Exploratory study on Marine SDI implementation in Malaysia

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Abstract. This paper discusses the explanatory study of the implementation of spatial data sharing between Malaysia's marine organisations. The survey method was selected with questionnaire as an instrument for data collection and analysis. The aim of the questionnaire was to determine the critical factors in enabling marine spatial data sharing in Malaysia, and the relationship between these indicators. A questionnaire was sent to 48 marine and coastal organisations in Malaysia, with 84.4% of respondents answering the questionnaire. The respondents selected were people who involved directly with GIS application in the organisations. The results show there are three main issues in implementing spatial data sharing; (1) GIS planning and implementation in the organisation, (2) spatial data sharing knowledge and implementation in the organisation and (3) collaboration to enable spatial data sharing within and between organisations. To improve GIS implementation, spatial data sharing implementation and collaboration in enabling spatial data sharing, a conceptual collaboration model was proposed with components of marine GIS strategic planning, spatial data sharing strategies and collaboration strategy.

1. Introduction

A shoreline and marine area contain marine resources and producing economic growth in the country, especially in Malaysia [1, 2]. Malaysia's marine area consist of five areas (Figure 1); Strait of Malacca, Gulf of Thailand, South China Sea, Sulu Sea and Sulawesi Sea. Malaysia's marine area is approximately 574,000km square kilometres, and its management and responsibilities are divided between local, state and federal government [3].

Figure 1: Malaysia's surrounding sea [4].

In managing marine activities, it is important to have good governance with assistant from marine Spatial Information System (GIS), to ensure sustainable planning and development of marine area [2, 3, 5]. Current practice shows lack of vital spatial information, spatial data not covering and concerning coastal dynamic information and the biological diversity is not completed [3]. Besides that, the developments of GIS for marine and coastal areas were autonomous, heterogeneous and distributed between organisations, and need for spatial data sharing between marine organisations for sustainable marine management [6, 7].

Marine GIS was used for spatial data viewing, textual and spatial record, planning, monitoring, forecasting, navigating, managing transportation and facilitate communication [8, 9]. To improve marine GIS development, marine spatial data infrastructure (SDI) was introduced to facilitate and coordinate the spatial data exchange and sharing between stakeholders in the marine spatial community [10-12]. Marine SDI is a framework that comprising a system of information, products and enabling technologies that are critical to sustainable development and management of coastal, marine and freshwater areas, and will improve spatial data quality and availability, reduce spatial data duplication and redundancies, and make the spatial data interoperability [13, 14]. Marine SDI consist of five components; spatial data, policies, access network and people [12]. Besides that, marine SDI involves cooperation between marine organisations, and required partnership engagement which included engagement management, information management and capacity building [15].

This paper focuses on a study on the degree of GIS implementation practice, issues and limitation and partnership engagement in enabling marine spatial data sharing in Malaysia's marine organisations.

2. Research methodology

This study used survey method, using questionnaire as an instrument for data collection and analysis. The aim of the questionnaire is to identify critical factors in implementing spatial data sharing in Malaysia's marine organisations. The objectives of the questionnaire are; (1) to identify the level of GIS implementation in the organisations, (2) to identify critical factors in implementing GIS and (3) relationship between these critical factors. The questionnaire consists of three parts; (a) information on respondent's background, (b) information on GIS implementation in the organisation and (c) the level of spatial data sharing implementation. The questions using a Likert Scale to measure the extent of agreement describe by each item. The scale ranged from 1 to 5, where 1 = strongly disagree, 2 = disagree, 3 = fair, 4 = agree, and 5 = strongly agree. The process of developing the

questionnaire also included a pilot survey, where is used to modify and eliminate the number of variables. The feedbacks were analysed and few minor modifications were made, especially in the format. After the modification, the questionnaire was sent to respondents.

For reliability test, Cronbach's Alpha was conducted to measure the internal consistency of the research instrument. The generally agreed value of the lower limit for Cronbach's alpha is 0.70 [16]. The analysis was performed separately for the items of each factor, the summaries of the reliability analysis given in Table 1. All items show the results higher than 0.70 therefore it is reliable.

Table 1: Reliability test results.

Description	No of items	Alpha values	Items for deletion	Alpha if item deleted
GIS				
1. Geospatial Data	11	0.949	-	0.951
2. Technologies	7	0.958	-	0.961
3. Human Resources	11	0.922	-	0.929
SDI				
4. Data	6	0.974	-	0.975
5. Data 2	6	0.983	-	0.983
6. Data exchange	7	0.955	-	0.958
Collaboration				
7. Within organisation	4	0.994	-	0.994
8. Between organisation	7	0.934	-	0.938

3. Results

Analysis of the questionnaire was divided into three main categories; respondent's background, GIS implementation in the organisation, and implementation of spatial data sharing.

3.1. Respondent's background

Respondent's background focusing on respondent's experience in using GIS in the organisations. Table 2 shows the general background of the respondents such as user type, number of years using GIS and GIS function being used by respondents.

Table 2: Background of the respondents in using GIS.

	n	%
Background of respondents in using GIS		
Less than one year	3	7.9
One to two years	1	2.6
Two to three years	1	2.6
More than three years	33	86.8
Respondent's GIS user type		
Data User	14	36.8
Data Provider	1	2.6
Both (Data User and Provider)	23	60.5
Respondent's GIS functionality		
View information	6	15.8
Collect data	1	2.6
Analyze information	7	18.4
Integrated with other system	3	7.9
All above	21	55.3

Results from table 2 show that, the respondents were mostly using GIS for more than three years, most of the respondents were both data user and data provider, and using most of GIS functions. From these results, it can conclude that the respondents have knowledge of GIS background, and qualify to give an opinion on GIS.

3.2. GIS implementation in the organisation

GIS implementation discusses about the respondent's knowledge and experience in handling GIS, and the important aspect of GIS that need to have in the organisations. Analysis was based on three main components of GIS; data, personnel and software, hardware and network. Figure 2 shows the mean for GIS personnel understanding of the importance of spatial data components. Figure 3 shows the mean of organisations or people factors in succeeding spatial information system implementation in the organisations.
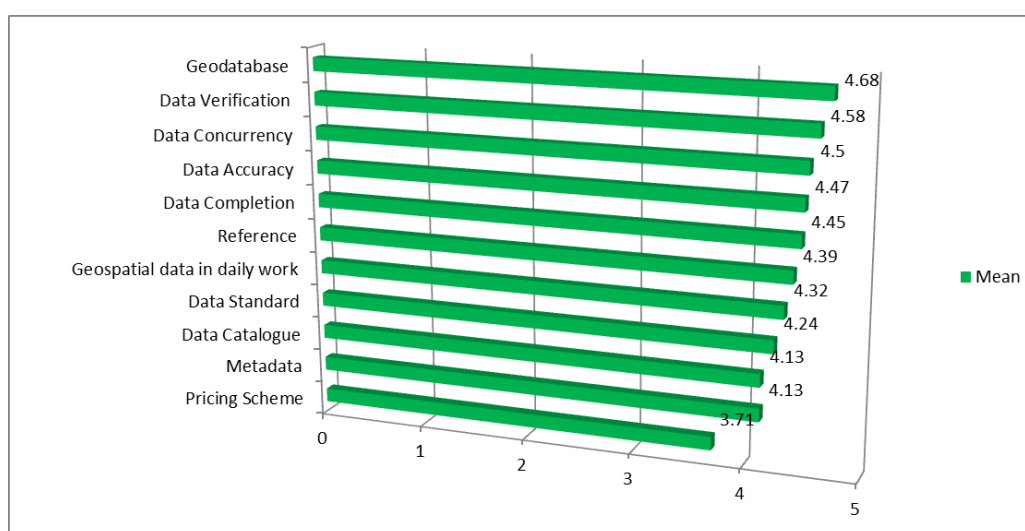

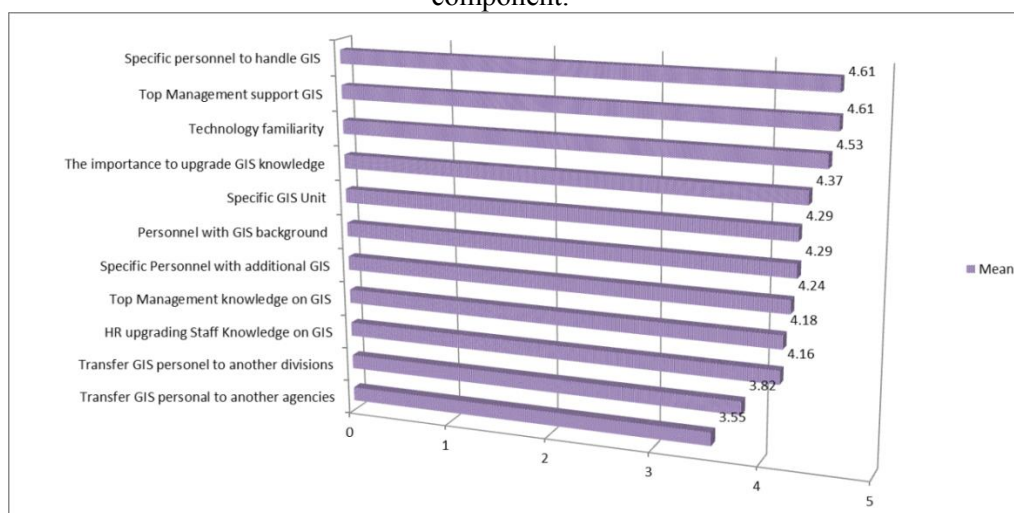Figure 2: View of GIS personnel understanding on the importance of spatial data component.

Figure 3: The organisational factors in succeeding spatial information system implementation in the organisations.

From the results, it shows most of the respondents are aware of the GIS components. The mean of the answer were mostly above 4, which indicated the respondents agreed with the importance of each component.

3.3. Spatial data sharing implementation

Implementation of spatial data sharing discussed on the knowledge of respondents in spatial data sharing, limitation in implementing spatial data sharing correlation between knowledge of GIS and SDI in the organisational implementation of spatial data sharing. For descriptive statistical analysis, three analyses were done. The first analysis is to understand the knowledge on cooperation on spatial data exchange in the organisation. The second analysis is to understand the cooperation for GIS implementation in the organisation, and the third analysis is to understand the opinion on collaboration in enabling spatial data sharing between marine's organisations. Table 3 shows the summary of the descriptive analysis

Table 3: Summary of descriptive analysis.

Factors	Mean Score
The knowledge on cooperation on spatial data exchange in the organisation	
Give data to other divisions to assist other divisions	4.05
Geospatial data pricing	4.08
Get data from other unit/division to assist processing	4.08
Get spatial data from other agencies	4.24
Give spatial data with other agencies	4.26
Integrate system with other divisions	4.39
The cooperation for GIS implementation in the organisation	
Geospatial data collection	4.39
Geospatial data upgrading	4.39
Cooperation on developing GIS	4.42
Cooperation on upgrading GIS	4.42
The opinion on collaboration in enabling spatial data sharing between marine's organisations	
Frequent meeting facilitating geospatial data protection	4.05
Frequent meeting facilitating geospatial data sharing	4.16
Lead organisation	4.21
Geospatial data development committee	4.26
Geospatial data sharing committee	4.26
Formal collaboration for spatial data sharing	4.55
Collaboration to improve GIS	4.66

To analyze correlation from the questionnaire, the inferential analysis was selected were Spearman's Rho analysis to analyze the correlation from the Likert scale question and Pearson Chi-Square to analyze the correlation of nominal data. The hypothesis were constructed based on three main criteria; the knowledge and implementation of GIS in the organisation, the knowledge and implementation of spatial data sharing in the organisation, and the collaborative process in enabling

spatial data sharing. To understand the correlation between the three main criteria, these hypotheses have been listed:

- There is correlation between duration using GIS in the organisation with personnel knowledge in GIS
- There is a correlation between GIS user in the organisation with the personnel level of knowledge in GIS
- There is a correlation between GIS knowledge on spatial data with GIS technologies
- There is a correlation between spatial data sharing implementation with knowledge about GIS
- There is correlation between knowledge about spatial data sharing with knowledge, spatial data sharing implementation

For the first hypothesis, Spearman's rho analysis was used to determine the relationship between duration using GIS and knowledge on GIS. There was a positive correlation, which was statistically significant, r = -0.373, p < .05. For the second hypothesis, A Pearson Chi-Square test was used to determine whether there was significant correlation between types of GIS user in the organisation with the personnel level of knowledge in GIS. There was no significant correlation between types of GIS user with a level of knowledge on GIS, X^2 = 69.450, DF = 38, p > 0.05. The third hypothesis using Spearman's Rho analysis, to determine the relationship between respondent's knowledge on GIS data with knowledge of GIS technologies and GIS management. There was a positive correlation, which was statistically significant between respondent's knowledge on GIS data with knowledge of GIS technologies, r = 0.665, p < 0.05. There was also a positive correlation between respondent's knowledge of GIS technologies with GIS institutional management, r = 0.414, p < 0.05.

The fourth hypothesis was used Spearman's Rho analysis to determine the relationship between respondent's knowledge on GIS with the implementation of spatial data sharing. There was a positive correlation with statistically significant, r = 0.671, p < 0.05, which indicate that to successfully implement spatial data sharing, the knowledge on GIS in important. The last hypothesis was analyzed using Pearson Chi-square analysis, to determine the correlation between respondent's knowledge of spatial data sharing with the spatial data sharing implementation, where there was also a significant correlation between the two components, X^2 = 176.263, DF = 38, p > 0.05.

From the inferential statistical analysis, the findings show;

- There is a correlation between personal knowledge of spatial information system component in the spatial information system implementation in the organisation.
- There is a correlation between personal knowledge of spatial information systems with the implementation of spatial data sharing in the organisation.
- There is a correlation between spatial data sharing with spatial information system implementation.
- There is a correlation between cooperation in the organisation with spatial data sharing implementation.
- There is a correlation between collaboration with other organisation with spatial data sharing implementation.

4. Discussion
From the analysis, it shows that several issues and opportunities need to be managed to improve GIS implementation and to enable spatial data sharing in marine administration and management in Malaysia. It can be summarized as;

- Spatial data need for planning for standardized spatial data collection, storage and distribution with proper metadata to simplify data sharing process

- Spatial data also need to be verified, have information on its concurrency, accuracy and level of completion.
- A proper GIS hardware, software and access network are essential to facilitate in spatial data view and analysis.
- In organisational aspect, specific GIS personnel and GIS unit were needed to handle GIS, and GIS personnel should not be transferred to another unit or organisation.
- Knowledge on GIS should be improve for GIS personnel and top management in the organisation
- Awareness on the importance of integration of GIS and other system related should be increased
- Knowledge of spatial data sharing need to improve for GIS personnel and organisation's top management
- Cooperation in the same organisation was needed in developing GIS in an organisation before upgrading GIS data and functionality
- Formal collaboration between organisations with proper lead organisation, the committee and frequent meeting are needed to enable spatial data sharing

From the findings, the results then were grouped into three main groups: issues in GIS planning and development, issues in enabling spatial data sharing, and issues in collaboration between organisations to enable spatial data sharing. To improve marine spatial data sharing in Malaysia's organisations, several strategies need to be applied, based on the three issues, marine GIS strategic planning, marine spatial data sharing strategies and collaboration strategies as shown in figure 4.
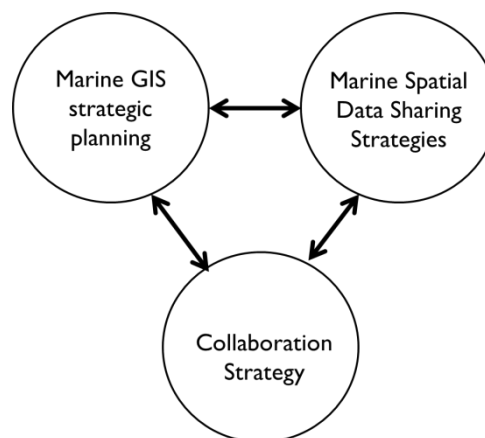

Figure 4: The key components to improve marine spatial data sharing in Malaysia's organisations.

5. Conclusion

This study has identified the critical factors in implementing marine spatial data sharing in Malaysia's environment, and also the relationship between the factors. This study is significant in improving the theory of marine spatial data sharing implementation, which should include three main components as shown in figure 4. This study was hoped to give a significant contribution to marine spatial data sharing implementation, hence improve the marine SDI development research.

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