The Bangkok Land Information System Project - Past and Future

*Ian Williamson PhD (NSW), LS, MIS(Aust).
Professor of Surveying and Land Information
The University of Melbourne
Senior Technical Adviser, BLIS Project 1990-92.*

and

*Garry Mathieson BApplSc (Surveying) (RMIT), LS, MIS(Aust)
Technical Adviser
BLIS Project 1990-92*

Abstract

Most cities in the developing world are expanding rapidly and are usually the "engines" of economic development in their respective countries. Yet the quality of life for the inhabitants is deteriorating together with the urban environment. The services and facilities that are essential for the city to operate are not coping with the rapid growth. At the same time the ability to raise sufficient taxes, equitably and efficiently, is severely limited because of lack of basic land information. In these circumstances, cities are turning to land information systems (LIS) as one possibility that may contribute to solving some of these problems.

Bangkok, with a population of 10 million, is one such city. This paper reviews a pilot project to develop a LIS for the city. It reviews the major justification for a LIS, looks at the objectives of the project and how those objectives were met. Lessons from the project are described in detail. The paper describes a conceptual model and a strategic framework for a future LIS. Even though the paper is directed at cities in the developing world, the experiences from the project should be of interest to any person involved in designing, building or operating a LIS for a large metropolis.

Introduction

The strategy to introduce a land information system (LIS) into a city of about ten million people in the developing world and across six key government organisations, most of which don't have any professional land surveyors or any engineers experienced in LIS technology, is an interesting story. It is a strategy that may be of interest to city administrations or organisations that wish to introduce such a system. It is also a good example of the contribution that Australian surveyors can make to solving some of the major problems facing the developing world.

A previous paper by Williamson and Mathieson (1992) describes the Bangkok Land Information System (BLIS) Project as it was conceived two years ago. This paper reviews the success of the project and considers the future of BLIS for the City of Bangkok. Further details on the project can be found in Mathieson and Williamson (1992).

Bangkok has many if not most of the problems facing cities in developing countries. There is rapid growth with which the city cannot cope. There is a major air pollution and traffic problem. There is no mass transportation system other than buses. It takes most people at least two hours to get to work and another two hours to get home. There is no sewerage system and the water is not drinkable. The many canals are often simply open sewers. The utility infrastructure is deteriorating, especially the electricity, telephone and water systems. There are long delays in getting connections. There are inequitable land and building taxation systems that mean the city has difficulty supplying and upgrading infrastructure. The

result is a deteriorating urban environment and a poor quality of life in the city. Yet the City of Bangkok is the engine of economic growth in Thailand.

After many study tours, demonstrations by LIS vendors and numerous pilot projects undertaken by countries as part of their aid programs, the city believed that LIS offered some hope in helping to manage and provide adequate services and infrastructure for the future. This is seen diagrammatically in Figure 1.

The major organisations in the city coordinated by the Bangkok Metropolitan Administration (BMA), decided that they wished to expose themselves to LIS concepts and technology. They comprised the BMA, Telephone of Thailand (TOT), Metropolitan Water Authority (MWA), the Metropolitan Electricity Authority (MEA), the Department of Lands (DOL) and later the Royal Thai Survey Department (Army). They consequently bought a relatively large hardware/software (HW/SW) system at open tender. Since there were no staff with any experience of the LIS technology and no professional surveyors in any of the organisations (with the exception of the DOL), although there were a number of geographers in the BMA, they sought assistance from the Australian Government to establish a BLIS Pilot project. Assistance was provided by the Australian International Development Assistance Bureau (AIDAB) in the form of a full-time Technical Adviser and a part-time Senior Technical Adviser. In summary, the key organisations provided staff and resources, set up a project office and then started to find out what the technology would do (and would not do). They decided to undertake a comprehensive pilot project involving all participants. The pilot project was started in May, 1990 and was completed towards the end of 1992.

The primary objectives for the pilot project were simple:

- *Education and training.* The organisations wished to determine what LIS technology would do. They wished to determine the strengths and weaknesses of the technology themselves. They recognised that the only real experience in Thailand, although that is also limited, rests with the vendors. There was also an expectation that the pilot project would train a number of staff from each organisation in the technology.
- *Common Base Map.* The organisations believed that it would be necessary to establish a common base map if any future LIS was to be established. There were, however, questions regarding the data items in the base map, the scale, how would it be prepared, who would update it and who would manage the process.
- *The Future.* The organisations hoped that the pilot project would provide some direction for the future if the technology and associated systems were to be adopted.

This paper describes what was achieved regarding each of these objectives at the conclusion of the pilot project. The paper also gives a brief summary of the operation of BLIS, a description of the associated activities and the achievements of the project in technical terms. The paper, however, concentrates on the success of the three primary objectives.

Management and Operation of BLIS

The management structure established for the project and described in Williamson and Mathieson (1992) proved satisfactory. However the importance of having inter-agency committees operating at three levels cannot be over-emphasised. The overall management of the BLIS Project was directed by an inter-agency Steering Committee chaired by the Deputy Governor of the BMA, an elected official, and met once or twice each year. A BLIS technical sub-committee chaired by the Director General of the Department of Policy and Planning within the BMA provided technical direction and reported to the Steering Committee on matters of policy and budget, and met about two or three times each year. Staffing arrangements, administrative support and general day-to-day management were made by an inter-agency Project Managers Group chaired by the Director of the Division of Infrastructure and Environment within the Department of Policy and Planning, BMA. This group met on a monthly basis.

Because of the interest generated by BLIS, both the Royal Thai Survey Department (Army) and TelecomAsia (a large, private provider of telephone services) were later invited to join the group. These participants were essential in ensuring the commitment to developing a common base map for political and financial reasons respectively.

While the communication of project activities and issues between project staff and up through the three levels of management proved difficult at times, the structure did ensure that senior officials became aware of the aims and the possible future impact of the project.

As a result of difficulties encountered in providing suitable office accommodation for the project within the BMA (the lead agency), the system was installed in a laboratory of the Department of Survey Engineering at Chulalongkorn University, since this Department was contracted to provide the digital base map to BLIS. While this did cause some delays, it had some unexpected and worthwhile benefits. The staff of the Department assisted in solving many of the early teething problems on the system and it provided a good working environment from the point of view of testing new technology. Most importantly it was non-threatening to any of the five partners, i.e. no partner dominated because the project was housed in their agency.

As mentioned, the BLIS agencies purchased HW/SW for the project prior to having any advisers appointed, a conceptual or system design undertaken, or a work plan developed. Within the Royal Thai Government (RTG) system it was a strategy that worked successfully, although it is not the usual approach taken in developed countries. Once the full-time technical adviser arrived, a conceptual model, a system design, a management structure and a work plan were developed.

The project utilised the latest HW/SW technology available at the time of the preparation of the specifications (1988). This consisted of six SUN 3/80 workstations connected in a local area network which included a SUN Server, six PCs and printers, five large format digitising tables, a laser printer, a pen plotter and a large format colour electrostatic plotter. The system used ESRI's (Environmental Systems Research Institute Inc.) ArcInfo.

Description of Project Activities

Conceptual Design

The conceptual design for BLIS developed throughout the life of the project. It quickly became evident that the major applications fell into three areas: strategic planning at a map scale of 1:10,000; land administration applications (requiring the land parcel layer) at a map scale of 1:1,000; and physical infrastructure (and utility) applications also at a map scale of 1:1,000.

Towards the end of the project, an LIS Training Centre and a BLIS Technical Support Group (from the lead agency) were incorporated into the model. The conceptual model is shown below in Figure 2.

System Design

The system design was primarily aimed at accommodating the needs of each of the individual BLIS agencies, whilst also considering the overall BLIS requirement of being able to integrate the various common individual data sets when required in the future.

The need to document a comprehensive list of graphical data items contained on each of the maps and plans and the associated attribute data for each BLIS agency, led to the development of a Data Dictionary. It is hoped that this will lead to an improved ability to interchange data in future and to use a common base map.

Unfortunately, the priorities of each of the agencies, in terms of application development, were not clearly defined prior to commencing the pilot study. However, while it was difficult to obtain the organisational objectives to be derived from the proposed system, the pilot study did help each agency better understand its own existing system as well as gaining a better understanding of its role in BLIS.

The use of the system's database software (INFO) was generally a slow process as virtually all the staff lacked experience in database development for LIS. As a result, some inflexibility was initially encountered in utilising the database for editing the data and producing reports.

In designing the database, a consultant from the vendor assisted in determining the specific needs of the various users in BLIS and translating those into a logical concept for the database and selected applications. A draft of the physical design of the database was subsequently developed with a system prototype application for each agency from the proposed BLIS database also being identified. A pilot database design document was produced in October, 1991 which described in detail the various layers, boundaries, facilities, themes and item descriptions for each BLIS agency.

System Prototype Application

To illustrate the potential of the system for integrating various common data sets for detailed analysis by each of the BLIS agencies for their own particular applications, a system prototype application was developed. The application selected was the examination of alternate locations for an existing road or the widening or extension of an existing road and the subsequent impact on each BLIS agency (Figure 3). Options for the proposed position of the road were explored within a 3 square kilometre area which had complete data from each agency.

The exercise was successful, particularly from a data integration perspective as well as from an educational point of view. The assessment of the impact of the proposed road construction on existing and new services varied from agency to agency, but generally the prototype applications developed allowed an evaluation of one or more alternative routes. Reports were produced from data stored on the system to assist in estimating the costs of land acquisition, utility services removal or relocation and the provision of new or expanded services.

Figure 3

(not currently available)

System Prototype Application - Road Relocation

1:10,000 GIS

During the project it became evident that the potential of the system could not be fully utilised with only one scale at 1:1,000 for the common map base. There was a particular need for a digital map base that could be used for strategic planning and initial design of large infrastructure projects such as sewerage or mass transit systems. As a result, some of the layers from an existing map base at a scale of 1:10,000 produced by the Japanese aid bureau about ten years ago were scanned and placed in the system. This system is now operational with the development of applications under way.

The development of a system at this scale has served a number of important tasks. As well as providing a base to serve strategic planning requirements, it has provided some early positive results and benefits which are of particular interest to senior policy makers.

BLIS Project Seminars

An integral part of the continuing education process associated with LIS within the BLIS agencies and other interested RTG organisations was the presentation of a number of Project Seminars. These forums

were recognised as very important in raising the level of awareness of the BLIS project and its progress in particular. Additionally, these forums provided other organisations with the opportunity to become involved and gain some understanding of LIS and its associated technologies. The results of the pilot project have been extensively documented in both Thai and English, and distributed around Thailand as well as internationally. The project personnel made presentations to visitors on a regular basis.

Achievements and Outputs of BLIS Pilot Project

Summary of Achievements

The progress of the various activities undertaken on the project were completed within the time frames estimated in the initial Work Plan. However, some activities took more time to complete than originally expected, for a number of reasons.

- Difficulties were encountered in identifying the overall organisational requirements (user needs). While specific user needs from the system were often identified in general terms, the priorities for the application development for individual departments within an agency and their interaction with other departments were usually not clear.
- Delays were experienced with the design and implementation of the system database as discussed previously. However, they were partly overcome during the development of the system prototype application.
- The project personnel generally found the development of application software difficult and consequently needed much assistance. Experience in developing utility agency applications using digital mapping systems is currently not readily available in Bangkok.
- A considerable amount of time was spent in attempting to understand the system's hardware and software, the development of input software, the database and the development of applications. As such, the time spent by most of the agencies in trying to understand fully the precise nature of data conversion in terms of the number of options available, time frames to convert each record set and the appropriate resources required for conversion, was generally insufficient for a project such as BLIS.

Output from BLIS Agencies

Each of the project teams from the five BLIS agencies were able to achieve major outputs in the following areas.

- *Collection, Input and Verification of sample data* - within a common 3 square kilometre area, each agency was able to collect and input detailed information regarding their systems from the range of plans and other data sets held by each organisation.
- *Output Products* - a variety of maps and plans were produced at varying scales showing detailed information regarding each of the networks that had been collected and input to the system. A variety of database reports were also produced from information collected and input to the system by each agency.
- *Application Software Development* - a number of applications were developed on the system by each agency that queried the information held in the database and its association with the graphical map data. These system reports were used extensively during the project seminars and demonstrations to highlight the potential applications of the system.
- *Development of the BLIS Database* - input was provided from all agencies on their specific needs from the system which were integrated into the final design of the BLIS database. See Figure 4 for an example of an Electricity Supply Map showing classification of customers connected to an electricity supply. Also see Figure 5 for an example of a Property Valuation Map showing land parcels classified on property valuation.
- *System Prototype Application* - each agency assisted in the design and jointly developed the prototype system application which for the purpose of the pilot study was a proposed alternative

location of an existing road. See Figure 3 above.

Figure 4

(not currently available)

Electricity Supply Map

Figure 5

(not currently available)

Property Valuation Map

General Experience

In terms of meeting the primary objectives of the project and completing the work plan according to schedule, the BLIS pilot study must be considered a success. The joining of the five major utility and land administration organisations in Bangkok to purchase LIS equipment and provide staff and resources to undertake system training and development on the equipment on a shared project basis worked well, in terms of a cooperative approach and sharing of experiences. Undertaking this joint LIS project in Bangkok was a significant achievement in itself, which has not occurred on this scale in most other cities around the world.

Throughout the project, the agencies encountered many of the technical, administrative and organisational issues normally associated with implementing Land Information Systems, which provided both the project staff and the senior officials with some understanding of areas which need to be addressed in the future. Particular problems which are unique to the City of Bangkok, which were also encountered, were mainly of an institutional and funding nature. They will take some time and effort to resolve fully in the future. The cooperation and commitment of the BLIS agencies displayed to this stage will need to continue if these issues are to be resolved satisfactorily.

The project did not completely resolve the majority of the issues that were identified during the course of the study. However, the agencies are now in a much better position to be able to realistically understand the necessary components that need to be put in place in order to establish a framework for successful implementation of an LIS in the major agencies in a coordinated manner across Bangkok. They now have a much better understanding of the potential and limitations of the technology and associated concepts.

Staff Selection and Training

Even though staff selected for the project had a high degree of enthusiasm and willingness to embrace and understand the new technology, none of them had any experience with LIS or digital mapping. There was no understanding of the broader concepts or potential of LIS and the longer-term implications of such systems. There were no professional surveyors or cartographers available to be involved in the project. This presented obvious difficulties, not only to the project staff but also to the supervisors. This highlighted the importance of some broad training in LIS concepts and principles prior to the vendor specific training on the hardware and software. Previous experience with computer systems such as AutoCAD proved to be extremely beneficial. It would have been a great advantage to have had some surveyors or draftspersons who understood technical aspects of supporting mapping systems, although the project did have some geographers involved.

The agencies are now in a better position to provide some input to the design and scheduling of training courses associated with any future systems or for training new project staff. While individual agencies will require specific training, a lot of the training between agencies could be made common. To address this, the BMA is planning to establish a LIS Training Centre, which will work closely with the academic

institutions to provide suitable training.

Establishment of Project Office

Establishing the project office and the associated support facilities clearly highlighted the difficulties generally in the Royal Thai Government (RTG), and most governments, in establishing new projects and groups, especially those that involve a number of government organisations. The time delays in establishing basic office support facilities can in fact be so significant as to undermine the viability of the project.

Significantly, in October, 1992, the BMA was able to establish a new permanent project office, within the BMA City Hall which provides good accommodation for the system equipment and staff. The project has emphasised to the agencies that LIS is not just HW/SW; appropriate administrative, staffing and institutional arrangements are the key to the success of LIS.

System Development

The development of a sub-system for each agency in the project took a great deal of time and effort, and was much more difficult than anticipated. In particular, the development and utilisation of the database proved to be a difficult task for the majority of the project staff. In retrospect, the original specification for the database should have specified a relational database which used SQL, such as ORACLE for example.

It is evident that each agency will require considerable technical assistance in formulating and developing an organisation-wide LIS or Automated Mapping/Facility Management (AM/FM) system. The MEA, for example, has recognised this situation and released a tender for an AM/FM system and data conversion project in early 1992, which relies heavily on the system supplier designing and developing the database, developing specific system applications and undertaking the conversion of the various map based records closely with the MEA staff. Project staff found that some training should have been more comprehensive, particularly regarding the programming of the macro language and plotting routines.

An insight was also provided during the project into the various components of system management that will need to be addressed by each agency in planning for their own systems. Project personnel were required to manage and resolve problems encountered with the system such as hardware and software problems, system security and maintenance contracts with the system supplier.

Inter-agency Cooperation

The interaction and the cooperative approach adopted by each of the BLIS agencies was a positive factor in the success of the project. Personnel worked well within the various work groups that were established and the team approach adopted on the project helped overcome some of the initial difficulties encountered in trying to understand the various components of the system, and the individual needs and priorities of each agency. The good cooperation between the personnel from the different agencies ensured a sharing of experiences and enhanced the educational outcome of the project.

Regular meetings of both the project supervisors and the Executive Committee members provided valuable forums to discuss many aspects associated with the proposed system and again increased the general awareness of each agency's concerns and requirements. Jointly undertaking the project provided this unique opportunity, which otherwise would not have occurred, particularly in the Thai bureaucracy where agencies are reticent to share problems and difficulties.

Project Management

An essential requirement for any future BLIS will be the appointment of a permanent senior official to manage the project team and to provide leadership and political support for the project. In addition a

permanent organisation needs to be established to ensure a career structure for project personnel.

Just as important is the political and financial support from the highest level in the agency and in wider government. This support has been one of the keys to the success of the project to date. However, future managers will need to work hard to ensure continued support at these levels.

Future management will have to concentrate on four main management related areas. First, the establishment of an appropriate management and career structure. Second, the determination of a strategic plan for the future establishment and growth of BLIS. Third, continued funding for the project and, finally, a serious commitment to education and training.

Experience has shown that funding for HW/SW is relatively easy to obtain. Funding for data conversion, strategic planning and education and training are much more difficult.

The strategy of purchasing HW/SW, obtaining some advisers and undertaking a pilot project, adopted by the BLIS agencies in undertaking the project was also proved to be successful. As the agencies now move into implementation, they are increasingly aware that the next phase will be more difficult.

Data Collection and Conversion

The complex nature of data conversion became apparent very quickly to the staff, when trying to interpret and integrate map-based data from a number of different record sets during the project. It became obvious that in some cases much effort was required to bring the records up-to-date and to include all the necessary base information.

Experience during the project indicated that agencies will need to allocate significant resources to the task of collection, integration and verification of the necessary data items that are to be included in any future digital system. The base records were found to be at differing stages of completeness and currency, which became apparent when a comparison was made with the digital map base produced for the pilot project. In addition, even though the aerial photography on which the new map base was derived was flown in 1987, there were also some problems with this new map being out of date. This occurred even in some heavily built-up areas, highlighting the rapid change being experienced in a dynamic city like Bangkok.

Generally, the development of conversion software by the agencies during the pilot study will require further development and tailoring in order to handle efficiently a large data conversion exercise in terms of the graphical input and the associated database linkages. The time taken during the pilot study in developing input software, and collecting and matching up records helped to illustrate the particular requirements, complexities and difficulties in each phase of the data conversion process.

Recognising this situation, the Department of Lands, as part of the Thailand Land Titling Project (see below), carried out in 1992 a small pilot study using Intergraph workstations and a large scanner to look specifically at the issue of data collection, conversion and integration. This study reviewed areas such as the suitability of existing DOL records, the possible interface to existing attribute data held on a mini-computer in a district office and investigated the possible options to input current map-based data. This experience will be a valuable supplement to the experiences of BLIS in data collection and conversion.

Similarly, in establishing the first stage of their AM/FM system, the MEA have also recognised that the data conversion component involving converting their existing manual asset record system is a complex operation. As such, the system supplier will also be required to carry out the conversion of the MEA's series of plans for the first stage of the overall implementation.

Data Maintenance

As mentioned above, the critical requirement for up-to-date digital data became apparent very early in the project. This was clearly highlighted when attempting to match up the manually drawn base maps and

building data held on the 'current' hard copy plans of each agency, to the new digital map base. Since each agency has differing needs from its recording and mapping systems, their map bases and associated data showed varying degrees of currency and accuracy with respect to such items as building outlines, house numbers, building modifications and changes to road patterns.

The correlation of this data proved very difficult at times, with the result that numerous field visits were required in order to resolve queries concerning building location, identification and number. The correlation also highlighted discrepancies between different agencies for data on the same building.

Both the data conversion and maintenance issue are compounded in Bangkok because of the very high density and complex mix of legal and illegal buildings used for residential, commercial and industrial purposes, and the very narrow streets.

All the above problems, however, have made the agencies much more aware of the deficiencies in their own recording systems in terms of detail, accuracy and currency, and also more aware of the recording systems of the other BLIS agencies.

Complexity of Introducing LIS

An aspect which became more obvious to the agencies as the project progressed was that the introduction of LIS concepts and associated technologies is difficult. An initial belief with some personnel that LIS was just HW/SW was soon corrected. One of the successes of the project was convincing senior management that implementing LIS is a long term exercise and a relatively costly exercise in terms of HW/SW/Maintenance, personnel, education and training and particularly data. On the other hand, senior personnel quickly recognised the need for the system to return some early benefits; the development of the 1:10,000 GIS over Bangkok to be used for strategic planning will serve this purpose.

Despite the 'teething' problems with the pilot study, the general understanding of LIS concepts and technologies in terms of their long-term potential, equipment and staffing costs, impact on current operations and the general needs for education and training requirements, are considerably greater now within each BLIS agency than when the project started.

However, it is recognised that the introduction of any new systems and technologies requiring major organisational change into the RTG bureaucracy is a difficult task. In recent times there are many examples of large infrastructure projects which have been delayed for considerable periods because of their complex nature and the organisational difficulties experienced by the responsible agency in attempting to manage their implementation. Taken in this light, the achievements of BLIS to date have been very positive and indicate a promising future.

Common Base Map

The digital base map covering 25 sq km at a scale of 1:1,000 for the BLIS pilot project was created from recent aerial photography flown for the Thailand Land Titling Project, another project supported by AIDAB (for further details see Angus-Leppan and Williamson, 1985; Smith and Holstein, 1987; Williamson, 1990). The map base included road patterns, footpaths, canals, buildings and building numbers. Interestingly, the cadastral pattern was not initially considered a basic data item on the common base map, since it is the buildings which are taxed in Bangkok, not the land parcels, and the utility agencies are only interested in customers and connections to buildings, not land parcels. Each agency was able to use this common map base to evaluate its own future requirements concerning the composition of the essential data items required for such a base map. A scale of 1:1,000 proved to be most practical and cost effective for the base map.

Significantly, each participating agency was able to recognise the many advantages of jointly funding and creating a suitable digital map base that could be used well into the future by BLIS and other interested agencies in Bangkok. As the pilot project progressed, many interested parties contacted the BLIS project

to enquire about the availability and extent of existing or proposed digital mapping in and around Bangkok. It was recognised that many of the current problems experienced by each of the BLIS agencies in updating and maintaining their existing manual mapping and recording systems could be partially overcome by the provision of an up-to-date, accurate, digital map base supplied from a single source.

Considerable time was therefore spent defining the composition and extent of the proposed common map base proposed for Bangkok, in order to ensure each agency's requirements were catered for and incorporated into an appropriate map specification. While there were slight differences between the agencies in the extent of data items considered essential for any future digital map base, general agreement was reached that the specification would be based around road patterns, canals and building details.

The BLIS agencies and the RTG are presently discussing appropriate institutional arrangements to produce and keep up-to-date a common map base for Bangkok. It is recognised that the production of an up to date common map base is the single most important issue in establishing a land information network across Bangkok, and is of national importance. It is also recognised as being a key to maintaining the necessary cooperation between the BLIS agencies in the future.

Several options are being considered. One option is to undertake the mapping of Bangkok from 'scratch' thereby providing the most up-to-date product. Such an approach would be coordinated by the Royal Thai Survey Department, would require new aerial photography, could be expensive, may not overlay the new DOL 1:1,000 cadastral maps and could involve considerable delays. A preferred option is simply to digitise the existing DOL 1:1,000 photomaps and accompanying cadastral overlay. These photomaps are one of the products of the Land Titling Project and are consequently based on relatively recent aerial photography, although some of the maps are based on aerial photography about six years old. This approach would have the added advantage that the resulting digital map would be fully compatible with the DOL maps and could be overlaid with confidence. In addition, this approach would have low cost, incur no time delays and utilise simple digitising technology. One disadvantage is that there may be a need for more field completion than if the map is produced directly by photogrammetric methods.

Future of BLIS

One of the prime objectives of the pilot project was to give some direction, particularly with regard to a conceptual model and a strategic plan, for a future LIS for Bangkok. A wide range of issues associated with implementation and the operation of a LIS became apparent during the project which were not recognised nor fully understood by the BLIS agencies prior to commencement. Throughout the project the specific requirements of the City of Bangkok were married to more generally accepted principles for an urban LIS. The framework for the development of the strategic plan has been developed over time and is summarised below.

Noting the key objectives of the Seventh National Economic and Social Development Plan (1992-96) for Thailand, it was recognised that the objectives of the service and facility agencies for the City of Bangkok were to support an acceptable quality of life for the inhabitants, a clean and healthy urban environment and provision of services to industry to sustain the country's economic growth. These objectives require timely and correct information in support of service delivery, maintenance of facilities, management of resources and collection of taxes. Without such information it is impossible to manage the provision of services and facilities in a rapidly expanding metropolis. The information is required to support three major activities, namely strategic planning, land administration and management of physical infrastructure. These concepts led to the conceptual model shown in Figure 2.

In order to provide such information, each service agency needs to establish a unit to create and manage an AM/FM system, a Geographic Information System or a LIS as appropriate. Such systems are central to the management of these agencies whether they are providing water, electricity, telephone services or are managing city planning, property taxation or strategic planning. Each system will be based around a

major computing facility, will be part of the organisation's information technology strategy and will be using spatially referenced textual data linked to a number of integrated map bases. These systems will require political support, corporate management, LIS/GIS technical and management expertise, HW/SW, data collection, education and training, and strategic planning.

Economically, strategically and practically, the only way that such systems can be created such that they contribute to the effective and efficient management of the metropolis, is by sharing key spatial and textual data sets. This is important to reduce the major cost of data collection as well as facilitating the combination of data sets from different agencies in future.

In order to achieve this objective, it is considered essential to develop a coordinated system with a user focus across the service authorities in Bangkok to provide the following.

- A Steering Committee to coordinate all policies, initiatives and systems
- A Common Base Map. Such a base map may include such data as houses, roads, canals, parcel boundaries etc and may in fact include a range of scales such as 1:1,000 and 1:10,000.
- A Common Textual Database. Such data may include building numbers, parcel identifiers, street addresses, building owners, parcel owners, and building and parcel values
- Mechanisms to ensure that all sectors of the community have access to the data. This will require funding arrangements with all participating agencies in the short term, to acquire the base data, and charging schedules in the medium to long-term to make the data available to all users, whether government or private.
- Mechanisms to maintain, update, provide access to, and to integrate data.
- Mechanisms to ensure that the appropriate individual agency data sets are shared and that data flows are established to ensure that key data generated in one agency can flow to another agency to update the common databases, ie parcel owners from DOL or building numbers from BMA.
- Technical expertise to provide technical advice to coordinating committee, standards for exchange and data accuracy, specifications for hardware and software (HW/SW), data collection and mapping.

From experience in other countries, it is important that the BLIS activities are seen to provide independent advice and support which can coordinate and steer the LIS activities over the next decade. However, experience has shown that there are some important principles which should be adopted in order for the concept to work, especially in the short term, as set out below.

- BLIS should not maintain operational data from the participating agencies, although it should maintain the common base map and common textual data. Its primary role should be to give leadership and advice, coordination and facilitation, and provide common data. It is important that the BLIS authority is not seen to be competing with the operational agencies with regard to data ownership, technical expertise and HW/SW acquisition.
- All operational data sets should be owned and updated by the relevant organisations such as MEA, MWA, TOT, DOL and BMA.
- BLIS should be attached to, or work very closely with, a lead agency, particularly in the short- to medium-term
- Common data should be maintained and coordinated on the computer systems of the lead agency and then distributed to the participating agencies as required. It is essential for the lead agency to establish a mechanism to update the base map. This process will require data updates from the DOL on subdivisions and from the BMA on new buildings, for example.
- The BLIS authority should draw heavily on the technical expertise within the 'lead' agency, to establish standards for reliability and interchange, to manage acquisition of data and associated contracts, to determine HW/SW specifications where required. It will also be necessary for the 'lead' agency to maintain sufficient technical expertise to ensure that data items from the participating agencies can be integrated, particularly on a project basis.
- An extensive education and training program is essential for the success of BLIS and the

introduction of LIS/GIS into the participating agencies. This issue cannot be over-emphasised. A LIS Training Centre should be considered.

- Financial arrangements must be put in place. Consideration should be given to cost sharing and mechanisms for financing BLIS.

Conclusions

Cities in the developing world don't have a choice. The deteriorating urban environment in most cities in these countries is lowering the quality of life of the inhabitants to unacceptable levels, and undermining the ability of these cities to sustain economic development. As a consequence, they don't have a choice. They must try all options to alleviate and hopefully improve the situation. Some cities, like Bangkok, are turning to land information systems as a way of improving their operation and management.

Developed countries have well established and well documented approaches for designing land information systems. For a range of reasons, some not easily understood, developing countries often take different approaches to introducing new concepts and technologies, and such is the case with the City of Bangkok in introducing LIS. The paper has described a successful pilot project for a LIS for the city, although the approach differs from that normally adopted.

In the case of Bangkok, the successful implementation of a LIS, networked across the major service and utility agencies, will be dependent on the success of the following: continued cooperation and goodwill between the agencies; the establishment and maintenance of a common base map; and a commitment to education and training. All of these will require continued political support and continued funding.

The future looks bright for the implementation of a land information system for Bangkok. The BLIS project appears to have gained its own political and institutional momentum. Most of the participating agencies are committing significant resources to introducing their own systems, but only time will tell whether they will follow the trend of many cities in western countries where the individual agencies compete and do not cooperate, with the resulting inefficiencies and costs to the taxpayer. There is currently discussion in Thailand at Cabinet level that BLIS should be given the status of a project of national importance; does Thailand really have a choice?

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Author/s:

WILLIAMSON, IAN;Mathieson, Garry

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