

# **GIS Application in urban planning and urban management: Utilising GIS in Kigali urban planning and city management**

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## **1 INTRODUCTION**

Urbanisation is inevitable, so are the impacts. In order to minimise these impacts we must have urban infrastructure that are properly planned, designed, operated and maintained so that it provides optimal efficiency. Part of the problem with today's urban structure is that it was built at a time when planning awareness was substantially different from todays. Consequently, we are playing catch-up in trying to retrofit existing system to achieve today's urban performance objectives. Consequently, one major issue of concern today in the survival of our cities is the problem of urban management. In this instance, efforts need to be paid to the institutions of appropriate development oriented governmental structures as well as to the provision of the wherewithal to manage the infrastructures.

Kigali is one of such city, and being the capital of Rwanda, it is experiencing a considerable growth. The morphology of the city exhibits a double duality; it consists of a capital city, complemented by associated rural environs sometimes referred to as Kigali rural. As such, there was an apparent increasing pressure on land, which has led to recent societal awareness of the fragile nature of land and its resources. With an estimated population of 1,000,000 people and an annual growth rate of 9.0%, planners anticipate that within the next 10 years, the population will double itself. The development of the city has been spontaneous, un-controlled and haphazard. At present Kigali has got no master plan to guide it's development, as such, cases of incongruous land uses, preponderance of misuse of land and unauthorised change of use occur. This lack of planning has adversely contributed to the inadequate provision and maintenance of urban facilities, utilities and amenities.

On the whole, planning of the city has been undertaken at central level with inadequate legislative sanctions to effect an orderly growth of the city while the available manpower and instruments could not effectively cope with population explosion in the last six years. Most houses have been built without a building permit, without registration and as earlier mentioned, not necessarily on land earmarked for residential purposes. All the foregoing cumulative deteriorating conditions arose a great concern and the realisation that as Kigali becomes larger, more complicated, more sophisticated and subject to un-predictable changes, it requires a pragmatic approach in the city management. It is against this background that interests have been geared up at developing an innovative urban plan and an appropriate technique for providing easy access to accurate, fast and reliable urban information, which will be used in the preparation of city development plan.

**Kigali Urban planning and management capacity building (KUMPCB)** program is therefore an offshoot of the urban development project of the United Nations Development Programme (UNDP) conceived with the major aim of building a decentralised capacity for effective functioning and strengthening of institutions responsible for urban management and local resource mobilisation in Kigali. The project was designed to provide anchors for complementary urban programmes funded by several donors with the purpose of increasing synergy and consistency between programs. It is also to stimulate the emergence and transfer of demand-driven local initiatives while at same time contributing to good governance, sustained public-private partnerships, community participation and responsible resource management.

The central thrust of the project is to develop a well-articulated **master plan** from which development plan for some selected zones will be structured along with development of an appropriate plan and management strategies within the administrative boundaries of Kigali Urban that will ensure environmental sustainability. Basically, this is to be achieved through multi-agency liaison and consensus building.

The program basically consists of 4 components:

- ?? Preparation of structure and development plans
- ?? Development of instruments and tools to control and implement plans
- ?? Development of urban management capacity in PVK
- ?? Development of immediate actions and projects

All these four components are related, linked and interdependent on each other.

The corner stone of this new direction is the adoption of the philosophy of **sustainable development** as our goal. In this regard, the supporting strategy to this goal is the strategy of maintaining an improved knowledge base about land and its resources.

## **INFORMATION TECHNOLOGY AND URBAN MANAGEMENT**

The importance of current data and information cannot be over-emphasised for planning to be effective and efficient. Basic data and information needed for the planning and development of our cities centre on the spectrum of the information needed for meeting the functions of government at that level. Indeed data and information have traditionally been the underlying principles in any development initiatives. Data are facts and information collected to improve the quality of decisions and actions. It is therefore not surprising that recently, much effort and resources have been concentrated by agencies and projects in developing countries on the collection, coalition, analysis, and interpretation of information and data necessary for their effective functioning.

In recent times, there has been an increasing awareness of the role of information technology in achieving these tasks for overall societal advancement. Particularly, the development of geographic information system (G.I.S) has revolutionised the collection, coalition, analysis and interpretation of data for planning and decision making process especially in urban and regional planning initiatives. This is because the data storage, updating, retrieving and manipulating capabilities of GIS have implications for developing strategies for urban management and planning for sustainability in the developmental process. In general, application of GIS has the following advantages:

- ?? Large quantities of data can be promptly updated than is otherwise possible
- ?? Eliminates manual operations between information input and output on the other hand
- ?? Helps in identifying, clarifying and addressing urban issues through a geographically differentiated approach

- ?? Supports participatory decision making and the formulation of strategy for better implementation
- ?? Supports in producing, storing, and updating urban information for planning and management
- ?? Helps to build broad based capacities in resource management.

One of the biggest paybacks of information technology is its need for this corporate vision in strategic planning. It cannot succeed without it and recognition of just that prompt the development of such corporate thinking here in Kigali City management where none existed previously. In what follows therefore, an overview of GIS related initiatives within the Kigali City management is given.

## GIS UTILISATION IN KIGALI CITY MANAGEMENT

It needs to be pointed out that prior to now, the city administration of Kigali has spent many years pursuing GIS related initiatives. However, these initiatives have not always been undertaken in a coordinated manner, while information on urban resources were known to be superficial and anecdotal levels, as such, previous decisions were based on limited or sketchy information.

My activities and involvement in the project is in respect of "***The development of instruments and tools to control and implement plans.***" This task will be highlighted from two different perspectives:

- ?? Establishment of an urban information system and;
- ?? Development of an operational cadastral system for PVK

The project began its development of the new capability for geographic data collection in January 2000 by conducting a formal information needs assessment after identifying the generic business functions that will be supported by the technology. This information needs assessment served as the basis in building the data base model to meet the requirements of Kigali urban program. An inventory of geographic information was also conducted. The good news is that we found ourselves moving from using the technology mainly for cartographic purposes to using it as a tool to support planning operations.

The application philosophy in this case was primarily engineered to focus on the city council business function. In this regard 3 important elements were focused upon:

- ?? The people – whom the system is to support and serve
- ?? The process – which the system is required to perform and lastly,
- ?? The product – which the system is expected to generate

All the above three elements are closely related in Kigali urban program.

A precise data requirement investigation was performed with the aim of

- ?? Identifying all data requirements and data location;
- ?? What data are available?
- ?? Identify the data formats;
- ?? Evaluate and assess the comparability and compatibility of data from other sources and their accessibility; this includes identifying those who controls the data and the methodology by which the data will be released to the project;
- ?? Identifies roles, responsibilities and relationships of all agencies and individuals to be involved;
- ?? Identifies tasks and expected products to be achieved in accordance with the time schedule.

Approximately, 4 basic data types were identified; these data types described the manuscript data layers that was later to be developed. In order to ensure the system compatibility with the existing data information, specific requirements were adhered to. These includes among others, a specification for positional accurate data (reference to a projection system). A solid geographic reference is an imperative for a GIS; if not adequately referenced, data will sooner or later be lost or become inaccessible for other potential users. Also each of the different features was assigned a unique combination of layer and symbology and for the purpose of data exchange, features were categorised according to Rwanda survey & mapping feature code.

In this project, there were two types of application front ends; urban information and land related information (cadastral). The database is maintained by GIS software (arc View). This software accepts non-intelligent drawings as well as converting points and lines into spatial database format while providing tools to correlate each piece of graphics with the appropriate textual record in the textual database. These spatial entities are categorised as different ***themes***. Basically, the task contains two sub-tasks; ***the system infrastructure development and the application development***.

I wish to stress that; the GIS being developed at this stage of the project were yet in a simple form. While it focuses on the present and immediate needs and planning function of PVK, it is made flexible and expandable to enable future and further development into a complete multi-purpose system. The entire theme structure thus contains four major elements:

- ?? The digital base map
- ?? The Administrative area
- ?? The land uses
- ?? The land records

The base map source element contains layers, which shows plannimetric layer, topographic layer as well as geodetic control points. The administration elements are made up of information showing the boundaries in city administration and road networks. The land uses category shows the breakdown of the different usages to which land within the project limit is been utilised. Lastly, the land records element (to be implemented later) will contain the legal plan boundaries, the legal block boundaries, the plot boundaries, the ownership plot boundaries, the lease plot boundaries and the easement/right of way. On the other hand, the entire land information system been put in place is to be an integrated system that will facilitate land administration through planning, registration of titles, issuance of certificate of occupancy and efficient collection of revenue through ground rents on land, tenement rates and building permits. For this purpose, a digital base map at the scale 1 /2000 is being processed from an aerial photograph that was taken in September.

In terms of conceptualisation and application, the evolving system is one that has series of layers defining the variable that represent various uses. The otherwise step-by-step application is as follows:

**Inventory:**

- ?? Index map of all available maps and plans with title and scale,
- ?? Inventory/database on all available maps related to urban planning and environmental issues.

**Digital Base Map:**

This is the basis of all our GIS activities and it involves the conversion of the existing available 1/20,000 map into a more usable format (digitising). The map contains; basic landforms, grid lines, road networks, hydrographic network, built-up area, common scale, legend, and layout.

**Research and Field work/survey:**

Here, other missing and additional information was collected from various sources

- ?? A traffic flow /study of the city was conducted
- ?? A socio-economic data survey was also conducted in this regard.

**Aerial Photography:** (Still in progress)

- ?? Basis for the development of the new 1/2,000 base map and
- ?? Help in updating the existing map.

**Generate Thematic Map:**

Other factual information and additional data's derived from the fieldwork was used to generate 2 significant thematic map; the existing land use map and the constraints map.

**Suitability map (Potential areas map):**

- ?? Provides a number of alternatives. This is the stage where we are on the project and the intention is to carry out map overlay operations, i.e.
- ?? Overlay maps within engineering constraints
- ?? Overlay maps with preservation constraints
- ?? Overlay maps with potential areas
- ?? Rank constraints
- ?? Transform rank of constraints into rank of suitability's and of course
- ?? Development pattern

## LESSONS FROM THE EXPERIENCE / CONSTRAINTS

The lessons learned to date are numerous and very useful to anyone attempting to undertake an application development project. Some of the more important ones are: -

- ?? Project's scope almost always increases and never decreases. Sometimes you have to be honest and simply recognise ones limitations and not take on more than what can reasonably be accomplished within the resources available
- ?? Knowledge about urban planning and management decision-making process is very diffuse. It is spread widely among various field practitioners and policy makers, and is not easily captured in a decision-making support system. In many respects, it is tied up in "natural expert system"
- ?? Hand in hand with setting the scope for the project is the need to manage users expectations. They often expect that once they have provided you with input, an application solution is literally weeks away, and expect you to fulfil all of the user's specifications at the same time.
- ?? Utilising GIS in urban planning and management is an iterative process, between the systems professionals, domain professionals, and end users. Likewise, applications of GIS technology will have an impact on corporate policy and procedures. Issues around standards, business rules, and processes to be employed in the planning will have to be addressed to ensure the smooth integration of the application into the business environment of the project.

## CONCLUSION

The new technology of geographic information system has brought and integrated diverse disciplines and professionals into a single framework for data acquisition, storage, and analysis and tracking a host of problems confronting Kigali urban management. This framework has made planning and control of Kigali urban development easier and more practicable.

The advantage of GIS to urban planning and urban management is therefore obvious. By using GIS, all necessary data and information needed for Kigali urban planning were stored, organised, and made available on request to users. It also provides the capability to respond adequately, to rapid urban growth and societal changes in norm's and values with increasing ease, foresight, and responsiveness. Finally, possible scenarios for resolving diverse urban problems has become easy to generate and has become handy in the decision making process with respect to planning in the Prefecture de la Ville de Kigali.

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