7. PLS SEM conceptual model for Task Information

3.2 VIF Collinearity Value

VIF Collinearity arises when two indicators are highly correlated. When more than two indicators are involved, it is called multicollinearity. The parameter is VIF and the acceptance threshold between > 0.20 and < 5 (Hair, J.F et al., 2014).

	Benefits Enterprise GIS
Benefits Enterprise GIS	
Data	1.386
Process	1.161
Task Information	1.495
Technology Information	1.265
organization Information	1.261

Figure 8. Collinearity Statistics value

Figure 8 shows the value of collinearity between data, process, task information, technology information and organisation information to the Enterprise GIS benefits. The highest value is the task information. Apart from that, data, process, technology information and organisation information also correlated with Enterprise GIS benefits.

3.3 Path Coefficients

Path coefficient is estimated path relationships in the structural model (i.e., between the constructs in the model). The acceptance threshold is positive value which means a positive path relationship while a negative value implies a negative path relationship. (Hair, J.F et al .2014)

The path coefficient or the regression coefficient of the inner model is listed in the Table 3.

	Benefits Enterprise GIS
Organization Information	0.455
Data	0.371
Process	0.267
Technology Information	0.113
Task Information	-0.151

Table 3. Path Coefficients – Benefits Enterprise GIS

Table 3 shows that organisation information has the highest coefficient value of 0.455. This shows that the organisation has information sharing between departments and several departments have the same information to share. The second highest relationship was data with path coefficient of 0.371.

This result shows that the organisation uses spatial data and digital GIS data to assist in carrying out daily activities. Task information has negative value which implies certain departments use less GIS in their daily activities.

4. CONCLUSION

This structural model is very important as a useful reference in the case of MBJB to develop an Enterprise GIS as the leading spatial data management. This analysis becomes a starting point to the next development phase of Enterprise GIS. Every department's functions and activities need to be seen in relation to spatial data applications. This structure model is able to assist in driving MBJB towards an effective Enterprise GIS implementation.

In conclusion, the structural model shows that Enterprise GIS is required at MBJB. Enterprise GIS can provide benefits in terms of managing and sharing spatial data between departments in MBJB.

ACKNOWLEDGEMENTS

We would like to convey our deepest acknowledgement firstly to Universiti Teknologi Malaysia for providing research Grant Project Vote No. PY/2018/03400, *Development of an Innovative Method for Assets and Security and Monitoring Based on the Geoinformation Field*. Additionally, our sincere appreciation to Majlis Bandaraya Johor Bahru (MBJB) for the support and cooperation in regards to their participation as respondents in interview and questionnaire. Our utmost gratitude also goes to Research Management Centre (RMC) of UTM.

REFERENCES

Chen, Qingyu, Justin Zobel, and Karin Verspoor. (2017). Duplicates, Redundancies and Inconsistencies in the Primary Nucleotide Databases: A Descriptive Study. Database 2017(1): 1–16.

ESRI. (2007). Enterprise GIS for Local Government, (December).

Hair, J.F., Hult, G.T.M., Ringle, C.M., & Sarstedt, M.A. (2014). A Primer on partial least squares structural equation modeling (PLS-SEM). Sage, Thousand Oaks.

Kirwan, Cyril, and David Birchall. 2006. "Transfer of Learning from Management Development Programmes: Testing the Holton Model." Ssrn (c): 1–2.

Lennox, Paul. (2012). GIS Is an Important Tool for Local Government - Geospatial World. *Geospatialworld*, 1–14.

McKee, L. OGC's Role in the Spatial Standards World: An Open GIS Consortium (OGC) White Paper. United States: Open GIS Consortium (OGC) (2001).

Ni Riordain, Richeal, Elizabeth Moloney, Kathleen O'Sullivan, and Christine McCreary. Validity and Reliability of Patient-Centered Outcome Measures in Oral Dysesthesia." Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology 112(5): 597-601.e1.

Nworgu, B.G. (2006). Educational Research; Basic Issues and Methodology. Windon Publishers Ltd., Ibadan.

Samadzadegan, F et al. 2001. "Enterprise GIS for Municipalities – A Service Oriented Approach." Archives: 1133–36.

Sekaran, U. (2003). Research methods for business: A skill building approach. John Wiley & Sons.

Sekaran, U. & Bougie, R. (2010). Research Methods. For Business: A Skill Building Approach.West. Sussex, UK: John Wiley & Sons Ltd (5th ed.).

"Structural Model." The Great Soviet Encyclopaedia, 3rd Edition. 1970-1979. The Gale Group, Inc. 30 Apr. 2019.

Union, European. 2016. "How to Determine Population and Survey Sample Size? CheckMarket.: 1–159.

Revised August 2019