SIDIF: Spatial Information Visualization Tools as a Determinant of the Effectiveness of Artificial Reefs Development Project Using SIDIM Model

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Abstract-Majority of the marine species relies or depends on artificial reefs as source of food. Evaluation of effectiveness and efficiency of artificial reefs (AR) is quite difficult, troublesome and costly. Evaluation of AR involves special diving task force in order to observe how AR has developed. The issue is whether the monitoring process is useful and effective? What method will be used and which agency is responsible for the monitoring? What information best measures the effectiveness of AR? In this study a prototype software application called SIDIF is used. The aim is to integrate location coordinate data of AR with the fish catches data at all identified jetties. The profile of the fishermen involved was also established. The data of fish catches will be mapped with data on location coordinate of AR as a whole via mapping and integration of three different databases combining with the fishermen boat profile database. Using this methodology, the effectiveness and efficiency of AR will be achieved. The evaluation will be measured without any diving or scuba activities.

Keywords-Artificial Reefs; SIDIF; SIDIM; Database Integration; Formal Specification; CLARANS

I. INTRODUCTION

The biodiversity on artificial reefs ecosystem includes million species of plants and marine life. It is quite difficult to know the benefits of artificial reefs unless specific approaches are used. The research on marine natural resources in Malaysia's coastal areas has been conducted by many scientists [1]. Most of the researchers used the SCUBA method. The information that obtained is too descriptive and limited. Much more relevant information of marine resources in Malaysia are not known due to the lack of format and standard data. It's quite problematic to integrate the information gathered for further evaluation on the status of artificial reef. The method proposed in this research involved applying hydro acoustic approach that generates information in synoptic viewing which encompasses bathymetry of its reef and type, coverage and dispersion of marine habitat.

Monitoring of artificial reefs is very useful in order to provide information that can be used for effective management of artificial reefs project. However, previous artificial reef studies were limited to species and certain condition only [2]. Yet, a complete status and trend of artificial reef ecosystem have not been discovered. This is due to cost factor, study time and its complexity [3].

In the Malaysian fishery database system, huge numbers of digital data are available and these data are increasing. However the data are scattered and have not been properly managed. Data that are analysed through merging and integration are useful for future planning and management of AR projects. The problem is how to merge the multiple of digital databases. How does one integrate and transform the data so that it is automatically visualized in the form of individual's desired information. It is a matter of how to group or unify all these different sources of database in various locations into one place.

Recently, many research give and emphasis on information-seeking were more diverting, merging and unifying spatial and non-spatial databases. The consumer (fishery officer) may require information of AR on some location and the the changes occuring in that location are the major concern. A comparison through a visualization method which is based on map may be insufficient. Therefore, the combination of both spatial and non spatial data is indeed important and crucial.

In this study, a web based tool called SIDIF by using Spatial Information Database Integration Model (SIDIM) was used as one of the prototypes. SIDIM can integrate spatial and non-spatial data from various databases format and locations. In principle, the model used in this study is based on location coordinate technique in order to merge the predicted results based on locations. The integration approach from various databases were used to give an impact analysis of information especially for spatial and non spatial data. The algorithm was developed using location integration technique in order to fasten the extraction process of spatial and non spatial data.

II. RELATED WORK

Research on data integration is one of the most important elements and is a 'hot issue' in research of spatial data. Previous researchers concentrated on developing a common form of information that is easier for the user to manage the database and is less time consuming [4].

The history of integration method started in early 80's which is known as MULTIDATABASE, followed by a mediator called "GARLIC". Later, INFOSLEUTH was introduced and updated into a method of integration based on ontology which is known as OBSORVER. The integration methods were then developed using peer-to-peer known as HYPERION. The journey of integration method led to current web based integration method which is known as ACTIVE XML [5].

Integration is defined as merger of various information from several sources that provide benefits in terms of collection aspect, processing time, resource conservation and data sharing for various purposes.

Information that one wishes to combine or integrate must be staying in a state of that analogous (uniform). However if the state of information to be consolidated is unequal, a modification process has is necessary.

Placing the information in various databases and at different or scattered locations will be difficult in performing the integration process. Thus research to integrate 'every single piece into one' should be initiated.

According to [10] concrete solutions to data integration are not available. In this study, the following methods were used:

1. Manual Integration -to resolve interface which differ in various demand language, consumer need to know by detail on location, data presentation logical and semantic.

2. Same interface – uniform interface is needed to facilitate information-seeking with the usage of one navigator.

3. Integration through application – application which enables information source and returns revenue back to the consumers.

4. Integration through middleware (intermediary software) – intermediary software reuse the function that can solve problem of data integration. Intermediary software using SQL command for data queries. Intermediary software difference needs to be combined so that the software will be allied. Standard Data Access – logical data integration could be achieved globally although located in different places, hence virtually connected.

5. Reserve the same storage utilization – Integrating physical data may be done by the same reserve storage partnership. Local storage will process the integrated information faster.

A. ARPOS

Artificial Reef Positioning System (ARPOS) is the open source software specially developed to enable all information on artificial reef can be recorded, updated and retrieved through internet access. The method on data collection and information of artificial reef development is conducted by two main farming based agencies under Ministry of Agriculture Malaysia (MOA) namely Fisheries Department (JP) and Malaysian Fisheries Development Authority (LKIM).

TABLE I ARTIFICIAL REEFS INFORMATION USING MS EXCEL FORMAT

No.	Artificial Reef Location	Location		GPS Code	Years Develpe	Cost (RM)	Sources of Fund	Artificial Reef Types				
		LATITIUD	LONGITIUD					Kuboid	S'Der	Old Tyre	Old Boat	Others
57	Telaga Batin 1	05° 25.730'U	103° 09.024'T	TTS 01	1998	49,970.00	KWP	950				
61	Batu Buruk	05° 21.575'U	103° 13.420'T	TTS 04	2001	183,000.00	Ihsan	2,000				
62	Batu Buruk 2	05° 20.935'U	103° 12.632'T	TTS 12	2003	30,000.00	KWP	300				22 Saramik
		05° 20.968'U	103° 12.562'T	TTS 13	2004	2,204,081.00	Dana					108 Saramik
.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.

(*Sources are from LKIM in year 2005*

Information on this artificial reef is kept or recorded use bloom software electronic (spreadsheet: MS Excel as in Table 1).

Due to this, ARPOS project is developed to resolve artificial reef data problem, from the normal electronics consumption pattern into a better database management system method and accessible through internet [6]. Furthermore the software is augmented with mapping function based on location visualization that is broadcast through map geographically (refer Figure 1).
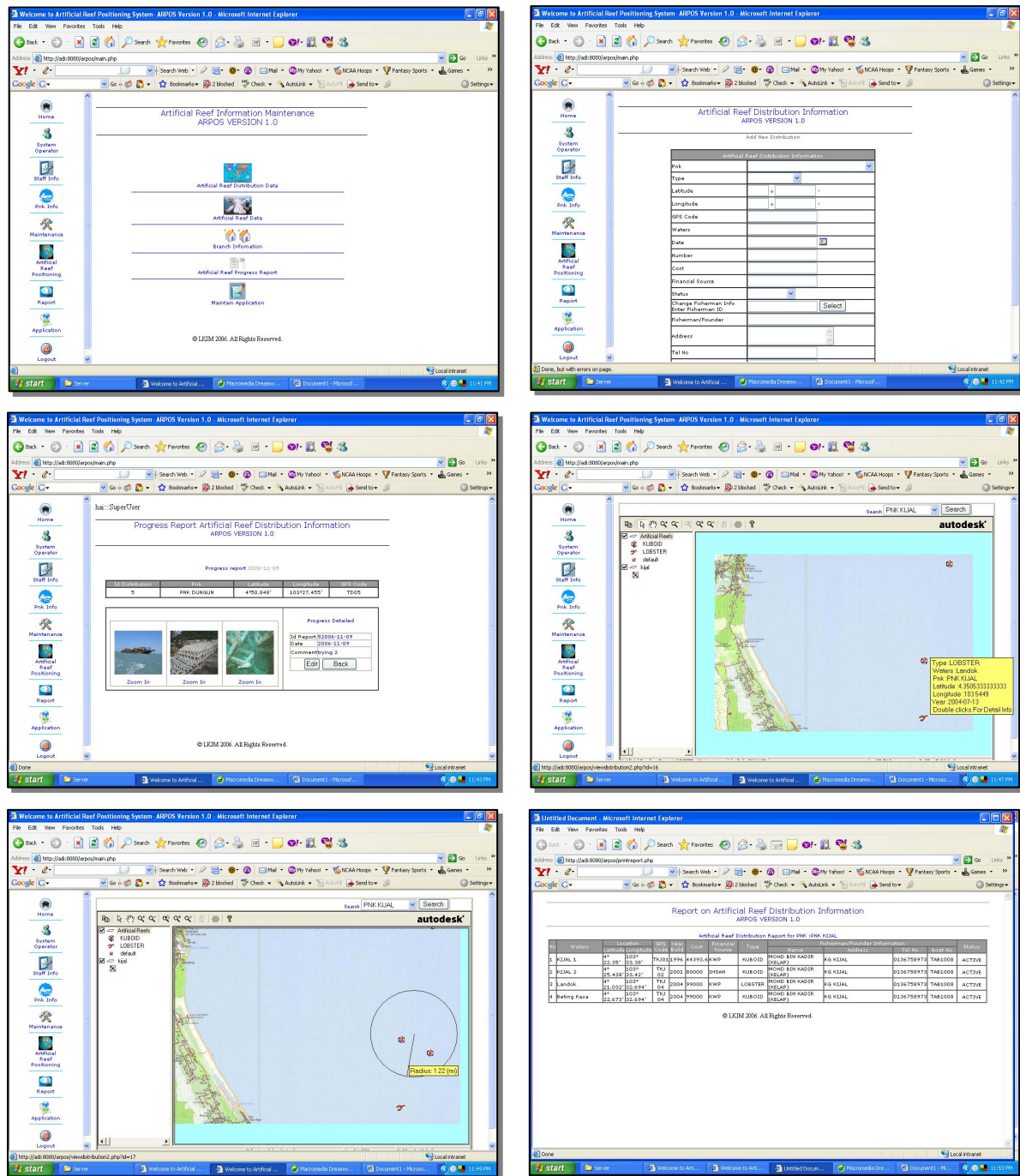
Figure 1 ARPOS User Interface

Through the software, integration problem between the two agencies can be worked out without disturbing the existing system used by the agency. The integration process of the two databases is indeed easy with ARPOS software.

Both of the agencies are given authorized password and secret code to allow all present information to be entered into new system. Once finished, the related information can be updated and processed directly. The progress of construction project also can be updated with pictorial image display as well as in video format.

B. WiFISH

WiFISH is a system that was developed to facilitate data collection process on fish landing at the landing jetties. Existing method used is using form manually which is filled by fisheries officers who work at landing jetties according to the prescribed schedule. Information on boat number, catch tool used, date, time, fish species and the volume of each species are classified according to the size whether small, medium or large.

In the meanwhile, WiFISH is open source software developed by using wireless technology that can record landing

information electronically without using form [7]. The task of Fishery officer only will have to use cellular phone facilitates with wireless internet access to enable fish landing information be recorded. User interface of WiFISH is illustrated in Figure 2.

Figure 2 WiFISH User Interface

Current manual system is such that fishery officer has to collect all those landing data by using a daily form. All information will be recorded and after that it will be sent to office and then the clerk will transfer the information in a form into electronic spreadsheet (MS Excel) software to get the landing record and the daily total would be updated.

After all information from each centre or landing jetty being received and recorded, then the grand total of every state will be calculated and further sent to Fisheries Office in Kuala Lumpur. Then a process of report writing will take place to publish a book which contained a figure on fish landing in Malaysia. Various analysis and graph may be achieved from a total of fish landing by fisherman over the country. Information on this figure will be accessible by downloading from the website http://www.dof.gov.my (2009).

Through WiFISH, an additional field was nominated which is catch area conducted or "area of fishing". Generally, fishermen will inform research officer on the exact catch location being conducted. Thus, this is quite troublesome in acquiring the information associated with artificial reef settlement areas each and every time. Because catch location made would actually not to be exactly known, then researcher will make comparison or assumption in general with information that informed by fisherman to officers like in the question as follows:

Fishery Officer: Which area did uncle catch the fish during out to the sea today?

Fisherman: Our catch yield by today is in the area of Bidong Island and Redang Island

Due to this, with are ARPOS, position location artificial reef can be ensured in general. With location information given by fisherman just now such as *Bidong* island and *Redang* island, it can be concluded that most probably the type of artificial reefs is cuboid and cylinder, and in the vicinity number of arrests that artificial reef may make his effectiveness estimate.

To facilitate information on artificial reef and association position with fish landing information, a design database integration space or SIDIF proposed to facilitate identification process artificial reef effectiveness can be valued. Information will be portrayed in mapping form based on accessible geography and map through Internet.

III. RESEARCH METHODOLOGY

Several challenges have been encountered in the process of merging and integrating databases from different sources and locations. It is required that data from different sources be priorities and selected prior to the integration process. The objectives of this research are:

1. To produce a model that enables the process of integrating spatial and non-spatial data from different types of database format

2. To know to what extent the proposed model can carry out an integration process among various information on spatial and non spatial online data which differ in database structure and environment.

3. To propose a model this improves the integration processing time.

4. To develop a web based tools for integration and visualisation of the information query by the user.

The normal method of integrating data from one format to another is by writing a specific program for each translation task. Examples are the Oracle and MS Access to MYSQL Format. Writing such a program is often complicated by numerous technical aspects of the specific data sources that are not really relevant to the integration process (e.g. specific DB access protocol). A sound solution for data integration task requires a clean abstraction of the different formats in which data are stored, and means for specifying the correspondences between data in different world and for translating data from one world to another.

To achieve the above objective, a *middleware* database integration model call SIDIM was introduced. This model serves as a basis for the integration task, and *declarative rule languages* for specifying integration. Translation from source to target format is achieved by (1) importing data from the sources to the middleware model, (2) translating it to another middleware representation that better fits the target structure, and (3) exporting the translated data to the target system [7].

SIDIM is an integrated spatial and non spatial database model designed to enable easy access to users. It also enables evaluation of AR based on the growth of phytoplankton and zooplankton for each dedicated artificial reefs area. SIDIM is considered as a method, model or new idea that ensures the effectiveness and efficiency of artificial reefs development projects.

More importantly SIDIM is less costly since it does not require hiring a special scuba task force. SIDIM enables the integration of more than one database either same or different schemes. The research methodology consists of systematic process flow as illustrated in Figure 3:
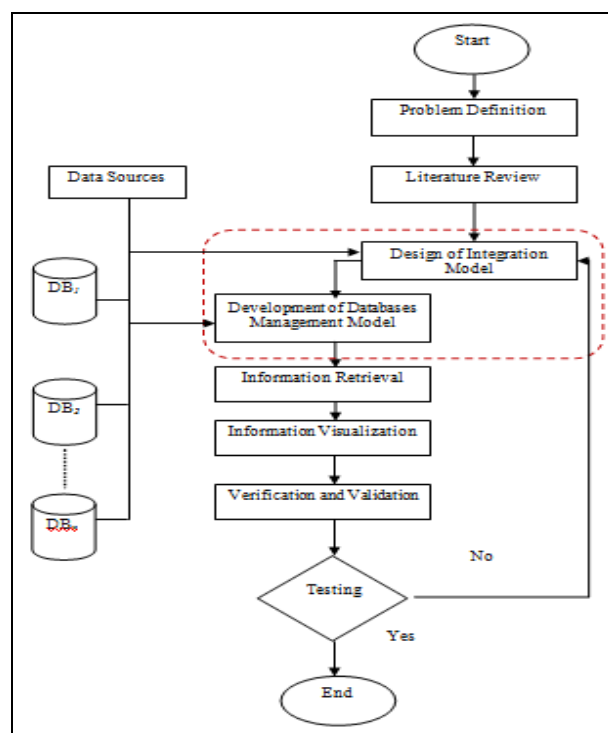

Figure 3 Research Methodology Flow Chart for Integration Process of Multi Database Types

As shown in Figure 4, the processes are subdivided into the four levels as follows:

i. *Pre-integration*: Processes to assess database environment are used, for example Oracle, MYSQL, ORACLE, MS ACESSS and from other database.

ii. *Scheme Comparison*: Scheme comparison or structure for each of this database is needed to facilitate integration process. In the early stage, this process is manually done.

iii. *Intermediary software development (middleware)*: an application developed for integration process the database workable.

iv. *Post-Integration*: Integration process assessment was conducted from credibility process aspect and "*interoperability*".
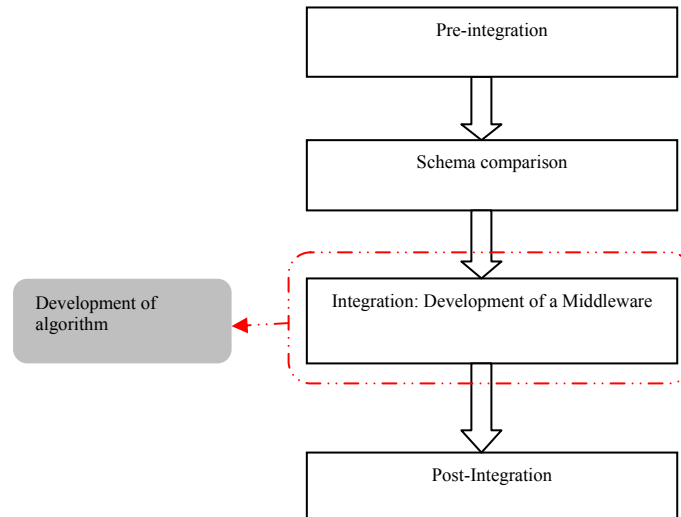

Figure 4 Work Flow Chart for Information Integration Process based on SIDIM Model

The research focuses on the algorithm development which enables multi database types in a distributed environment. It can be integrated into another database through online based on three-tier architecture.

Since those data in the three different databases are at different location and in different formats, then intermediary software (middleware) is very much needed for integration purposes. Table 2 to Table 6 below show the information about the data that covert to specific database type in different environment.

Integration theory and model are based on set and theorem proving to perform scheme comparison among distributed multi database types [8]. The formal specification through Z-eves scheme is used to verify the specification of a developed SIDIM model. Figure 5 shows a Z scheme development and verification based on theorem proving.
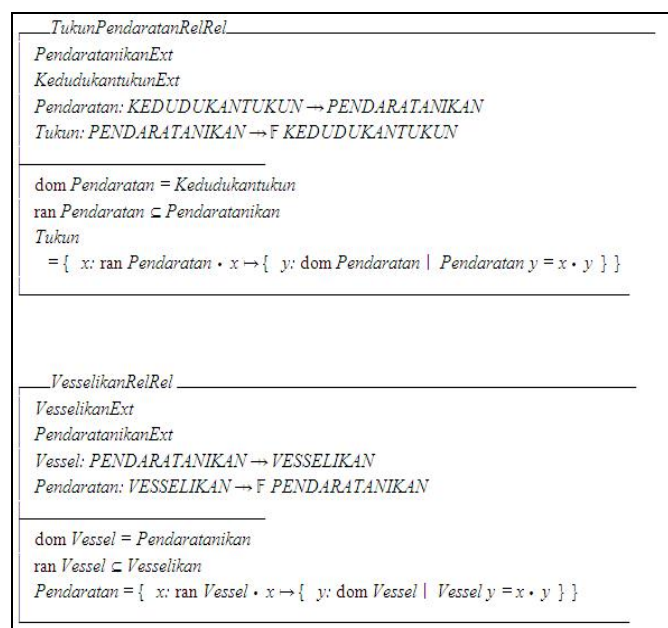

Figure 5 Scheme Proving Using Z-eves Tools for three different types of databases

Based on the proven scheme, another new algorithm which is called location integration technique is developed to evaluate the efficiency level of the artificial reefs. All of integration process and scheme comparison is done using the middleware developed.

After a formal specification and validation in successful, coding process was done using .net programming language for developing a middleware application. Below is one module of coding for two databases integration that was included in SIDIF framework.

```
//combining the data from two different databases

DataTable combine = new DataTable();
    combine.Columns.Add("TARIKHTANGKAPAN", typeof(string ));
    combine.Columns.Add("JENISIKAN", typeof(string));
    combine.Columns.Add("JUMLAHHASILTANGKAPAN", typeof(string));
    combine.Columns.Add("KAWASANTANGKAPAN", typeof(string));
    combine.Columns.Add("JENISTUKUN", typeof(string));

    for (int i = 0; i < dt1.Rows.Count;        i++)
    {
      for (int j = 0; j < dt2.Rows.Count; j++)
      {
        if (dt1.Rows[i]["TAPAKUNJAM"].ToString() == dt2.Rows[j]["KAWASANTANGKAPAN"].ToString ())
        {
     combine.Rows.Add(dt2.Rows[j]["TARIKHPENDARATAN"].ToString(), dt2.Rows[j]["JENISIKAN"].ToString(),
dt2.Rows[j]["JUMLAHHASILTANGKAPAN"].ToString(), dt1.Rows[i]["TAPAKUNJAM"], dt1.Rows[i]["JENISTUKUN"]);
        }
      }
    }

    GridView3.DataSource= combine ;
    GridView3.DataBind();
  }
```

TABLE II ARTIFICIAL REEFS (AR) DISTRIBUTION INFORMATION

Code	Areas	Latitude	Longitude	Type	Total	Year Built	Total Cost	Granted By
TTS01	PULAU BIDONG	1000	123555	KUBOID	950	1998	49970	KWP
TTS01	PULAU BIDONG	1000	123555	KUBOID	950	1998	49970	KWP
TTS16	PULAU PERHENTIAN	200	205	SERAMIK	180	2003	343300	DANA KHAS
TTS04	PULAU KAPAS	95	100	KUBOID	1400	1999	122900	KWP
..	..	..	..	..	..	..	..	..

TABLE III DAILY FISH LANDING DATA COLLECTION

Boat No.	Landing Date	Landing Time	Fish Code	Fish Type	Total Landing	Price	Area of Fishing	Landing Port
TAP001	12.12.2009	11.00	AA1	KERISI	100	2	PULAU BIDONG	PULAU KAMBING
TAP001	12.12.2009	11.00	AA2	KEMBONG	200	7	PULAU KAPAS	PULAU KAMBING
TAP002	13.12.2009	10.00	AA1	KERISI	100	2	PULAU PERHENTIAN	PULAU KAMBING
..	..	..	..	..	..	..	..	..

TABLE IV VESSEL PROFILE

Fisherman Name	IC No	Registration No	Boat No	Loading	Fishing Zone	Main Fishing Equipment	Other Fishing Equipment	Licence no.	Licence Expiry Date	Crew No.
Ahmad bin Ali	6879112345	1112	TAP001	100	Zon A	PUKAT HANYUT	BUBU	1234	20/2/2012	8
Ahmad Durah B. Sameon	76598117786	2222	Tap002	500	Zon B	PUKAT TUNDA	TIADA	5678	23/3/2013	4
..	..	..	..	..	..	..	..			..

TABLE V INTEGRATION TWO TABLES USING SIDM MODEL

Landing date	Fish Type	Total Landing	Area of Fishing	Artifcial Reef Type
12.12.2009	KERISI	100	PULAU BIDONG	KUBOID
12.12.2009	KEMBONG	200	PULAU KAPAS	KUBOID
13.12.2009	KERISI	100	PULAU PERHENTIAN	SERAMIK
..	…	…	…	…

TABLE VI INTEGRATION OF THREE TABLES USING SIDIM MODEL

Landing date	Boat No.	Fish Type	Total Landing	Area of Fishing	Artifcial Reef Type	Fishing Zone	Main Fishing Equipment	Other Fishing Equipment	Crew No.
12.12.2009	TAP001	KERISI	100	PULAU BIDONG	KUBOID	Zon A	PUKAT HANYUT	BUBU	8
12.12.2009	TAP001	KEMBONG	200	PULAU KAPAS	KUBOID	Zon A	PUKAT HANYUT	BUBU	8
13.12.2009	TAP002	KERISI	100	PULAU PERHENTIAN	SERAMIK	Zon B	PUKAT TUNDA	TIADA	4
..	..	…	…	…	…	…	…	…	…

Since data are located in different databases and in different formats, the development of algorithm for the application software (middleware) is required. The algorithm is developed based on CLARANS algorithm and identified Abstract Representation in integration process by multi database types in distributed environment [9]. The Overall process is depicted in Figure 6 as follows :

Step 1: CLARANS Approach
Classification or clustering all the spatial data and non-spatial data for Artificial Reef Distribution Database, Landing Fish Databases and Vessel Profile database.

Step 2: Abstract Representation Visualization Approach
Combining all the data spatial and non-spatial into one news database and after that visualizing it in online mapping format (GIS Format).

Step 3: Query Processing
Information for all the database could be done by using SQL query and visualize according to the user specification on online map (GIS format).
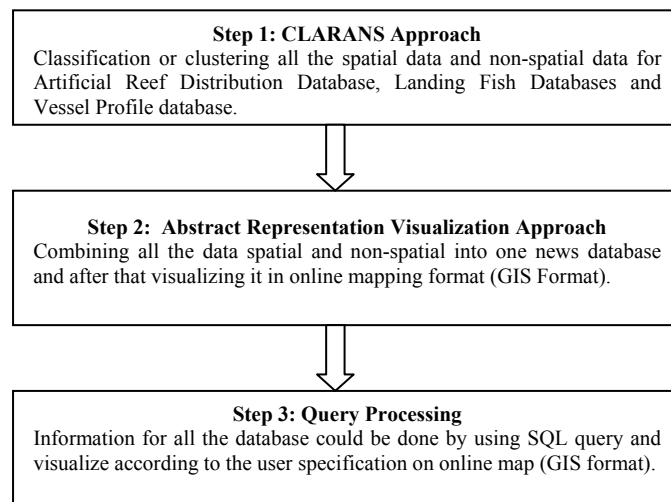

Figure 6 Algorithm Development Process to integrate spatial and non-spatial data in distributed environment for heterogeneous SIDIM Model

The CLARANS algorithm is suitable and fit to be used to evaluate the integration process of spatial and non-spatial data in multi database types.

In the second step, after the clustering process heas completed, the next process is *abstract representation* for the estimating the integration. The estimation determines the efficiency of artificial reefs development in comparing with the number of fish catches at the already defined cluster. The relationship known as Spatial Semantic like ABOVE, NEAR, IS-NEXT-TO, and BEHIND will be used to map and display every entity in various database types.

The third step is the display of output of integrated database in a visual form based on map. This method will help in searching of information about on artificial reef growth. A comparison was made with the fish catch obtained through searching technique using the Geographical Information System (GIS) [10].

The evaluation will test the efficiency level and reliability of developed middleware in integrating process. Evaluation is carried out at the system user level. The process time is recorded to obtain and justify the information processing speed and interoperability.

Under this activity, evaluation will be made to test for efficiency level and reliability of developed middleware in integrating process. The evaluation is carried out at the system user level. The process time is recorded to obtain and justify the information processing speed and interoperability is fulfilled.

Other than processing time factor, evaluation of Catch Per Unit Effort or Ability Rate (CPUE) is also encountered in order to assess the whole project's efficiency for each dedicated artificial reef location [11]. CPUE is defined as the level and efficiency degree between the catch in tan (t) and the ability of catch (frequency of fish catch) is being conducted. CPUE with non zero catch is modelled in the following formula:

$$In(CPUE)_{i,j,k,l} = \mu + \alpha_i + \beta_j + \gamma_k + t_l + \varepsilon_{i,j,k,l} \qquad (1)$$

where μ is the variable, α_i is the year factor, β_j is the month factor, γ_k is the zone factor, t_l is the rate factor, and $\varepsilon_{i,j,k,l}$ is the

random error component. As a means to integrate travelling trip without catch, the writers have modelled the success probability of fish catch where it relates with the efficiency degree between the travelling trip with non-zero catch and the total of *jack mackerel* fish catch trips. The model followed binomial distribution and 'Logic' function which used to relate *P* with its estimator.

$$In(CPUE)_{i,j,k,l} = \mu + \alpha_i + \beta_j + \gamma_k + t_l + \varepsilon_{i,j,k,l} \tag{2}$$

where μ is the variable, α_i is the year factor, β_j is the month factor, γ_k is the zone factor, t_l is the rate factor, and $\varepsilon_{i,j,k,l}$ is the random error component. Then the yearly value of CPUE is calculated in tone / total travelling trip that relates to statement below:

$$CPUE_i = \exp(\mu + \alpha_i + 0,5\sigma^2)\exp(\mu' + \alpha_i' + 0,5\sigma'^2) \tag{3}$$

Besides, if 'p' is defined as efficiency evaluator, then the yearly value of *CPUE* will relate to the calculation as follows:

$$CPUE_i = \exp(\mu + \alpha_i + 0,5\sigma^2)\exp(\mu' + \alpha_i' + 0,5\sigma'^2) \tag{4}$$

Assumption is made where an increase in *CPUE* trips with the catches can be influenced by the changes of boat's efficiency and the catch resources which represents either the fish catch is a success or otherwise. The result of integration process can determine the fish types with the catch area. Through this, we can identify artificial reefs type for the production of phytoplankton and zoo plankton which in fact is the food source for marine life.

IV. RESULT AND TESTING

Prior to formal specification and validations proving process, then coding were developed in the middleware to run the program. The coding was done using open source Hypertext Pre-Processor (PHP) programming language to develop a middleware application. The output of this module is as shown in Fig. 7. This figure was depicted under Extensible Markup Language (XML).

Figure 7 User Interface for SIDIF System

Evaluation and testing process for SIDIM model were conducted by comparing between manual data with a SIDIM processed data. The testing focused on the '*interoperability*' feature in spatial and non-spatial data processing among the different types of database within a centralized server. It is then compared with spatial and non-spatial data processing in a different types of database within a distributed server.

The result obtained as shown in Table 7 is compared either the two different servers (centralized or distributed) having a similar results or on the other way around. The comparison will confirm whether each algorithm deployed at each particular step has achieved the objectives or otherwise.

TABLE VII AN INTEROPERABILITY TESTING BETWEEN DIFFERENT TYPES OF DATABASE IN A CENTRALIZED ENVIRONMENT

Database Types	Types of Web Server	Interoperability Testing with Multi-types of Databases		
		MYSQL	ORACLE	MSAccess
MYSQL	Apache	√	√	√
ORACLE	IIS	√	√	√
MSAccess	IIS	√	√	√

After the result of data integration is obtained, the next process is to visualize the result by adopting a clustering process through CLARANS approach. The Google Map software together with the abstract visualization element is generated so as to show the result of an integration process. The visualized information is depicted in Figure 8.
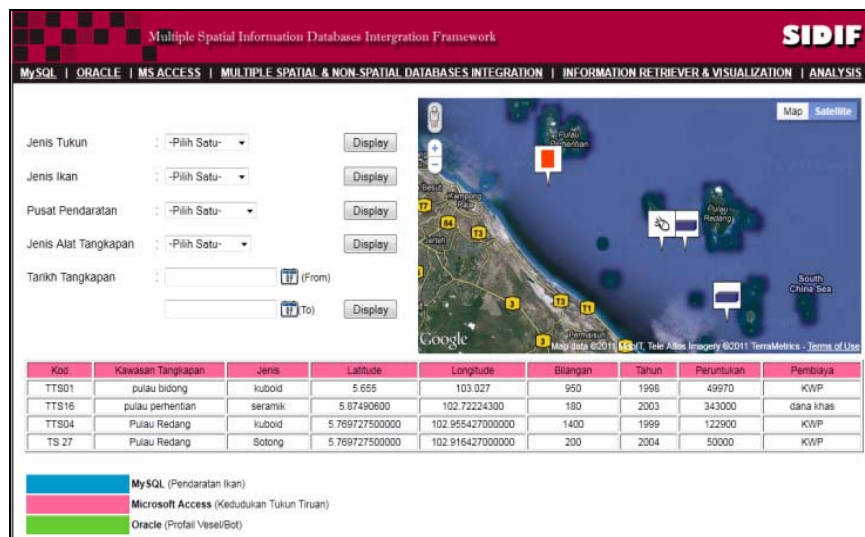

Figure 8 User interface for Multiple Spatial Information Retrieval and Visualization

From the visualized information, it was confirmed that the evaluation of efficiency for the fish catches for a spesific artificial reef location can be done. The fish catch to be obtained for the following years can also be estimated.

The result of integration in both databases can be analyzed using intermediary software and comparison will be acquired such as in bar graph as shown in Figure 9.
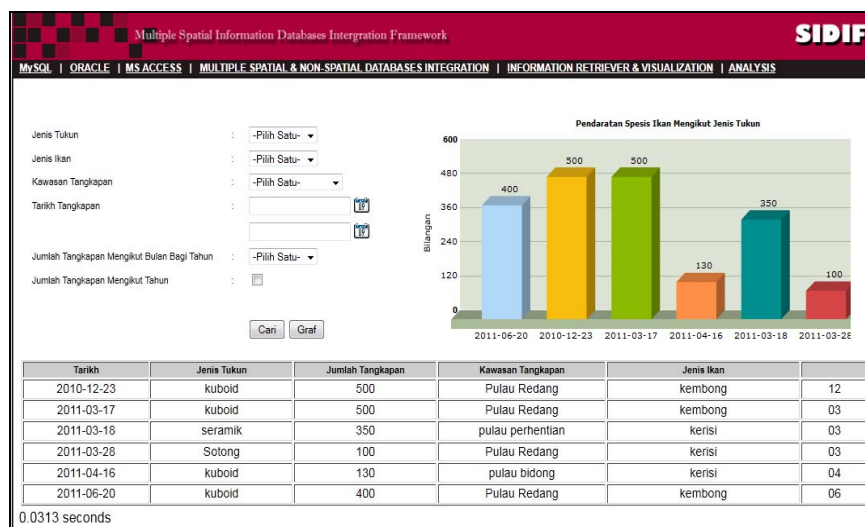

Figure 9 User Interface for Multiple Spatial Information Analysis in Bar Graph

V. CONCLUSION

SIDIM is a model designed for solving various types of database integration problem. The location based integration technique for artificial reefs determination was successfully conducted and good result were obtained. First, it supports data integration by allowing the resolution of different data representation conflicts. Secondly, it permits the representation and use of query capabilities that may not be provided by all integrated GIS systems. As a result, this study has also tackled the problem of tools integration and extension. It is hoped that this tool can be extended to other domain as a solution for multiple types of database integration.

ACKNOWLEDGMENT

REFERENCES

[1] S. Aikanathan and E. Wong (1994). Marine Park Island Management Conceptual Plan for Peninsular Malaysia. WWF Project Report, MYS 256/93. Department of Fisheries Malaysia and the World Wide Fund for Nature (WWF) Malaysia, Kuala Lumpur.

[2] Salm and Coles (2003). Resistance and Resilience to Coral Bleaching: Implications for Coral Reef Conservation and Management. Conservation Biology, Volume 17, No. 4. pg 956–967.

[3] Kajian Tukun Tiruan oleh NAHRIM (2005). http://www.nahrim.gov.my/my/tukun-tiruan.

[4] C. Parent and S. Spaccapietra (1998). Issues and approaches of database integration. CACM, 41(5): 166–178.

[5] C. Parent and S. Spaccapietra, Y. Dupont (1992). Model independent assertions for integration of heterogeneous schemas. Very Large Database Journal 1. 81–126.

[6] Z. Patrick, R. Klaus (2004).Three decades of data integration-All problems solved?. IFIP Congress Topical Sessions'2004. Pg.3-12.

[7] J. Kim, Y. Peng, N. Ivezic and J. Shin (2011). An Optimization Approach for Semantic-based XML Schema Matching. International Journal of Trade, Economics and Finance, Vol.2, No.1, February, 2011. 2010-023X.

[8] J. Bowen (2003). Formal Specification and Documentation using Z: A Case Study Approach: Thomson Publishing.

[9] T. N. Raymond and H. Jiawei (2002). CLARANS: A Method for clustering objects for Spatial Data Mining. IEEE Transactions on Knowledge and Data Engineering, Vol. 14, No. 5. Pg 1003 – 1015.

[10] W. Ismail and K.S. Joseph (2010). Future IT trends for GIS/Spatial Information Management. Scientific Research and Essay Vol. 5(10), pp. 1025-1032.

[11] A. Stephans and A. MacCall (2004). A multispecies approach to sub setting logbook data for purposes of estimating CPUE. Journal of Fisheries Research Published by Elsevier Science Ltd, Science Direct. Pg 299-310.

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