Case study: geographical information system (GIS) for a water utility company

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Abstract

This paper attempts to look at the practical implementation of a geographical information system (GIS) for a water utility company in a developing country. The aim is to exchange ideas and provide JBMSB's experience of actual implementation of a working GIS, starting from the choice of GIS, database structure, data capture, data integrity, and the follow up maintenance required to ensure a full working GIS that can be used as a tool for management. It is unfortunate that many GISs, after implementation, simply stop growing, with no further development or new applications being added to the system. Eventually the GIS can become a showpiece only, with an out of date database, and used by the company/department to boast "they also possess a GIS".
Keywords: GIS, water utility company, choice of GIS, GIS a tool for management, practical implementation.

1 Introduction

Perbadanan Bekalan Air Pulau Pinang (PBAPP) denotes Penang Water Supply Board. The main elements of their distribution system are tabulated in Table 1. This is the most efficiently managed water authority in Malaysia.

Jurukur Berjasa (M) Sdn Bhd (JBMSB) assisted PBAPP to translate their GIS data from its original ArcInfo™ GIS format into StruMap™ GIS, a specialist water GIS. By utilizing StruMap™ GIS, PBAPP was able to implement the GIS applications much quicker and is now embarking on Hydraulic Network Modelling. Being a purpose built GIS for the water industry, there are many specialised tools available within the software to help verify and correct the pipeline network for integrity and connectivity. There is also a network analysis program called "Hydraulic Analysis Report Processor" (HARP) within StruMap™ GIS.

Table 1: The main elements of the PBAPP distribution system.

Area covered		1031 km^2
From GIS data	Length of mains	3 466 km
	Diam. less than 300 mm	2 713 km
	Diam. between 300 and 600 mm	531 km
	Diam. between 600 and 1800 mm	385 km
	Diam. more than 1800 mm	0 km
Treatment Works		10
Reservoirs / Water Towers		80
Pumping stations		8
Production		759 MLD
Population served		1.3 million
No of Customers		402 777
Domestic		356 628
Trade		46 149
Metered Consumption		611 MLD

In a normal GIS, the network is built using the GIS data and then all the elements inside the network model are converted to a format acceptable for the hydraulic network analysis program. That program then performs the analysis and the results are then converted back into the GIS. With StruMap™ this is not necessary. Once the network model is built using all the tools available, the HARP processor is activated and the analysis performed with the results immediately available within the StruMap™ GIS environment. This resulted in PBAPP being able to complete building their model faster and obtain the necessary results much quicker.

2 GIS: a tool for management

It is common knowledge that GIS is a tool for management. With the information on water assets captured spatially, a host of queries can be answered for the benefit of the managers.

Managers who used to look at their pipeline assets on individual plans can now view the whole state in one picture. Retrieval of data can be carried out more efficiently and response times to problems greatly reduced. Maintenance of pipes can also be improved, with queries, such the number of leaks along a particular section of pipe in a year, easily reported on. Burst pipes can be repaired more efficiently with the knowledge of the material and diameter easily available from the GIS.

Planning for new developments can be greatly improved with the pressure and pipe flow data information easily available to network analysis programs that utilize the GIS data.

2.1 Which GIS fits best

There are many GIS engines available in the market. How can managers make the correct decision and choose one which best satisfies their particular business needs and requirements?

Prior to any purchase and implementation it is advisable to engage a GIS consultant to provide the necessary expert technical advice on the most appropriate software and hardware. The consultant must be able to provide information as to the availability of all appropriate GIS software available in the market. It is wise to investigate and evaluate all such software first before making any final recommendations on the GIS engine to be used.

2.2 Understanding the water business

A GIS consultant may not understand the water business. Sufficient time needs to be allowed to understand the organisations operations and services before preparing any User Requirement Specification. The GIS Consultant must then clearly define all the technical requirements and steps involved in the implementation of the GIS for the particular organisation.

2.3 How many steps?

Care needs to be taken not to attempt to implement a complete GIS in a single step. A priority based staged implementation, is much better, with carefully developed procedures that must be followed to successfully complete each stage.

2.4 Design implementation methodology

Once the different stages are ready for implementation, careful planning and training is required to involve all officers in the various departments of the company. The development of a well-educated and committed staff is the key to the success of the GIS.

2.5 Management commitment: financial and human resources

Any project requires financing and the management has to be fully committed for the GIS to be successful. Officers in the various departments involved must be available through all stages of the project.

2.6 Follow up

Any consultant appointed should be highly experienced and professional in his approach and “follow- up” through all stages until the successful completion and implementation of the GIS.

Any training in the use of the system has to be as “user friendly” as possible, and any resistance to change in the staff, needs to be addressed early. This is best done by illustrating the comprehensive benefits of utilising the system, so that the organisation’s personnel will readily embrace the new technology.

The Consultants Scope of Work needs to include a maintenance agreement that allows for at least one site visit per year, to audit the database and provide any additional assistance and training to the Client.

3 Scope of works for the consultant (JBMSB)

3.1 Proposed GIS package for PBAPP

In 2000, JBMSB were invited by PBAPP to convert the existing water utility data from ArcInfo™ GIS format into StruMap™ GIS. Most of their main pipe network had already been digitised but the tools available to verify the data were not yet available in ArcInfo™ and further scripts needed to be written. When StruMap™ GIS was demonstrated to PBAPP, the decision was made that they did not want to “re-invent the wheel” and they made a decision to change to using StruMap™ GIS. Being understandably apprehensive about changing, they imposed many conditions upon JBMSM so as to ensure that their targets were satisfied. Some of the required conditions are outlined in the following sections.

3.2 Speedy conversion of existing base maps

JBMSB needed to prove to PBAPP that JBMSB were able to import the existing base map onto the StruMap™ platform quickly. At this moment the Malaysian National Survey and Mapping Department are developing more accurate base maps, refer to examples in Figures 3 & 4. JBMSB were required to provide PBAPP evidence of StruMap™’s import capability to these more accurate base maps.

The base map was the geographic platform into which all the assets of PBAPP, namely pipelines, valves, treatment plants, reservoirs, water tanks and pumping stations etc needed to be digitized into. The use of an accurate and universally accepted national standard base map is necessary. In Malaysia these mapping standards are normally set by the Survey Department. The use of a single standard base map should ensure that data exchange with other authorities in the future is seamless.

It was also a requirement, that a layer of aerial photography be used as a background to the base map. An example is given in Figure 5. This photo background layer also provides an easy navigational tool for any user unfamiliar with Penang Island.

3.3 Accurate and speedy import of the existing assets record data.

Being a GIS software, StruMap™ is able to import all the asset records data, both textual and graphical, direct from ArcInfo™ GIS, refer to examples in Figures 1 and 2. After import; the integrity of the pipelines were checked and corrected using various editing tools available in StruMap™. There existed a host of connectivity problems and many redundant floating nodes had to be deleted. There were also many cases of double entries with over lapping pipelines and the number of hydrant valves did not agree with the number of hydrants. By using query functions available inside StruMap™, all the discrepancies in the assets data could be rectified within the project's programmed time frame.

With this clean set of engineering data, PBAPP is now ready to move on to the next phase of the project, being the integration together of the consumer database, the network analysis program and the SCADA communication system.

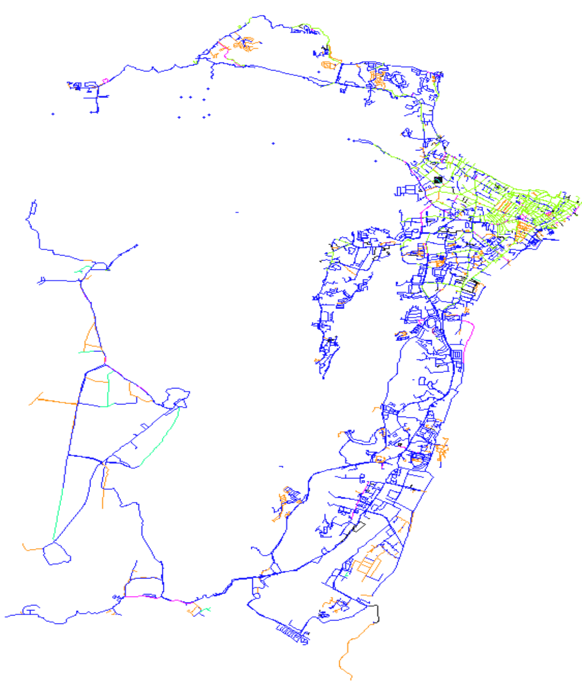

Figure 1: View of the whole pipeline network on Penang Island – A compilation of thousands of paper maps.

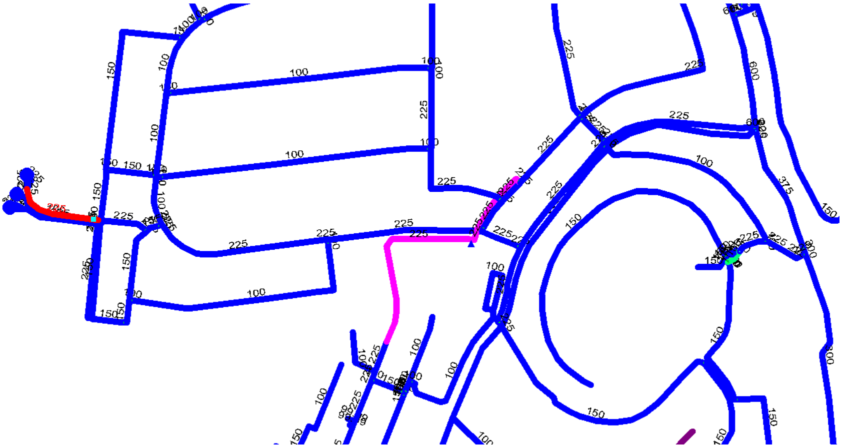

Figure 2: Pipeline network with some attributes shown.

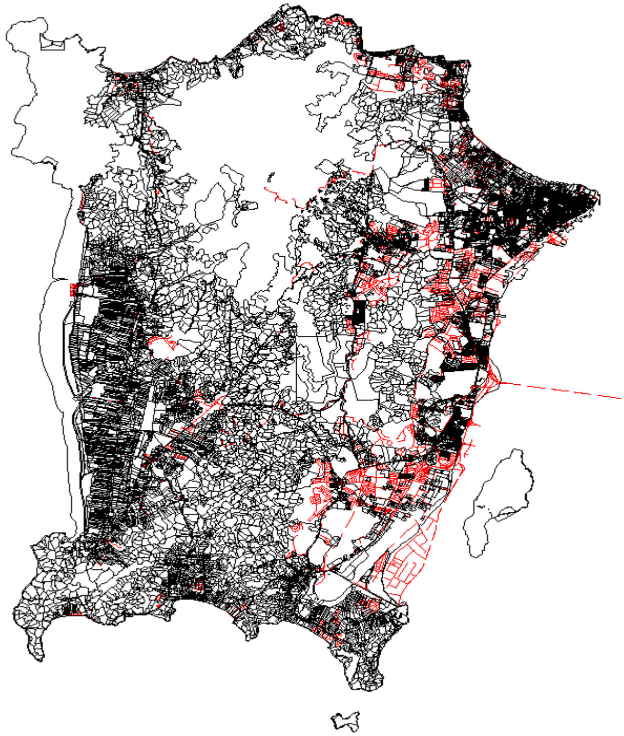

Figure 3: Base map of Penang Island.

3.4 Linking to the consumer database

More than two thousand paper plans were printed from the GIS and given to the field meter readers for them to notate the consumer points on the plans. This information was then entered into the GIS. These consumer points were then linked to the consumer details database. A sample of the attributes collected can be viewed in Figure. 6.

Figure 4: Zoomed in view of the base map.

Figure 5: Example of aerial photographic background.

3.5 Network modelling

The Harp hydraulic modelling analysis processor that is included within the StruMap™ program can then convert the water works assets data into the format it requires, and perform any analysis.

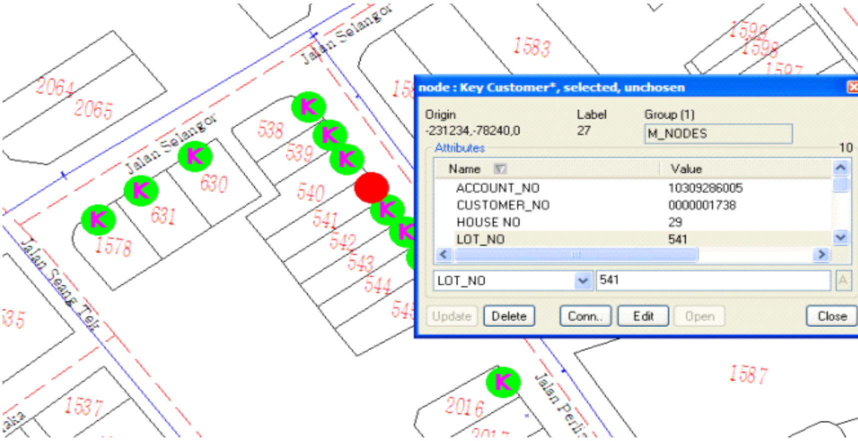

Figure 6: Example of consumer points and their attribute data.

3.6 Training and support

Training was carried out at the projects office as the work progressed. A dedicated GIS team was set up to follow through the whole implementation of the project, and in the process acquire all the necessary skills to effectively utilize and apply the GIS. The members of the team consisted of staff predominantly from the PBAPP's design and drawing office. The configuration of the PBAPP GIS is shown in Figure 7.

Procedures were set in place for the submission of information to the drawing office on any new pipeline works and facilities, in digital format, and using fully specified designated layers.

As the project's consultants JBMSB were always present, giving full support to PBAPP in the implementation of the GIS. The purchase of StruMap™ GIS by PBAPP also includes a maintenance license which provides for follow up half yearly visits by JBMSB.

4 Conclusion

GIS implementation is better to be managed by experienced GIS consultants rather than by vendors of software.

The GIS Consultant must obtain a clear understanding of the operations and services of the organization that will use the GIS, before providing any advice. All appropriate existing GIS available in the market need to be evaluated.

Care needs to be taken not to attempt to implement a complete GIS in a single step.

The management of any organization embarking upon developing and utilizing a GIS must be fully committed. They need to be involved in all stages of its development, and allocate all necessary finance and manpower resources to ensure its successful implementation.

Proper training and support to the personnel involved, is required, through all stages of a GIS implementation. It is the people in the organization, and not the organisation itself, that will ensure the success of the GIS.

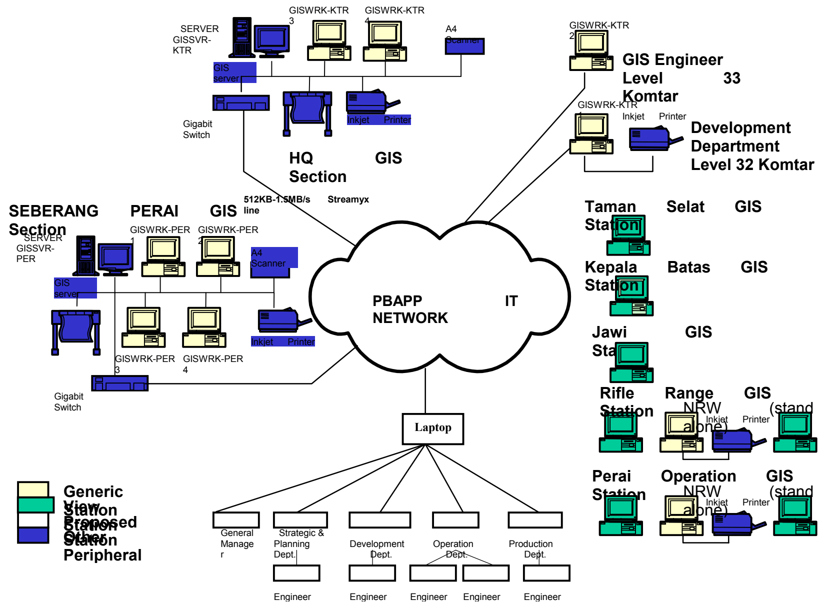

Figure 7: PBAPP GIS configuration.

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