EXPLORING THE UTILISATION OF GEOGRAPHIC INFORMATION SYSTEMS TECHNOLOGY TO EFFECT INTEGRATED REGIONAL AND SECTORAL DEVELOPMENT PLANNING FOR SARAWAK: AN ACTION RESEARCH CASE STUDY

ANTHONY VALENTINE LAISEH

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FACULTY OF COGNITIVE SCIENCE AND HUMAN DEVELOPMENT
UNIVERSITY MALAYSIA SARAWAK

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I dedicate this piece of work to all who persistently strive for changes through action learning.

Anthony Valentine Laiseh

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1. SPU	-	State Planning Unit
2. GIS	-	Geographical information systems
3. CIDA	-	Canadian Integrated Development Authority
4. SADP	-	Sarawak Agriculture Development Project
5. FOMISS	-	Forest Management Information System Sarawak
6. SPANS	-	Spatial Analysis Systems
7. SAINS	-	Sarawak Information System
8. SDSS	-	Spatial Decision Support System
9. GEMPIS	-	GIS-based Earthquake Emergency Management Planning Information System
10. MARDI	-	Malaysia Agricultural Research and Development Institute
11. DBKL	-	Dewan Bandaraya Kuala Lumpur (Kuala Lumpur City Hall)

ABSTRACT

This study employed action research methodology in exploring the utilisation of geographic information systems (GIS) technology to effect integrated regional and sectoral development planning for Sarawak. Unlike the traditional and conventional method, action research has its own uniqueness as it involves among others; problem focused in the context of real life situations and the solving of such problems in a research sense would contribute to the practice and the development of social science knowledge; action-oriented where it brings an action element to the solving of an immediate problem which has strategic change implications for the organisation; highly collaborative, with a team effort who owns the problem; re-educative; and normative. The most unique characteristic in action research is the cyclical process which involves cycles of planning, action, observation and reflection. In these cycles of action research methodology, it allows the group members to develop a plan, to act, to observe and to reflect on this plan and to modify it based on the needs of the group members and the requirements of the organisation and situations. From this study, it was found that action research methodology can be used as an effective tool in solving problems related to integrated regional and sectoral development planning for Sarawak. It assisted in answering research questions pertinent to the study and gave the opportunity for the group members to involve themselves in action learning. The findings from this study would hopefully be a guideline for the State Planning Unit in formulating future development policies and practices to effect integrated regional and sectoral planning for the state of Sarawak.

ABSTRAK

Kajian menyelidik penggunaan teknologi sistem maklumat geografi (GIS) ke atas kesannya kepada perancangan pembangunan bersepadu wilayah dan sektoral di Sarawak menggunakan kaedah kajian tindakan. Berbanding dengan kaedah tradisional, kajian tindakan mempunyai keunikan tersendiri yang melibatkan, antara lain; berfokuskan permasalah sebenar dan penyelesaian ke atas permasalah tersebut akan menyumbang kepada amalan dan pembangunan pengetahuan sains sosial; berorientasikan tindakan yang melibatkan elemen tindakan di mana ia menyelesaikan masalah terkini yang mempunyai kesan perubahan strategik organisasi; melibatkan usaha berkumpulan; pembelajaran semula; dan normatif. Apa yang lebih unik dalam kajian tindakan ini ialah ciri yang melibatkan proses kitaran perancangan, tindakan, permerhatian dan pertimbangan semula. Dalam kitaran kajian tindakan, ia membolehkan ahli-ahli kumpulan membentuk pelan, bertindak, memerhati dan kemudian menimbang semula dan mengubahsuai pelan berdasarkan kepada kehendak ahli kumpulan, kehendak organisasi dan mengikut keadaan semasa. Daripada kajian ini, adalah di dapati bahawa kaedah kajian tindakan boleh digunakan sebagai kaedah yang efektif dalam menyelesaikan masalah berkaitan dengan perancangan pembangunan bersepadu wilayah dan sektoral negeri Sarawak. Pada masa yang sama ia dapat membantu menjawab soalan-soalan kajian dan di samping memberi peluang kepada ahli kumpulan melibatkan diri dalam pembelajaran. Adalah diharapkan penemuan daripada kajian ini dapat di jadikan panduan oleh Unit Perancang Negeri dalam merangka polisi pembangunan untuk memberi kesan terhadap perancangan pembangunan bersepadu wilayah dan sektoral di Sarawak.

CHAPTER 1
INTRODUCTION

Introduction

Over the past decade, Sarawak has tremendously embarked on major development in order to achieve a status of a fully developed state in tandem with the nation's aspiration as envisaged in vision 2020. In order to achieve this objective, a comprehensive state development policies and strategies were formulated.

The overall objective of regional development is to ensure a more-balanced development in terms of fair distribution of the benefits of development across the state. The thrust of the regional development is aimed at sustaining the growth momentum especially in the less developed areas in the state through utilising their resources in a more productive and efficient manner.

Being the largest state in Malaysia with a landmass of 124,449 square kilometres, strategies for regional and sectoral development has to be properly formulated. This is to enable the state to achieve a fair and balance distribution of development.

Under the seventh Malaysia plan period five development strategies of key sectors were identified. The key sectors include transport infrastructure, manufacturing, commercial agriculture and land development, tourism and human resource development. For transport infrastructure, the development strategy is to provide and expand road network to the less developed areas with economic potential.

Other strategies would include constructing missing links, improve alignment and construct major bridges so as to increase the efficiency and reliability of the trunk road system as well as to provide and expand other infrastructural facilities such as airports, ports, wharves and jetties.

Under the manufacturing sector, the strategies include developing more industrial estates in major towns and in less developed areas with economic potential. Beside that, the strategies under this sector would look into the possibility of promoting high value-added downstream processing activities. In order to encourage more private sector participation and productive investment from foreign investments, provision of appropriate incentives, industrial training facilities and development of strategic industrial sites should be properly planned.

Agriculture, which was traditionally the core sector developed on small scale, has been replaced with commercialised agriculture through land development. As such, more land including the native customary land would be developed for big scale plantations such as oil palm, sago, rubber and other cash crops. The emphasis would also include promoting spatial development through the implementation of integrated agriculture development programmes and regional growth centres.

Tourism industry has also been identified as a key sector, which will be further developed. The development strategies would focus on marketing the potential tourism products. Other development to support this industry would include provision of greater mix of accommodations to cater for first class and budget tourists as well as developing new potential tourist attraction.

Meanwhile, under the human resource development, the strategies would include providing, expanding, upgrading and rehabilitating existing schools, technical training institutions and tertiary education.

Given the scenario on the state development strategies with the five sectors identified, the task would be to effectively and efficiently plan so as to provide a balanced and fair distribution of development in the state. For this purpose, the State Planning Unit, being an agency for planning of socio-development in the state need to carefully plan to achieve the objective. To substantiate this noble objective, the State Planning Unit has recognised Geographic Information Systems (GIS) as a powerful decision-support tool to facilitate in integrated regional and sectoral planning.

Geographic Information Systems (GIS)

GIS is a computer technology consisting of hardware and software that is used to produce, organise and analyse information. The distinguishing factor, which separates GIS from other information storage and retrieved systems is the use of the formal locations of features in co-ordinate space as the fundamental referencing principle and as important variables in quantitative analysis. There are many types of GIS available today, and this technology has been in existence in some form since the early 1960's. It continues to advance and develop with new capabilities in input analysis, display and output occurring every year.

Ever since its existence in the early 1960s the use of GIS has grown dramatically and has become popular in businesses, universities and government agencies where they are now used for many diverse applications. Consequently, many different definitions of GIS have developed. Among them is the definition given by the Environmental Systems Research Institute Inc., U.S.A which describe GIS as an "organised collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyse, and display all forms of geographically referenced information". In other words, GIS is a computer system capable of holding and using data describing places on earth's surface.

Another definition of GIS is given by Star and Estes (1990, p.2) which states that GIS "is an information system that is designed to work with data referenced by spatial or geographic co-ordinates. In other words, a GIS is both a database system with specific capabilities for spatially referenced data, as well as a set of options for working with the data." While the two definitions given are quite similar, the main function of GIS should be to produce meaningful output or results after having gone through the process of computer hardware and software manipulation.

The output produced after manipulation through computer-assisted technology then helps to correctly ascertain the nature or visualisation of the possible relationship among attributes. Relationships among the different types of data or coincidence of factors for instance can be explored, such as finding areas with a certain combination of soil types and vegetation cover or finding suitable areas for a proposed industrial site. On the other hand ranking methods can be used to evaluate the suitability of land for a particular purpose to evaluate alternatives for improved land used patterns.

Despite the technological power of this computer-based tool, a GIS cannot exist on its own. Sufficient data as well as the institutional context and appropriate personnel to handle the system must be made available. New tools can only be used effectively, if they are properly integrated into the entire process, otherwise the GIS technology might not be utilised to its full capability.

Assessment of the present GIS capacity at the State Planning Unit

The overall function of the State Planning Unit is to plan and co-ordinate development in Sarawak. However, some, but not all, of the sectoral functions of the State Planning Unit require the use of GIS to assist in decision making. GIS can be utilised to cater to integrated development planning and decision-support for site selections in regional and sectoral planning. Under regional planning GIS can be utilised for zoning and gazzeting while as for sectoral planning it can be used for agriculture, industries and infrastructure.

Realising the importance of a more co-ordinated planning in the state, the State Planning Unit has appended a GIS unit, which was initially placed under the management of the Agriculture and Rural Development Sector. The unit was established in 1993 within the framework of the formerly CIDA-Supported Project on Integrated Agriculture Development (SADP). The function of the GIS unit then was mainly to generate maps as visualisation tool for all sectors in the State Planning Unit. However, the unit is not frequently requested by in-house users to produce outputs.

Based on the findings by the study team co-ordinated by Forest Management Information System Sarawak (FOMISS) in 1997, there is no institutional regular exchange of geographic information between the State Planning Unit and other state departments. Inter-Institutional co-operation is based on ad hoc requests, and information flow is in the majority of cases towards the State Planning Unit and not the reverse.

The findings from the study also show that there are no signs for the existence of a central information pool within the State Planning Unit. This is closely related to the fact that presently GIS unit is placed at a low hierarchical level and not as a separate division.

Hardware and software facilities

The hardware and software which is also referred to as the technoware relates to the physical facilities available which includes equipment, software and office infrastructure.

Presently at the GIS unit, the available hardware facilities consist of four units of PC Pentium equipped with ARC/INFO and dBase IV, one unit of 368-PC with SPANS, four units of AO digital table, two units of A3 printer and 1 unit AD pen plotter.

Assessing from the facilities available at the moment, the GIS unit is considered to have the basic requirement to cater for the needs of the State Planning Unit as most of the time the GIS-application software PC ARC/Info can be used for map production.

Statement of the problem

Proper planning is important especially in the allocation of limited resources. It involves a continuos process which involves decisions, or choices, about alternative ways of using available resources, with the aim of achieving particular goals at some time in future. The resources include not only natural resources (land, water, mineral wealth and so on) but also human resources, capital resources such as roads, buildings and equipment and finance.

Planning involves making decision about how to make the best use of the available resources. Consequently, the quantity and quality of these resources has a very important effect on the process of choosing between different courses of action.

On the other hand, the fact that there are almost always limits to the quantity and quality of resources available, is the main reason why planning involves deciding which of a number of desirable courses of action should be given priority. Furthermore, where choices have to be made between alternative courses of action, the availability of resources plays an important part in determining both the range of alternatives available and the one, which is likely to be most acceptable.

Since the concern of this study focuses on development planning it should be defined very broadly to include, among other things, many of the activities conventionally under the heading physical or land use planning. However, development planning can further be subdivided into a number of more manageable operational levels. The three most common levels into which it is subdivided are probably project planning, sectoral planning and integrated regional planning. The main concern here is about sectoral and integrated regional planning.

Sectoral planning means planning for a particular part or sector of a country's development. It is usually possible to identify a number of different functional sectors, which normally correspond, with the division of the government into ministries, departments, divisions or other organisational units. These sectoral plans could be prepared for sectors such as agriculture, education, housing and so on.

Meanwhile, integrated regional planning involves planning for all sectors or types of activity within a particular geographical area. Integrated regional planning suggests an approach to planning which cuts across sectoral planning. Thus integrated regional planning is seen as an alternative operational level of planning to that of planning by sectoral agencies. The main aim for an integrated regional planning is to make sure that there are no obvious conflicts or inconsistencies between the activities planned in each sector. In other words, integrated planning not only allows a more positive sense of achieving functional and spatial harmony between the activities of different sectors and the most effective distribution of resources between agencies.

The difficult task in sectoral and integrated development planning is to make sure that there will be no conflicts or inconsistencies. Perhaps it is of importance to incorporate the organisation aspects of planning. For the organisational issue which arises most often in planning is how the organisational structure required to plan and implement the project should fit into the wider organisational structure of the sector or area within which the project is located. However, there is no easy solution to the organisational problem. Hondale (1979) as quoted by Conyers and Hills (1994) described that "if the project does not fit, it will not have any significant impact; if it fits too well, it will only perpetuate the status quo. Designing a satisfactory balance is part of the art design".

Another problem, which arises in sectoral and integrated regional planning, is the lack of co-ordination between the agencies involved in difficult stages of planning. Very often the initial planning processes are done in isolation and more often than not, problem of conflict in interest occurs.

It is therefore, to the best interest for a more proper and orderly sectoral and integrated regional planning in the state that the State Planning Unit being the lead agency is gearing itself to utilise the GIS as a systematic planning tool in its planning.

Research questions

As this is an exploratory study in the utilisation of GIS technology to effect regional and sectoral development planning for Sarawak, it is appropriate to base the study on the research questions which includes:-

1. Is GIS an effective integrator for co-ordinated integrated regional and sectoral development planning ?
2. How can GIS be integrated into regional and sectoral development planning?
3. What are the benefits of integrated regional and sectoral development planning?
4. How could the planners be more effective and efficient in the processing of a plan?
5. Can action research be an approach to improve and expedite the approving process of a plan?

6. To what extent is integrated regional and sectoral development planning currently being affected in practice?
7. Could GIS provide for more effective integrated regional and sectoral development planning?

Research design and strategy

An exploratory study research design was employed for the investigation of the use of an action research methodology in exploring the utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak. Using the cyclical process of action research, the method followed the sequence of planning, action, observation and reflection.

Under planning stage, four main components of GIS technology which includes humanware, infoware, hardware and software and orgaware were discussed.

These components acted as a basis for the proposed plan that would be discussed during the socio-technical action group meeting. A concise review of action research literature was also included to determine the appropriateness of the method employed in this study.

The action stage proposed how issues under the planning stage were discussed in depth focused on how they could contribute to the effectiveness of GIS technology as a decision support tool in decision making. Feedback and proposals put forward by the group members were discussed, elaborated and recorded. These inputs served as a basis perceived by the group members as the alternative ways to solve problems which was of thematic concern.

While this was ongoing, the writer who acted as facilitator employed various techniques to determine the reaction of the group members. This process is called the observation stage. The study however, employed the participatory, emancipatory as well as participant observation to determine how the group members assisted in the problem solving pertinent to GIS technology. It was interesting to note that under this stage, the group members acted naturally as none of them realised that they were under observation. Definitely the advantage of being natural would of course determine the accuracy of the findings.

The next stage in the cyclical process of action research is reflection. Under this stage, whatever had been discussed earlier on were reviewed to determine the appropriateness of the issues discussed. In other words it was merely a process to verify the outputs which evolved from the discussions.

For the purpose of this study, the data were collected through discussions and brainstorming. The outputs based on the discussions were later evaluated with the sector heads and the other senior officers.

Purpose of the study

The general purpose of this study was to explore the utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak. Unlike any other researches that employed the traditional method, this study was conducted by action research methodology which involves a spiral of cycles of planning, action, observation and reflection. Thus, the specific purpose of this study was to:-

a) Investigate the use of an action research methodology to explore the utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak; and

b) Make significant changes to the organisation with regard to integrated regional and sectoral development planning for Sarawak by means of recommendations and suggestions.

Scope and limitations of the study

This study investigated the use of an action research in exploring the utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak. It is not the intention of the study to undermine the capability of GIS technology as it is assumed that this technology has made considerable contribution for planning purposes.

The study was limited by duration of time frame set which was six weeks with an interval of fortnightly. This then placed a time restriction and limitation on the researcher as most often it was difficult to get everybody to attend the meeting. Furthermore, during the first few meetings which happened during the fasting month, most of the Muslims group members were tired. Thus, few meetings had to be called-off earlier than scheduled.

The other limitation to this study was the use of participant observation. In this technique the observer becomes part and parcel of the setting and therefore has an effect on it. This is coupled with the fact that as time is a limitation, the researcher who acted as an observer dominated the meeting sessions so as not to deviate from the real purpose of this study.

Another limitation was the fact that the researcher was also the facilitator of the action research process. Very often the researcher would dominate as he felt that the outcome of the meetings should suit his requirement. As a result the proceeding of the meetings became very formal and direct to the subject matter.

Assumptions

As specified earlier, this study employed action research methodology which involves a spiral of cycles of planning, action, observation and reflection. The data and information collected would come from the group members who worked on the subject studied. Thus, it is assumed that all the relevant data and information collected during the

discussions were accurate and reliable. Furthermore, it was assumed that information given by the group members were free from biases and the members chosen were competent enough to contribute their thought and ideas related to this study. This includes an assumption that the researcher was capable of accurately and objectively recording observations made during the discussion.

Significance of the study

As quoted by Abraham (1997, p.9), research was conducted to fulfil three aspects where firstly, it must contribute to knowledge. Secondly, the relevant policy areas should find usefulness and meaning in the study. Finally, the study should be useful for practitioners. At this level this study should be able to fulfil at least two out of the three aspects and that would include leading to policy and practice. As the specific purpose of this study was to make significant changes, the recommendations and suggestions would hopefully be incorporated in future policies and practices with regard to formulating a proper and orderly integrated regional and sectoral development planning for Sarawak.

CHAPTER 2
LITERATURE REVIEW

Introduction

The technology of Information System in general and Geographic Information Systems (GIS) in particular have been extensively applied by many countries during the past decade to assist in planning and spatial decisions. They are being utilised for preparing integrated regional and sectoral development plans in municipalities, provinces, states or countries, or for improved and sustainable management of natural resources as well as for the monitoring of environmental changes. GIS application has also been widely used by Universities and Schools to administer admissions planning among students as well as in businesses and predicting natural disasters.

While it is important to know the application of GIS technology, it is also important to know how this technology works and the various factors that contribute to its effectiveness. In the following chapter it is noted that the data and information used should be accurate, reliable and up to date.

Application of GIS technology in schools

Wilson (1994), applied a PC-based GIS as a decision support tool for a public school district where two types of applications were examined. The first application significantly lessened the time required to draw boundaries that balanced school enrolments in terms of ethnicity and the second application sped up site selection for new school campuses to increase a rapidly growing school-age population. By using specific criteria established by the district made it possible to restrict the field of potential sites immediately. The criteria that could be predetermined include the acreage and the distance from the other main landmarks. The astonishing result using GIS is that it permits many different layers of map features to be displayed at any one time. On the final analysis the results would be displayed by locating the general area of residence and thereby the parents can determine which school their children would be going to. The second application sped up site selection for new school campuses for a fast growing student population.

The criteria used in determining the landmarks include for example ten acres of an elementary school site, not within a one hundred year flood plain and adjacent to a compatible zoning. This site screening was accomplished through queries of the database to locate vacant land parcels meeting those specific criteria. Criteria such as fault lines and distance to airports are part of the geographic file and are displayed on screen during the decision analyses.

Using a GIS meant that information on zoning, new developments, vacant parcels, student distributions, flood plains and geoseismic hazards

could be obtained both textually and geographically. Plot of the location of parcels meeting these criteria were then evaluated for their proximity to the location of projected future student populations.

Future classrooms or schools requirements were calculated and translated with acreage requirements. Predicting the location of the forecasted students narrowed the areas to search for available acreage. The GIS interactively showed available spots for an additional three elementary sites, one junior high site and one high school sites.

It is important to note that much of the analysis took place in real-time with district representatives seeing the results of their decisions displayed on the computer screen. This is to say, the map of the district was displayed on the screen and a possible boundary was described by drawing a polygon representing an attendance area.

Drawing the polygons on the screen was facilitated because the street network was displayed along with the location of each student in the district. When the polygons achieved the desired racial balance and met the other agreed upon criteria, hard copy plots were made for further study by district staff. By following this procedure, it was possible with minimal additional cost to present a number of options to the district staff in advance of the presentation to the board of education and parents.

As a result maps of the final options to be presented were of sufficient detail (at the street level) so that residents were easily able to locate the general area of their residence and thereby determine which school their children would be going to. In summary, the use of GIS as a single purpose decision support system made it possible to accomplish the stated objectives in ten working days with lower cost. Despite the reduced time and cost incurred, GIS did not, nor was it expected to allow the district's decision makers to escape emotionally based on the criticism by members of the community concerned by the adopted changes.

Application of GIS technology in universities

There has been a substantial change in the freshmen admissions process at most US Universities. There is a growing emphasis upon attaining both quantity and quality coupled with the ability to target various specialised groups within the pre-college population such as individuals of Hispanic descent, potential majors or those coming from out-of-state secondary schools.

By applying GIS technology to the freshmen admission process conducted at Ohio State University (OSU), as a pilot study indicated that significant returns may be expected from the application of GIS technology to visualisation and analysis of the freshmen admission process, Marble, Mora & Herries (1995).This study was to explore the application of GIS technology in the admission process. Approximately 80,000 applications from 1993 to 1994 admission streams were geocoded and analysed with respect to both student and school district of origin.

Geocoding of applicant files has been successful and it has proven to be straightforward to match these with relevant census data elements.

Prior to this pilot study, a GIS feasibility study was carried out in 1994. This study demonstrated that the provision of several Spatial Information Products (SIPs) could lead to better targeting of freshman recruitment efforts and that sufficient information appeared to be available when utilised in conjunction with standard socio-economic information from the census, to create the products.

Marble and Herries (1996) suggested a methodology for leveraging in expensive GIS Software, existing geographically referenced data sources, locally developed geocoded student information, and existing spatial analysis technique in university admissions planning. The resulting integrated tool kit provides a detailed demographic and geographic view of the existing and potential students body that provides an effective basis for strategic enrolment planning.

The outcome of the study revealed that GIS technology, when properly applied can lead to increased awareness of the demographic and geographic structure of the institution admission stream. However, this technology cannot function if the three important aspects, which include methodology, people and procedures, are not developed. Therefore, it is imperative that the development of people be given emphasis so as to be competent in the use of GIS technology as a tool for planning.

Another work of Herries (1996), when applying GIS technology and geodemographics to college and university revealed among others that the combination of geodemographic and GIS technology does indeed work within the context of college and enrolment management activities.

However, he argued that introducing significant levels of new technology into an organisation accustomed to more traditional method, of operation is a difficult task. Developing competence in the use of GIS/geodemographic approaches requires devoting substantial resources to both staff education and to staff training.

Application of GIS technology in public and private organisations

Computerised GIS are increasingly used by public and private organisations as tools for storage, selective retrieval, and manipulation of spatial and nonspatial data. GIS diffusion in an organisation is a very complex process especially when it involves people within the organisation that has varied level of computer competency as well as academic background. A study by Budic and Godschalk (1996) focused on the factors that influence GIS diffusion in local government agencies. They looked into various aspects of employee perception, experience, attitudes, and communication behaviour as they affect the success of GIS implementation. Organisational and management factors are studied as important contextual elements in the diffusion and process.

From the study, it was found that perceived relative advantage, previous computer experience, exposure to the technology and networking are the most significant determinants of employee willingness to use new GIS technology while organisational and GIS management factors strongly influence GIS diffusion.

Further to the above findings, which was conducted in four agencies of the local government within a North Carolina County, perception of personal benefits emerged as the most essential factor for the adoption of GIS technology by individual employees on all the four agencies. Meanwhile, organisation benefited from implementing GIS technology recognised the importance of the individual competency in handling GIS technology. However, the doubts about the advantages from relying on the technology were conditioned by the current situation and the awareness about the time and effort needed to compile a GIS database.

The other factors that were more relevant for the individual decision to adopt the technology than an exposure to it, such as provision of training, political and financial support for GIS, openness to change and the readiness to learn new things.

On the attitude toward work-related change there were instances where the main GIS nonusers showed a negative attitude toward work-related change, that is, showed a preference for a rather static work environment. A variety of reasons, however, could have simultaneously contributed to their failure to adopt GIS technology which includes passive communication behaviour, low exposure to GIS technology, high computer anxiety, lack of perceived personal benefits, lack of computer experience and concern about the consequences of computerisation.

Application of GIS technology in marketing

Lately GIS technology has also been used as a tool for decision support system in retail location planning and marketing. The application of GIS technology is seen as viable as it helps the planner in decision making. Clarke and Rowley (1995), outlined four factors that impede the faster adoption of spatial decision decision-support systems (SDSS), which is specifically GIS, as a useful tool in location planning by the retail industry.

The four factors include cost-benefit balance, the evolution of site and site marketing strategy within the industry, the role of GIS as SDSS and the lack of awareness among retailers of the benefits of GIS. It was evidently noted that there have been a slow diffusion of awareness of the benefits and application of site evaluation techniques and the application of GIS in particular. Furthermore, the lack of appreciation of the competitive advantage to be gained by appropriate use of GIS further hindered the development of the use of GIS as SDSS.

Application of GIS technology has gained popularity and it has also been widely used in marketing. The results from the use of this technology have benefited many organisations and companies. One of such application in marketing was the study done by Goodchild (1991). It was found that there are several benefits gained by using GIS technology in marketing as GIS provides an efficient way of generating some of the necessary variables, particularly demographic counts within each store's surrounding area.

Application of GIS technology in natural disasters

The application of GIS technology has also been widely used to control the use of land in order to avoid or mitigate the effects of natural hazards. In New Zealand for instance, the Wellington Regional Council (WRC) has pursued a programme of earthquake hazard mapping within the Wellington region. Since 1990, when maps showing active faults were produced, the council has developed a comprehensive library of earthquake hazard maps. Projects had been carried out to map potential tsunami inundation areas around Wellington harbour, variations in ground response to strong shaking, liquefaction potential, and earthquake-induced slope failure. All of these data had been digitised and forms part of the WRC GIS.

Because the effects of various earthquake hazards can be quite different, and can affect both land and urban infrastructure in various ways, there was a need to find a sensible way to normalise and combine the data. This was accomplished by considering the average infrastructure in the region, and assuming that the infrastructure existed in all parts of the region.

The effects of each earthquake hazard on each element of the average infrastructure by using appropriate damage ratios or assessments were investigated. By calculating the damage for each of the six infrastructure types and each of the five earthquake hazards it was possible to combine the individual damage components and arrive at a total value, termed as "Combined Hazard Index".

Another application of GIS technology in natural disasters was used to detect earthquake in Japan. On January, 1995 the city of Kobe ,Japan was jolted by an earthquake measured at 7.5 on the Ritcher scale. During this disaster more than 5,000 people were reported killed, 25,000 injured, and thousands of houses, public and private buildings destroyed. As a result many agencies involved in the emergency response and recovery efforts were quickly overwhelmed by the enormity of the disaster. In parts, this was due to the lack of first hand information needed to make crucial emergency management decisions. In order to make such information readily available, a GIS-based Earthquake Emergency Management Planning Information System (GEMPIS) has been developed.

One of the main objectives of GEMPIS is to acquire comprehensive and detailed spatial information of the project area. To achieve this objective, various spatial data pertaining to the physical environment, resources, socio-demographic, economic, infrastructure and social facilities that are related to earthquake disaster management planning were collected and digitised and then converted and stored digitally in the GEMPIS database.

With appropriate modification, GEMPIS can respond and recovery system can be readily transferred to many cities in Japan as well as other countries. However, before a disaster emergency management and planning agency can adapt and implement this system few important factors must be noted. Firstly, is the availability and accessibility of data on socio-economic

and land use. These should be shared and less bureaucratic producers in obtaining them.

Secondly, workers who work on this project must have direction when it comes to using spatial data not to mention how to use GIS to manipulate these data. It requires imagination and experience to appreciate how the spatial analysis techniques of GIS can truly assist disaster emergency management planning. Next is training and education. It is generally easy to train someone in the art of digitising data and overlay preparation. But, it becomes a formidable task when the training touches on the more crucial aspects of designing and managing an emergency management planning support system, given the complexity of the local political, cultural and social environment.

The Kobe earthquake experience has been particularly useful in furthering an understanding of the benefits and limitations of using a GIS-based response system in an emergency. The project however provided useful insights into such questions as how such a GIS should be developed; what basic data should be included in the GIS database; what institutional arrangements are required to ensure a rapid and smooth dissemination of information to various agencies and organisations involved; and how database can be updated quickly and effectively to meet additional needs following the event.

Application of GIS technology for development planning

Application of GIS technology had also been used for development planning in Bangladesh. In trying to utilised this technology it is essential that timely data be made available to planners and researchers as required so that the waste that is incurred as a result of either non-availability of appropriate , current data or the duplication of effort can be avoided. GIS technology can take much of the system to allow for better analysis of the situation and a much quicker satisfactory resolution of the problem, albeit not necessarily the most optimal. However, such planning requires accurate and recent large-scale maps of the area under study.

The whole process of examination and evaluation was integrated into a menu driven information system which management can use in the generation of alternative scenarios. This was done through a pop-up menu under the ARC/INFO environment. This method has been reported to be successfully been implemented in one of the districts in Bangladesh. This work has provided a unique database for the country which will benefit other development work. Furthermore, this method has the advantage of being easily updated.

Application of GIS technology in Malaysia

In Malaysia this technology has also been popularly used in the management of agricultural resources, land use, urban development and in managing traffic. The Malaysian Agricultural Research and Development Institute (MARDI) for instance had installed a GIS to help with inventory,

planning and management of agricultural resources. This was done due to the shortage of agricultural land and therefore accurate planning is necessary.

The other agency that applied GIS technology is the Kuala Lumpur City Hall or fondly called DBKL. GIS in DBKL is very much required to give long term benefit to the management and planning of the city of Kuala Lumpur. Generally at DBKL, GIS technology is used among others to determine suitable sites for the development of projects, provides fast, effective and orderly plan and it is also used for the valuation of realty in and around Kuala Lumpur.

Basically the benefits that GIS technology can provide for DBKL includes, the management of effective database to assist in decision making and to produce a fast, easy and accurate design plans for development.

Chapter summary

This chapter concludes by focusing on how GIS technology can be applied to facilitate various planning purposes, which includes students' admissions, development planning, forecasting natural hazards, and formulating marketing strategies. Before GIS technology can be effective, various factors including human, data and information as well as the hardware and software facilities need to be in place. This is imperative as GIS technology functions with the availability of these components.

Under the human resource or the humanware, aspects such as employee perception, experience, attitudes and communication behaviour determines the success of GIS technology. Likewise, for the data and information or infoware, reliability and accessibility of this component need to be made available. On top of that, the basic component of hardware and software facilities or the technoware should be available to run the technology. However, as the demand for GIS technology as a decision support tool becomes popular, a more sophisticated technoware should be rendered possible.

CHAPTER 3
METHODOLOGY

Introduction

This chapter presents first the thematic concern of the project and give a brief description of the background, site and the purpose of the study. It will then outline the research questions to be answered in the study and provide rationale on the use of the action research methodology. The chapter would conclude by giving a rationale of the action research method adopted in this study.

Thematic concern

The thematic concern defines the substantive area in which the action research group decides to focus its improvement strategies. The thematic concern for this study is in developing strategies for a more orderly and co-ordinated regional and sectoral development planning for Sarawak.

Traditionally, integrated regional and sectoral development planning in the state was done on a piece meal basis and in isolation. The approval process will only be done through a series of lengthy meeting and more often than not when conflicting interests occurred, the project had to be re-planned and thus affected the timing or timeliness of the implementation process. A number of projects for instance which were due to be implemented during the Fifth Malaysia Plan period (1991-1995) had to be rescheduled until the Seventh Malaysia Plan (1996 – 2000).

Background

In many organisations the requisition of expensive equipment often fail to realise the expected potential, seemingly making little contribution to the goals of the organisation. While researchers and suppliers are always in the midst of developing new technological breakthroughs yet there are instances that the potential user organisations are still trying to assimilate obsolete technology. As a result, users find themselves being caught in between the dilemma of trying to use the technology.

The Geographic Information Systems (GIS) which is a computer technology introduced in the early 1960's has developed dramatically and has been accepted as a powerful decision-support systems in many areas such as in businesses, universities and government agencies where they are now used for many diverse applications. Basically GIS consists of hardware and software that is used to produce, organise and analyse geographic information. However, GIS technology cannot exist on its own. Sufficient data or attributes and institutional context and appropriate personnel to handle the system must be made available to enable GIS to work efficiently.

Realising the importance and capability of GIS as a decision-support system, the State Planning Unit (SPU), Sarawak whose main function is to plan and co-ordinate integrated regional and sectoral planning in the state

has appended a GIS Unit within the organisation. The GIS Unit was established since 1993 within the framework of the formerly CIDA - supported project on integrated Sarawak Agriculture Development Project (SADP).The function of the GIS Unit then was mainly to generate maps as visualisation tool.

Site of the study

With the view that GIS technology has been widely accepted as a decision-support system, the State Planning Unit planned to embark on the full usage of the technology in its planning purposes. This study was conducted at the GIS Unit within the State Planning Unit. The choice of this site reflected the true picture of the State Planning Unit as a central planning agency in the state and moreover the technology has been strategically located there. Within the GIS Unit there exists five technical personnel which includes one System Analyst, a Programmer and three draughtsmen.

Purpose of the study

As the State Planning Unit is entrusted to plan and co-ordinate development planning in the state, the purpose of this study is to explore the use of GIS technology as a decision support tool in the decision-making for integrated regional and sectoral development planning in the state of Sarawak.

Research questions

As this is an exploratory study on the use of GIS technology to effect the integrated regional and sectoral development planning in the state, it is considered appropriate to base the study on the research questions which includes:-

1. Is GIS an effective integrator for co-ordinated integrated regional and sectoral development planning?
2. How can GIS be integrated into regional and sectoral development planning?
3. What are the benefits of integrated regional and sectoral development planning?
4. How could the planners be more effective and efficient in the processing of a plan?
5. Can action research be an approach to improve and expedite the approving process of a plan?
6. To what extent is integrated regional and sectoral development planning currently being effected in practice?
7. Could GIS provide for more effective integrated regional and sectoral development planning?

Rationale for using the action research methodology
Introduction

In academic research, researchers employ various methodologies to conduct research. Traditionally, researchers confined themselves in conducting research by employing methods such as qualitative, quantitative or survey methodologies. But lately action research has been widely accepted as one of the methods in research work.

As against the traditional concept of learning which is formal, rigid and structured in nature, action research and action learning involves situation which are real events or happenings. In a learning organisation the concept involves the sharing of knowledge and information with the aim to benefit all individuals who are participating in the process. The individual or participants learn and share with each other a common goal to achieve something that they can be proud of. The role of the trainers are being replaced by the facilitators and of course the participants themselves.

It is with this view the participants are able and in fact encourage to express ideas and the group has to pick up from that angle so as to allow more ideas to follow. Eventually, once this is allowed the group are able to generate many more creative ideas.

Literature review on action research

Researchers, scholars, scientists and students had in the past been very familiar in conducting researches by using the traditional or conventional ways. But over the years the application of action research has gained its popularity and has been widely used in researches related to real life problems. In fact the action research methodology had been used in organisational problem solving in the American Industry as early as in the 1940's. It is a form of collective self-reflective enquiry undertaken by participants in the social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out.

Perhaps it is important to note how action research works by referring to the pioneering work of Kurt Lewin (1890- 1947) better known as the founder of action research. Hart and Bond (1995) for instance, outlined a comprehensive history linkages and divergence in the emergence of differing action research approaches. However, some writers argued on the origin of action research. Hodgkinson (1957) for instance claimed that the emergence of action research was actually traced back to the work of Collier in North America between 1933 and 1945 as commissioner at the Bureau of Indian Affairs.

Even though there are two different thoughts about the emergence of action research, Hart and Bond (1995), maintained that due recognition should be attributed to Kurt Lewin. In Hart and Bond (1995), Lewin's proposal in action research involves a series of steps which is initiated by a general idea and a general objective.

The first step was to examine the general idea in relation to the means available for reaching the objective, including more fact-finding about it. From this, an overall plan was developed about how to reach the objective and a decision was taken about the first action step, which might involve a modification of the original idea. Eventually, the action step was then evaluated, modified, re-planned and making decision about the proceeding step.

They further elaborated that from then on the next step is composed of a circle of planning, executing and reconnaissance or fact-finding for the purpose of evaluating the results of the second step, for preparing the rational basis for planning the third step and for perhaps modifying again the overall plan. In other words, the whole process would turn out to be in a spiral order each of which is composed of a circle of planning, action and fact-finding about the result of the action. The spiral of action research cycles can be depicted in Figure 3.1.

From the diagram in Figure 3.1, it is noted that the action research methodology follows a cyclical pattern of planning, action, observation and reflection. Improvements occur as the action research moves along one mini cyclical route to the other.

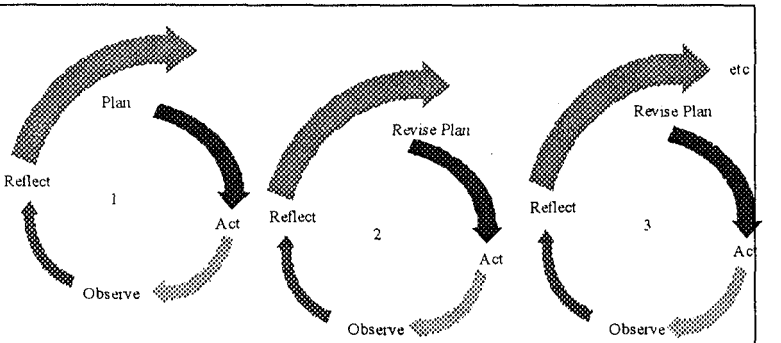

Figure 3.1: The spiral of action research cycles

Source: Zuber-Skerrit (1996, p.95)

In practice, the process begins with a general idea that some kind of improvement or change is desirable. In deciding where it begins in making improvements, a group identifies an area where members perceive a cluster of problems of mutual concern and consequence. The group decides to work together on a thematic concern. However, before an action research can begin, there must be an acceptance of its goals and methods as well as a positive and co-operative attitude among those who are carrying it out.

According to Cunningham (1993, p. 70), there are five sequences which form part of this initiation effort; entry, forming an action research group, developing goals for the group, training the action research group, and drawing up on a research agreement that will be conducted.

Entry

In an action research process, anyone in the organisation can initiate and in order for it to be successful, he must be personally interested in examining the organisational processes and taking action. In an ideal situation, organisational participants, on their own become aware of the problem and the need for change. Awareness of the need for change in the organisation may come even from an interested and motivated lower ranking officer in the organisation. However, commitment from top management should precede the research. Most importantly, the action researcher must also have the co-operation from other members who share the same interest in the organisational problem. In short, it is important that before the research can be carried out, a formal access to the organisation through the top management must be done.

Forming the action research group

In this kind of research, membership of the group would ideally be composed of those in the focal organisation or work groups who are in the position to initiate action, those with the obligation to respond, and committed to the problem's resolution. Every member of the group should be briefed on what is expected out of them as required by the action research method.

Development of goals for the group

In order for the action research group to function as a team, it must define common goals evolved from its need to solve a problem or plan an overall direction. The goals provide an orientation for the research effort, effectively focusing and co-ordinating the many aspects of the research.

Training of the action research group

As people cannot make intelligent choices about action research techniques, group building from the start is necessary. This is to make the group's research genuinely co-operative and effective. The best way to train the research team would be by demonstration or practical application. Action research for this matter provides this kind of exposure.

The research agreement

The authority at top management of the organisation should be well informed and briefed of the purpose of the study. Obtaining this access would facilitate the researcher in getting the permission to conduct the research. The action research agreement can be proposed by members of the group or it can be secured indirectly through members of the action research group who are connected to other legitimising agents. A well-defined agreement would include a statement of needs, goals, justifications and expectations. This in turn leaves little question as to exactly what activities the organisation is authorising and supporting.

Another very important component in action research is the people. Hart and Bond (1995) cited research of the Harwood factory where earlier attempts by the management to improve and bring about changes in high turnover, low productivity, restriction of output and aggression towards management failed. The changes in these characteristics were attributed in three ways. Firstly, the group did not participate in the changes, secondly the group participated through appointed representatives and thirdly the group as a whole participated fully in all aspects of the changes and took part in discussion with the management. Thus, for action research to succeed, a careful selection of committed people must be made available and it should work with the commitment and blessing of the top management of an organisation.

A further elaboration of how action research works was cited by Hart and Bond (1995, p.22) in Susman and Evered (1978:589-90) which states that the cyclic process of action research has characteristics which make it appropriate to the needs of organisations. It deals with practical and real life concerns of people about the future of their ideals, goals and intentions.

This means that action research provides a mean to enhance the system of problem-solving and communication, thus enabling the organisation to adapt to its environment better; it serves to alleviate the problem and to generate new knowledge about the system. The role of the action researcher which is synonymous to the set facilitator in action learning would be as a catalyst to help members define a problem, think differently about an existing one and interventions made by the researcher would offer a new way or method to think about the old problem.

Hart and Bond (1995) in Action Research in Context, the process and practice cited many examples of organisations which applied action research for problem-solving. Action research were applied extensively to address and alleviate problems in the U.S.A and Britain for electronics corporation, Xerox corporation, the community development projects, education and nursing. Perhaps one that cautioned the possibility of failure in using action research is the research that took place in an electronic corporation in North America. In this study the top managers feel that they were being threatened. However, as Pasmore and Friedlander (1982, p. 350) cited by Hart and Bond (1995, p.25) cautioned that researchers engaged in action research must prepare management for the shock of dealing with the information gathered by a group of people which is actually the action research group.

The work of Abraham (1997) in Exploratory Action Research for Manager Development under the subtitle of Establishing the Gap in literature gives an account of the use of an action research methodology in the design and implementation of a management training and development programme that addressed the needs of indigenous community leaders. One of the most fundamental aspects in action research is the general plan that emerged from fact-finding that serves as a blueprint for action and a decision made regarding the first step. Quoting from Lewin (1947),

Abraham (1997, p. 17) mentioned that the general plan should be flexible and not frozen. Thus he further stressed that :

> "...accepting a plan does not mean that all further steps are fixed by a final decision, only in regard to the first step should the decision be final. After the first step is carried out, the second step should be investigated whether the effect of the first action was actually what was expected."

Following this protocol in action research, it is of paramount importance that once the first step does not comply to what is expected then further investigation should be made. In other words a new approach or a modified approach with regards to the first step should be introduced to avoid failure.

Similarly to what Hart and Bond (1991) has suggested, Abraham (1997) stressed in action research, the role of the researchers differ from that of the traditional research. In this respect the researcher is part of the group or the action research team or having a participatory emphasis. As such, the researcher's duty is to record the implementation process in order to evaluate the effectiveness of such actions so that the plan for the intervention can be modified based on the experience at the project sites. As part of the action research group he has to work collaboratively with the members to address problems that are of concern to the group which is also termed as the thematic concern. This method consists of cycles of planning, action, observation and reflection which are repeated to form a spiral.

Collectively Abraham (1997) listed twelve characteristics of an action research. This include that it must be problem focused, collaborative in nature, must be based on ethics, experimental in nature, re-educative, emancipatory, should be naturalistic, normative and should have group dynamic which involves a group of people working together collaboratively to solve a mutual problem. The twelve characteristics of action research as summarised by Abraham *et al* (1997) can be seen in Table 3.1.

Another definition of action research is what Burns (1997, p. 346) termed as the application of fact-finding to practical problem-solving in a social situation with a view to improving the quality of action within it, involving the collaboration and co-operation of researchers, practitioners and laymen. He applied action research based on the Lewin's cyclic model which he further developed to involve seven stages.

The first stage, involves the identification, evaluation and formulation of the problem or general idea perceived as critical in an everyday teaching situation. Stage two, is the time for fact-finding so that a full description can be given of the situation. Meanwhile stage three involves a review of the research literature. Stage four is the gathering of information relevant to the research. Stage five, decision on the selection of research procedures such as choice of materials and resources. Stage six, involves the implementation of the action plan. Finally in stage seven it involves the interpretation of the data and the overall evaluation of the project, often by writing a case study.

	Characteristics	Description
1	Problem Focus Characteristic	The action research method is problem focused in the context of real life situations and the solving of such problems in a research sense would contribute to the practice and development of social science knowledge
2	Action orientation Characteristic	The diagnosis of a problem and the development of a plan can only be considered to be action oriented if it becomes part of the process to implement the plan. This brings an action element to the solving of an immediate problem of the organisation which has strategic change implications for the organisation.
3	Cyclical Process Characteristic	The action research method involves cycles of planning, action, observation, and reflection(evaluation).Also the cycles of the action research method allow the group members to develop a plan, to act, to observe and to reflect on this plan and to modify this plan based on the needs of the group members and the requirements of the organisation and situation. A record of the processes of each cycle enables its strengths and weaknesses to be reviewed so that modifications and strategies can be developed for future cycles.
4	Collaborative Characteristic	Collaboration is a fundamental ingredient of the action research method, because without this team effort to solve problems in an environment of participation, action research cannot exist. Collaboration on group problems using the action research method can be viewed as a continuum from total dependence on the facilitator, who acts as a leader directing the group problem solving process, through to the total management of the problem by the group members with the facilitator acting as a resource person. The position of the facilitator and the group on this continuum depends on the situation and the needs of the group.
5	Ethical Characteristic	Community interest, improvements in the lives of the group members , justice, rationality, democracy and equality are some of the themes of 'ethical' behaviour. The ethical basis of action research is an important characteristic to consider, because the action research method involves, to a large extent, groups of people with limited power who are open to exploitation. It behoves the researcher to compromise his/her personal needs so that the needs of the group are given the highest priority.

6	Experimental Characteristic	Experimental action research involves the rigorous testing of hypotheses and can thus contribute to knowledge in social science. Nevertheless, the quality of the action research may be affected by the control group which can lead to other problems and complications.
7	Scientific Characteristic	Since the action research method does have a scientific basis and can provide an alternative to the positive view of science, it is essential that the research be conducted in such a way as to defend itself against criticisms of lack of scientific rigour.
8	Re-educative Characteristic	Action research can be viewed as re-educative, since it contributes to a change in the knowledge base of the client organisation, a change in the skills, attitudes and knowledge of the researcher. It also makes some contribution to several of the social sciences.
9	Emancipatory Characteristic	The action research method includes an emancipatory characteristic which will result in some improvements in the lives of the people involved in the action research project, and may also lead to wider social action and reform.
10	Naturalistic Characteristic	If one accepts that action research should be scientific but that there are problems in adopting a positivistic model of science and applying it to social science settings, then follows that a naturalistic approach is appropriate for the action research method.
11	Normative	The normative characteristic of action research implies that the social 'norms' of the group are not only considered during the research, but, in order to bring about change in the group, they are modified during the action research process.
12	Group dynamics Characteristic	The success of the action research method will depend on how well the group can operate as an effective team. An understanding of group dynamics therefore seems essential in facilitating this process and dealing with problems that arise during the action research cycles.

Table 3.1. Twelve characteristics of action research

Source: Abraham *et al* (1996, p.13-14)

Hart and Bond(1995), Abraham(1997) and Burns (1997) shared the same view that in action research the role of the researcher is clearly defined. Burns (1997) however, simplified the role of the researcher in

action research as the initiator of the research, a resource person for advice and information as well as a teacher to the certain group.

The other renowned researchers who used action research in their studies are as seen in the work of Kemmis and McTaggart (1988, p.5).They defined action research as a form of collective self reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices as well their understanding of these practices and the situations in which these practices are carried out.

Literature review on action learning

It is appropriate that a brief literature review of action learning be highlighted in this study as the use of action research involves members of the research group who are in a way also involved in the process of action learning .

Cunningham (1993, p.24) described action learning as "a strand learning which is philosophically connected to the action research tradition. It is based on training process which is experienced based, and highlights the process of learning by doing." This concept was further developed by Reg Revans in coal mines and later on spread it to hospitals, schools, factories and offices. Subsequently after working on the specific organisational problems, Revans developed an action learning formula as L+P+Q. where L is for Learning, P for Programmed Knowledge, and Q for ability to ask for right questions.

Various definitions of action learning evolved in recent years and one of it is the definition by McGill (1992, p. 17) who described action learning as a

> "continuous process of learning and reflection, supported by colleagues with the intention of getting things done. Through action learning, individuals learn with and from each other, by working on real problems and reflecting their own experiences."

Perhaps the most recent definition on action learning is in the work done by Inglis (1994, p.3) who defined it as

> "a process which develops people and organisation using important issues confronting the organisation as a vehicle for doing so. In action leaning, these two aspects are always present – the growth and the development of people and of organisation, and simultaneously finding of solutions in problems."

The action learning has various features which characterised it from other forms of learning. First, in action learning it must be problem focused. In other word, the action learning process should be used to address real problems and not merely hypothetical problems or case studies.

Secondly, there must be client. This is important as the participative role of the client is vital since the action learning process is organisationally driven. In this respect, for an action learning to take place a written agreement or consent from the organisation by the top management should be made available.

Thirdly, the project component should be available. The problem is the basis upon which a project proposal is developed and to be implemented by the group members.

Next is the group, as action learning cannot be done on an individual basis. The number of each group varies depending on the project but basically it ranges from 3 to 6 people. This group of people are referred to as 'sets' and they should be interested in the problem because at the end of the project measurement has to be based on 'sense', 'serve' and 'satisfy'.

As sets are also confidential group therefore it is the obligation of all set members to adhere to this setting. Any issue discussed within the group should be kept confined among the set members only. In this way, the members can feel free to be open and honest without fear of being the victim of the subject. Over time, the set becomes a group of people who build up trust among themselves. It is the trust that enables them to begin to talk about issues of real personal concern or admit to any lurking fears.

The other roles of the set members is that they must be supportive and at the same time can challenge the opinion of other set members. Sets will be non-judgemental of others but rather a place where people can come and be open and honest about themselves and others. They are required to give and receive honest feedback as this itself would conform to the operation of how set works.

Another characteristic in action learning is the availability of questions. For action learning to occur, every group member should question issues that arise. Issues raised by other group members and even the new knowledge that is being shared by the group members and the facilitators should be addressed. In other words there must be synergy. This group should meet regularly to discuss and resolve issues pertinent to the group. In this way, each member of the set would continuously be dwelling on issues or problems common to the set.

The sixth characteristic in action learning is the presence of facilitator or known as set adviser. The role of the facilitator in this case is to provide guidance to the group by playing different supportive role based on the needs of the group and the nature of the situation. To initiate this to happen, the main task of a set adviser or facilitator is to encourage the set and each individual within it to look, listen and question, understand and learn. The next important role of the set adviser is to create a conducive environment for learning as it has been proven that people learn and work effectively within a conducive setting.

The next important characteristic in action learning is the evolvement of new knowledge. This new knowledge is provided by the facilitators and the tutors in their respective areas of expertise. Along with that, views from every member of the set are also taken into consideration

as each member has his own part to play as each member is given equal opportunity to voice out their views and ideas.

Another characteristic in action learning is the presence of group learning as it cannot be done on an individual basis. In this respect, members learn from each other by working on real problem by reflecting on their own experiences and new knowledge that they have acquired. The real problem that the group worked on should be substantiated by evidence that can be quantified.

Creative thinking process is another characteristic of action learning. In this situation individual members and the group as a whole would undergo various processes such as saturation, deliberation, incubation, illumination, and accommodation. Perhaps of no least importance in action learning is the evaluation. This is an important aspect to find out whether the result obtained from the process is significant or not. In other words, the result obtained can be used as benchmark for other projects that would follow later. However, in action learning it is imperative to note that the result must meet particular objectives and to have this materialise the learning processes should be identified and manages effectively.

Action research methodology adopted for the study

It is evident from the discussion that action research and action learning processes overlap one another. In other words, while action research is conducted, the action research group members are also involved in action learning.

The action learning which is a component of action research used in this study provides a researcher as well as the action research group members to learn through discussions and meetings undertaken. Meanwhile action research is chosen for this study as it is considered suitable in collecting data in a more systematic way. The process which ultimately leads to improvement and change involves understanding the system, defining solutions and discoveries, applying and modifying these solutions and assessing the results of the actions.

As the action research methodology involves forming an action research group, the study had chosen six members which are shown in Table 3.2.

Group Members	Reason for member to be involved
1. The researcher 2. Assistant Director 3. System Analyst 4. Programmer 5. Digitiser 1 6. Digitiser 2 7. Draughtsman	As a facilitator The members are experts in their own fields and would be able and competent enough to address and resolve issues pertinent to this study. Moreover, they are involved directly in this subject matter.

Table 3.2: Action group members for the study

In order for the of research to be carried out more effectively within a limited time frame of six weeks, a research schedule is provided as in Table 3.3.

No.	Role	Duties
1	Researcher	• Courtesy call on the Director and Deputy Director of State Planning Unit. Submit a proposal regarding the research topic, explain about the project, purpose of the study and most importantly, explain how action research would be carried out • Discussion with the Principal Assistant Director (HRD) who is in charge of the research, on the proposal to conduct research and briefly explain the modus operandi of the research
2	Researcher	• Inform and to get consent from the Deputy Director and Principal Asst. Director (HRD) on the need to involve officers from the organisation (State Planning Unit)
3	Researcher / Facilitator	• First socio-technical action research group meeting Activities (i) Brief the group members on the study to be undertaken by using action research

		methodology (ii) Why group members are chosen? (iii) What benefits does it give to the organisation and members? (iv) How does the group members participate and contribute?
4	Researcher / Facilitator	• Second socio-technical action research group meeting Activities (i) To discuss on topics pertinent to the study i.e. human resources (humanware), information (infoware), hardware and software (technoware) and linkages with other agencies (orgaware) (ii) to discuss on the first issue - humanware (iii) Researcher / Facilitator initiates the discussion and record the outcomes of the discussion
5	Researcher / Facilitator	• Third socio-technical action research group meeting Activities (i) To discuss on the second issue, i.e. infoware (ii) Researcher / facilitator initiates the discussion and record the outcomes of the discussion.
6	Researcher / Facilitator	• Fourth socio-technical action research group meeting Activities (i) To discuss on the third issue - hardware / software (ii) Discussion and data collection
7	Researcher / Facilitator	• Fifth socio-technical action research group meeting Activities (i) To discuss the fourth issue - orgaware (ii) Discussion and data collection

8	Researcher / Facilitator	• Sixth socio-technical action research group meeting Activities (i) Reflects on findings (ii) Re-plan (if necessary) (iii) Discuss on learning outcomes (iv) Observe action learning taking place within the group members

Table 3.3: Plan for action research in the study

For the purpose of this study, the methodology used include participatory, emancipatory and participant observation. The outcome of each cyclical process of planning, action, observation and reflection would be assessed by the evaluators through the process of triangulation. Two principal assistant directors were involved as evaluators.

Under the participatory method the action researcher would be involved actively in the study to probe into questions related to issues or problems common to the group. At the same time all the action research group would also be encouraged to involve actively in the study by providing information and also questioning in an attempt to resolve the common issues or problems.

This study would also involve a method known as the emancipatory method. Zuber-Skerrit (1996, p.84) defined emancipatory method includes collaborative, critical and self-critical inquiry by practitioners into a major problem or issue of concern in their own practice. In other words they own the problem and responsible and accountable for solving it through teamwork and through cyclical process of strategic planning, implementing the action plan, observation, evaluation, critical and self- critical reflection of the results and making decisions for the next cycles of action. Under this method everybody including the researcher has equal footing .

Another method that would be used in this study is the participant observation. Through this method it is possible to describe what goes on, who or what is involved, when and where things happen, how they occur and why things happen as they do in particular situations. This method provides an avenue to answer the research questions related to this study. As had been stated earlier action research literature preceded action learning. This is due to the fact that action learning is a subset of action research. In other words, while action research method is used to conduct research, action learning takes place within the action research group.

However, the action research methodology was used appropriately for this study based on various reasons. Firstly , action research focused and dealt with real life work-based situations. In this respect the problem

associated with regional and sectoral development planning undertaken by the State Planning Unit is co-ordination. Once the development planning is not properly co-ordinated it would affect the untimely execution of the other processes which includes project design and implementation.

Secondly, as this study is exploratory in nature, the cyclical process involving steps of planning, action, observation and reflection would provide an avenue to source out practices thus generating new and creative ideas.

Thirdly, is the collaborative nature of action research methodology. Under this situation the action research methodology allows an environment of participation thus creating an avenue for interaction among the action research group members. Therefore this situation would give an opportunity to enable the exploration of new ideas as to how effective integrated regional and sectoral development planning for Sarawak can be done through the use of GIS technology. The collaborative aspect can also be related to the group dynamics which are necessary for effective collaboration among the action research group.

In order to realise the effectiveness of this method employed in this study the action research group worked on an assignment to produce a preliminary spatial development plan for the proposed northern Sarawak highlands study.

Process of triangulation

Another important component in action research is the process called triangulation. Triangulation has been defined as a combination of methodologies in the study of the same phenomenon "measurement". Based on the definition, triangulation is supposed to support a finding by showing that independent measures agree with it, or least do not contradict it. The measures are considered imperfect because the researcher usually invents these measures on the spot and that very little is known about their validity or reliability. What makes it even more imperfect is the fact that in action research the measures usually come from the same instruments which is, observations made or conversations recorded by the researcher alone. Thus, when the same instrument is used in establishing and corroborating a finding, this would amount to a potential cognitive conflict of interests.

Basically, there are few types of triangulation. For the purpose of this study two types of triangulation was employed. This includes data sources triangulation and investigator triangulation. For the data sources triangulation this method involves comparing and cross-checking the consistency of information derived at different times by different means within the qualitative methods. Meanwhile the investigator triangulation means using multiple as opposed to singular observers. This method helps reduce the potential bias that comes from a single person doing all of the data collection and provides means of more directly assessing the reliability and validity of the data obtained.

This study focused on the four components of GIS technology; humanware, infoware, technoware and the orgaware. This means that based on these components which act as the plan proposed by the writer were discussed during the meetings with the socio-technical action group members. Included in the triangulation process the writer had chosen two key personnel in the State Planning Unit with the rank of the Principal Assistant Director.

Chapter summary

This chapter had provided rationale for an action research methodology used in this study. The action research group in later stage used this method on a case study where they worked on producing a preliminary spatial development plan for the proposed northern highlands study in the form of digitised maps.

The study had the relevant characteristics which includes among others, problem focused, collaborative, ethical, re-educative, naturalistic in nature and so forth. The cyclical process in this study would not be completed unless a consensus had been made through triangulation.

CHAPTER 4
APPLICATION OF ACTION RESEARCH CYCLES AND PROCESSES

Introduction

This chapter describes the plan for the project as well as the action research cycles and processes undertaken by the researcher and the group members. It also demonstrate how action research methodology had been used in making a proposal for improvement for consideration by the top management of the State Planning Unit.

The action research cycles and processes employed in this research were primarily to explore the utilisation of the geographic information system (GIS) technology as a decision support system (DSS) in an attempt to effect integrated regional and sectoral development planning for the State of Sarawak. The group involved or so called the socio-technical action research group comprised of the writer, an assistant director and five technical personnel attached to the GIS unit within the State Planning Unit. The technical personnel include a System Analyst, a Programmer, two digitisers and one draughtsman.

Following the protocol of the action research methodology, the socio-technical action research group worked on issues associated with the production of digitised maps which will later be used in a preliminary spatial development plan for the proposed study area. It is thus imperative that this group be competent enough to interpret the data and attributes in order to produce a more acceptable and presentable maps for the decision makers.

Before embarking further into the process of problem solving (as in this case is the production of a more presentable and acceptable digitised maps) it is thus appropriate how action research can help to assist the group. Karlsen (1991) as quoted in Whyte (1991) commended that in Norway, research institutes within different disciplines have gradually become interested in the methods employed in action research, with importance being attached to experimentation, participation and development of the understanding and solution of problems through dialogue. Whyte (1991) pointed out, one is not only a researcher and responsible for the research process but rather one is at the same time a participant and jointly responsible for the change process. Although Whyte (1991) distinguishes few types of research but the one closest to this research would be the participatory action research.

In participatory action research (PAR) according to Whyte, Greenwood and Lazes (1991), some of the people in the organisation or community under study participate activity with the researcher throughout the research process from the initial design to the final presentation of results and discussion of their action implications.

Following a brief overview of action research method, this study attempts to explore existing problems related to the use of GIS technology

in producing digitised maps for integrated regional and sectoral planning for Sarawak by employing various techniques such as PAR, participants' observation and emancipatory.

Purpose of the study

The main purpose of this study is to explore the use of GIS technology as a decision support tool in decision - making for integrated regional and sectoral development planning for the State of Sarawak by employing an action research methodology. However, in order to verify the importance of GIS technology as a decision support tool various research questions associated with the technology need to be dealt in detail. It is with the perception that GIS technology had and can assist in the decision-making for planning, therefore the aim in this respect is to verify to what degree it can be realistic. The verification as to what degree output produced by GIS are realistic would be further verified by the decision-makers.

Research questions

As this study employed an action research methodology it is appropriate that an exploratory approach be used. The exploratory approach is used based on the nature of research questions, whereby it requires a team working on certain issues to deal with in detail with the aim of improving or bring about changes every time when applying.

Accordingly as Hartman and Hedblom (1979) quoted by Abraham (1997. p. 63) described exploratory study as: - .

> "An exploratory study examines new areas of inquiry, including new and previously unintegrated social phenomena as well as techniques of data collection and measurement. The design should be employed in areas which theory is lacking or disputed (mixed results), or when concepts, variables, measurement instruments, and techniques are poorly defined. The design should not be used when theory, methods, and procedures are well established in an area and available in literature. A discipline develops through building on work already completed."

Based on the definition, the research questions that need to be addressed under this study should be able to answer the "What" question. It is thus with this view in mind, various research questions pertaining to the study has been put forward to be analysed. The research questions mentioned includes: -

i. Is GIS an effective integrator for co-ordinated integrated regional and sectoral development planning?
ii. How can GIS be integrated into regional and sectoral development planning?

iii. What are the benefits of integrated regional and sectoral development planning?
iv. How could the planners be more effective and efficient in the processing of a plan?
v. Can action research be an approach to improve and expedite the approving process of a plan?
vi. To what extent is integrated regional and sectoral development planning currently being effected in practice?
vii. Could GIS provide for more effective integrated regional and sectoral development planning?

Whilst it is important to deal with the research questions in detail it is useful that the basic application of action research be applied. The application of action research methodology involves the cycles of planning, action, observation, reflection and evaluation. This cyclical process can be depicted in the diagram as follows:

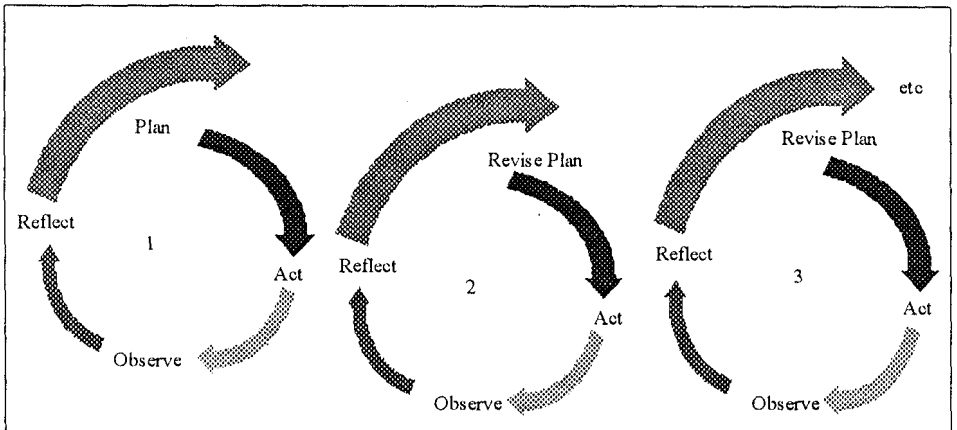

Figure 4.1 : The spiral of action research cycles

Source : Zuber-Skerrit (1996, p. 95)

Findings - Beginning the action research project

Under this section, the process of mini action research cycles including planning, action, observation, and reflection is described. Before the action research can be conducted, initiation process based on the five sequences enunciated by Cunningham (1993) need to be followed. This include entry, forming an action research group, developing goals for the group, training the action research group and drawing up an agreement.

Entry

The proposal of this study using action research methodology was first presented to the top management of the State Planning Unit the site of the research on the 8th September, 1997. The management upon discussion agreed to the topic to be studied. Subsequent to that on the 10th December, 1997 the writer went back to the State Planning Unit to brief the management on the methodology to be applied in the study. Among the subjects discussed were how action research can be applied to solve immediate problems and how it can be applied to produce results that would lead to policies and practices beside providing additional knowledge. In other words, explanation was more focused as to how this study which employed action research can bring about incremental changes to solve immediate problem which is of thematic concern to the organisation. In summary, the proposed project using action research can be depicted as in Figure 4.2.

The top management involved include the Deputy Director, Principal Assistant Director of Human Resource Development and Research Sector and Principal Assistant Director of Agriculture and Rural Development Sector. This group of top management would later be involved in the triangulation process once the cyclical process of action research applied to this study is completed. The letter certifying the researcher to undertake the study is attached as Appendix A.

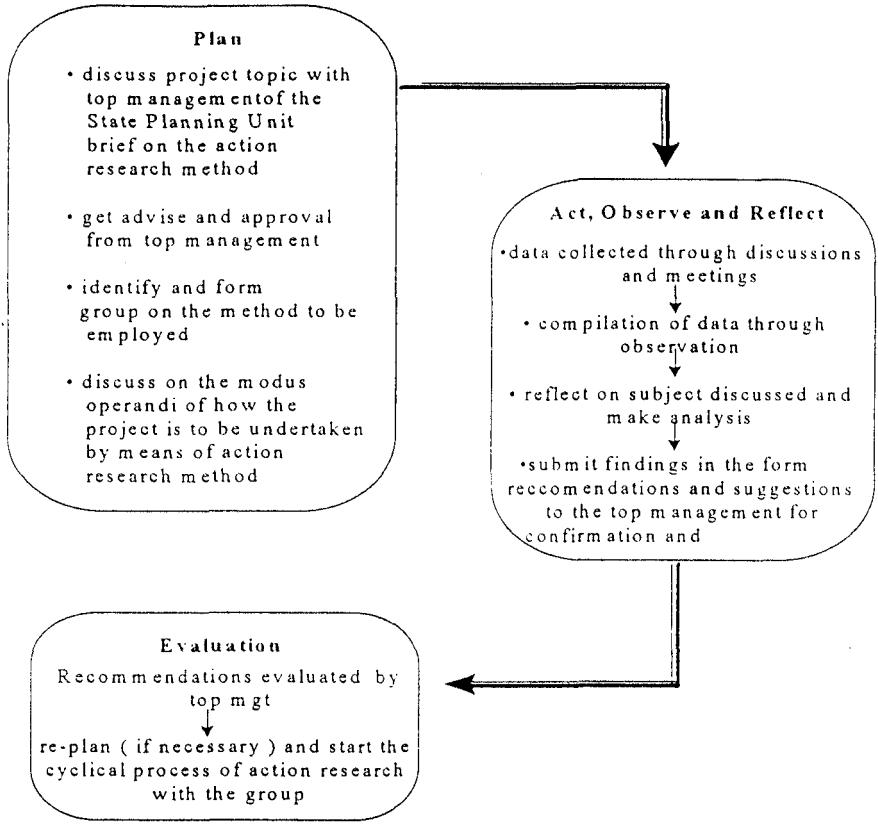

Figure 4.2: The cyclical process for the study

Forming an action research group

After securing the consent from the top management, which consisted of the Director and the Deputy Director of the State Planning Unit, the researcher discussed about the possibility of forming an action research group. The group was later known as the socio-technical action group as the members include a general economic planner, and five personnel assigned to the GIS Unit. The letter of appointment to the group members is attached in Appendix B.

Development of goals

Finally the first meeting with the Socio-Technical Action Research Group was convened on the 11th December, 1997 at 10:00 a.m. Like any other meetings the first thing that the writer did was to inform the group about

the intention of the study and the benefits it would provide once the study is completed. He further elaborated that there would be a series of meetings and would be focusing on four main areas; human resources; data and information; hardware and software; and the linkages with other agencies. Every member of the group seemed to be aware of the writer's intention as they had been informed about this earlier on by the management. This again showed how serious and supportive the top management was. The writer find no problem dealing with the group as everyone was exposed to meetings and discussions conducted by other researchers and consultants in the past. For the purpose of anonymity the group members requested the writer not to reveal names when quoting statements. The writer agreed to keep sensitive issues raised strictly confidential. The other aspect that the group discussed on was how the project would benefit the organisation as well as the GIS Unit in future.

Training of the action research group
As action research requires full co-operation and participation from all the group members the researcher briefed the members on the need for everybody to participate fully in the process. This was to ascertain that training would take place and this was done by way of demonstration or practical application where members are allowed to air their views. The researcher who acted as facilitator made sure that this situation happened and gave assurance that every point raised would be recorded and analysed.

The research agreement
During the courtesy call on top management of the State Planning Unit an assurance was made in order for the researcher to gain access to the organisation to undertake the research. In other words the top management had consented that this project would be carried out and informed the researcher to make a detailed study on the use of GIS technology for planning purposes. The letter of approval and consent is presented as in Appendix C.

Action research process

As the writer has agreed to the request by the group members not to reveal names, when quoting statements, the proceeding of the meeting was done smoothly though at times there were some dissatisfaction and grievances aired by the group members. Basically the problems faced by this unit can be divided into two. First, with regards to human resource and secondly on the physical aspect which included the overall set-up of the Unit. Under human resource aspect, the group members felt that there should be a planner to oversee, to guide and support them in their day to day work. It is important to note here that after an officer assigned to supervise them left in 1996, the unit was left alone without anybody to oversee and act as intermediary between the unit and the management. They further stressed that the planner should be conversant on the sectoral

work as this is important especially in conceptualising the requirement for GIS output. On top of that the person should be knowledgeable on GIS as he would be able to appreciate any shortcomings. The person should also be able to anticipate the future needs of the sectors or the organisation as a whole.

On the physical aspect, the group members expressed their concern on the future requirement of the unit especially in terms of the infrastructure which includes software and hardware related to GIS. Beside that they also expressed their concern on the data and information which according to them were either not available or obsolete. With regard to maps for instance, the limitation was the unavailability of maps with scale 1: 50.000. Most of the available maps came in with scale of 1: 250,000 which according to them were not detailed enough and had various limitations.

From the first meeting it was observed that only a few members responded well even though the questions posed were very general in nature. This could be due to the fact that questions are either not relevant to their job or perhaps those type of question be best answered by their senior in the unit who happened to be very conversant and knowledgeable with GIS technology. The first meeting lasted for two hours and was adjourned at 12:00 p.m.

Issue of human resources (Humanware)

As agreed in the first meeting with the socio-technical action research group on the 11th December, 1997 a series of meetings would be held focusing on four main areas which include human resources (humanware), data and information (infoware). hardware and software (technoware) and the linkages with other agencies (orgaware).The four areas mentioned were highlighted basically because with GIS, these aspects are vital in order for the technology to be an effective tool as a support system.

The second meeting held on 6th January 1998 was attended by all the members and the topic for discussion was primarily on the issues of human resources or the humanware. Within the present set-up GIS unit is composed of five personnel out of which two are executives (System Analyst and a Programmer), two digitisers and one draughtsman. With the exception of the draughtsman all the rest are staff seconded from SAINS, a private organisation wholly owned by the State Government.

During the meeting a free flow of ideas and concern were discussed. Unlike during the first meeting which was dominated by only one member within the group, this time around majority of them expressed their views and opinions especially with regards to issues on human resources. Their main concern was the voluminous workload assigned to them lately. Whilst they were concerned with the volume of work they were also required to complete the task in a fairly unrealistic time-frame. Coupled with the lack of required data, their problem had been made more serious when at times they were required to do desk top publishing work. Towards this end they

unanimously requested that the unit be provided with additional manpower. Right now the existing manpower could only serve one sector within the State Planning Unit, but as more and more sectors required GIS technology as a decision support system they felt that the existing manpower is not adequate to perform the tasks. The other aspect that they were concerned with was the proposal to establish a central GIS for the State, which may be housed in the State Planning Unit. Towards this end, one of the members of the group informed that in early 1997 a group of consultants had already made a study on this proposal. If this were to materialise then realistically more personnel need to be deployed to the unit.

The other pertinent aspect in relation to humanware that was brought forward by the team members were the issue of career path. This concern was very pertinent to the digitisers and draughtsman and the question raised was where do we go from here. Is there any opportunity for promotion? Presently as there is limited movement for them to go elsewhere (unless to the private sector) will there be any opportunity for them to be transferred to other departments once the Central GIS Unit is formalised. This question of career path was discussed at length and at this juncture they showed some dissatisfaction as the future was uncertain for them. Related to this issue was the destiny of the personnel once the Central GIS Unit comes into reality. If they were to be absorbed into the new management would they be enjoying a better offer in terms of perks and benefits. At this juncture the writer enquired whether it would be better for them to join the Central GIS Unit and they unanimously replied that they would be more than happy to join as they perceived that they would be taken good care. In other words they can have a sense of belonging to the organisation. As they were then with the exception of the draughtsman, they felt that they were being neglected and they have no avenue to pose any grievances. The effect obviously can cause tension among the personnel.

The other aspect related to the humanware discussed was how appraisal system had been handled. As mentioned earlier four of the personnel were seconded from SAINS and strangely their appraisal was done by their head office who knew very little or nothing at all about what they were doing in the State Planning Unit. They felt that their performance appraisal was not done in a proper way. Their grievance was again tied done with the set up of the unit where they were left on their own without any supervisor looking after them.

The same problem arose with regard to opportunity for training. As training is handled by the human resource manager who is in a different office, they see that their opportunity for training is rather slim. This was evident as most of them especially the digitisers only went to attend training once in five years. They only gained experience when they were attached to the Sarawak Agriculture Development Project (SADP) and that was done locally or in-house training some years back.

Basically with regard to the issue of humanware that were discussed within a period of more than two hours, the group members felt that there should be a proper system in GIS unit. They need somebody or a supervisor to oversee them and at the same time act as a mediator between the unit and the management (State Planning Unit). Beside that, they felt there should be a system design for career pathing and a proper handling of their performance appraisal. Training was another pertinent issue and the writer while attached to the State Planning Unit for many years endorsed the notion that it was rather unfortunate these group of people has little opportunity to attend training or seminars related to GIS technology.

The second meeting ended at about half past twelve noon with everybody eagerly looking forward for the next meeting. During this second meeting with the group the writer observed that most of the members participated in the meeting and provided valuable ideas and prepositions for reflection. Although at times the situation was rather tense especially when it came to career path and training, but with the writer as facilitator, the situation was amicably settled. The writer also observed that the group members were more at ease during this stage as compared to the first meeting but still kept the reservation that they want the critical statements be kept confidential. It was further suggested that they would like to see the reports later before submission. To this request the writer obliged and promise them that the report would be accessible by them once it was completed.

As time was a limitation to undertake this study, a third meeting was conducted a day later and that was on the 7th February, 1998 at 9.00 a.m. The venue of the meeting remained the same i.e. at the GIS unit as the writer felt that it would be better to keep them feel at ease and at the same time can take break off once their service were required by the management.

On the issue of humanware the most pertinent to them after the discussion on the 6th January, 1998 was training. Everyone was requested to reflect on this particular element under humanware and to suggest why training was important to them. It was indeed strange to see that since the establishment of GIS unit within the State Planning Unit the members had little opportunity to attend training or seminar. Most of them learned the software packages by themselves. However, with this opportunity they voiced their concern that if this were to prevail they would be left out in terms of new knowledge and technology.

With regard to the specific training required, the members felt that they should be given the opportunity to attend advanced training in the application of ARC/Info software. They were actually exposed to this software way back in 1991 under the SADP project and it was conducted in-house. The other training specified were Map Info and ARC/view software. With regard to the locality of training they suggested that they preferred to attend the training somewhere outside the state as this would give them the exposure to meet other participants and in this way they can learn and judge themselves with other users of GIS technology. In this way they can

learn both theoretically and practically as they feared that the equipment used by the trainer might be different from the available equipment at GIS's unit.

Based on the reflection on humanware especially on training the writer observed that the members were very eager to undergo training to enhance their skills. It was further observed that training was not offered to them for various reasons. Firstly, four out of five of the members were personnel seconded from SAINS and the management (State Planning Unit) felt that the issue of training be handled by SAINS. Secondly to date they have come up with results preferable by the management and thus making the management complacent and the need for training did not arise. Thirdly, with different physical location between the personnel and SAINS, they claimed that they were being neglected or overlooked when it came to training nomination. The cyclical process of action research with regards to the issue on humanware can be summarised as in Figure 4.3.

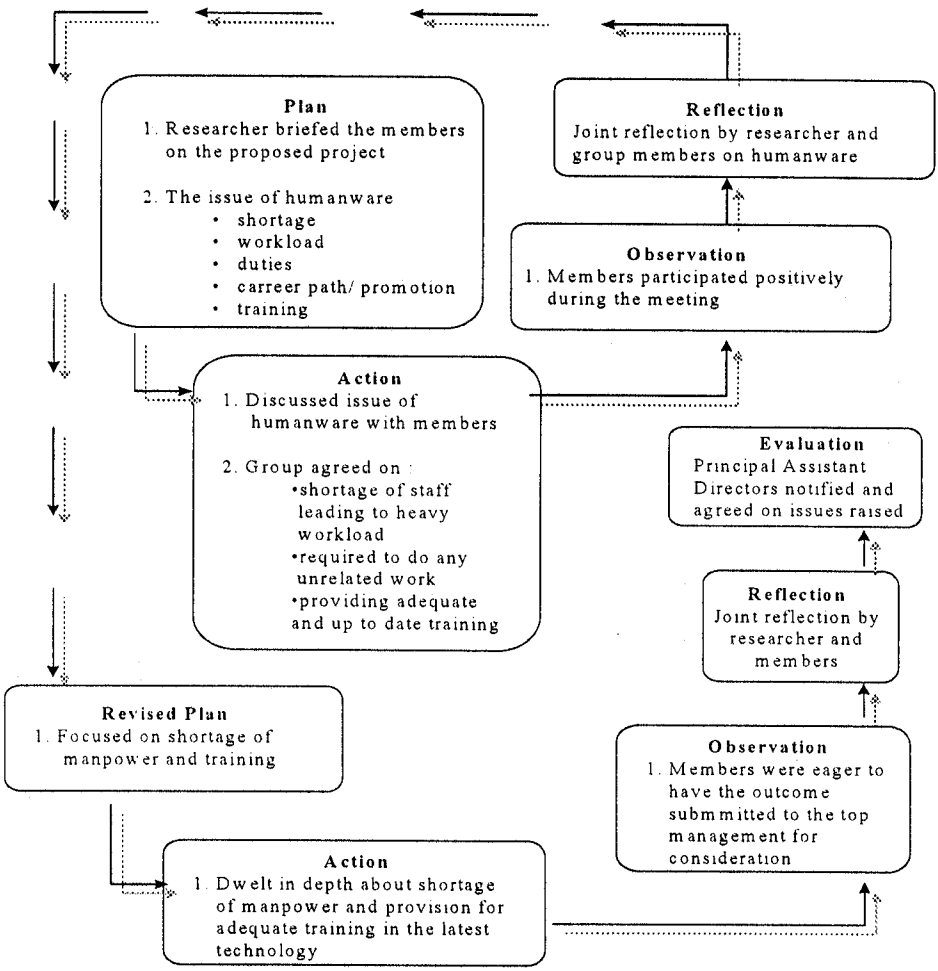

Figure 4.3 : The first mini cycle of the action research process

Issues of data and information (Infoware)

Once the issue of humanware was over, the group continued on to discuss the second important component in GIS technology and that was the data and the information or what is termed as infoware. The approach applied under this issue was similar to that of humanware. Unlike in the first few meeting this time around the members were more responsive. The role of the writer was more as a facilitator and probed into questions related to the issue so as not to deviate too much from the objectives of the study.

Firstly with regard to the infoware was the issue of availability. The System Analyst explained that there were two categories of maps, the analogue and digitised forms. It was interesting to note that since 1991, they had been working on keying inputs into the system and as a result most of the state maps were now in the digital form with different scales. However, due to the unavailability of larger scale maps, digitised maps were mostly with scale of 1: 250,000, 1: 500,000, 1: 1,000,000 and 1: 2,000,000. These scales according to them were not detailed enough and can only be used to roughly estimate the area required.

With the availability of these digitised maps the group had so far worked on keying in extra inputs such as the natural features of the area which include rivers and soil types. Besides that, inputs on the other features such as roads and other land use had also been included. These maps would act as base maps for the purpose of overlaying with other required attributes later. However, there seemed to be problems associated with the production of digitised maps once the data available were not sufficient. It was at this juncture the group felt that the officers from the sectors that requested the maps should provide sufficient and up to date information. In other words to produce a more reliable digitised maps for the purpose of planning, there should be a collaboration between the requesting officers of the State Planning Unit and the GIS unit.

This linkage was important as the members felt that it should be the duty of the requesting officer to provide them with relevant information. At this juncture the members recalled the suggestion of having a human resource person to oversee as well as act as mediator between the GIS unit and the sectors within the State Planning Unit. The person should be able to negotiate not only in term of requesting for information but also in term of realistic time in the production of outputs. This was important to avoid unnecessary delay as well as to be able to produce outputs according to the requirement of the requesting officers.

Based on the reflection on the issue of infoware, the writer observed that the members agreed about the unavailability of large scale digitised maps. As a result, very often the result of the outputs could not be interpreted correctly and hence they would have to redo the whole process of digitising. The other aspects that was highlighted was the collaboration between the GIS Unit and the sectors within the State Planning Unit. At the present moment, these two sectors worked independently. The cyclical process of action research with regards to the issue of infoware can be summarised as in Figure 4.4.

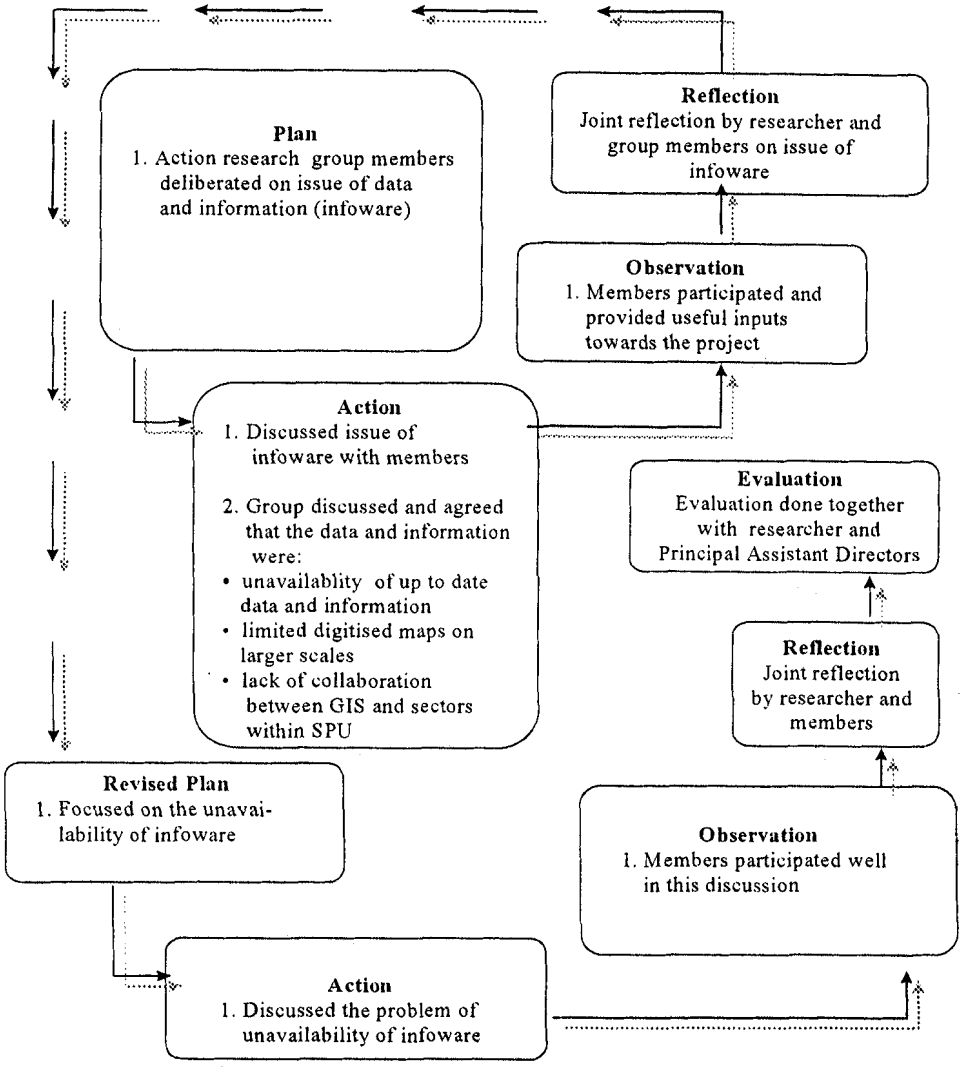

FIGURE 4.4 : The second mini cycle of the action research process

Issue of hardware and software facilities (Technoware)

Following the same procedure in the previous meetings with the group, the third meeting which was held on the 10th January, 1998 focused on the third component of GIS technology, the hardware and software facilities or so called the technoware. Ever since the set up of GIS technology, the unit had been equipped with relevant software and hardware facilities to enable the unit to produce the required output. However, the level of sophistication of the facilities was still at an operational level.

Basically the hardware facilities available included 4 units of PC Pentium, 1 unit of 386 PC, 4 units of AO digital table, 2 units of A3 printer and 1 unit of AO pen plotter. Meanwhile the software facilities available included Windows/PCARC/Info, Windows/SPANS and Windows/ARC/View. These components of hardware and software available were all at stand alone PC-GIS level.

Although the level of sophistication of the facilities were seen to be adequate at the present moment, the group members felt that in the near future the unit should be equipped with a workstation of ARC/Info as these facilities can perform a more advanced GIS analysis. Everybody felt that the workload assigned to them had increased and it was high time that they should be operating on a workstation facility. It was at this juncture the group members felt that there was a necessity for them to undergo training in the use of a more advanced GIS technology rather than to wait until the unit be supplied with this facility.

As all the members were already exposed to ARC/Info software, every member expressed satisfaction working on projects using the software. However, according to them they would like to try using other packages available nowadays. The writer in his capacity as one of the officers in the State Planning Unit gave them the assurance that this matter be brought forward to the attention of the management to consider but first a detailed study need to be conducted especially in term of cost-effectiveness of the facility.

During the discussion on the aspect of hardware and software facilities, the writer observed that all the members were competent enough in handling the facilities. This was due to the fact that all of them had been exposed to the technology since 1991 and moreover they had been using it ever since. Their primary concern was how long were they going to use the available facilities. They required change and that could be realised if they were given the opportunity to have hands on practical experience with the other more advanced technology. The cyclical process of action research with regards to the issue of hardware and software facilities can be summarised as in Figure 4.5.

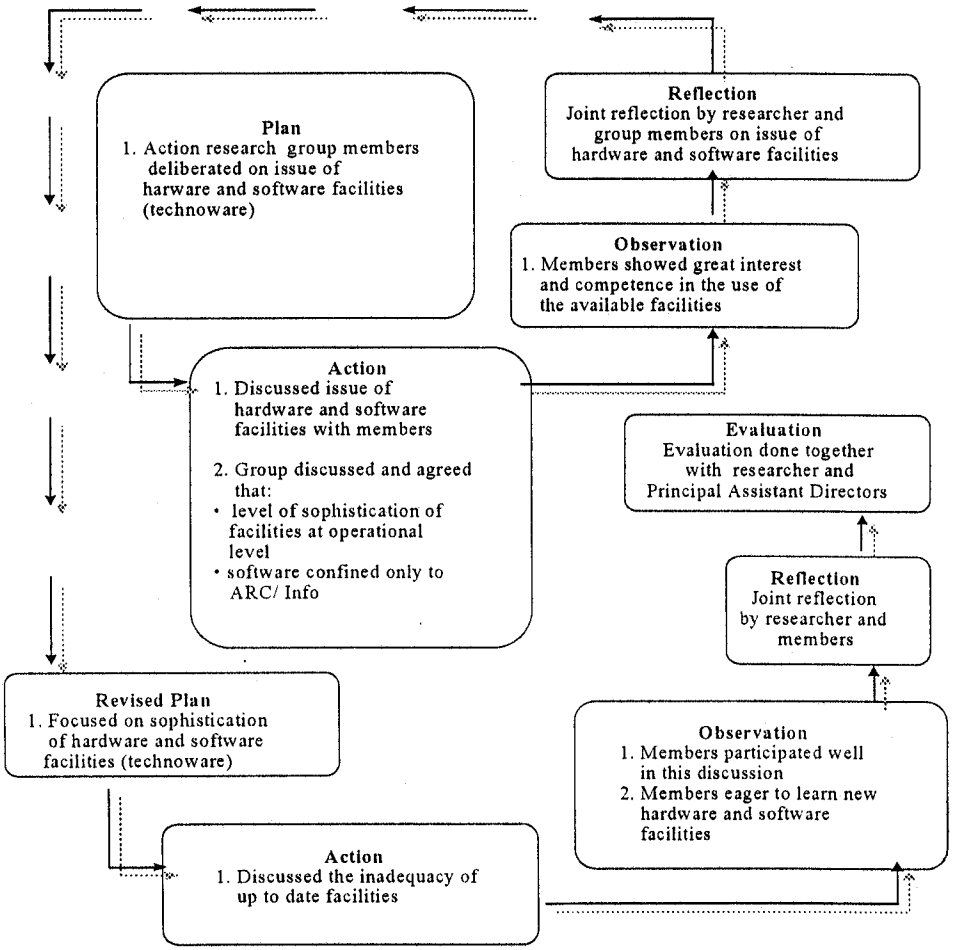

FIGURE 4.5 : The third mini cycle of the action research process

Issues of linkages with other organisations (Orgaware)

Related to the issue of GIS technology, the group also discussed on the organisational matter or so called the orgaware. The aspect focused was on the linkages and co-operation with the other government agencies especially the Land and Survey Department, Public Works Department, Agriculture Department and Forest Departments. These departments were important in the sense that they have the up to date information on the

respective land use. The members experienced at times they could not get the information from these departments and they have to produce digitised maps with the available attributes which may not be very accurate. They felt that co-operation in terms of data sharing should be in place and they suggested that these departments should provide the required information in the digital format to GIS Unit of the State Planning Unit regularly. The work of this collaboration should be done by a planner in charge of GIS Unit.

Towards the end of the discussion the group members made useful suggestions from their view point if GIS unit were to be expanded in future, firstly, they suggested that there should be software support person to do the maintenance. This support person can also be utilised as a general technician to do other back up services. Secondly, they suggested that emphasis on R & D should be in place. They viewed that in future work, will be more challenging and thus require more advanced analysis. Another suggestion was to establish a resource centre in GIS as this would provide them with the opportunity to get access to the resources related to GIS technology. The group felt that since this issue was beyond the control of the research group, therefore it was suggested that they should not discuss this matter in depth.

The meeting ended with nearly three hours of deliberation. As time was a limitation to the writer, he informed the members that the next meeting could only be convened during the second week of February, 1998. The subject to be deliberated during the meeting would be more focused on an assignment to produce a preliminary spatial development plan for a study area. The group members were anxious as they see that this was an opportunity for them to show how the outputs were being produced and at the same time grateful because it was rather rare that the officers involved themselves in the work. The cyclical process of action research with regards to the issue of linkages and co-operation with other organisations can be summarised as in Figure 4.6.

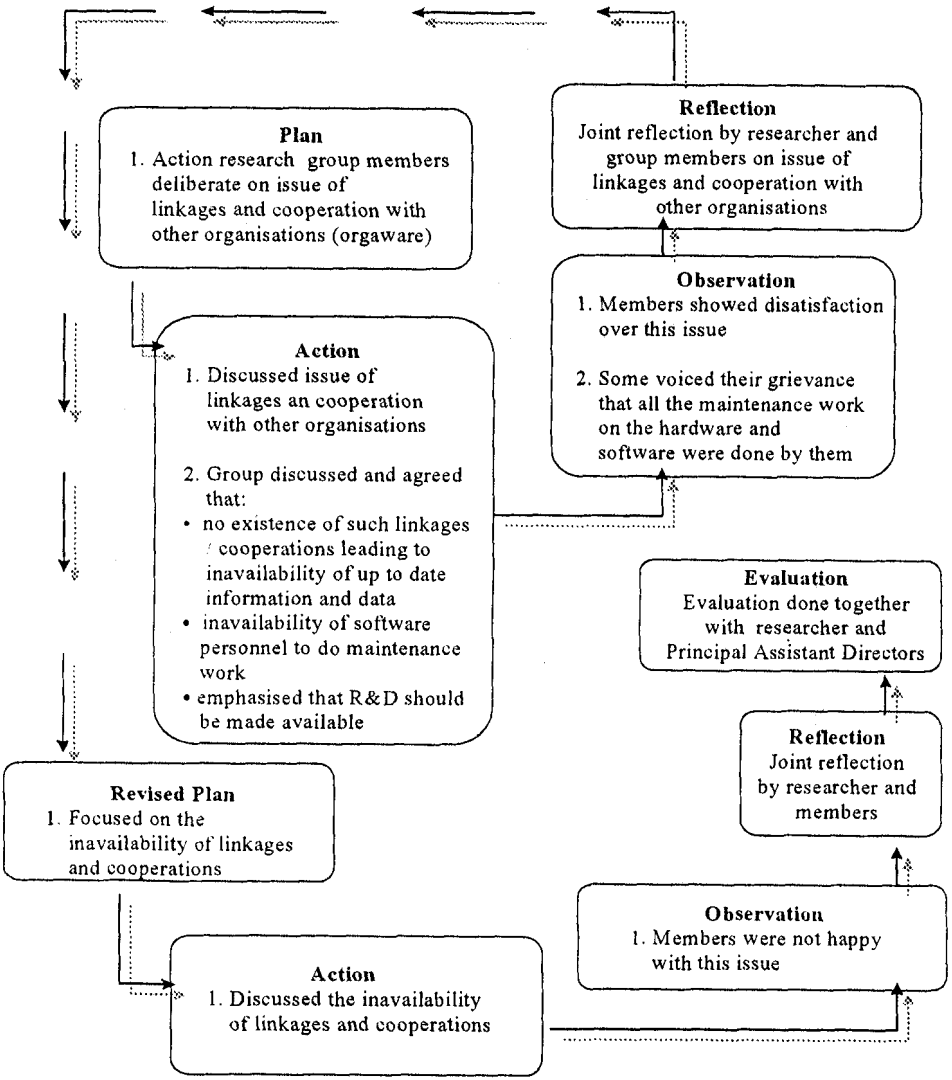

Figure 4.6 : The fourth mini cycle of the action research process

Production of GIS output

As had been indicated to the group members the meeting which was held on the 19th and 20th February, 1998 was to get involved in hands on practical experience in producing output for a preliminary spatial development plan for a study area. Before the start of the meeting the writer was fortunate to have the opportunity to discuss with the requesting officer on the 17th February, 1998. The writer found that this opportunity to get involved in the output production would help to answer the various research questions introduced earlier. The assignment might not be a classical example but the writer found that it was an opportune time as this would as well give an idea of how the output was produced, the problems associated with the production and above all whether the outputs were acceptable by the client.

The work assigned to the GIS Unit was given through a minute which is attached in the Appendix D. During the short meeting with the requesting officer, the writer was briefed on what was required out of the output. The assignment was to produce a digitised map for a preliminary spatial development plan for the proposed northern Sarawak highlands study. The detailed information required to be digitised on the maps include the agricultural capability areas, existing road network including logging roads, settlements, schools, health centres, forest status (forest reserves, national parks etc.) and topography showing contour bands of more than 1,500 feet. From the instruction given, the maps were to be ready within three weeks.

The discussion with the action group on the 19th February, 1998 was to get feedback on the process of producing the digitised maps for a preliminary spatial development plan for the proposed northern Sarawak highlands study.

Prior to this, a discussion was held between the requesting officer and the group members. This was done to make everybody fully understand what the requesting officer wanted and to sort out problems associated with the attributes.

Normally the group would request the requesting officer to get ready any attributes which were not available. Once this has been done the leader of the group who was the System Analyst would distribute the task to the fellow members based on their expertise.

Working on the assignment given, the other process undertaken by the group was extracting. The work in extracting required the group to choose the suggested area by cutting the base map with a frame. The base map required in this particular assignment contained soil types, contour maps, logging roads, settlements, rivers and tributaries and forest estates. All these attributes need to be digitised. As to the contour map it needed to be first converted to a format that can be used. After all this has been done the senior member of the group, the System Analyst and Programmer would produce the map and create legend as well as to choose the colour and to name the settlement and to give title.

During the process of producing the maps, digitising took a longer time as the task was very tedious and any mistakes with regard to digitising had to be done all over again. It was at this juncture the members felt that training was very much required for them to master the technique. The time taken to digitise the maps depend very much on the features of the locality. For instance an area with undulating soil polygon would require more time to digitise. At the meantime while the digitisers were working on their task the other group members would be arranging the software package that would be used in the process later. The process of producing maps was done by the two senior members who would do the overlaying based on the base map that had been digitised by the digitisers.

Based on the discussion with the group members there were few things that arise and need improvement. All the production of digitised maps were entirely left to the GIS unit with very little involvement from the requesting officer. The requesting officer would only be involved once the attributes required were not available. However, the members felt that more involvement from the officers were needed as this could save a lot of time. The time lost in this particular aspect was mainly due to the fact that the members have to do things all over once it was not up to the satisfactory level of the officers. The most important aspect in order to produce a good map were the attributes or data pertinent to the project. A good map would produce a more realistic decision support tool for planners. Therefore, a more collaborative teamwork between the GIS unit and the officers from the other sectors within the State Planning Unit need to be established. The problem associated with digitising is calibration. Calibration is the process to get the co-ordinates right in order to get a good result.

Another meeting was held on the 20th February, 1998. This meeting was primarily to reflect on what was discussed during the meeting on 19th February, 1998 especially with respect to the process of producing the digitised maps. During the process the writer observed that every member of the group were competent enough to do their work in order to produce what was required by the requesting officer. At the same time action learning took place especially in the production of the digitised maps. In fact they did a number of simulation to come up with few alternatives. When the writer proposed to the group to minimise the colours used in the maps so as to give a better picture of the location required, the group agreed. This idea was actually brought forward by the writer to the requesting officer prior to this meeting and was also agreed upon by him.

The output produced by the group members were later discussed with the officer but in order to portray a better and realistic maps there were few amendments to be made. The group had to select few other options to suit the requirement but judging from the process, the writer found that the group would not find any problems in producing the alternatives maps. Basically the work process with regard to maps production as a decision support tool involved few stages and this can be depicted in the Figure 4.7.

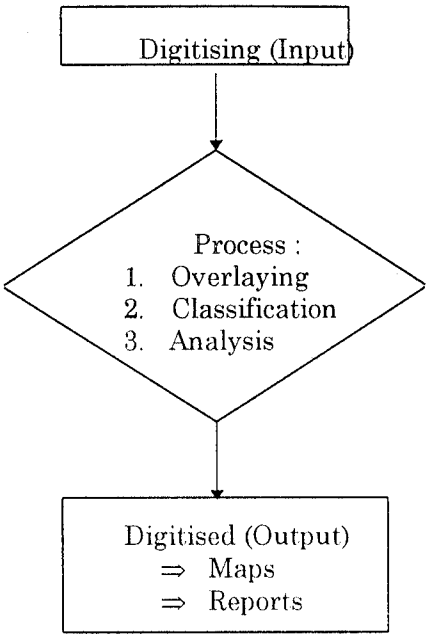

Figure 4.7: Process of maps production

Chapter summary

Using the cyclical process involved in the action research the socio-technical action research group had successfully completed the cycle. The writer started off the study with a plan which was basically the roles and functions of each important components that make up a GIS technology. The components included the humanware, inforware, technoware as well the orgaware. With the exception of the latter, all the other three components were within the control of the GIS unit. However, the fourth component which was the orgaware involved inter-departmental collaboration and this was not dealt in depth as the group felt that this should be handled by the organisation as a whole.

The issue of humanware which included the competency, training and career path was much debated on during the discussion. Although training was required, based on the output produced, the writer found that

at the present moment with the existing facilities it may not be too pressing. The training could perhaps be an avenue for the group to enhance their skills as well as to learn new technique of data processing.

As to the issue of infoware a lot of improvement need to be made. This include collection of data and to up date the existing ones. Collection of data should ideally be done by the sectors within the State Planning Unit and there was a need to fully involve these officers in understanding the types of data to be collected and reformat them in order to be usable by the GIS technology.

With regard to the software and hardware facilities the writer found that it was sufficient though it was still at an operational level. However, with time and requirement the unit should be equipped with more advanced technology. This could thus helps in producing a more realistic plan for decision making as it can ensure accuracy and reliability. Furthermore, the time taken to produce these maps could be shortened. The implication obviously would expedite the approving process of a proposed plan. This as well would keep the planners more effective and efficient in executing their duties especially with regard to processing of a plan. Generally, the basic components of required in a GIS technology can be depicted in Figure 4.8.

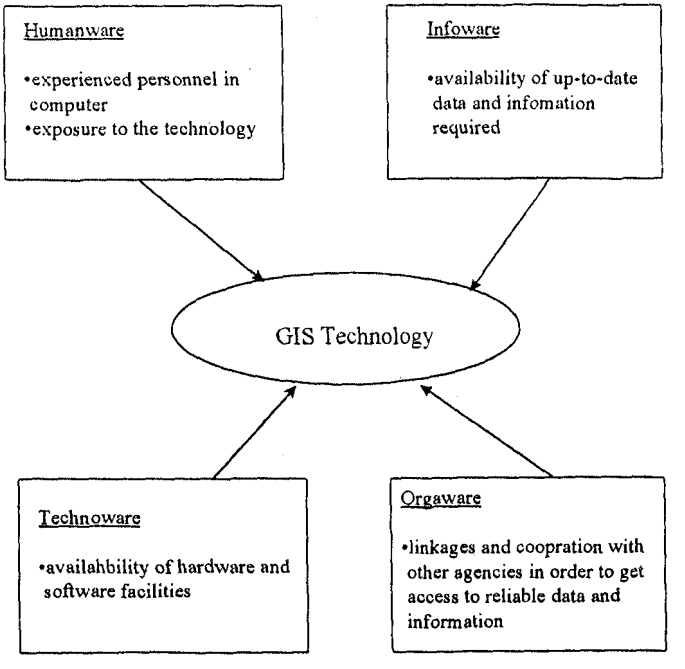

Figure 4.8 : Basic components of a GIS technology

From the discussion with the action group members and the hands on practical experience conducted to produce digitised maps for the proposed spatial development plan, the writer being a general planner had benefited from the exercise. The implication would hopefully give an insight to the appreciation of work process. The exercise had definitely answered the research questions which are pertinent to this study. Indeed from the writer and senior planners' point of view, GIS technology does help a lot in co-ordinating an effective integrated regional and sectoral development planning.

GIS technology being a system for decision support tools for decision makers can provide alternative sites or locations. This is important to avoid doing repetitious work of re-planning in the event that conflicting interest arise. Political intervention is an example of such conflict. Macro-planning in the form of integrated regional and sectoral planning is imperative for a big state like Sarawak as it can provide direction for the overall planning or a masterplan. It is thus appropriate that a mechanism be developed. At a micro level, project planning can at times cause conflicting interests and normally it is done on a piecemeal basis. In this aspect, GIS technology interestingly does help to alleviate this problem. However, to make it works effectively, a good teamwork and collaboration among interesting parties involve in planning should be in place. If this exists then only GIS as a technology can be an effective decision support tool particularly in integrated regional and sectoral development planning.

Action research being a new methodology employed in research as an approach in solving organisational problems can be viewed as appropriate as it involved a highly collaborative team which include the action research group as well as the top management. Furthermore the cyclical process did help in getting the members involved and the results were further evaluated in a process called triangulation. In this respect, the production of digitised maps for spatial development plans went through this cyclical process and eventually presented for evaluation. This could assist the decision makers in giving a decision in a much shorter time.

CHAPTER 5
CONCLUSIONS

Introduction

The previous chapter has shown how action research methodology was used for this study. This concluding chapter presents by way of summary and attempts to suggest recommendations for practice in the effective utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak. At the later part, conclusions would be derived from the use of an action research methodology in this particular study.

Summary

As mentioned in Chapter 3, the purpose of this study was exploring the use of GIS technology as a decision support tool in the decision making for integrated regional and sectoral development planning for Sarawak. In pursuance to realise this purpose, an action research methodology had been employed which involved a research team (so called the socio technical action research group) comprising of an assistant director. five GIS technical personnel and the writer. Towards the end of the research, the group worked on an assignment in the production of digitised maps for spatial development plan for the proposed Sarawak northern highlands study.

It was interesting to note how the process of maps production took place by using GIS technology and the involvement of the requesting officers. The combination of the basic components of GIS technology which included humanware, infoware and the technoware facilities contributed effectively in the high quality digitised maps production.

Notwithstanding the fact that in the process, there existed related problems but it was solved amicably through an action research methodology. The action research group contributed positively in the problem solving and it had a considerable effect on the effectiveness of the group in producing reliable and realistic maps to assist in the decision making.

Although the product out of this research could not be reaffirmed due to time limitation (as this plan needed to be discussed with different relevant parties), the writer was very optimistic that if not all, most of it would be accepted by the decision makers.

Background of the problem

Allocation of limited resources involves a tedious process of proper planning. The process involves decisions or choices about alternative ways of using available resources, with the aim of achieving particular goals at sometime in the future. As planning consists of the process of making decisions about how to make the best use of the available resources, the quantity and quality of the these resources have a very important effect on

resources available, are the main reasons why planning involves deciding which ones of a number of desirable courses of action should be given priority.

The problem associated with regional and sectoral development planning in the State is the lack of co-ordination between the agencies involved in different stages of planning. Very often the initial planning processes are done in isolation and more often than not, problems of conflict in interest occurs. Once this happens, re-planning has to be done and thus disrupting the implementation of the development projects.

It is thus imperative that in order to design a proper and orderly regional and sectoral development planning, the State Planning Unit being a lead agency, utilised a GIS technology to assist as a decision support tool.

Research questions

It was considered appropriate that this study be based on the research questions. The main research question which formed the basis of this study was:

"How could action research be used to effect integrated regional and sectoral development planning for Sarawak through the utilisation of GIS technology?"

However, the corollary research questions that followed were:-

1. Is GIS an effective integrator for co-ordinated integrated regional and sectoral development planning?
2. How can GIS be integrated into regional and sectoral development planning?
3. What are the benefits of integrated regional and sectoral development planning?
4. How could the planners be more effective and efficient in the processing of a plan?
5. Can action research be an approach to improve and expedite the approving process of a plan?
6. To what extent is integrated regional and sectoral development planning currently being effected in practice?
7. Could GIS provide for more effective integrated regional and sectoral development planning?

Research design and strategy

An exploratory study research design was employed for the investigation of the use of an action research methodology to exploring the utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak. Using the cyclical process of action research, the method followed the sequence of planning, action, observation and reflection.

Under planning stage, four main components of GIS technology which includes humanware, infoware, technoware and orgaware were discussed.

These components acted as a basis for the proposed plan that was discussed during the socio technical action group meeting. A concise review of action research literature was also included to determine the appropriateness of the method employed in this study.

The action stage proposed how issues under the planning stage were discussed in depth which focused on how they could contribute to the effectiveness of GIS technology as a decision support tool in decision making. Feedback and proposals put forward by the group members were discussed, elaborated and recorded. These inputs served as a basis perceived by the group members as the alternative ways to solve problems which was of thematic concern.

While this was ongoing, the writer who acted as facilitator employed various techniques to determine the reaction of the group members. This process is called the observation stage. The study however, employed the participatory, emancipatory as well as participant observation to determine how the group members assisted in the problem solving pertinent to GIS technology. It was interesting to note that under this stage, the group members acted naturally as none of them realised that they were under observation. Definitely the advantage of being natural would of course determine the accuracy of the findings.

The next stage in the cyclical process of action research is reflection. Under this stage, whatever had been discussed earlier on were reviewed to determine the appropriateness of the issues discussed. In other words it was merely a process to verify the outputs which evolved from the discussions.

For the purpose of this study, the data were collected through discussions and brainstorming. The outputs based on the discussions were later evaluated with the sector heads and the other senior officers.

Scope and limitations of the study

The study investigated the use of action research methodology in an attempt to explore the utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak. This study did not attempt to compare integrated regional and sectoral development planning using the conventional way of not utilising GIS technology. Nevertheless in the course of conducting this research there existed an element of effectiveness in terms of accuracy, reliability and time factor that unintentionally gave some insights of the advantages and disadvantages of employing GIS technology in integrated regional and sectoral development planning.

This study was very much limited by duration of time as six weeks allocated was split at an interval of fortnightly. The advantage was of course it gave more time for the action research members to reflect on issues discussed but nonetheless the disadvantage was, by the time next meeting was conducted most of the members would have forgotten. Another limitation in this study was that most members could not stand long hours

of meetings and frequently had to attend to other more important office assignments.

Assumptions

As specified in Chapter 3, this study employed action research methodology and that it was exploratory in nature to determine the effectiveness of GIS technology to effect integrated regional and sectoral development planning for Sarawak.

Following that notion, it is thus assumed that all the relevant data and information collected out from the discussions with the socio-technical action group were accurate and reliable. Furthermore, it was also assumed that information given by the group members were free from biases and that all the members chosen in the group were competent enough to contribute their thought and ideas pertaining to the study.

Under the literature review in Chapter 2, it was assumed that all the findings pertaining to the effectiveness of GIS technology in various kinds of application were correct and without any prejudice. This was applicable especially for literature review obtained from the Internet sources.

Conclusions based on the results of an action investigation of an action research methodology conducted at the GIS unit of the State Planning Unit

The following findings are drawn from the analysis of data and information collected during the meetings with the socio-technical action group members. It is further emphasised here that the findings apply to the members included in the study at the specific site and at that particular time. In other words, the findings could be different if different group members were to be involved.

The same application is true if the site chosen for the study was different from the GIS unit of the State Planning Unit . However, for the purpose of this study, it was assumed that there might be some similarities and differences in the findings should it be conducted elsewhere with a different set of action research group.

From the findings drawn out of this study, the time taken had been reduced to draw boundaries and to produce digitised maps as had been demonstrated during the process of map production. The utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak contributed significantly in term of time saving similar to that conducted by Wilson (1994) who applied a PC-based GIS as a decision support tool for a public school district. However the utilisation of GIS technology cannot function if other aspects were not in place. The other aspects or components include humanware, infoware, technoware and orgaware. The findings drawn from this study also followed that of the study conducted by Marble and Herries (1996), whereby the application of GIS technology for freshmen admissions at Ohio State University could only functioned with the three aspects namely, people and procedure (although in

this respect the terminologies used mat not be the same) were not made available.

The other important aspect that contributed to the success of using GIS technology in this study related to the humanware was the computer experience of the staff and exposure to the technology. The findings revealed that in order to produce high quality digitised maps in much lesser time, a group of experienced staff with good knowledge about the technoware should be made available. This findings had similarities with the study conducted by Budic and Godschalk (1996) when applying GIS technology in public and private organisations. They found that perceived relative advantage, previous computer experience, exposure to the technology and networking were the most significant determinants of employee willingness to use the technology.

The findings of this study also revealed that training and education were important factors that contributed to the success of GIS technology in development planning. This study had benefited the group members especially the general planners in appreciating the work of GIS technology and at the same time the technical personnel benefited on how to conceptualise and interpret the results. Similar findings was also found from the study to determine and detect earthquake conducted in Kobe, Japan where this technology can be a useful decision support tool if proper training and education were given to the staff who worked on using GIS technology.

Another important factor that need to be considered when applying GIS technology is the availability of information and data or the infoware. The findings of this study revealed that accessibility of reliable and recent infoware contributed significantly to the success of GIS technology in proper development planning. The findings with regard to the infoware from this study was similar to the findings for development planning in Bangladesh whereby they found that for a better analysis, timely data and recent large-scale maps should be made available and accessible.

The use of the action research methodology

In an attempt to explore the utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak, an action research group was formed which included the writer, an Assistant Director and five personnel from the GIS unit.

For this study using an action research methodology, four mini cycles of planning, action, observation, reflection and evaluation were involved. The issues of concern namely humanware, infoware, hardware and orgaware that the group members dwelt became the basis for the planning stage. It was from these specific issues that the group members discussed in a cyclical process of action research. The action phase was merely that of a brainstorming session where every member was free to give inputs and comments. The writer meanwhile did the initiating and facilitating role to make sure that the cyclical process of action research was conducted.

In the observation phase, the writer used the participants' observation method to determine their contribution to the success of the study using action research methodology.

The reflection phase normally reaffirm the group's stand on the issues that had been discussed before being brought for evaluation to the senior officers within the State Planning Unit.

Thus, from the four mini cycles which formed the basis for this study using action research methodology, the processes that took place followed the sequence and characteristics of an action research. Generally the processes that emerged in all the four cycles can be translated as in Table 5.1.

Spirals of cycles	Processes
Planning	The researcher (writer) worked on important issues (components) of GIS technology which contributed to the effectiveness in integrated regional and sectoral development planning for Sarawak.
Action / Observation / Reflection	The socio-technical action research group members dwelt on pertinent issues related to GIS technology and how it can effect integrated regional and sectoral development planning with reference to Sarawak. While the action phase took place, the researcher made observation on how the members reacted and contributed to the study. The outputs from the discussion were further elaborated and amended if necessary in the reflection phase.
Evaluation (Triangulation)	The outputs from the discussion which were amended and agreed upon was then brought to the management for evaluation in the process called triangulation. This would therefore be presented later to the management for consideration and if accepted would be for practice and policy of the organisation.

Table 5.1.: Action research process involved in the study

Another interesting observation that was made out of this study was the involvement of all the group members in learning new ways of solving organisation problems. In other words, while the group discussed issues pertaining to the study, they were actually involved in action learning. Action learning in this study followed the general characteristics whereby,

first, the issues discussed were problem focused; secondly, there was a written consent from the organisation to enable the study to be conducted; thirdly, the study involved and required a teamwork effort or learning set of six people who in turn were given equal opportunity to question issues raised; fourthly, the presence of the researcher to facilitate and provide guidance to the learning set; and finally there was an element of creative thinking that took place whereby in this situation individual members went through various processes of saturation, deliberation, incubation, illumination and accommodation.

Characteristics of action research methodology

Abraham (1997) listed twelve characteristics in an action research. This was emphasised in the literature review on action research in Chapter 3. For this study, the characteristics of the action research identified were :

i. This method focused on the lack of co-ordination in integrated regional and sectoral development planning for Sarawak Very often, development planning was done separately by planning agencies and where there existed conflict of interest, re-planning have to be done.
ii. The action research method was action oriented which consisted of fact-finding, planning, conceptualisation, analysis and more fact finding. For this study the socio-technical action research group involved the planners as well as the technical personnel from GIS unit in problem solving.
iii. A cyclical process which involved a spiral of cycles of planning, action, observation, reflection and evaluation occurred. Four mini cycles which dwelt on the component of GIS technology were conducted throughout this study.
iv. In action research, collaboration and participation is a fundamental ingredient. In other words, a team comprising of several members should work together to solve problems. Meanwhile, the role of the researcher who acted as a facilitator was later taken over by the action group members.
v. This study was conducted with an ethical basis. Even though the research topic was suggested by the writer but consensus was sought from top management of the organisation whereby the Director and Deputy Director of the State Planning Unit were involved.
vi. As there was no control group involved, this study was not experimental in nature. Thus no hypothesis were developed as this study was conducted merely on exploration in the use of GIS technology to effect integrated regional and sectoral development planning for Sarawak.
vii. There had been significant implementation of knowledge in this study whereby the action research group together with the researcher participated positively to the research topic.
viii. Re-education occurred in this study with action learning taking place through teamwork and practical experience in problem solving. The researcher gained considerably in the work process especially on how

GIS technology can be used as a useful decision support tool in decision making.

ix. The action research method used in this study was emancipatory as it purportedly aimed to improve the way integrated regional and sectoral development planning was done.

x. As the outcome of the study was conducted in real world setting where data was recorded, this study came in a naturalistic manner. In fact the outcome of the study was based on the data which was agreed upon by the group members.

xi. This study was also having a normative aspect of the action research. This was emphasised as the study took into consideration the general views from the action research group members especially on the aspect of confidentiality. The study as far as possible tried to safeguard the interests of the group members.

xii. Group dynamics was another fundamental aspect in this study as it encouraged the members to participate actively in the process. Teamwork and co-operation played a very important part in the success of this study.

Generally it was found that this study followed the elements of an action research method whereby eleven of the characteristics were adhered to except for characteristic (vi) above, that is experimental . This was so because this study was aimed to explore and not as an experiment to test any hypothesis.

Recommendations and suggestions

This study which was exploring the utilisation of GIS technology to effect integrated regional and sectoral development planning for Sarawak employed an action research methodology. Perhaps one of the most obvious successes of this study answered the question on whether an action research methodology can be an approach to improve and expedite the approving processes of a development plan. As had been mentioned in Chapter Four, the findings of the study revealed that an action research did, to a certain extent helped in solving the problem of expediting the development plan for Sarawak. However, in the course of conducting this study, the group members actually went through action learning as mentioned earlier on. Thus ideally, in action research, a process of action learning does take place whereby every group members would in the end, gain through this experience.

It is thus appropriate in this concluding chapter to draw out some recommendations and suggestions for the State Planning Unit to consider in its future implementation with regard to the process of designing integrated regional and sectoral development planning for Sarawak .

Firstly, all regional and sectoral development plans should utilise the GIS technology as a decision support tool to help in the decision making process. As GIS technology can be a reliable decision support tool, more realistic decisions can be made by the decision makers. However, in order to

make GIS more effective, all the four components, namely, the humanware, infoware, technoware and orgaware should be made available.

Secondly, collaborative and teamwork should be in place among various sectors within the State Planning Unit as well as other relevant agencies. This is to avoid duplication and also to avoid conflict of interests among various parties. This would definitely provide a more organised and proper development planning. Subsequently the implication would be a smooth and timely implementation of the proposed plan.

Thirdly, as the state is progressing into future development planning, the GIS Unit should be accorded a status at least equivalent to that of any sector within the State Planning Unit . For that purpose, a senior officer should be recruited to be in charge of the GIS section. This particular officer should be competent in the use of GIS technology and should be able to conceptualise the proposed planning for the state.

Fourthly, with the upgrading of the GIS unit, the hardware and software facilities should also be upgraded to cater for the anticipated increasing demand for the use of GIS technology as a decision support tool for decision making. It is further suggested that the unit be equipped with a work station of ARC/info as this facility can perform a more advanced GIS analysis.

Fifthly, training among the GIS technical personnel be conducted regularly in a more systematic manner. This would expose the personnel to a more up-to-date technology and software beside giving them the opportunity to exchange new ideas with their counterparts in different areas.

Next with regard to the production of digitised maps for spatial development any sector through the requesting officer should work closely with the GIS personnel. The officer should be responsible to supply the GIS personnel with relevant and up-to-date attributes in respect to the area identified for development. This is to make sure that there would not be any overlapping and thus would expedite the decision making process.

For the interest of integrated regional and sectoral development planning for Sarawak, the state through the central planning agency (in this case State Planning Unit) should be on line with other GIS units in other relevant agencies such as the Land and Survey Department, Agricultural Department and Forestry Department. Being on line with these departments, the GIS Unit could get access to the latest and up to date information related to any GIS projects. In this way, there would be no question of unavailability of data which are vital for the development planning for the state. It is thus hoped that with this linkage the integrated regional and sectoral development planning in the state could be done in a more orderly and systematic manner.

As has been discussed, action research methodology did help to solve organisational problems and at the same time action learning took place. With this view, it is recommended that the organisation should apply action learning in order for it to become a learning organisation. A learning

organisation is one that keeps on striving for new ways and knowledge for the purpose of initiating change.

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Faculty of Cognitive Sciences and Human Development

SARAWAK

94300 Kota Samarahan
Sarawak Malaysia
Tel (082) 671000
Fax (082) 672281

UNIMAS-CMM/12-01/01-01(70)

21 January 1998

Director
State Planning Unit
14th Floor
Wisma Bapa Malaysia
93502 Kuching
Sarawak

Sir

This is to certify that Mr. Anthony Valentine Laiseh is required to undertake a work-based research project in his organisation to fulfill his thesis requirement under the UNIMAS-CMM joined MSc(HRD) programme. The topic of his study is:

> *"To Explore The Utilisation Of Geographic Information System (GIS) Technology To Effect Integrated Regional And Sectoral Development Planning For Sarawak"*

This work-based research project is slightly different from the one using a traditional research methodology. To undertake this work-based research, Mr. Anthony V. Laiseh is required to form a problem-solving group made up of his colleagues and staff, besides obtaining the necessary data and other relevant information.

The cooperation and support given by your Department to Mr.Anthony V. Laiseh while undertaking this research project is highly appreciated.

Thank you.

Yours sincerely

Assoc. Prof. Dr. Peter Songan
Coordinator, UNIMAS-CMM Joined MSc(HRD) Programme

c.c.: Mr. Anthony V. Laiseh

APPENDIX B

G. 20
(Rev. 8/64)

KERTAS MINIT
MINUTE SHEET

Mr. Abdul Rahman Sebli (Assistant Director)
Mr. Bernard Lye (System Analysist)
Mr. Rahim Tamel (Programmer)
Ms. Dayang Latifah (Digitize)
Ms. Mariani Edi (Digitize)
Ms. Habibah Bojeng (Draughtsman)

Per : APPOINTMENT OF ACTION RESEARCH GROUP MEMBERS

Following our discussion earlier on, i have the pleasure in appointing you as members of the action research group. As the group is comprised of general planner and technical personnel it would be called the Socio-technical action research group.

As this study involves a series of meetings and discussion I would appreciate if you could give your fullest support by way of participation and contribution in order to make this study a success.

Thank you.

Yours sincerely,

[ANTHONY VALENTINE LAISEH]
Researcher

Date : 5 December, 1997

m-avl

G. 20
(Rev. 8/64)

KERTAS MINIT
MINUTE SHEET

Director
State Planning Unit
Chief Minister Department
14th Floor
Wisma Bapa Malaysia
93502 Kuching, Sarawak

Dear Sir,

Project Task of The Organisation

As advised, I am presently attending the MSC (HRD) programme at UNIMAS, Samarahan.

As part of the programme, I am required to undertake a project entitled " *To explore the utilisation of Geographic Information System (GIS) technology to effect Integrated Regional and Sectoral Development Planning for Sarawak*". I hereby seek your consent to my undertaking this project task.

Would you please confirm your consent by signing and returningto me a copy of this letter.

Yours faithfully,

[ANTHONY VALENTINE LAISEH]
Researcher

I hereby consent to the above project undertaken

Date : 1/12/97

ABDUL KADIR ZAINUDDIN

KERTAS MINIT
MINUTE SHEET

GIS SECTION

PROPOSED NORTHERN SARAWAK HIGHLANDS STUDY

1. Please see attached information by D/SPU on the proposed study of the Northern Sarawak Highlands. The study area is marked in the map attached.

2. To start with, we need to produce a preliminary spatial development plan for the Study Area. The supporting information required to be digitised on maps are:

2.1 Agricultural Capability Map
2.2 Existing Road Network including logging roads.
2.3 Settlements, schools, health centres
2.4 Forest Status (Forest Reserves, National Parks etc..)
2.5 Topography showing contour bands:
<1,500ft.
>1, 500ft @ every 500ft.

3. Please get all the Maps digitised by 19/12/97.

4. We discussed on the above today (Ose/Bernard).

Sekian, terima kasih.

BERSATU BERUSAHA BERBAKTI

(OSE MURANG)

Date: 28 November, 1997

c.c:

Director
State Planning Unit

En. Abd Kadir bin Zainuddin.