

APPLICATION OF INFORMATION SYSTEMS IN IRREGULAR SETTLEMENT MANAGEMENT AND LOW-COST HOUSING PROVISION

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DECLARATION

I hereby declare that this thesis is my original work and has not been submitted in any form to another university.

Simon Crone

ABSTRACT

Information Systems, both paper-based and computer-based, are integral in the management of irregular settlements and the process of delivering low-cost housing in South Africa.

An Irregular Settlement can be defined as an area where the 'shacks' have no fixed street address.

Due to policies by previous regimes, under whose rule irregular settlements were almost ignored, there is often little or no spatial or socio-economic data available about existing irregular settlements. Thus for the use of the community, or to organisations interested in helping to improve the quality of life of the residents living in these settlements.

As a prerequisite to quality of life, the basic need of shelter, along with food, healthcare and education need to be made available. The emphasis today is thus being placed on the provision of low-cost housing. A need thus arises to have up-to-date information about these irregular settlements in order to plan either for the upgrading of the settlement or for the relocation to new low-cost housing developments. Currently mostly paper-based systems are being used in these developments.

There are two opportunities where computer-oriented information systems could be used at this time in 1996 and 1997 to assist with the management and upgrading of irregular settlements. The first is the stage of managing an existing irregular settlement; the second is managing the process of housing provision, taking advantage of the project-linked subsidy scheme.

Two Cape Town based projects provide case studies for the application of information systems at the two stages identified above.

The first is the Marconi Beam 'From Shacks to Houses' project located in Milnerton. The second is the Integrated Services Land Project (iSLP) of the Cape Flats.

The Marconi Beam Settlement is an irregular settlement that has been accepted as part of the 'Project-Linked Subsidy Scheme' for the provision of new low-cost housing.

Previously only paper-based systems were being used to manage the settlement and its move to the new Joe Slovo Park formal housing development. There was also found to be a lack of appropriate tools and awareness of which technology could be used in the process.

Some of the specific application areas in which we were able to provide solutions in Marconi Beam included:

- the identification of people directly affected by the fire that swept through the settlement in October 1996;
- the residents who would be affected by the construction of a new road through the one area of the settlement could be identified, facilitating their movement away from the area; and
- a system of tracking the internal moves of residents was devised by which we were able to maintain a record of the internal movements of residents whilst the system of the lottery was in place. Subsequently, with the use of the Block System, the identification of residents who were required to come in and have their applications for new houses processed, as a result of their spatial location in the settlement, was accomplished.

The Indlu Management System, a computer based system, resulted from the need to keep track of, and process, large amounts of socio-economic data in order to speedily process the large number of applicants applying for national

housing subsidies. As a result of the implementation of this system, the processing times per applicant have been reduced from 30 minutes to 10 minutes per applicant.

The successful use of these systems in the two projects demonstrate that there is thus a definite role to be played in the use of information systems in relation to the management of irregular settlements and the provision of low-cost housing.

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GLOSSARY

Backup In relation to data and software, maintaining copies of data and programs in order to recover from a system failure.

CD-ROM Compact Disc - Read Only Memory, an optical disc used to distribute recorded information.

Client/ Server networks

Computer networks in which certain nodes (servers) are dedicated to performing services (such as printing or database management) in behalf of the nodes (clients) accessed by the users.

Computer A general-purpose processor of symbolic information.

Computer network

In a distributed system, computers, terminals and other equipment, as well as the communications links connecting them.

Data A collection of values of various types (numbers, characters, etc.) that are used by information systems to produce information.

Database An integrated collection of persistent data that serves a number of applications in an enterprise.

Data dictionary A tool for describing the contents of a database or, more generally, for describing the entire system under development.

Decision support system

Interactive information systems that assist a decision maker in approaching ill-structured problems by offering analytical models and access to databases.

Electronic Mail (E-Mail)

A system that enables the exchange of messages over computer systems.

End-user An individual who uses the information produced by an Information System in his or her work.

Entity-relationship diagram

A data model that shows entities represented in a database and the relationships among them.

Field (data element)

The smallest named unit of data in a database.

Geographic Information Systems. (GIS)

A computer system of hardware and software that integrates graphics with databases and allows for display, analysis and modelling.

Graphical User Interface

A user interface that relies on windows, mouse, icons and menus instead of verbal commands.

GPS Global Positioning System. A technology that uses ranges from satellites to determine geodetic position.

Internet The world-wide connection of LANs into one large WAN using the TCP/IP protocol. Commonly used for e-mail, the World Wide Web and file transfer.

Intranet The use of Internet technologies in a corporate LAN or WAN environment.

Irregular Settlement

A collection of structures that have no fixed physical street address.

Java Sun Microsystems' platform independent programming language.

LAN Local Area Network. A high-speed data link between a number of computers and computer related equipment, frequently based on PCs or workstations, in close physical proximity to each other.

Photogrammetry

The science of gathering information about physical objects through aerial photography and satellite imagery.

Plotter Equipment that can draw a graphics file using multiple line weights and colour.

Polygon An area defined as a two-dimensional figure with three or more sides intersecting at a like number of points.

Shack A structure in an irregular settlement that has no fixed physical street address.

WAN Wide Area Network. A high-speed data link between a number of computers and computer related equipment, frequently based on PCs or workstations, often situated in different cities or even countries.

Workstation A workstation is a device or a combination of devices integrated to provide the user with graphic data entry, display and manipulation.

1 INTRODUCTION

As a result of previous apartheid measures, designed to keep as many Africans out of the Western Cape as possible, urban planning and development in this region was discriminating and disjointed. Consequently, no formal urban development took place and 'squatting' was the only available option.

The post-apartheid government has taken steps to address this issue nationally, recognising that a conservative estimate of 3 million housing units will be needed over the next ten years. Various steps have been taken, in conjunction with the Reconstruction and Development Programme (RDP), to address this situation.

Much attention is being paid to upgrading existing 'squatter' settlements, as well as helping communities take advantage of the housing subsidy scheme already in place from 1994.

This thesis reports on the application of Geographical Information System (GIS) technology in assisting in the management of irregular settlements, information systems in general and the use of information system technologies in the low-cost housing process.

The objectives of this thesis are to:

- understand the housing and irregular settlement upgrading situation in South Africa;
- determine the role of information system technology in the management of existing irregular settlements, and the low cost housing provision process;

- report on the progress made in two case studies undertaken in the Western Cape; and
- propose models for the future use of information systems and information technology in the management of irregular settlements and provision of low-cost housing in South Africa.

The scope of this thesis was limited to the processes in place for providing housing in the Western Cape.

This thesis begins by giving some background to systems and specifically information systems in Chapter 2. Chapter 3 describes the housing situation in South Africa, as well as the programmes in place attempting to resolve this problem. It also gives a background to the two case studies in this thesis. Chapter 4 presents the studies that were completed in the course of this thesis. Chapter 5 analyses the study and proposes some models for future use. Finally, in Chapter 6, conclusions are drawn.

2 INFORMATION SYSTEMS THEORY, TYPES, IMPLEMENTATION AND FUTURE

In this chapter there is an interest in understanding some of the theory of systems, and information systems in particular, in order to understand later which of these systems are found, and which can be applied, to the housing situation in the Western Cape.

2.1 SYSTEMS THEORY

2.1.1 What are Systems?

A system is a collection of components that constitutes a whole. Physical systems, such as information systems, and social systems, such as organisations, are arrangements of sub-systems to achieve predefined objectives.

A manager organising the work of his or her unit creates a system - which then becomes a sub-system of the broader organisation. The developer of a new personal computer system creates a system of hardware and software components that then link together with other such computer systems to meet the objectives of a specific organisation.

Thus, a system is composed of many different parts. In each case, the sum of all these parts is relevant.

In addition to physical and social systems, there are also abstract systems of concepts and ideas. An abstract system can also be of a procedural nature - such as a system's development life cycle - a system for developing software systems.

Zwass (1992) discusses various representations of systems:

The first is a 'black box' view of a system that delimits a system from its environment by its boundary.

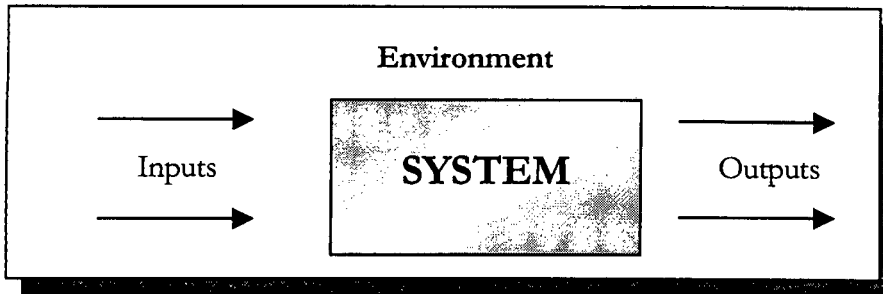


Figure 1: 'Black Box' view of a system. (modified from Zwass (1992))

This is also termed the 'Elementary' system model by Matthews (1971) where the input consists of data concerning the environment that must be converted into a form useable by the system. This data must be processed and then outputted in a form that is useful again to the environment.

Further analysis of the system will progressively identify its sub-systems and then, recursively, its own components in increasing detail. Necessary interconnections between these components (their individual inputs and outputs) will also be identified. Such a model can be seen in Figure 2, modified from Zwass, 1992.

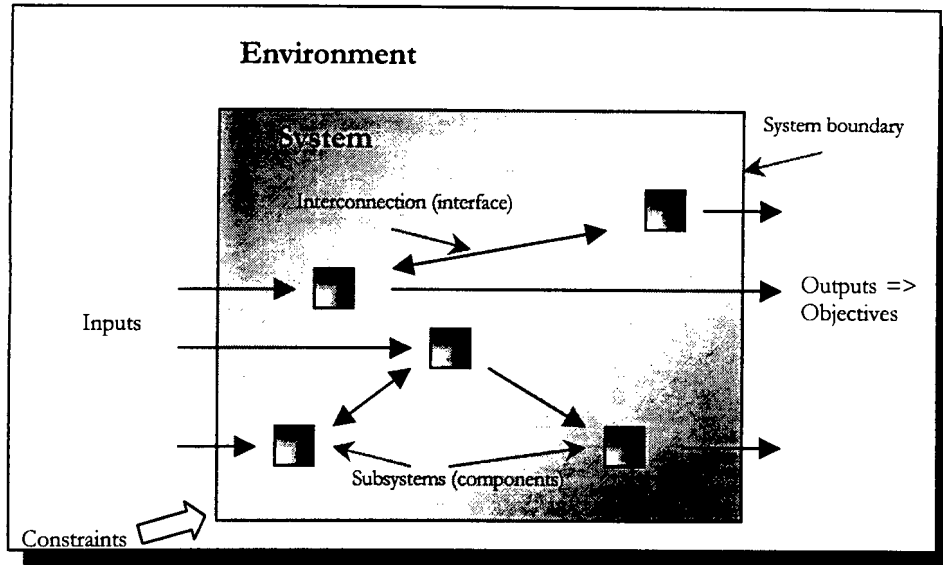


Figure 2: A system and its descriptors (modified from Zwass (1992))

2.1.2 Classification of Systems

Several aspects of systems allow us to classify and thus characterise them. The primary division is between *natural* and *artificial systems*.

Natural systems occur in nature without human intervention. Such a system could be a self-sustaining ecosystem.

We are, however, more concerned here with *artificial systems* developed expressly to support certain predefined objectives.

The value of an *artificial system* can be measured in terms of effectiveness and efficiency. Effectiveness measures the extent to which a system achieves its objectives. Efficiency is a measure of the consumption of input resources in producing given system outputs.

The operation of a *deterministic system* is completely predictable. The present state and the inputs of such a system fully determine its outputs and its next state. A microprocessor chip or software packages are examples of such a system.

The outputs of a *probabilistic system* can be predicted only in terms of the probability distribution of their values or of some aggregate measure, such as the average value. There is always uncertainty as to the actual value at any given time. Both organisations and information systems are probabilistic because they deal with unpredictable inputs, outputs and surrounding environments; their behaviour is, therefore, more difficult to characterise than that of a digital hardware unit, such as a computers central processor unit.

Zwass (1992) classifies systems as *open, relatively open or closed*. These are represented in Figure 3.

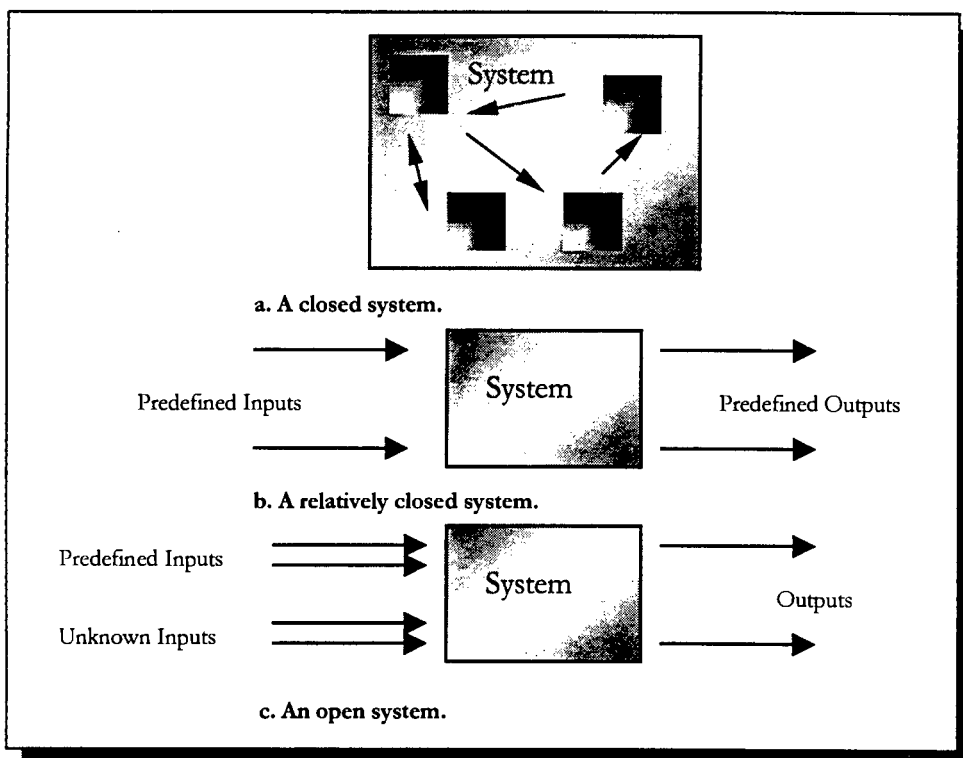


Figure 3: Closed, relatively closed and open systems (Zwass, 1992)

A *closed system* does not exchange resources with its environment. This implies that the system has no inputs and no outputs relating it to this environment we may consider the system as having no environment in the systems-theoretic sense.

Open systems exchange resources with their environment via inputs and outputs, some of which are ill defined or even unknown. Informational inputs and outputs are the categories important to us. Some of these inputs serve the purpose of adaptation: as its environment changes, the system perceives the change via appropriate inputs and changes its operation. An organisation is thus an *open system*.

This is especially the case with organisations involved in the low cost housing process, as the process is in a constant state of flux, with inputs and outputs changing on a regular basis.

Between the two extremes of *closed* and *open systems* are *relatively closed systems*. These systems exchange resources with their environment only through well-defined inputs and outputs. Their inputs and outputs are defined when the system is designed, and the inputs are controlled to conform to this predefined form.

2.2 SYSTEM TYPES

In the broad interpretation of Information System concepts, we are thus able to identify the following elementary types of systems in the organisations dealing with low-cost housing processes in South Africa:

- Office Information Systems, which support and co-ordinate knowledge work in an office environment by handling documents and messages in a variety of forms - text, data, image and voice;
- Transaction Processing Systems for operational data processing that is needed. This includes the registration of customer orders, processing of invoices and issuing of receipts, but can also include some of the functions evident in the low cost housing process, where large amounts of data needs to be stored and processed. This type of system is

particularly evident in the iSLP project where large numbers of applicants details had to be processed in a short space of time;

- Management Reporting Systems capable of producing reports for specific periods designed for leaders responsible for specific functions in a project. These are often required to report on the projects progress to the Minister of Housing at Local Government level;
- Decision Support Systems (DSS) expressly designed for the support of individual and collective decision-making such as some of the reports emerging from the Indlu System.

Combinations of the above systems are generally found in practice. Figure 4 illustrates the hierarchy of these systems. Two, which are of particular importance to this thesis, include:

- strategic information systems
- spatial information systems

These are discussed further overleaf.

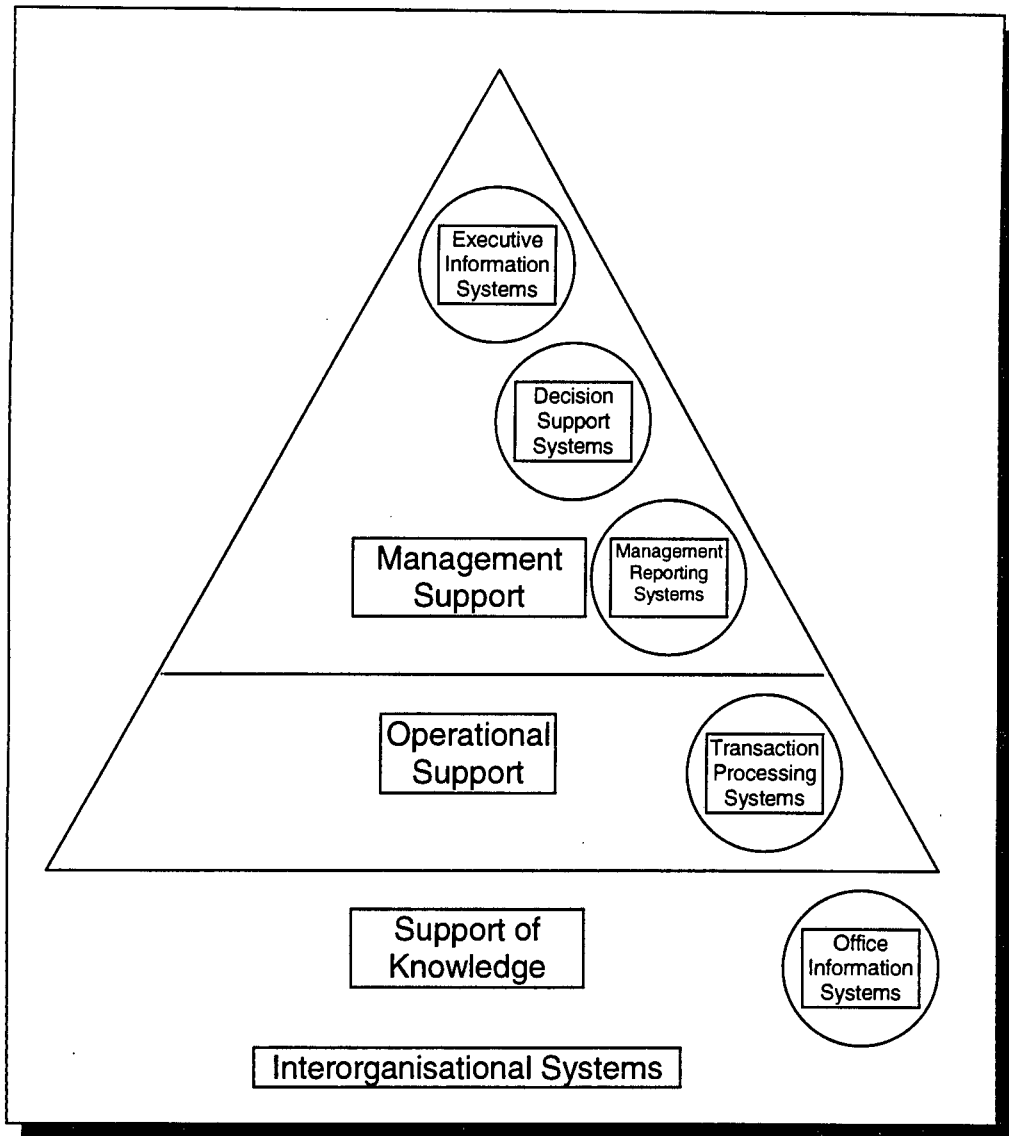


Figure 4: Information Systems in Organisations (Zwass, 1992)

2.2.1 Strategic Information Systems

A strategic information system may be designed to give an organisation or project an enhanced ability to fulfil its role.

Such a system could only be classified in terms of combinations of the systems illustrated in Figure 4. It may consist of one, or many, elements illustrated. The system can be aimed at saving a project either time or money, or a combination of both time and money.

2.2.2 Decision Support Systems

A Decision Support System is a coherent system of computer-based technology (hardware, software and supporting documentation) used by managers as an aid to their decision-making in semi-structured decision tasks (Bennett, 1983). Studies of specific decisions and general studies of decision-making have indicated the potential benefits of computer support for decision-making. These potential benefits can be divided into two categories: displaced cost and added value. Displaced cost results from reduced costs for data gathering, computation and data presentation in support of decision-making. In these mechanical tasks, the value of computer support is measurable. Added value results from investigating more alternatives, doing more sophisticated analyses of alternatives, using better methods of comparing alternatives, making quicker decisions, etc. Often it is difficult to identify the added value because it does not occur on a routine basis. Measuring added value is complicated by the difficulty of linking increased profits or other monetary measures to a change in the decision-making process, such as considering more alternatives. Small improvements in decision-making can result in high added value.

2.2.3 Spatial Information Systems

Laurini and Thompson (1996) describe Spatial Information Systems as a computerised environment whereby utility programs performing specific functions are used in an integrated environment, in which the users are shielded from the details of computer processing to achieve some goal of research, education or decision-making. They also break down a spatial information system into the following components / processes:

Data acquisition involves the direct capture of data by either some form of digital imaging, or some other survey technique. Information may be held in a database in different ways. However, there will be a need for tools to

manage the material, to provide security, to allow for its verification and validation, to control access, to correct and update, to convert, to organise efficiently, to help the user, to identify and describe the contents of the database, and to facilitate import and export of digital data.

Tools for *output* may be many, depending in part on the kind of information in the system, and in part on the mode of its use. Analytically oriented systems will most likely provide capabilities for the creation of physical documents - maps, scientific graphs, presentation graphs or other images, tables of numbers or narrative text. Query oriented systems will focus more on the preparation of virtual output in the form of quickly produced maps or graphs, the contents of particular sections of the database, or derived statistics, all made available immediately in response to a user request. The same physical resources and capabilities of the information system may be used in both cases, such as the basic drawing capabilities.

The most important functions, however, are the processing functions, as these are the tools by which the *spatial analysis* is performed. Again, depending on factors like types of data we can identify functions involving or not involving spatial properties.

Spatial Information systems can be further broken down into:

- **CAD systems.** Most CAD systems are designed primarily to automate drafting. A display-oriented technology like CAD consists of points and lines stored in one or more data layers. The layers can be displayed separately or in combination; the data intended for CAD are generally not structured to allow for spatial analysis. Most CAD systems applied to mapping merely over-plot separate layers of data types but do not have the capability to relate data across layers. That is, the system codes such features as buildings, streets, streams and property boundaries, to be mapped later as separate, unrelated layers. Humans

can see the relationship among layers but determining the number of buildings or the length of a stream within a bounded area like a parcel of land requires both geometric manipulation and appropriately structured data, which CAD systems may not support. With technological developments and the evolution of CAD, some systems are beginning to provide management capabilities and the ability to link spatial information to attribute data - evolving to become desktop mapping systems.

- **AM/FM systems.** Many automated mapping/ facilities management systems combine CAD system capabilities with some database functionality. Database designs focus on attribute management, with few data manipulation capabilities. The initial objective of these systems was to convert manual maps into digital format and to link maps to facility-related information. AM/ FM systems typically offer work order handling capabilities and network management features, but offer little spatial analysis capabilities.
- **LIS/ GIS systems.** Geographic Information Systems and land information systems were first introduced in the field of natural resource management. GIS is a computer technology that combines mapping and information stored as data to generate maps and reports, to provide a balanced and systematic approach to collecting and managing location-based information to improve planning and decision-making.

2.3 THE INFORMATION SYSTEM PROJECT LIFE CYCLE

The following section is based on work by the following organisations/ authors: McNurlin, B.C. (1993), I/S Analyzer (1994) and Computer Associates (1993).

The overall objective of any Information System project is to fulfil the user requirements within the constraints of the project case. Therefore, full involvement with the target users throughout the project is essential.

Regular communication with the target users, management and other project team members - plus an acceptance sign-off as a milestone for each stage - ensures satisfied customers and controlled expenses.

a) Organisation

An Information System project must have a team derived from across the current line organisational structure. It is very important to current involved persons in all phases of development. Issues such as capacity planning, systems administration issues, fault tolerance, printing requirements and back up must all be considered on a network basis.

b) Development Methodology

Management at a unit may decide to either adopt a proprietary methodology package or to develop a methodology in-house, depending on several factors.

c) Project Life Cycle

Although the degree of formal communications and sign-off may vary between very small projects and large projects, the same basic principles apply to all Information System projects. These principles are embodied in the system development life cycle explained in this chapter.

For example, a large project affecting several users and involving a project team would require substantial documentation, regular meetings and reporting and formally signed acceptance statements for each stage.

On the other hand, a project for assisting a user to develop a customised spreadsheet for a single PC may only require documentation. In both cases,

however, the user requirements need to be specified within a project case, the solution needs to be designed, constructed, tested, installed and implemented. System performance needs to be checked after it has been in operation for three to six months.

d) Security

Measures must be taken to ensure that only authorised persons have access to the system, both during development and at implementation. Security must also be considered for granting access to the system and to confidential data.

2.3.1 Checklist of Mandatory Standards

Project unit and Information System managers are responsible for:

- selection or construction of a development methodology that incorporates the principles outlined in these *Standards*. Although the system development stages may vary when a methodology is applied, all the stages and their deliverables need to be fulfilled in the overall methodology;
- development of local procedures that detail the use of the adopted methodology, including:
 1. physical database design;
 2. program code;
 3. job control code;
 4. program testing;
 5. system testing;
 6. acceptance testing;
 7. implementation;
 8. user documentation; and
 9. operations documentation.

2.3.2 Management of Information System Projects

Management of an Information System project requires several planning and control activities:

- management of the project schedule, cost and resources;

- risk analysis and control;
- configuration control; and
- quality planning and control.

Proprietary computer-based tools or structured methodologies may assist project leaders perform their management activities and produce progress reports. Project leaders are responsible for providing progress reports, comparing achievement and expenditure against plans, on a regular basis throughout the life of a project. These progress reports can then be used to monitor possible threats to the success of the project and to assess when to take contingency measures.

2.3.3 Selecting a Development Methodology

Management at the project unit are responsible for deciding if proprietary computer-based development tools are adopted. For project units having large development projects, implementing a proprietary package might be a prudent commercial decision if it can speed up and control the development process, thereby justifying the expenditure and effort.

However, whether a structured methodology package is bought-in or a complete methodology is developed in-house the same iterative process of definition and development followed by review and refinement applies regardless of the actual tools used.

If the purchase of a proprietary package is a possibility, the following points may be useful to consider during product evaluation:

- How easily and completely can the methodology be applied within the Information System project life cycle? What terms are used within the methodology for each stage of development and each deliverable? What amount of effort would be required for implementation?

- What tools are included? How effective are the tools for project management, identification of user requirements and development of a prototype system?
- How easy are the tools to use? How powerful is the query language and report writing facilities? What provision is made for controls, data locking, cross-referencing, data dictionary and documentation?
- On what platform does the package run, compared to the current systems and those to be developed? What programming language, operating system, database and hardware are used?

2.3.4 The Information System Project Life Cycle

The Information System project life cycle was divided into eight stages, as listed below.

Stage	Deliverables
1	Project Case Project Approval
2	Requirements Specification
3	Product Evaluation Report (if applicable) Technical Specification Prototype System
4	Unit-tested Code Integration Test Plans
5	Integrated Software
6	User Manual System Operations & Administration Manual Installed and accepted software, hardware (if applicable) and network services (if applicable) Regression Testing Strategy Training Materials and Schedule
7	Registered users and terminals Trained users Live data taken on System operational in project context
8	Post-implementation Review Report

Table 1: Table showing deliverables at each stage of the Information System Project Lifecycle

Sections 2.3.5 through 2.3.12 explain the purpose of these stages and identify the contents of the deliverables.

The purpose of the Information System project life cycle is to ensure that user requirements are defined and achieved within a controlled budget. This is done by specifying points of review, testing and approval before continuing on to the next stage. Deliverables are those documents, software, hardware, or activities to be achieved during the specified stage. Ultimately, signed-off versions of deliverables become configuration items held in the control library.

The start of a stage marks the start of work on the set of deliverables characterised by that stage. The stage is complete and a new stage can begin when the project sponsor gives preliminary sign-off on the completed deliverables. The deliverables are then put under formal change control.

a) An Iterative Process

System development is an iterative process and deliverables from a completed stage cannot be considered frozen until the project is complete. Therefore, a feature of Information System projects is that most deliverables are in a more or less fluid state right up to implementation (Stage 7):

- Stages 1 to 4 are concerned with the definition of the system at successively finer levels of detail. Therefore, previously signed-off deliverables may require revision.
- At the end of Stages 2 to 6, the project plan and quality plan need to be refined to take account of the greater depth of understanding the project's scope.
- Any significant change in the activities or deliverables of Stages 2 to 7 (as defined in the project and quality plans), require a review of the Project Case, initially approved in Stage 1. If there is a change in the forecast cost or time beyond the available contingency allowance, the project approval process (Stage 1) may need to be repeated.

- Throughout Stages 2 to 7, the project leader regularly produces progress reports to advise management of the project's achievements and costs, compared to the approved plans. Management decisions based on these reports may affect previously signed-off deliverables.

b) Terminology

Throughout the Information System industry and specifically across different proprietary methodologies, different terms may be used for similar concepts. For example, User Requirements (Stage 2) may be called 'Analysis', Technical Solution (Stage 3) may be known as 'Design.' Conversely, the same term may be used to mean different activities or levels of detail.

Care is needed when selecting a proprietary methodology and developing local procedures to ensure that all aspects of the Indlu Information System project life cycle are included. Terminology used in local procedures needs to be clearly defined and used consistently throughout documentation for every project.

2.3.5 Stage 1 - Feasibility Study

An Information System project is initiated by a request for a new system or a change to an existing system. A bought-in product should always be considered as part or all of the solution.

Stage 1 of the Information System life cycle is begun if the user and Information System groups concerned agree to authorise a feasibility study. The way in which this agreement is reached and the level of seniority required, varies for each project, depending on the likely scale of the requested product acquisition or development and the relative status of the parties involved. However, the agreement itself should be documented for each project.

Based on the review of the Project Case, the project is either approved or discontinued.

a) Objective of Stage 1

The objective of Stage 1 is to determine whether or not the project is feasible in terms of expected benefits *versus* estimated costs, identified in the Project Case.

b) Project Case Document

The results of the feasibility study are documented in the Project Case document, the main deliverable for Stage 1.

The investigation must advance on a broad front, addressing technical options as well as users' needs and wants. The technical options which may need to be considered can include programming language, database, operating system, communications network, hardware, system design and construction.

The study needs to be conducted in sufficient detail to ensure that the Project Case document contains realistic estimates of resources, time scales, costs and risks. However, because of the time constraints typically applied to this stage, the various topics need to be progressively developed in more detail in the subsequent three stages, should the project be approved.

Contents of the Project Case document should include:

- management overview;
- project objectives;
- terms of reference;
- project scope;

- existing systems and procedures;
- expected benefits
- project organisation;
- study approach;
- alternative solutions considered;
- proposed technical solution;
- cost/benefits analysis;
- project plan;
- quality plan;
- risk analysis; and
- references and acknowledgements.

c) Project Approval

At the end of Stage 1, the main investment decision - whether to continue or abandon the project - is made. The people considering this decision must be comprised of persons who represent a range of responsibilities for the impact of implementation and level of expenditure. Typically, this would include at least representatives from the project sponsor and Information System project team.

2.3.6 Stage 2 - User Requirements

In Stage 2, project and systems analysis techniques are used to determine the user's needs and wants in terms of functionality, inputs and outputs, logical data structure, user interface, data and transaction volumes, performance, availability, resilience and security.

a) Objective of Stage 2

The objective of Stage 2 is to produce a Requirements Specification, approved by the responsible user staff, that can be used as the basis for beginning Stage 3 - Technical Solution.

b) Requirements Specification

The Requirements Specification document carries forward the project scope defined in the Project Case of Stage 1 into more detail, specifying all aspects of the requirements for the new system. Its development involves working with the user, presenting the requirements as currently understood and revising them as a result of further discussions, until agreement is reached.

Some software development tools facilitate the presentation of a non-operational mock-up of the proposed system. This can help to provide the user with the look and feel of the proposed system and refine the accuracy of the Requirements Specification. However, it does not eliminate the need for a full technical specification or a true prototype.

The Requirements Specification needs to balance technical breadth and detail with a style, tone and content that is understandable by the user staff responsible for signing off the document, committing to the next stage. Contents of the Requirements Specification should include:

- management overview;
- summary of project and operational objectives;
- project context;
- on-line Process requirements
- batch Process requirements
- on-line enquiry requirements
- batch Reporting requirements

- performance requirements
- resilience requirements
- availability requirements
- volumetric requirements;
- legal considerations;
- audit considerations;
- security considerations;
- logical database design;
- conceptual on-line dialogues;
- conceptual hard copy output
- operational characteristics;
- user Interface characteristics;
- development strategy;
- implementation strategy;
- training strategy;
- user responsibilities;
- transition/conversion strategy; and
- interfaces with other systems.

2.3.7 Stage 3 - Technical Solution

The shape of Stage 3 - Technical Solution varies considerably, depending on whether the requirement can be met by a bought-in proprietary package or needs bespoke development. A bought-in package should always be considered first.

If a proprietary solution seems possible, then the priority is to undertake a product evaluation exercise. From this, a Product Evaluation report is produced. If the evaluation successfully identifies a suitable package, then the report becomes the main deliverable from this stage.

If bespoke development is required (either as assessed self-evidently or following an abortive product evaluation), a choice must be made on whether to adopt a classical approach to technical design or, if the available hardware and software tools are suitable, to embark on prototyping.

When the technical solution has been identified, it is important to ensure that the project plans include sufficient lead-time for acquiring bought-in packages, equipment and services. These considerations need to be made at this stage and checked throughout subsequent stages, in order to avoid delays at Stage 6 - Installation and Acceptance and later stages.

a) Objective of Stage 3

The objective of Stage 3 is to identify the technical solution, based on the user requirements identified in Stage 2, so that a fully engineered system can be constructed in Stage 4.

b) Product Evaluation Report

If a bought-in package has been identified as the technical solution, the Product Evaluation Report (PER) is the deliverable from this stage.

In addition to describing the package and how it meets the user requirements, the report needs to detail the proposed tactics for procuring and installing the package. It must also describe any tailoring or setting of parameters required to turn the package into a system that is effective and efficient for the specific user.

c) Technical Specification

If bespoke development is required, the Technical Specification is the main deliverable from Stage 3, although a prototype system might also be included. The Technical Specification identifies the technical design of the system.

Developing the Technical Specification involves re-expressing the functional requirements from the previous stage into a form specific to the hardware and system software environments in which the system is to be constructed and run.

The Technical Specification document is detailed to a level at which all the individual activities in the following stage can be identified. Contents should include:

- management overview;
- summary of functional, project and strategic requirements;
- description of hardware configuration;
- description of system software;
- description of communications networks;
- application software characteristics;
- database characteristics;
- physical database design;
- overall system design;
- interfaces to other systems;
- process descriptions;
- function descriptions;

- program descriptions;
- system inputs;
- screen designs (including a standard design format for all screens);
- report layouts (including a standard design format for all reports);
- data formatting, validation and internal conversion rules;
- on-line tutorial and Help facilities;
- interfaces between functions;
- user (man/machine) interfaces;
- approach to achieving required performance levels;
- approach to achieving required availability levels;
- security, recovery and audit procedures;
- training facilities; and
- additional functionality for transition/conversion.

d) Prototype System

If rapid development tools, such as a 4th generation language, are available, development of a prototype system can be an effective way of producing the technical design.

In this context, prototyping means building a system that functions according to many of the user-visible requirements but does not encompass other refinements, such as multi-user operation, performance and recoverability. Such a prototype is capable of being realistically demonstrated to the user and of being quickly reworked in response to any comments prompted thereby.

After several iterations of the demonstration/rework cycle, the system should stabilise. The code thus produced is the deliverable from the phase. From this prototype, the fully engineered system evolves during Stage 4 - Construction.

2.3.8 Stage 4 - Construction

In Stage 4, the system code is constructed, based on the Product Evaluation Report, Technical Specification or prototype system produced in the previous stage. The code becomes a deliverable for Stage 4 after it has been tested.

Also during Stage 4, integration-testing plans are prepared and signed off as a deliverable.

a) Objective of Stage 4

The objective of Stage 4 is to construct the system and prepare the plans for integration testing in the next stage.

b) Unit-tested Code

During construction, code is produced or modified and is brought together to produce the functioning elements of the required system. The amount of code, the nature of the code and the nature of the proprietary software varies from project to project.

Proprietary software may be general-purpose tools - operating systems, compilers, database schema processors, interpreters, etc. - or application packages.

c) Integration Test Plan

The Integration Test Plan needs to define all relevant test categories (functionality, performance, etc.) indicated by the Requirements Specification and all the individual test cases within each category. It also

identifies the machine resources required for testing in the next stage and the schedule for executing the tests.

The contents of the Integration Test Plan should include:

- management overview;
- summary of test objectives;
- functionality test cases;
- performance test cases;
- resilience test cases;
- hardware, software and communications configuration; and
- test team resources and organisation.

A set of test scripts is prepared from the test plan. These define the specific initial database and transaction values to be used for each test case, the screen and hard copy outputs and the database values expected after execution of the test.

2.3.9 Stage 5 - Integration and Testing

In Stage 5, the tested units of code delivered by the previous stage are brought together in an environment which is, as far as possible, identical to the target production environment .

The total system is subjected to a comprehensive series of tests defined as scripts in the previous stage. Test scripts are needed for every aspect of the Requirements Specification including performance, migration and conversion, resilience and functionality.

Integrated software is the deliverable from Stage 5.

a) Objective of Stage 5

The objective of Stage 5 is to ensure that the units of code developed during the previous stage work correctly when put together into a complete system.

b) Integrated Software

When testing has been completed, along with any resulting system changes, the integrated software is ready for installation at the target site for user acceptance testing.

c) System Test Data

System testing usually requires a substantial quantity of test data that is as close as possible to live data. However, as a security measure, live data should not be used for testing unless it has been completely sanitised, taking away any indicators of actual persons, companies or other organisations.

2.3.10 Stage 6 - Installation and Acceptance

The central deliverable for Stage 6 is user acceptance of the installed and documented system. User acceptance should be made formally, in writing.

Stage 6 can involve several activities in preparation for the final implementation, depending on the requirements of the new system.

a) Objectives of Stage 6

The objectives of Stage 6 are to install the complete system, gain system acceptance from the user and provide all documentation required for the final implementation.

b) User Manual

The User Manual should be written from the user's viewpoint, ideally structured to reflect the project context in which the system is used, rather

than the technical structure of the system. Functional examples and screen illustrations should use realistic, but not actual, data to ensure confidentiality.

Contents of the User Manual should include:

- system functionality;
- user registration;
- system start-up and logon procedures;
- system shut-down procedure;
- system operation and user (man/machine interface);
- system availability;
- batch process schedule;
- instructions for use of system facilities;
- instructions for use of on-line Help facilities;
- error conditions/interpretation;
- available end-user facilities;
- training facilities;
- fault reporting; and
- re-start/ recovery after abnormal termination.

c) System Operations and Administration Manual

Contents of the System Operations and Administration Manual should include:

- system start-up procedures;
- system shut-down procedures;
- system recovery procedures;

- back-up/check-pointing procedures;
- user registration procedures;
- system parameter maintenance utilities;
- system monitoring utilities;
- security considerations;
- audit considerations;
- database maintenance procedures;
- communications: local area network (LAN) maintenance;
- communications: wide area network (WAN) maintenance;
- batch process - scheduling considerations;
- batch process - hard copy distribution;
- support procedures;
- software upgrade release control procedures; and
- system consumables - procurement and control.

It should be possible to build the system from scratch with the use of the manual.

d) Regression Testing Strategy

If any required system changes are identified during user acceptance testing, a plan needs to be formulated which details the affected deliverables, the work done to make the change, the quality control assignment and testing, system re-build and installation, according to configuration management standards.

2.3.11 Stage 7 - Implementation

Stage 7 includes a variety of activities that require particularly careful planning and control, including:

- registration of users and terminals into the application and system software;
- training of users;
- take-on of live data; and
- begin use of the new system in the project context. In some cases, where risk to the project operations needs to be minimised, this may involve a period of running the new system in parallel with the superseded processes.

The objective of Stage 7 is to ensure that the new system can be used successfully in the project environment from a specified date.

2.3.12 Stage 8 - Post-implementation Review

The objective of Stage 8 is to learn from the experience of the Information System project so that lessons can be applied to future projects, for this and other systems.

Contents of the Post-implementation Review Report should include:

- management overview;
- assessment of functional match against project requirement;
- assessment of actual against projected benefits;
- assessment of actual costs and time scales against estimates;
- summary of problems encountered and lessons learned;
- general observations;

- conclusions;
- recommendations; and
- plans for future releases.

2.3.13 Security Summary

a) System Access

Throughout the Information System project life cycle, persons should be authorised to access only functions relevant to their assigned activities.

b) Confidentiality of Data

Measures need to be taken to ensure the confidentiality of data when:

- producing documentation, for example, the Requirements Specification, the Technical Specification and prototype system, the User Manual and training materials;
- system testing in Stage 4, in Stage 5 and in Stage 6; and
- loading live data in Stages 6 and 7.

2.4 EVOLVING/ FUTURE TECHNOLOGY

Some new technologies are relevant in that they could possibly be used in an information system context for the central management of irregular settlements and provision of low-cost housing. A brief background is given on these technologies, to be built on later in this thesis.

2.4.1 The Internet

The term the 'Internet' was first used in 1982 to refer to the enormous collection of inter-connected networks that use TCP/IP protocols.

Despite only gaining mass recognition over the past three years, the Internet has existed under various guises since the late 1960's. Originally, the United States Department of Defence introduced the 'Advanced Research Projects Administration Network' (ARPAnet), with the intention of experimenting in Wide Area Networking that would survive a nuclear war.

Throughout the 1970's and 1980's a growing number of small networks developed and connected to the Internet via gateways as a means to exchanging electronic mail. In the mid 1980s there was a significant growth in the number of available Internet hosts, and since the late 1980's, exponential growth in the Internet has been experienced.

The growth of the Internet has provided people with a means to share and distribute information.

2.4.2 The World Wide Web

The World Wide Web (WWW) has developed as an interface to the Internet, and allows people to create 'Web Sites' where other users can access information. The opportunities that the World Wide Web offers has in many ways fired peoples imaginations and opened corporate eyes to potential commercial opportunities. A host of tools can be used to access information on the Web; the most commonly used are HTTP, FTP, Gopher and Telnet which are supported in most Web-browsers.

2.4.3 Dissemination of Spatial Information on the Internet

The demand for serving dynamic maps and related data is increasing. Government organisations want to add digital maps to their web-sites as a public service, while commercial organisations need to provide customers with geographic information such as the location of their nearest outlet.

By means of Internet and Intranet technology, Mapping and GIS departments can now share spatial information with non-GIS specialists, which was previously not possible.

Spatial data can be presented on the client side in either a raster or a vector format. The representation of the data in raster format would be a mere image (GIF or JPEG format) of the data. Java permits the client to view vector-based data.

Web-based map servers function to communicate requests between a map browser and server side application. The application manages the database and processes the geographic information allowing many users to retrieve and display information with map browsers. The map server receives a request from a web browser. It then communicates the request to GIS application. The GIS then generates a map and sends it back to the map server. This map is then returned to the web browser.

Java also offers new capabilities for geographic information retrieval and display. Java applets and 'plug-ins' provide for web browser interfaces similar to the ones available in dedicated GIS software packages. These either manipulate the existing browser interface, or operate in their own dedicated window. Castanet also enhances Java's efficiency in providing timely and secure software and data distribution on the Internet. A disadvantage of applets is that they require reloading each time a web page is opened. However, Castanet allows users to download a persistent mapplet that locates itself on the client's hard disk that resolves the problem of repetitive downloading (Strand, 1997).

3 HOUSING IN SOUTH AFRICA

"The RDP endorses the principle that all South Africans have a right to a secure place in which to live in peace and dignity. Housing is a human right" (The RDP, 1994).

3.1 THE CURRENT HOUSING SITUATION IN SOUTH AFRICA

The estimated housing backlog in South Africa is 1.5 million housing units. If the natural population growth is added to the backlog, 3.5 million housing units will have to be provided over the next ten years (Department of Housing, Online "So how many houses have to be built?" <http://www.gov.za/house/watch.html>).

The total cost of government financial support to eradicate the backlog and to accommodate natural population growth over a period of ten years is estimated at R47.5 billion at current Rand value. On the other hand, the RDP envisages the provision of one million housing units over a period of five years. A total amount of R16, 8 billion is expected to be spent over the next five years with regard to housing subsidies (Department of Housing, Online. "So how many houses have to be built?" <http://www.gov.za/house/watch.html>).

Although the Department of Housing does not have the statistics for how many houses have been built via the Housing Subsidy Scheme, it does provide the statistics for how many of these subsidies have been approved.

Table 2 summarises housing delivery from 15 March 1994 until the end of May 1996 (the most recent statistics available at present - June 1996):

Description	Non-Credit Linked	Credit Linked	Total Subsidies
Project-linked subsidies	34 699	5 480	40 179
Individual subsidies	9 876	5 317	15 193
Total subsidies	44 575	10 797	55 372

Table 2: Housing delivery statistics (Department of Housing, Online. "So how many houses have to be built?" <http://www.gov.za/house/watch.html>)

During the period 15 March 1994 to 31 May 1996, 55 372 individual ownership subsidies (project-linked and individual subsidies) were approved in respect of beneficiaries who had bought residential properties (Department of Housing, Online. "So how many houses have to be built?" <http://www.gov.za/house/watch.html>).

Once individual ownership subsidies are approved, conveyancers are instructed to register transfer of the residential property in the name of the subsidy beneficiary. In the case of existing homes and completed homes in projects, this means that the beneficiary can take occupation of the home soon after registration of transfer or earlier if the agreement of sales so provides. Where the housing unit is still to be constructed, indications are that construction is completed within two to three months after registration of transfer.

The average monthly delivery in respect of individual and project-linked ownership subsidies for the period 15 March 1994 to May 1996 amounts to 2 090. The delivery only for May 1996, amounts to 8 181, showing a marked increase (Department of Housing, Online. "So how many houses have to be built?" <http://www.gov.za/house/watch.html>).

The average monthly delivery in respect of individual and project-linked ownership subsidies approved increased from a monthly average of 5 170 for the period 1 September 1995 to 31 May 1996. In global terms delivery in respect of individual ownership subsidies increased from 8 845 at the end of August 1995 to 55 372 at the end of May 1996 (Department of Housing, Online. "So how many houses have to be built?" <http://www.gov.za/house/watch.html>).

Nevertheless, no matter how effective the housing delivery process may be, lead times (the time it actually takes to get a project approved, a house built, etc.) remain substantial.

Owing to the extent of unemployment in South Africa and the associated poverty, approximately 80% of those requiring housing earn less than R3 500 a month and therefore depend on government assistance to obtain a home of their own. Approximately 60% of those in need of housing, earn less than R1 500 per month and are totally dependent on government assistance.

Approximately 48% of households in South Africa earn below R800 per month. These households are living below the minimum subsistence level, which is currently calculated to be R970. This category of household cannot afford the payments on a mortgage loan (Department of Housing, Online. "So how many houses have to be built?" <http://www.gov.za/house/watch.html>).

The government subsidy of R15 000 for this income category should give them access to a serviced site and a permanent home, without the need for a private loan. The formal banking sector are currently only extending loans to households earning over R1 000 a month.

For example, according to a recent study of housing for blacks in Gauteng by the Bureau of Market Research in 1994, 168 000 of the approximately 176

200 households that live in squatter shacks on serviced sites may be eligible for a consolidation subsidy of between R5 000 and R7 500, depending on their income. A further 21 500 of the households in shacks and 310 400 of the households in rented houses in Gauteng are eligible for a first-time capital housing subsidy. Approximately 44 700 of the black households in the survey are eligible for a capital subsidy of R15 000, 97.500 households for a subsidy of R12 500, 119 000 households for a subsidy of R9 500 and 68 900 for a subsidy of R5 000 (Department of Housing, Online. "Department of Housing Annual Report." <http://www.gov.za/house/annual5.html>).

3.2 THE RECONSTRUCTION AND DEVELOPMENT PROGRAM

The RDP recognises that a fundamental part of development is to deliver houses. The government's outlook on this issue is reflected in the following quotes from the RDP:

" The approach to housing ... must involve and empower communities..."
(RDP, 1994).

" The lack of adequate housing and basic services in urban townships and rural settlements today has reached crisis proportions " (RDP, 1994).

" The urban housing backlog in 1990 was conservatively estimated at 1,3 million units. Including hostels and rural areas, the backlog rises to approximately three million units " (RDP, 1994).

" At minimum, one million low-cost houses should be constructed over five years " (RDP, 1994).

" Administrative procedures must be simple, cheap, quick, transparent, must support community participation and must prevent corruption, with no form of discrimination of any kind whatsoever " (RDP, 1994).

3.3 STABILISATION OF THE HOUSING ENVIRONMENT

Many communities were in disarray when democracy dawned in South Africa. A lack of functioning local authorities, since the activities of many had been disrupted by rent, bond, and service charge boycotts, meant that even the previously limited stream of private sector investment had dried up.

The task now is to stabilise the residential environment. Conditions conducive to investment by the public and private sectors and by individuals in these areas must be created (Department of Housing, Online. "Stabilising the housing environment." <http://www.gov.za/house/environ.html>).

The Mortgage Indemnity Fund (MIF) is a wholly government-owned company. It was formed in June 1995 after extensive discussions and the signing in October 1994 of the Record of Understanding (ROU) between the Department of Housing and the Association of Mortgage Lenders. The main objectives of the Mortgage Indemnity Scheme (MIS), which is run by the Fund, are:

- to encourage private sector banks to resume lending in areas where they have stopped;
- to indemnify accredited banks against loss where they are unable to gain possession of a property after a borrower has defaulted;
- to act as the interface between government and private sector housing finance institutions, particularly in areas where normal lender/borrower relations have ceased.

(Department of Housing, Online. "Stabilising the housing environment." <http://www.gov.za/house/environ.html>)

The Minister of Housing appointed a board of directors consisting of representatives of various government departments and other relevant government institutions.

Flanking the MIF and working to change public perceptions and attitudes regarding the rights and responsibilities of individuals and communities, is the Masakhane campaign, which was initiated by the Departments of Housing and Constitutional Development and the office responsible for the RDP.

Masakhane was launched in February 1995 by President Mandela.

Masakhane has become a powerful community opportunity to uplift themselves and their environments in partnership with the government and the private sector.

3.4 THE PROVISION OF HOUSING IN SOUTH AFRICA

The Housing Subsidy Scheme, with various interventions aimed at mobilising credit, is a cornerstone of the Government's approach to the housing challenge. The aim of the scheme is to help households that cannot provide their own housing.

3.4.1 Individual ownership subsidies

Individual ownership subsidies are allocated to beneficiaries to help them to get ownership of fixed residential properties (housing opportunities) for the first time.

The level of subsidy is linked to household income. During 1995, a fourth subsidy level was introduced retrospectively with effect from 15 March 1994. The following subsidy levels are currently applicable:

Household income	Subsidy
R0 - R800	R15 000
R801 - R1 500	R12 500
R1 501 - R2 500	R 9 500
R2 501 - R3 500	R5 000

Table 3: Income to subsidy relationships (Department of Housing, Online. "Stabilising the housing environment." <http://www.gov.za/house/environ.html>)

There are two types of individual ownership subsidy, project-linked subsidies and individual subsidies.

c) Project-linked subsidies

The project-linked subsidy provides housing opportunities for individuals on an ownership basis in projects approved by Provincial Housing Boards.

d) Individual subsidy

The individual subsidy was introduced on 5 June 1995. It gives persons access to housing subsidies in order to acquire ownership of an existing property or a property not located in a project approved by a Provincial Housing Board. A person may also buy a serviced site and construct his or her own top structure. The individual subsidy can be used in different ways, namely:

- on a non-credit-linked basis, where only the subsidy amount is used to get a property; or

- on a credit-linked basis, where a home loan is also obtained from a mortgage or non-traditional lender to buy a property.

In the case of the credit-linked subsidy, a person who cannot afford to pay the required deposit and other fees can enter a savings plan with the mortgage lender concerned to save the deposit and other fees. However, unlike individual subsidies in general, this type of subsidy is approved up front, and the participants in the scheme are sure that they will have the loan amount and the subsidy amount available to buy a home at the end of the savings period.

Individual subsidies are approved quarterly on a first-come-first-served basis.

3.4.2 Consolidation subsidies

Through the consolidation subsidy, persons who, before the inception of the Housing Subsidy Scheme, received housing assistance from the state only in the form of ownership of serviced sites only (including Independent Development Trust serviced sites) can apply for a further benefit from the State to improve their housing situation. The consolidation subsidy is granted for the provision or upgrading of a top structure on such a site. The subsidy amount is fixed at R7 500 for persons earning R800 a month or less and R5 000 for those earning R801 to R1 500 a month (Department of Housing, Online. "A subsidy scheme to provide housing opportunities for millions" <http://www.gov.za/house/subsidy.html>).

3.4.3 Institutional subsidies

Institutional subsidies are available to institutions that create affordable housing stock to enable persons who qualify for individual ownership subsidies to live in subsidised residential properties on the basis of secure tenure. The properties will often be rented, but tenure forms based on share blocks, deeds of sale or full ownership are not excluded.

To ensure that the institutions concerned are subject to statutory control, only institutions established in accordance with legislation such as the Companies Act, the Share Blocks Control Act or the Co-operatives Act may access institutional subsidies. Any association to be formed in terms of any legislation that may be based on the Communal Properties Association Bill, 1995, will also be included.

The subsidy amount awarded to an institution is equal to the total amount of the subsidies to which the qualifying beneficiaries are entitled in terms of the Housing Subsidy Scheme.

To enable viable projects and socially and economically integrated communities, institutions are permitted to provide housing also for households that do not qualify for individual ownership subsidies. Institutions will not receive subsidies in respect of such households, however, and must handle that aspect of the project on a strictly commercial basis.

3.4.4 The 'People's Housing Process'

While many people need houses, official housing programmes have not been able to meet the diverse needs of our various communities, and the necessary resources are not always readily available.

Poor people throughout the world have proved in many innovative ways, that they are willing and able to provide in their own housing needs. All they need are appropriate forms of support and financial assistance from the government. For the poorest of the poor, the South African government is in the process of facilitating the establishment of housing support initiatives, some of which are in the form of building centres, throughout the country.

This is what is referred to as the 'People's Housing Process'. Typically this is where individuals, families or groups take the initiative to organise the

planning, design and the building of, or actually build, their own houses. In such a process they are in control of important decisions such as:

- how, if an organised group is involved, the area in question should be planned;
- where they wish to live;
- how the house is designed;
- how resources are used;
- where and how they can obtain affordable building materials.

The government already acknowledges that this process contributes significantly to providing housing in South Africa. Thus, the government and other stakeholder bodies and institutions involved in housing, including community organisations, the private sector and organs of civil society, have committed their energies and resources in support of this process.

Support for the People's Housing Process can include:

- access to suitably located serviceable or serviced land;
- access to housing subsidies and appropriate forms of credit to build their houses;
- opportunities for skills acquisition;
- appropriate technical and financial assistance;
- simple, innovative and people-sensitive procedures and guidelines.

Organised community groups in partnership with an NGO, local authority or any other body committed to the principles of a People's Housing Process, can obtain support and create support networks.

These housing support initiatives will provide:

- advice and support to communities in planning and funding new housing developments;
- their continuous upgrading;
- advice to prospective home owners/tenants on technical, legal, financial and consumer issues;
- protection aspects;
- planning and design assistance including the quantification and costing of building materials;
- help and advice on contracting and supervision;
- help and advice on buying materials at affordable prices;
- support during the implementation and construction phases of the housing process.

3.5 HOUSING PROVISION IN THE WESTERN CAPE

With the adoption in December 1996 of the Constitution and a Bill of Rights, which includes the right to housing, and the launch of the 'People's Housing Process' by the Department of Housing, the State has the obligation to respect, protect, promote and fulfil that right to housing.

An ever-increasing amount of attention is therefore being paid by the government, NGOs, the private sector and universities to both the management of irregular settlements and the timely delivery of formal housing. The two case studies in this study constitute two options for upgrading by means of project-linked subsidies.

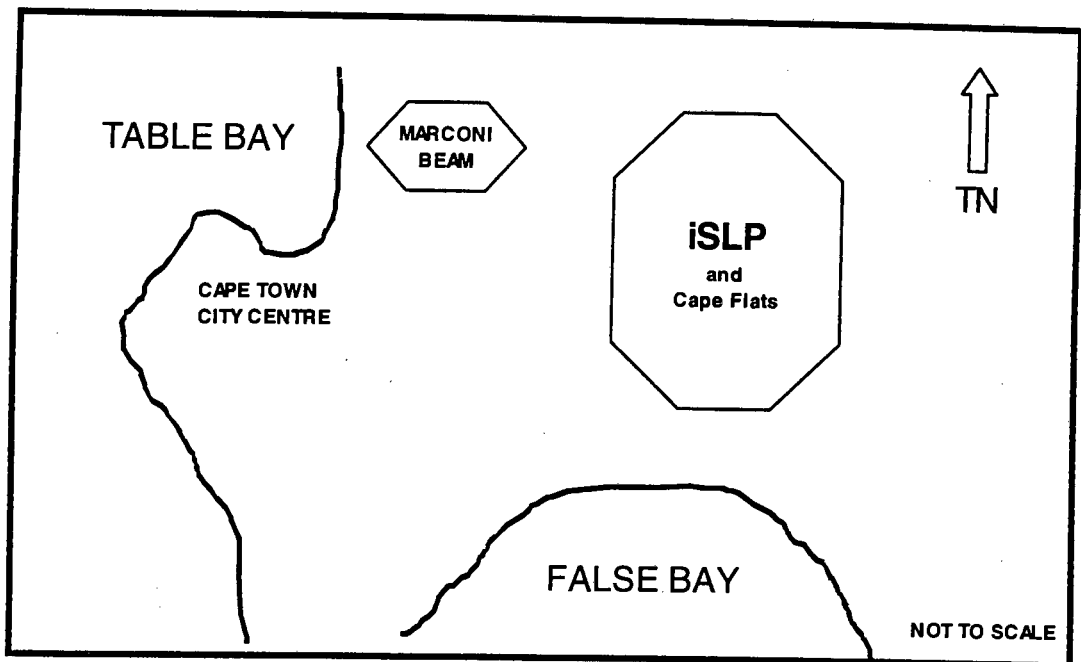


Figure 5: Locality of Marconi Beam and iSLP (Please note: The purpose of this diagram is to indicate the location of the projects but does not in any way reflect the relative sizes of the irregular settlements.)

The first is the Marconi Beam 'From Shacks to Houses' project, where an entire community is relocating to new formal housing in nearby Joe Slovo Park, thus vacating the land they are currently occupying. The second case study is the Integrated Services Land Project (iSLP). This project accepts applications from people living in any area of Greater Cape Town.

The two projects are similar because:

- they both take advantage of the project-linked individual ownership subsidies;
- both have been using the Housing Information Management System (HIMS) (see section 4.2.1 for further information) to manage the applications for subsidies; and
- they both fall within the Western Cape administration area.

Moreover, they represent two of the options for settlement upgrading. (See Figure 6)

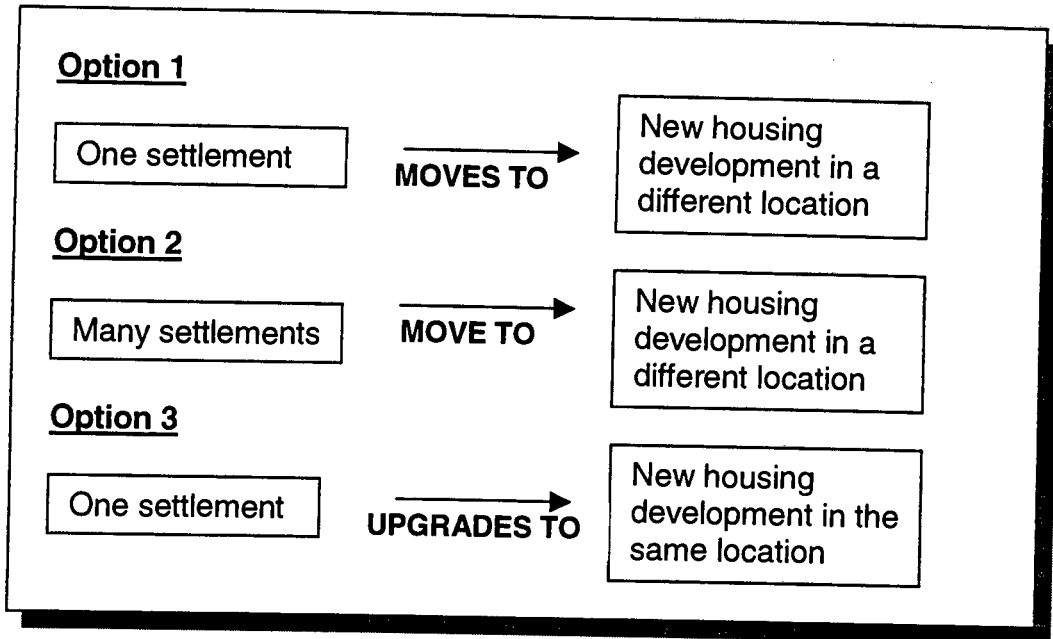


Figure 6: Some options for upgrading of irregular settlements

3.6 MARCONI BEAM 'FROM SHACKS TO HOUSES'

3.6.1 Background

The Marconi Beam irregular settlement is situated in an industrial park in the Milnerton area approximately 8km from the centre of Cape Town. Its dimensions are approximately 465m x 220m on land owned by the telecommunications company Telkom. The land on which it is situated is under development as an industrial site as an extension of Montague Gardens.

Saff, 1996 gives a detailed overview of the historical development of Marconi Beam until 1995.

In January 1991, the Marconi Beam inhabitants moved to the 8.02 hectare transit area after negotiations with the 'squatters' and Milnerton Municipality.

The space where they now reside was originally intended as a temporary area of residence until a more permanent site could be found. The du Noon site was proposed but rejected by Marconi Beam residents as being too far from places of work and suitable transportation facilities. (Saff, 1996)

Joe Slovo Park was later suggested as the first choice for the 862 'owners' of shacks in Marconi Beam who registered with the Milnerton Municipality. Residents of Marconi Beam who arrived later than the initial registration were to be housed at du Noon.

The Marconi Beam Development Trust (MBDT) was established in 1990 as a result of negotiations with the Marconi Beam residents groupings (called Ikareni), Telkom, Rabie Property Developers and two ratepayers associations. The MBDT was then established as the developer for the new housing project. The Development Action Group (DAG) was requested to assist in an advisory role in this process. (Barry, 1997)

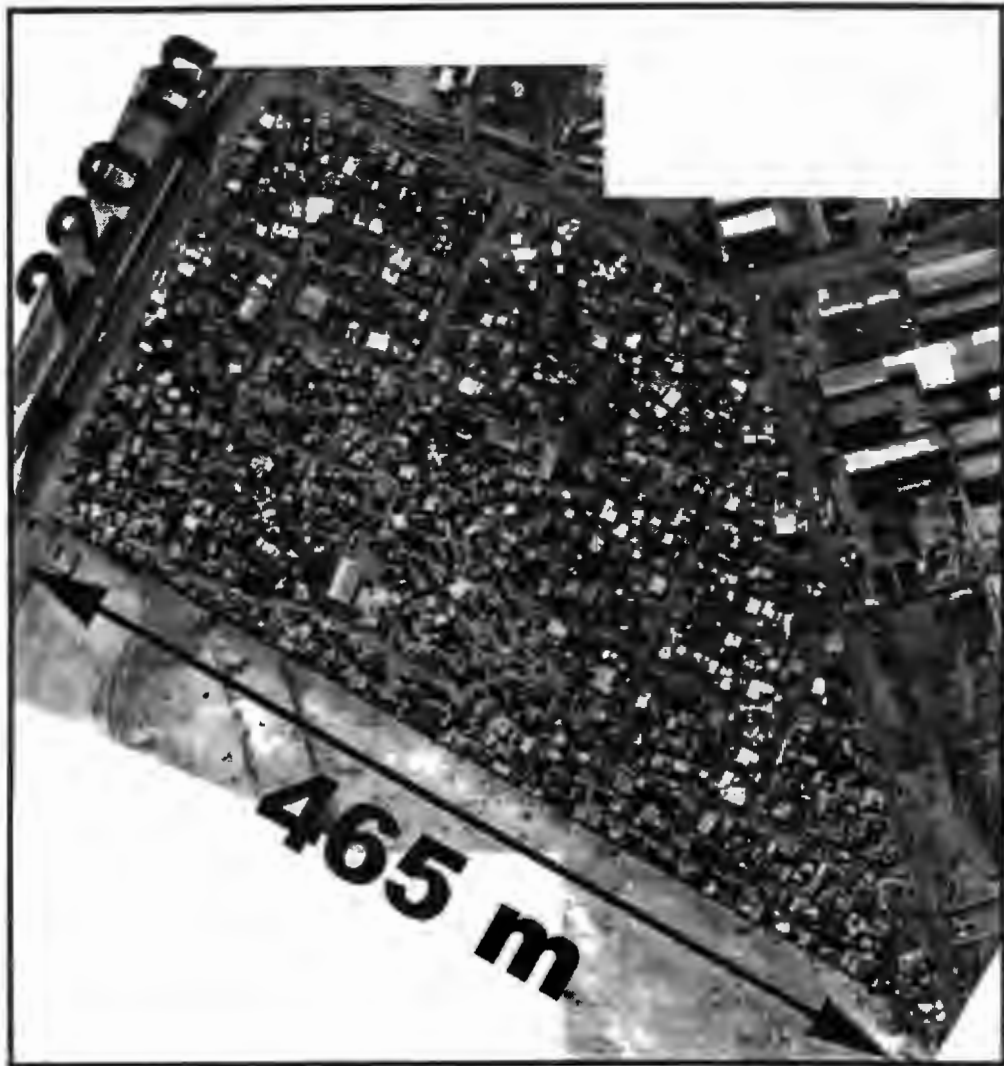


Figure 7: Mosaic of Aerial Images of Marconi Beam

3.6.2 Participants in the upgrading of Marconi Beam

The overall managing authority in the community is the MBDT. The South African National Civics Organisation (SANCO) became involved in setting up structures such as street committees in 1990 (Barry, 1997). Thirty-two elected street committees were responsible for local conflict resolution and community management. Marconi Beam was divided into four sections (A → D), each section containing eight street committees. Each section had an area committee representing its street committees.

The MBDT had an administration office inside the Marconi Beam community hall that was used for meetings and for general administration such as the processing of National Housing Fund subsidy applications. Its ultimate role was that of property developer, with the help of the non-profit organisation - DAG (Barry, 1997).

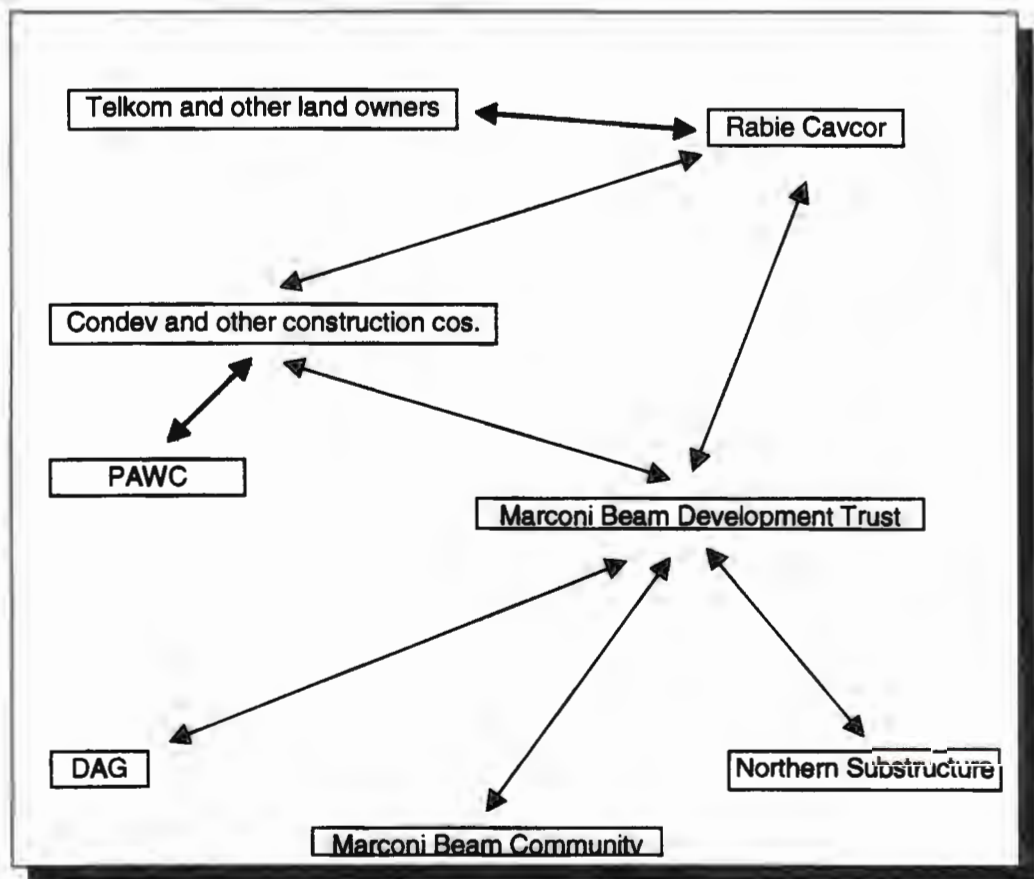


Figure 8: Organisations and their relationships involved in the upgrading of Marconi Beam

3.6.3 Process of housing provision

Due to the outcome of negotiations in 1994, the right of occupation of a shack at the time of registration meant the right to a house in the new Joe Slovo Park.

In the negotiations to move people from Marconi Beam to a new site, Milnerton Municipality registered all heads of family units and some single people living in Marconi Beam and issued them with a rent card in August 1994.

This registration was done in conjunction with the MBDT. Residents of the settlement were employed by the municipality to effect the registration. The registration entitled the holder of the card to a site in Joe Slovo Park and, if the person qualified, a National Housing Fund subsidy to build a home or have a house constructed for them. If a person left Marconi Beam and sold their 'shack', then the card and the right to a site in Joe Slovo Park was transferred to the buyer.

The street committees were responsible for ensuring that a person entitled to a house in Joe Slovo Park was the official 'owner' of the shack as decreed by MBDT policy. If a person wished to forgo his/her right to a house in Joe Slovo Park then s/he could sell his/her shack to whoever the street committee decreed, usually some family that had stayed in the settlement as lodgers for some time.

The order in which the successful applicants were chosen to move to Joe Slovo Park was determined by a lottery. This lottery was held one Saturday every month at the Joe Slovo Park show village for most of 1996.

In terms of the lottery, the first names out would be the first to move to a new house. However, the area D (see Figure 9) needed to be cleared first in order for the new road to be built.

The two options were thus:

- if the person selected from the lottery lived outside of Area D, s/he would demolish his/her 'shack' and move to a new Joe Slovo site.

His/her site in Marconi Beam would then be taken by a family from area D in Marconi Beam. (Illustrated as 'Internal' move in Figure 9)

- If a family selected by the lottery that lived in Area D, then it would move directly into the new house, demolishing the shack it were leaving. (Illustrated as 'Direct' move in Figure 9)

As families moved, they would have to prove that their huts had been dismantled and all material removed from the site before being given the keys to their new houses.

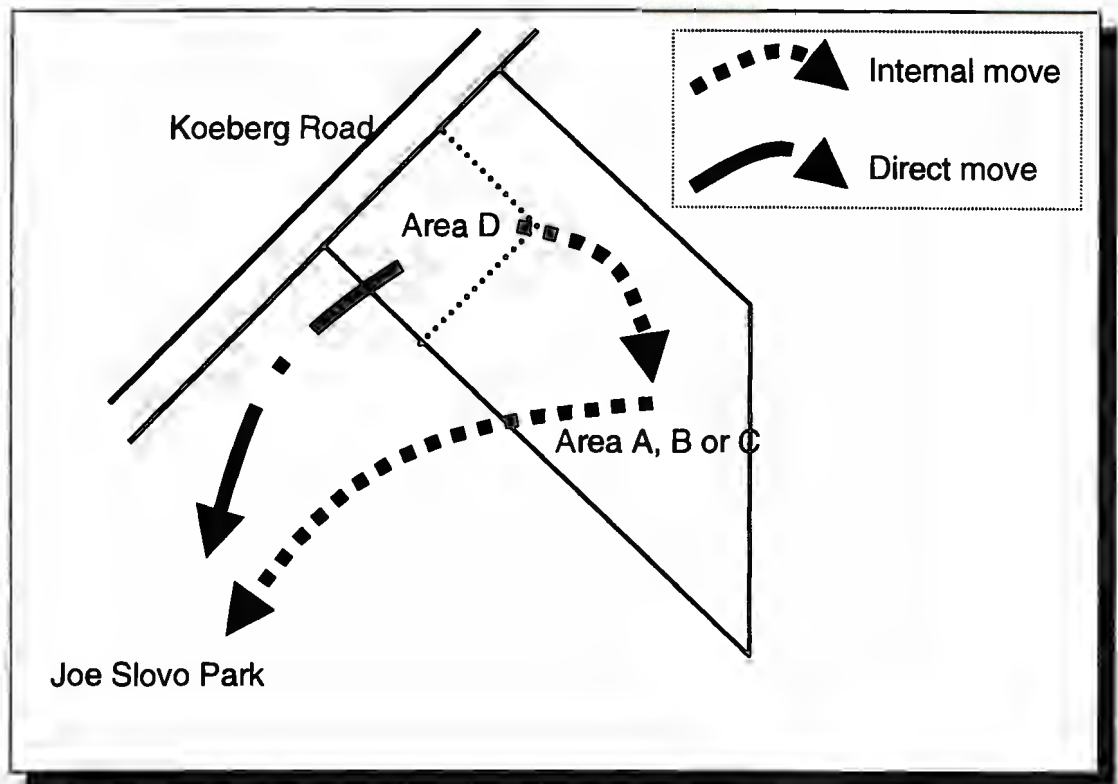


Figure 9: Devised methods of moving from outcome of monthly lottery.

This system, the technological management of which is described later, was eventually abolished after it had been used for the first 212 occupations, as it was too complicated to manage on the ground.

Rabie Property Development, in conjunction with Condev, is the project management company overseeing the development of the entire area. (See Figure 8) At the request of Rabie Property Development, in December 1996, the settlement was divided up into blocks of approximately twenty 'shacks' per block. These were numbered sequentially with the first few blocks being the ones that urgently needed to be cleared for the new road to be built. (See Figure 15) A MBDT trustee, referred to as an 'on-site administrator', was employed by Rabie Property to administer, on the ground, the clearing of these new blocks.

The process was as follows:

1. when a new house was nearing completion and the application forms for services were ready to be filled in at the show village
2. a shack owner in the block currently being cleared was informed by the 'on-site administrator' that s/he had to go to the show village to fill in the appropriate forms
3. the existing 'shack' number was spray painted onto their 'shack' along with their new erf number from Joe Slovo Park
4. one or two weeks later the new house was ready for occupation
5. the house was then checked by the new owner
6. s/he signs a declaration to say that the house was as they expected and complete
7. they demolished their 'shack' in Marconi Beam and a certificate of demolition was issued and signed by the 'on-site administrator'
8. this certificate was exchanged for a key to the new house in Joe Slovo Park

This process is known affectionately in the settlement as '**One Shack One Key.**'

As of August 1997, 370 families had taken occupation of their new houses in Joe Slovo Park, and 500 homes were under construction or had been completed.

However, contrary to the agreement made by the residents with Rabie Property Developers, as at mid-August 1997, people not entitled to a new house had some new shacks erected in the spaces cleared by people moving to new houses. Consequently, a decision was made by Condev that no new houses would be delivered until these people had been evicted from the settlement. This decision was taken in order that the overall goal - to clear the area and put the deserving residents into new houses - could be fulfilled. This decision was to be announced by means of loudspeakers in the settlement by the MBDT in order for the residents to deal with the situation. This was the status as of September 1997.

3.7 THE INTEGRATED SERVICES LAND PROJECT (iSLP)

The Integrated Services Land project is a 5 year project with many players (described later) to upgrade the standard of living for many disadvantaged Cape Flat residents.

At least forty thousand Cape Flats families living in the irregular settlements and overcrowded backyards of Crossroads, Guguletu, Langa, Nyanga, KTC and surrounding areas will ultimately benefit from the development of the iSLP.

The iSLP's record of accomplishment involving consultation and inclusively, and its plans for integration and holistic development, have been recognised in its appointment by President Mandela as a Special Integrated Presidential Project on Urban Renewal of the RDP.

3.7.1 Origin of the project

In 1991, the Western Cape Provincial Administration invited all major relevant stakeholders in the metropolis to meet to determine a strategy for the development of the project area.

A Policy Committee was formed with representatives from the:

- South African National Civics Organisation (SANCO)
- Western Cape United Squatters Association (WCUSA)
- African National Congress (ANC)
- Western Cape Regional Services Council
- Western Cape Civic Association
- Umzamo Development Project
- Cape Provincial Administration
- Cape Town City Council
- iKapa Town Council
- Crossroads Town Council

The Pan Africanist Congress (PAC) expressed support for the project from the start but only attended meetings after the general election in April 1994 (Hn Communications, 1995).

The first policy phase lasted from April 1991 to August 1993. During this time a technical committee calculated the demand for housing and services, researched the availability and suitability of land, formulated principles to govern town planning and engineering designs, negotiated principles for land acquisition and site allocation and developed structure plans for Philippi East and Driftsands.

In September 1993, agreement was reached on the project objectives and these were recorded in the iSLP Principles. In 1994, a Business Plan was developed for the iSLP. (Hn Communications, 1995)

3.7.2 Aims of iSLP

The project has been devised to meet the residential needs of low-income families in the project area who qualify for the national government's Capital Subsidy Scheme. These families applying for the subsidy can come from the greater Cape Town area.

The need for services, and facilities, which promote health, education, welfare, employment and recreation, are being addressed.

The developments of Weltevreden Valley North, Southern Delft and Philippi East are included in the project area and are designed to accommodate some of the families who may have to move when their areas are upgraded.

Within the project area is Philippi East, which has been approved as the Fourth Regional Node of the Cape Metropolis. A structure plan has been created and development in this area will establish commerce, industry and social facilities near the communities in the iSLP area.

3.7.3 Budget and funding for iSLP

The budget for development of the project is R1.2 billion over 5 years. A major proportion of this budget, R708 million, is allocated for meeting the residential needs of project communities, while the balance covers capacity building of community members and health, education, community and recreation facilities. (Hn Communications, 1995)

The national government, through the RDP, is to provide 50 percent of the project funding. The balance of the budget is being provided by the

Provincial Administration of the Western Cape (PAWC), the Cape Metropolitan Council (CMC), local authorities and other sources within the province.

3.7.4 Participants

The initiative is undertaken jointly by communities, RDP Forums, the provincial government and regional and local authorities. The iSLP is designed to plan and implement strategies for integration and holistic development that are characterised by community involvement and representation during all phases. Holistic development is best defined by what it is not. It is not just the provision of a serviced site and a house, but, rather the development of a families entire life style – with the concept of leaving them in a self supported environment, having all the amenities (such as schools and clinics) available and near to hand.

Responsibility for the co-ordination of projects rests with the provincial MEC for Housing, and housing developments are facilitated by the Department of Housing, Local Government and Planning of the Provincial Administration of the Western Cape.

The provincial office of the RDP, under the provincial MEC for Economic Affairs, is responsible for facilitating and accrediting the establishment of RDP Forums. The department has also played a role in establishing participatory structures involved in the implementation of the project.

Holistic Settlements (Pty) Ltd are responsible for the co-ordination of the project. Indlu Marketing cc is the marketing company assigned the task of overseeing the management of the developments at Weltevreden Valley and Delft.

3.7.5 Systems in place

The process of housing delivery can be realised for an applicant if they qualify in terms of the following criteria:

- their household income is less than R 3 500 per month
- they have never owned property previously in South Africa
- they are South African citizens, or permanent residents
- they are married or divorced with dependants

Suitable applicants then attend a workshop on ownership of a house, financing a house and an explanation of what top structures are available at what cost.

The applicants then complete the housing subsidy application form with the housing consultants.

If they qualify for a subsidy, then they attend a workshop to select a house of their choice, dependant on what they can afford.

The successful applicant then has to come in and choose their property, indicate the desired position of their chosen house on the selected erf and to sign the remaining forms and applications. It was at this stage in the process that Indlu Marketing cc requested us to assist.

The successful applicant is then given a date on which to return, in order to take delivery of their house, or they are contacted when the house is completed. During this time, the houses are erected by the contractor.

Delivery involves the clients accepting the condition of their house by signing the 'Delivery Certificate' and indicating the date when they wish for their services to be initiated. The clients are issued keys for the house, and can occupy the house at their convenience.

4 STUDIES

4.1 A NEEDS ANALYSIS OF IRREGULAR SETTLEMENTS

At the beginning of the project, we had no knowledge of irregular settlement culture, management processes, structure, the processes involved in housing delivery and had not even been into an irregular settlement.

As the process of upgrading irregular settlements in South Africa is very new, there is very little literature on the subject.

Our approach was thus to begin from scratch, drawing on our experience in other fields, and speaking to as many people who had been in the irregular settlement management and upgrading process as possible.

Many meetings and discussions were held with a variety of organisations. The purpose of these was to generally familiarise ourselves with some of the issues, conditions and processes in place, as well as to determine their views and policies on irregular settlements, in order to derive needs for these settlements.

Some of the organisations/ people included: Doug Milne (ex Cape Town City Council (CCC) Director of Surveys and Land Information, CCC Urban Studies Department, CCC Information Systems, GIS and Photogrammetry Departments, Steve Horn from the Community and Urban Services Support Project, Nigel Edmead from the Planning and Development Collaborative International Geographical Information Services (PADCO), the University of Cape Towns Town Planning, Civil Engineering and Computer Science Departments, the Development Action Group, the Marconi Beam

Development Trust and the Council for Scientific and Industrial Research (CSIR) and Indlu Marketing cc.

In many activities leading to improve living conditions, a framework of up-to-date spatial and socio-economic information is a prerequisite.

The potential of GIS in informal settlement management and upgrading has been broadly recognised. For example, the UNCHS (Habitat) has developed a methodology for rapid mapping of informal settlements using scanned amateur analogue photography under its Visual Settlement Planning (ViSP) programme. The sheer enormity of the issue of administering the number of families involved implies the use of some form of information system.

The research team initially envisaged our role in dealing with irregular settlements as being in the field of data collection. After discussions with the people and organisations mentioned above, it became clear that we would need to involve ourselves in information management to be able to contribute meaningfully to irregular settlement upgrading.

Information management would mean that we became involved at all stages of irregular settlement management and upgrading processes.

Some essential points arising from the discussions evolved into 'information needs' for organisations dealing with irregular settlements, and are discussed briefly.

The Urban Studies Department often makes use of 'sample frames'. (Minutes of meeting with CCC Urban Studies Department, 26 March 1996) These 'sample frames' are 'accurate' sub-samples of an area of an irregular settlement from which they are able to speculate on trends pertaining to a whole settlement. They currently only make use of socio-economic data in these 'sample-frames', but these could be advantageously expanded to include spatial components. They also communicated the idea of visual

spatial applications for use by community organisations in community meetings to demonstrate the effects of flooding and fires.

Mr Stavridis (CCC Department of Information Systems) gave us some ideas on where to begin in setting up an irregular settlement GIS. He suggested by initially mapping some form of fixed reference. This could include anything that would not be easily moved – in spatial terms spatially - in the near future and could be used as a basis for positioning other objects at a later stage. He suggested the use of roads (in a formal housing environment) – but the muddy tracks in an irregular settlement are suitably fixed. We ultimately used some of the only permanent fixtures in the mapping of the Marconi Beam settlement – such as schools and community centres – that could be easily identified from aerial photographs.

The information gleaned from the meetings and discussions are the foundation for this thesis and are discussed later in greater detail.

4.2 INVESTIGATION INTO OTHER SYSTEMS

4.2.1 Investigation into the effectiveness of the Housing Information Management System relational database

The Housing Information Management System (HIMS) has been developed by the Council for Scientific and Industrial Research (CSIR) to “support the process of low-income residential development”, quoted from the Information System for the Support of Low-Income Housing Projects (1996). It consists of a suite of software tools. The software is integrated under a Windows environment to give a uniform user interface. It is designed to run on a single machine, or across a small local area network.

The application is written in Microsoft Access Version 2. It takes advantage of the Access Developers Kit – in that it is distributed as a stand-alone

application, with the distribution including all the necessary MS Access 2 run-time libraries.

In the Weltevreden Valley situation, HIMS was initially running across a peer-to-peer IPX Windows 95 local area network (LAN). Unfortunately, a 16 bit standalone database application in a networked Windows 95 32 bit environment is very unstable, with 'crashes' and 'hang-ups' frequently occurring. This could be improved, if the HIMS application were periodically adapted to stay up-to-date with the advances in platforms and database technology available. This, however, is not the case.

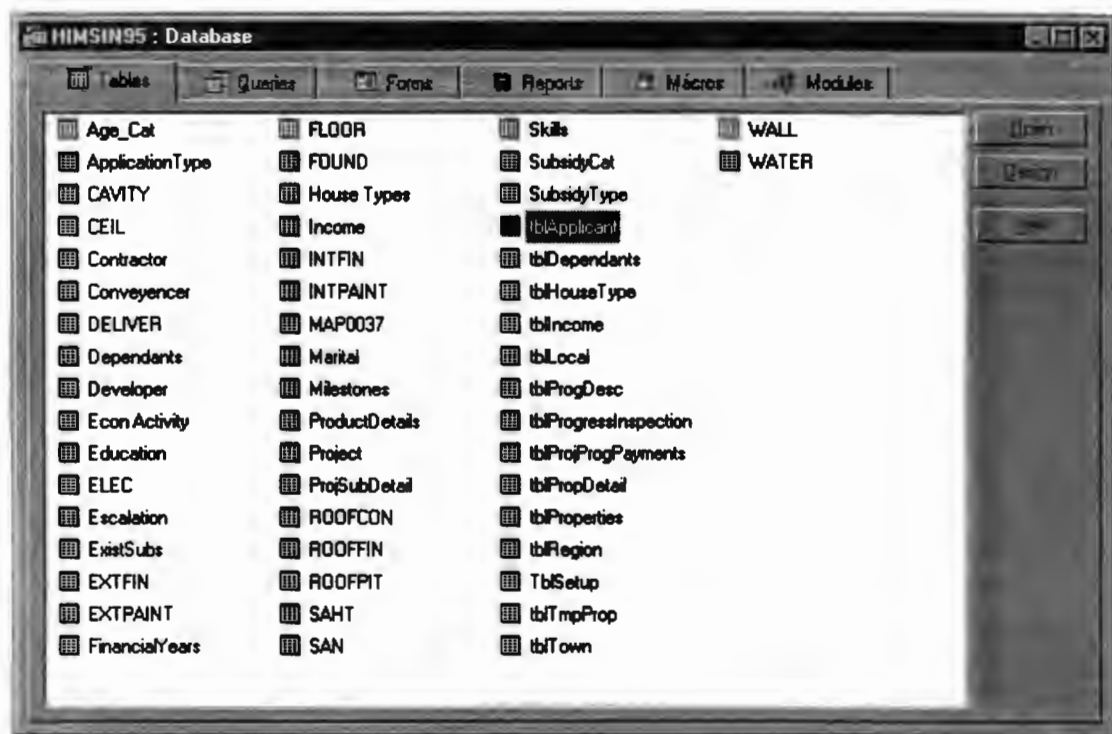


Figure 10: The tables in the design of HIMS

The design of the database also includes many facilities that in practise are seldom used and are thus unnecessary overheads, complicating the use of the application. (See Figure 10 and Figure 11)



Figure 11: The Housing Information Management System

The application was also unable to operate in an Access95/ 97 environment, which would have increased the applications stability and performance, due to the use of non-conforming table names used in the design of the database by the CSIR. At no time were these issues addressed by the CSIR, in our two years of exposure to HIMS.

The most fundamental problem was that the application did not fulfil most common needs of the organisations dealing with low cost housing provision. This was especially evident in the lack of reports that were available. Many additional functions and standard reports were often recommended by organisations dealing with the housing process, as well as by us, but at no time were these recommendations addressed by the CSIR.

A list of applications, modified from “The Information System for the Support of Low-Income Housing Projects”, 1996, follows.

The following functions were available in early 1996.

- **Registration of participants:** All participants and their directly dependent family can be registered. The work status i.e. employed, unemployed, informally employed, as well as specific skills that can contribute to the development of the project may also be captured.

The screenshot shows a software window titled 'Applicant'. At the top, there is a field for 'Application No.' with the value '35'. Below this are fields for 'Type of Application' and 'Conveyance/Lender Ref No.'. The main form is divided into two columns. The left column, labeled 'Applicant', contains the following fields: Surname: MEANGA; Maiden Name: ; Previous Name: ; Full Name: MAGAZOME; Gender: M; Marital Status: Married in LDP; ID No.: 1102; Birth Date: ; Postal Address: ; Residential Address: ; Monthly Income: ; Occupation: ; Employer Name: ; Employer Address: . The right column, labeled 'Spouse', contains: Surname: MEANGA; Previous Name: ; Full Name: MORFIELD; Occupation: ; Job No.: 1102; Birth Date: ; Monthly Income: ; Country of Citizenship: . At the bottom right of the window are four buttons: 'Income Details', 'Dependents', 'OK', and 'Cancel'.

Figure 12: Form for capturing applicants details in HIMS

- **Housing type and related costs:** The type of house available can be indicated.
- **Analysis of age and income of applicants.**

Some of the foreseen extensions – which were mentioned as early as May 1996, but as of August 1997 are still not available, include:

- **Reports:** The production of the housing subsidy application forms, together with other applications and documentation relating to the provision of services.

- **Site Planning:** The integration of the system with a GIS to enable planners and engineers to produce an Urban Design Framework including a layout plan and services plan for the area. Once a layout plan is produced, it is envisaged that participants will be able to select a site and link it to the particular participant. In a multi storey building environment, it is envisaged that the CAD drawing of the layout outlines of each storey will be included in the GIS in order to allow a participant to be linked to a specific unit.
- **House type design and choice:** A facility will also be provided for the calculation of cost of building materials and providing labour estimates for different construction methods. A drawing with a list of materials, qualities, costs and loan amount will be produced for the head of household to sign and verify the choice.
- **Siting of individual houses:** A site should be selected depending on where the house types of certain density or design should be situated according to the urban design. After a site has been selected it should be connected to the household's database and the site should be removed from the range of choices for the next households. A site plan with the number, dimensions and service connections shown will be produced for the head of the household for signature to verify acceptance. This will then be submitted to the local authority.
- **Tenure documentation:** A document will be generated to confirm the household's security of tenure and to satisfy the government's subsidy requirements. Legal documents with all the necessary information, ready for signing before a commissioner of oaths, will be produced.
- **Completion and hand-over:** The system will issue occupation certificates, warranty certificates, and completion lists and indicate the date for the end of retention period inspection.

- **Management of Land Invasion Problems:** The integration of the household registration and aerial photography in the GIS module is envisaged to facilitate the monitoring of the relocation of households from land invasion sites to formal settlements. This is aimed at alleviating queue jumping.

4.2.2 PADCO's Lots by Dots™ System

PADCO is an American Organisation that consults to organisations in developing countries to assist them in implementing mapping solutions. They follow various methodologies in providing a solution, one of which is described briefly below.

Under PADCO's approach, a land parcel is not stored as a polygon or area in the Land Information System (LIS) and hence is not used as the base framework for the related database. Instead, a single point feature representing each property is used as the geographic identifier and geographic locator (PADCO, 1993).

By using a single point to define a property parcel, the question of property boundary and its adjustment to other surrounding parcels is not considered in the LIS. The area and measurement information is stored in the related database by relating the actual surveyed parcel details with each property point. The shape and form of the property parcel can also be contained within the database by scanning the individual surveyor field diagram and then relating this information as a data record to the property point.

Some of the benefits of PADCO's point-based LIS versus a polygon-based system are that:

- there is reduced time for input;
- there is reduced processing overhead as the databases are small and faster to manage, analyse, update and use;

- all relevant cadastral information is stored within the database just as it would be with a polygon-based system, only no resources are expended resolving land geometry problems during database and system development.

Some of the limitations of this system when dealing with irregular settlements include:

- 'shacks' are often extended or slightly shifted, the only way to determine if this 'shack' has moved, is to look at the polygon representing the 'shack' in relation to its proximity to the neighbouring polygon;
- in order to determine areas where there is still space for development, the whole extent of the 'shack' needs to be seen, not just a point representing it.

4.3 CASE STUDY - MARCONI BEAM

4.3.1 Information Requirements and Development of a GIS for Marconi Beam

The need to manage large amounts of both spatial and attribute (socio-economic) data, as is found in irregular settlements, is not unlike many of the other application areas in which a geographical information system (GIS) is used. The development of a GIS, as a form of information system, can follow the well-documented methodologies for the evolution of information systems in any environment.

The first of these is an initial identification of the data types available. The data types were examined to see what applications could be derived that would be useful. The identification of specific needs and the solutions to these needs are described below.

The possibilities for the use of available data were discussed with DAG and the Marconi Beam Development Trust. We identified that it would be useful to know how the situation on the ground had changed between the data sets from August 1994 and that of May 1996. Our first task was to import the data from 1994, kindly donated by an engineering firm involved in the project.

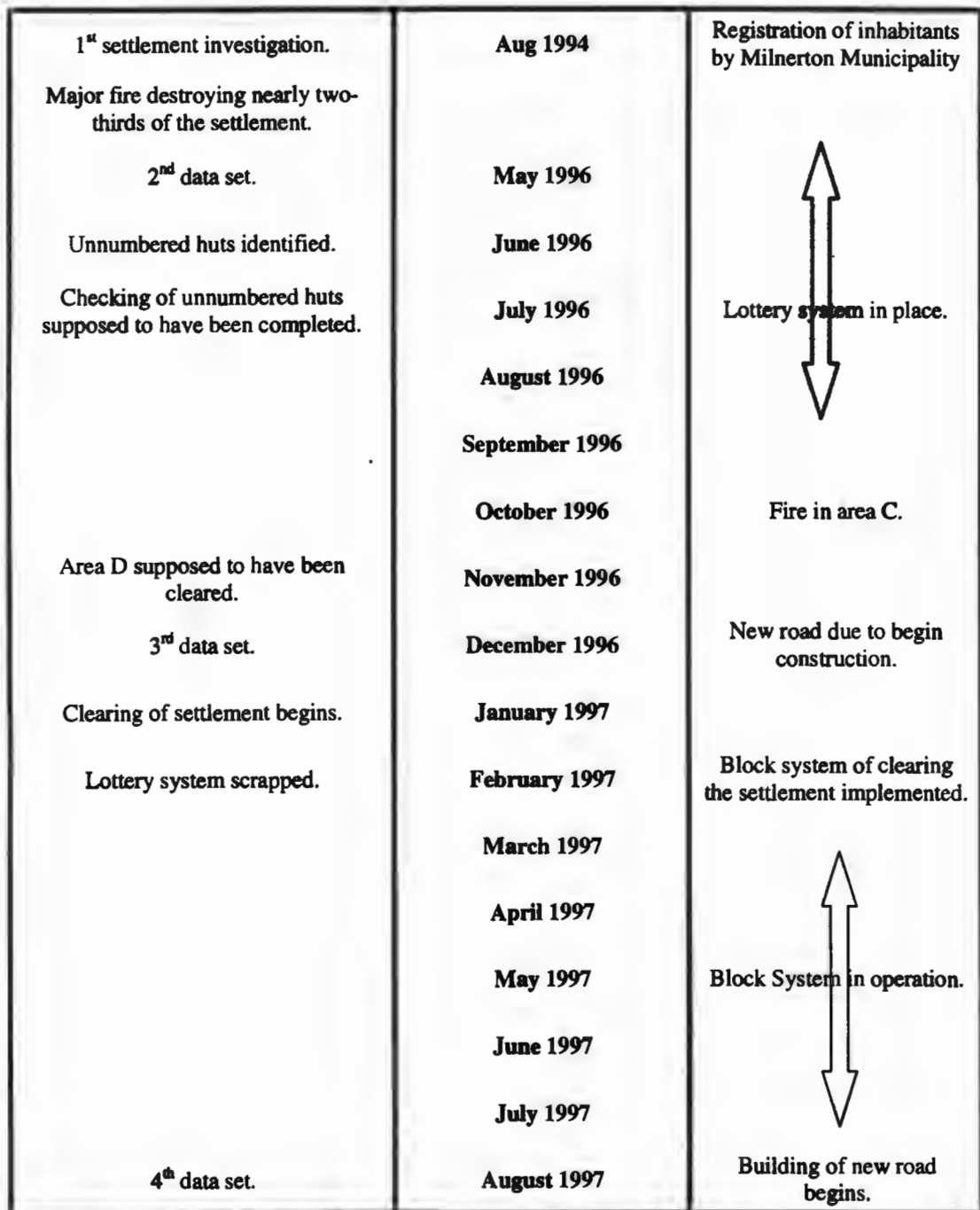


Figure 13 Timeline of Marconi Beam Project

The data consisted of a theme in the GIS showing the outlines of the roofs of the shacks and a label from the hut numbering system used in 1994. At the same time, we acquired aerial photography of the settlement. The images were rectified, mosaiced and then used for the online digitising of the outlines of the roofs of the huts. For more information on this see Mason et al 1997. The mosaiced digital image was placed on a layer, as were the two sets of hut outlines. From these, we were able to identify (see Figure 14) which huts:

- were new to the settlement. i.e. which had been built between August 1994 and May 1996;
- had been destroyed or moved from their original location between August 1994 and May 1996; and
- needed renumbering.

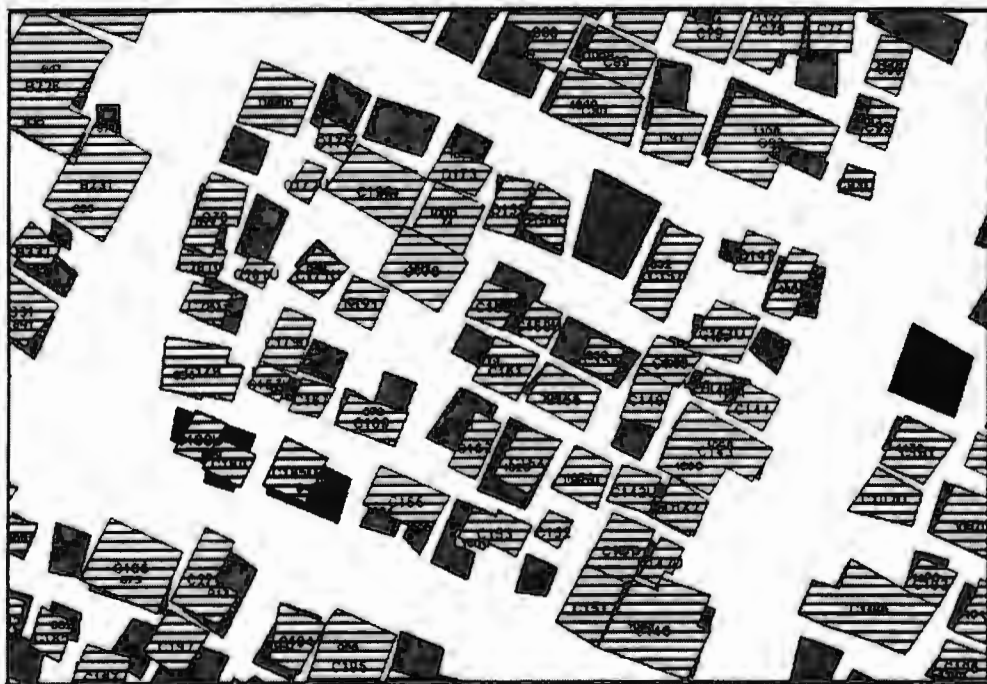


Figure 14: May-Dec 1996 hut changes (May 96 - Stripes, Dec 96 - Solid)

The results of this investigation were presented to the DAG and MBDT to be taken out in to the field by teams from the MBDT for:

- assigning numbers to the huts without numbers; and
- finding out the names and application numbers of the people living in the new huts.

It was planned that we would use this data to update our database for future use. DAG assured us that this work would be completed by the end of July 1996. i.e. before occupation of the new housing at Joe Slovo Park was due to have begun.

The process of checking the house numbers never took place. This left us with a data set that was incomplete. After much discussion, we were left with no other choice but to continue with the data that was available.

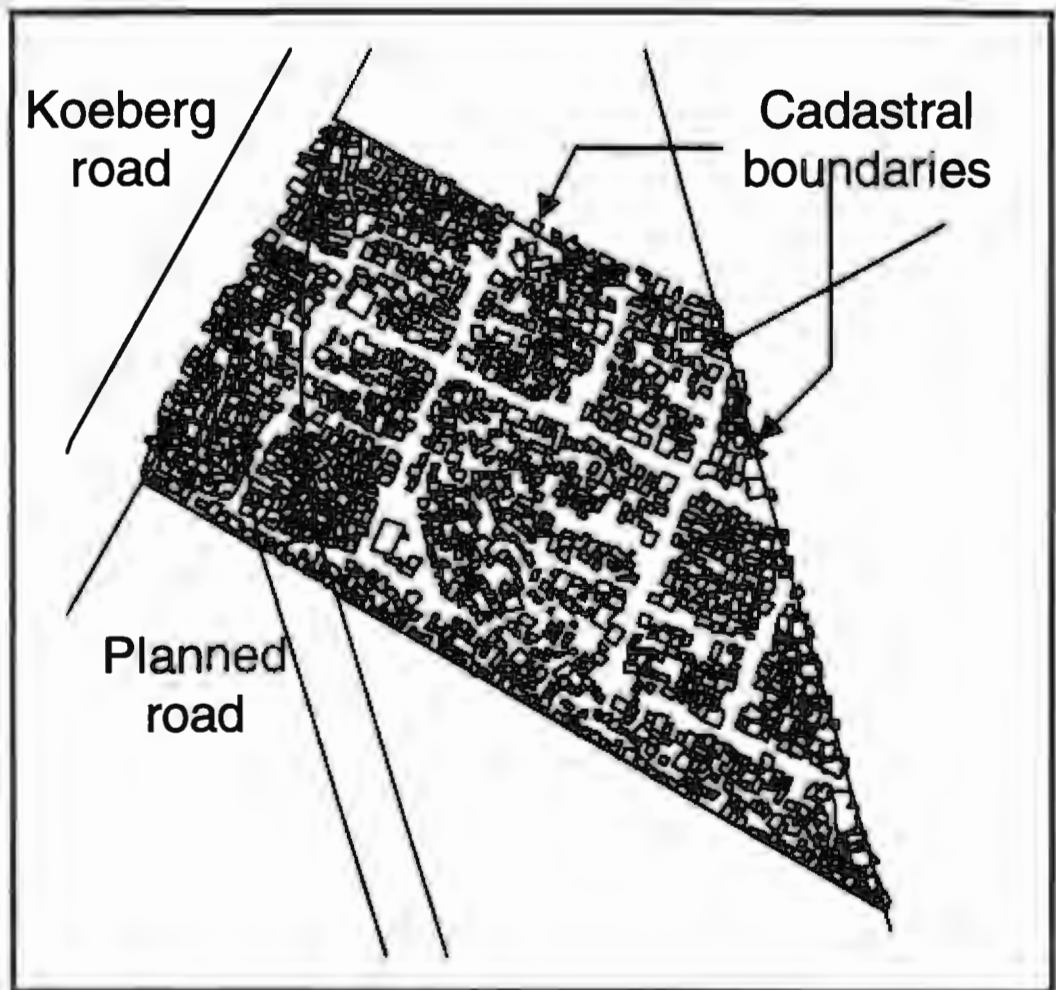


Figure 15: Marconi Beam – Layout of planned new road cutting through Area D of the settlement

The Housing Information Management System was prototyped on the Marconi Beam project. The capturing of data on prospective applicants for subsidies was initially performed by members of the Marconi Beam Development Trust. They entered the data onto the subsidy application forms provided by local government. This data was subsequently entered into the Housing Information Management System. Approximately 700 entries had been processed, but many were incomplete and incorrect.

Throughout this process, the lottery system was in place, and applicants were being selected for the new houses one Saturday per month.

In August of 1996, the Marconi Beam Development Trust office manager was replaced, as was the Marconi Beam project co-ordinator from DAG. DAG's efforts thereafter were focused more on the building of houses, and not on the management of the moving to new houses. This management process was taken over by Mr Kevin Francis of Condev.

The development of the Marconi Beam GIS required a link between HIMS and the GIS. We did this by setting up a SQL connection from ArcView, using the numbers of the huts, being common to both data sets, to geocode the data in the HIMS relational database.

The capability for such a database connection from a GIS was in its infancy at the time (September 1996), but is now (August 1997) an integral part of most common GISs. This posed the problem that the original database tables could not easily be updated through the GIS. The solution to this was to create fields for these attributes in the GIS table with which the HIMS "tblApplicant" table was being linked. This permitted data such as the date a 'shack' was demolished to still be stored in relation to other data pertaining to the 'shack', but without affecting the original HIMS database.

The four areas (A, B, C and D) of the settlement we represented by polygons in the GIS. This enabled us to identify the number of huts in each of the areas. The schools, churches, crèches and shebeens were also identified and placed in separate themes in the GIS. (See table below.)

Theme Name	Theme Type	Key used for relationship to HIMS
Community centres/ Schools/ Shebeens	Polygon (vector)	
Rabie Areas (A-D)	Polygon (vector)	
New road buffer	Polygon (vector)	
New road layout	Line (vector)	
Fire October 1996	Polygon (vector)	
New or moved huts (May- Dec 1996)	Polygon (vector)	
Huts gone (May-Dec 96)	Polygon (vector)	
December 1996 Huts	Polygon (vector)	Hut Number
May 1996 Huts	Polygon (vector)	Hut Number
August 1994 Huts	Polygon (vector)	Hut Number
MB Image Dec 1996	Image (raster)	
MB Image May 1996	Image (raster)	

Table 4: Themes in the Marconi Beam GIS

In October 1996 a devastating fire swept through a large part of area C. The extent of this fire was consequently surveyed with the use of GPS. As a result of the fire, and the frustrations of the community at the slow delivery of houses, many of those affected by the fire occupied the show village.

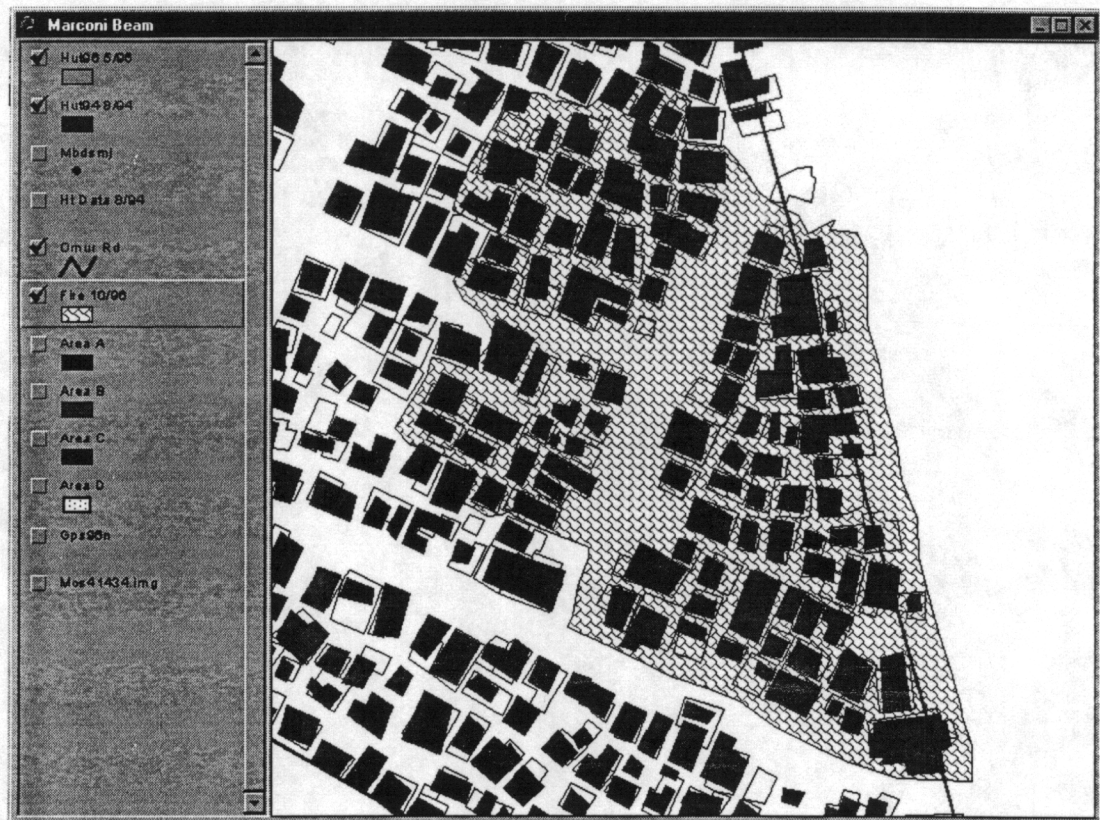


Figure 16: View of area affected by the fire.

From the results of the GPS survey of the fire damage, that had been imported into the GIS, it was possible to identify those huts (families) directly affected by the fire, most of whom were now living in the show village.

The new road, planned to be built through area D, was due to begin construction in December. The families affected were identified by buffering the road in the GIS. The original plan to clear this area was to move the people selected from the lottery into the new housing, which was due to have been completed, and move people from Area D into the gaps that they left as they moved. See Figure 15 to further understand this.

A system was thus formulated, using the GIS (illustrated in Figure 9), to keep track of the internal moves. Marconi Beam Development Trust staff were

trained on how to use the GIS for this purpose, and the graphical user interface was modified to simplify the interaction between the user and the GIS. As a house was graphically relocated, the date of its move would be recorded in the database. This permitted the auditing of movements in the settlement.

The processes of moving internally, however, never took place because of delays in the building of the new houses.

In December 1996, a second data set was acquired from a further set of aerial imagery. This now gave us the opportunity of comparing the changes in the settlement, by comparing our data sets from May and December. See Table 5 for details.

Description	Number of Shacks
Total number of structures in settlement (Dec 1996)	1 345
Huts demolished or moved	45
Huts erected or moved internally	105

Table 5: Changes in Marconi Beam between May and Dec 1996

Thirty-two huts were directly affected by the fire, of which only about 10% were rebuilt in the same position - these are included in the table above.

In January 1997, the Rabie Property Developers requested us to help them with identifying the huts that needed moving for the construction of the new road to begin. A further breakdown of the settlement was done into blocks on about 20 huts per block. These were numbered sequentially, with the blocks in the direct path of the road being the first ones to be cleared. These families affected were moved into the new houses, which had then been built.



Figure 17: Rabie Block System – for sequencing the clearing of the settlement

A layout of each of the individual blocks was printed out; along with what socio-economic data we had in the relational database pertaining to the area. These have been used by Condev to manage the entire process of clearing the settlement and allocating new houses.

4.3.2 Problems at Marconi Beam that hindered the use of the GIS

A fundamental problem in the development of the GIS for Marconi Beam was a lack of complete, up-to-date or accurate data. Some of these data problems included the inconsistent and incomplete method of numbering the huts as well as the inaccuracy and incompleteness of most of the socio-economic data stored in HIMS associated with the Marconi Beam families.

This was compounded by the slow delivery of houses that drew much attention away from the requirements for data. At many stages during the

evolution of the GIS, we could not fully demonstrate the capabilities of such a system - hindering its success.

There were also alleged cases of corruption in the process of construction of houses, often a lack of commitment by people and organisations, compounded by a frequent turnover of staff at both DAG and the MBDT. At one stage, the MBDT manager even disappeared. These all caused delays that setback the process.

Unfortunately, these problems were due to circumstances beyond our control, and it was not within the scope of this thesis to gather and input all the socio-economic data that we typically would have liked. Had the data been up-to-date and correct, more analysis could have been made, which would have helped raise the awareness of the use of such a system to an even higher level.

Some examples of such data may have been useful include:

- up-to-date hut numbers - this would have permitted us to more accurately tie in the data from the HIMS database and use it for spatial analysis;
- location of services such as toilets and water outlets - given rise to analysis such as the most suitable positions for extra temporary services;
- the location of crèches - to understand the way in which these communities tie together to help look after one another's families, as well as the locations of the many shebeens in the settlement to help understand some of the social practises that occur; and
- number of people per hut - to allow us to accurately gauge the number of people in the settlement;

- income per household - this data would have been very useful in understanding the 'workings' of the settlement but in reality would never have been possible to capture, due to the fact that admitting to more income meant less of a subsidy
- place of work - to give an indication whether or not the residents are living in the settlement because of its locality to place of work or whether it is just because there is nowhere else to go;
- skills in the household- to match up the skills with local businesses requiring labour in the area.

4.4 CASE STUDY - WELTEVREDEN VALLEY/ ISLP

Weltevreden Valley is a new housing development that is part of the iSLP Project on the Cape Flats in the Western Cape. It is being managed by Indlu Marketing cc.

4.4.1 Weltevreden Valley Site Data Management

Indlu Marketing cc had purchased the HIMS system early in 1996 and had implemented its use on two networked machines at the Weltevreden Valley Site Office.

The data on prospective applicants applying for subsidies had initially been captured on the official paper application forms that had then been entered into the HIMS system. Indlu Marketing cc had also, as part of their agreement with the Western Cape Administrative body, to introduce a spatial component to the information they were dealing with in the form of scaled building plans. These plans were used to show the locality of the selected houses on the erven, in relation to the erven boundaries, the road the erf was neighbouring and the services that were present on the erf.

Their information needs were thus, for successful applicants, to:

- print out the relevant forms for the housing delivery process (10 forms in total, averaging three pages each = a total of 30 pages per applicant)
- print out scaled building plans of each erf, showing clearly the position of the house and engineering services (3 pages in total)

Indlu Marketing cc approached us to provide a solution to this problem, and to later develop a customised computer based application to streamline their role in the provision of housing.

Our initial task was to develop (or modify) an application(s) capable of fulfilling this role. After investigating a number of options, it was decided that, in terms of functionality and cost, the package Visio Technical would provide the best solution.

Visio Technical is a two dimensional CAD package that currently (September 1997) costs around R 1000 per license. This cost is a fraction of fully-fledged CAD packages such as AutoCAD, but it still provides the functionality required.

The individual erven were extracted from the original DXF format layout, and saved as individual DXF files for further on-site processing. The initial project at Weltevreden Valley involved extracting just over 2000 erven.

The Visio package was then customised to meet the required needs as follows:

A Visio stencil was created, which contained scaled plans of each of the possible houses available to successful applicants. A range of templates consisting of a frame, a north indicator and areas for the data about the applicant (such as name, erf number, ID number etc...) to be filled in were also created. (See Figure 18 for a sample finished plan)

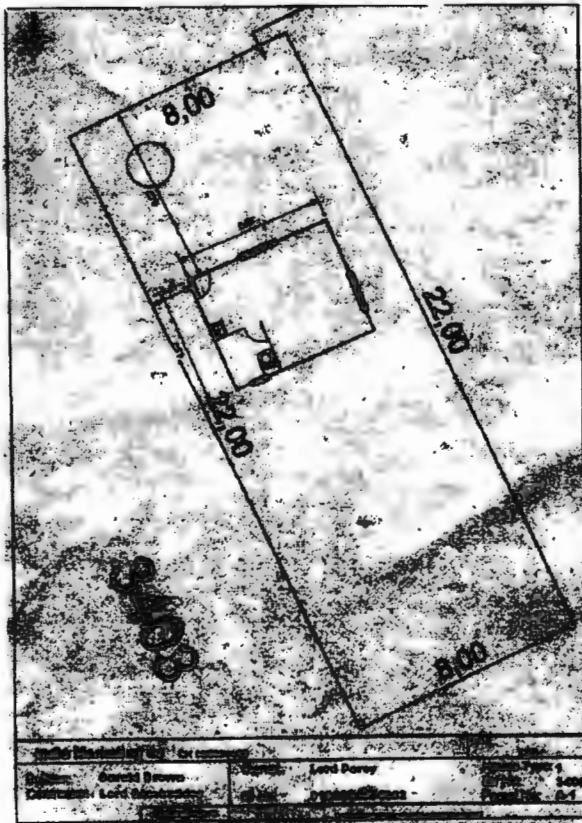
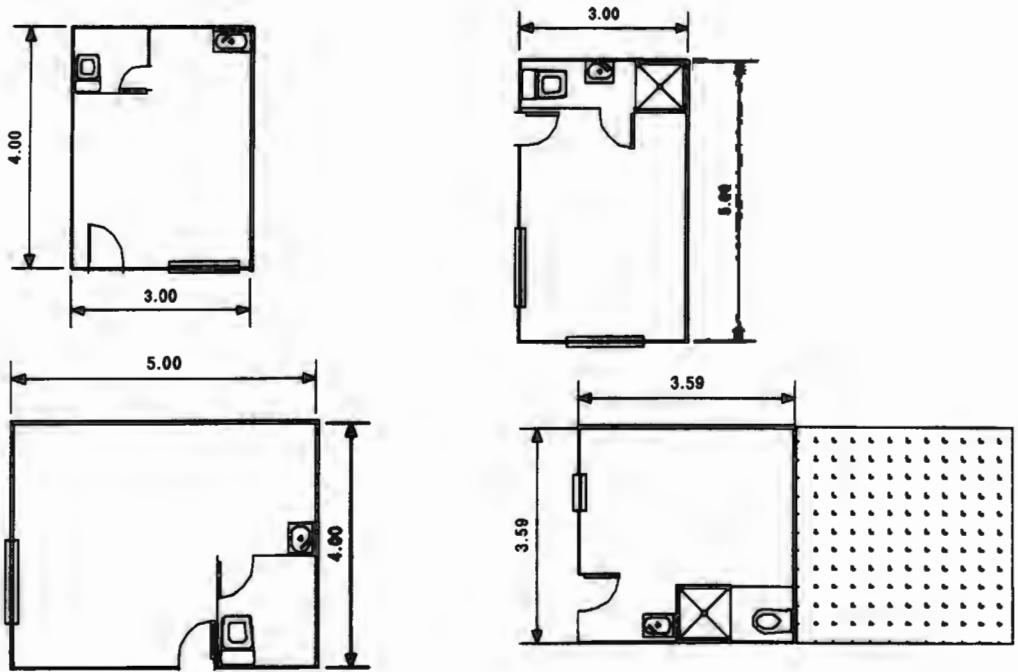


Figure 18: Example Stencils and Building Plan produced by modified Visio Application

It was recommended that, given their current computing facilities, Indlu Marketing cc upgrades their current two machines, add two additional machines to their network, as well as two high speed laser printers. The processing of information would be very 'printing' intensive, given that over 45 000 A4 laser prints would need to be completed in one month – an average of over 4 A4 prints each minute during working hours for the entire month.

The customised Visio application and pre-processed data were installed on site in the few days leading up to the month when applicants would be met. During this time, computer operators were trained in the use of the Visio Application.

A stringent time restriction was in place, as the applications all had to be processed in one month. This entailed processing an average of nearly one hundred applications per day.

During the first day of processing, the applicants were consulted on the positioning of their house on their newly acquired erf. The computer operator first had to explain the possible options, and then wait for the applicants to decide on what they wanted. Problems with this included:

- being presented with often never seen before computer technology, combined with the excitement of the concept of owning a house, made the decision of positioning a house difficult as applicants were not aware of factors such as the positioning of existing services, the concept of a north facing house in the southern hemisphere etc ...;
- the inability of the applicants to conceptualise the idea of the erf on the computer screen relating to their actual erf, as well as make informed decisions about the spatial location of their new house, meant the operator had to go to great lengths to educate the applicants about the situation; and

- given the short time they had with the operator - the options available to them were very difficult to take in all in one go – leading to irrational decisions.

These problems lead to an unacceptable amount of time being spent at this stage of the process, often resulting in an incorrect decision being made on the location of the house. The operator could, in fact, given their experience and overall grasp of the task at hand, make an informed decision in nearly one fifth of the time, completing the processing at the same time.

Thus, the decision was made to leave the placing of the houses up to the operators, who were to take into account the considerations that follow when placing a house. These considerations evolved from our experiences, and from consultations with relevant authorities and lead to a 'policy' for housing placement, which was dictated by the following criteria:

- to take into consideration the existing underground services, and to not place any part of the house, or its future likely extensions, over or within one meter of these underground services;
- to take into account the possibility of extensions to the house, which, due to the nature of the construction of the houses, was only possible from one side of the house as a result of the construction and placement of the flat sloping roof;
- to position the house in such a way on the property that the front of the house would face in a northerly direction - to take advantage of the extra sunshine it would receive in that fashion; and
- to not place any part of the house within one meter of the borders of the property, or within three meters of the side of the property bordering on the road.

In our experience, the removal of this 'consultation' time speeded up the processing dramatically and allowed the processing of applications to

continue unhampered for the remainder of the month (the rest of that phase of the projects times-span).

4.5 INDLU MANAGEMENT SYSTEM (IMS)

The scope for a customised information system had been mentioned from our initial involvement. Upon completion of the processing at the Weltevreden Valley site, a feasibility study was initiated researching the possibility of such a system.

The project life cycle followed much of the Information System Project Development Lifecycle as described in Section 2.3. However, due to the circumstances and pressure applied to quickly produce a working application, many of the stages in the development were passed through extremely quickly - and most were left up to us to decide if they were at sufficiently complete to continue to the next stage.

The project is also under continued development by the UrbanModeler Team in the Department of Geomatics at the University of Cape Town.

4.5.1 Stage 1 - Feasibility Study

The feasibility of a new system was mostly deemed practical due to Indlu Marketing's dissatisfaction with the HIMS system at an operational level due to:

- it not meeting Indlu Marketing's functional and strategic requirements;
- it not producing the hard copy outputs sufficient for Indlu Marketing's needs;
- a lack of ongoing development; and
- their being insufficient support.

(Source: Personal communication: Mr Camroodien, Indlu Marketing cc)

The current system, as used in the Weltevreden Valley project, consisted of a variety of systems including the use of MS Access, MS Word, Visio, HIMS combined with a paper-based system. This use of a many different applications with each being used independently left scope for improvement especially in the time it takes to process applicants details and output necessary hard copy outputs to complete the application.

A business case document was produced and after discussing the implications with Indlu Marketing cc, it was agreed to begin development.

4.5.2 Stage 2 - User Requirements

In meetings with members of the team from Indlu Marketing, as well as from input from our previous experiences in the low cost housing process, needs and wants were established.

Some of the requirements included:

- a summary of the objectives of the system;
- the online processing requirements - the basics of which would be similar to their current 'manual' system of making use of many different applications;
- storage of all the information necessary to produce the hard copy outputs required in the housing delivery process (this included all forms such as water and electricity application forms);
- the user interface requirements;
- a link it to the Visio application for the generation of building plans;
- a communication link to facilitate a search for previous ownership of land at the Deeds Office;
- the performance requirements of the system;

- the scalability of the system given that the low-cost housing process is increasing;
- a development strategy and time-scale; and
- a training strategy.

Once these requirements were agreed upon, it was possible to continue to Stage 3.

4.5.3 Stage 3 - Technical Solution

Given the nature of the application required by Indlu, it was not possible to make use of a proprietary package and was thus decided to proceed with bespoke development.

Developing the technical specification involved re-expressing the functional requirements from the previous stage into a form specific to the hardware and system software environments in which the system was to be constructed and run.

The following key technical features are discussed in further detail:

- a) Physical database design
- b) Overall system design
- c) Report Layouts

a) Physical Database Design

Indlu Marketing supplied the research team with all the sample hardcopy outputs that the system was to produce. From the supplied hardcopy outputs we identified the data fields required and logically grouped them into relational database tables.

These tables were then normalised to Third Normal Form according to relational database rules. Fourth Normal Form (Boyce-Codd Normal Form) was not used, as this would entail the use of additional tables that would complicate the overall physical design of the database. Minimising the complexity of the physical design will enable additional structures to be added at later stage.

The physical design is illustrated in Figure 19, showing the tables in the database and their relationships, as well as in Appendix I, showing the structure of the tables and their associated field type and field lengths.

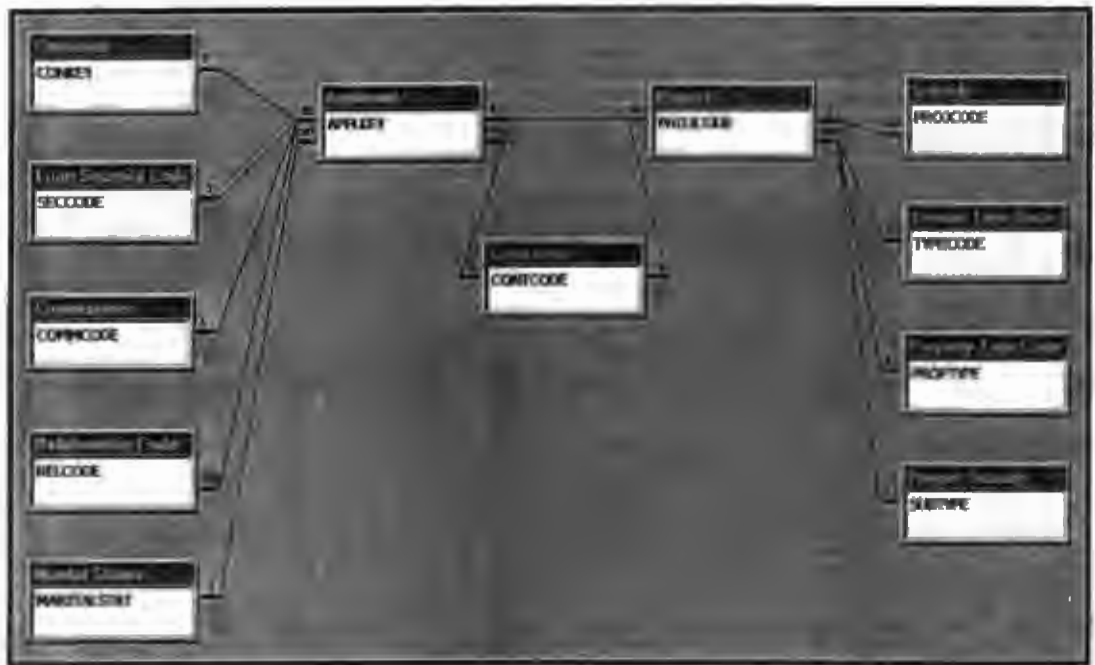


Figure 19: Relationship Diagram for the Indlu Management System (1-1 = one-to-one relationship 1-∞ = one-to-many relationship)

b) Overall System Design

The existing network consisted of some 10 Pentium based PC's all taking advantage of the Microsoft Windows 95 32-bit platform. The network was

based on a peer-to-peer design and consisted of 10 Mb/sec Ethernet Adapters attached to BNC cabling. The IPX protocol was used.

The Indlu System was designed to be able to run on the existing infrastructure of PC's and LAN. It's client/server environment was used to minimise network traffic and permit scalability. The existing server, on which the data was stored was a Pentium 166 MHz machine with 64 Mbytes of RAM running Windows 95, but there are plans to upgrade this to the Windows NT Server Version 4 platform to provide for enhanced security and stability. An on-site/off-site data backup scheme has also been implemented.

When IMS runs, the user is able to open a particular affordable housing project. A screen similar to Figure 20 appears, showing a list of all applicants registered on the system. The use of brightly coloured icons immediately shows the status of each application.

By double clicking with the mouse the screen illustrated in Figure 21 appears, the user can edit the application to add missing details or enter dates. Notice that the applicant's details have been logically grouped to speed up data capture. Here the system user enters the all applicants' details that are required to generate the subsidy and other forms. This ensures that all data can be captured in only one session with a single tool, although it is reused many times in the production of the forms and reports.

Once all the (known) details have been captured, the application can be validated. A simple click on a button generates a list of missing details and updates the application status icon. Other subsidy criteria, e.g. the applicant's age and income, are also automatically checked at this stage. This ensures that incomplete or not-qualifying applications are not submitted to the Department.

App No	Applicant Name	Applicant ID	Applicant Address	Applicant Phone
0001	SEBASTIAN ZWANE	5901030130086	WALWITZ	08123
0002	ANDREW DUBOIS	5901030130087	WILLIAMSBURG	08124
0003	SIBONGILE DUBOIS	5901030130088	ZONKLEEM	08125
0004	5905055066081	5905055066082	JAARS	08126
0005	6509170866085	6509170866086	VERMEULEN	08127
0006	6712060140013	6712060140014	MEHL	08128
0007	5901030130086	5901030130087	MACK	08129
0011	6703025198089	6703025198090	RHODE	08130
0012	4410090432086	4410090432087	XALABILE	08131
0013	5805125168085	5805125168086	ZIERVOGEL	08132
0014	6212020244088	6212020244089	LIEBENBERG	08133
0015	4571120000000	4571120000001	MTOTOTY	08134

Figure 20: The main screen in IMS listing all the applicants in a project

Applicant's Detail

Applicant Name:

ID: Address:

Date of Birth: Married in community of property: Gender: Male Female

Language: English Afrikaans

Telephone:

Figure 21: Screen design of the main data capture form in IMS

c) Report Layouts

Once an applicant's details have been captured, the required number of forms, affidavits and letters can be produced. The subsidy application form is an exact replication of that produced by the Department of Housing, as is the electricity connection application required for Eskom (See Figure 22). Some

of the letters include pre-scanned signatures to alleviate excessive unnecessary signing.

Note that all forms related to an application are printed in batch once and signed in one session by the applicant. This step in itself has led to major gains in efficiency both in terms of stationary costs and time, as applicants now no longer need to return to the office multiple times.

WESTERN CAPE AREA
APPLICATION FOR SUPPLY OF ELECTRICITY
BUDGET ENERGY CONTROLLER - TARIFF HOMELIGHT (SA1)
- POWER SETTING 20 AMPERE

ESKOM

1. GENERAL 1) PLEASE PRINT.
 2) IF YOU ARE THE FIRST CONSUMER OF ELECTRICITY ON THE PREMISES, AT LEAST 30 DAYS NOTICE IS REQUIRED.
 3) PLEASE ENSURE THAT YOU ARE CONVERSANT WITH THE CONDITIONS OF SUPPLY HANDED TO YOU.

IDENTITY NUMBER	7 0 1 0 1 3 5 5 2 5 0 8 9	3. ADDRESS WHERE SUPPLY IS REQUIRED:	
DI NAME:	ARIEFDEN		DELFT SOUTH
FULL NAME:	SEDICK		
POSTAL ADDRESS:			OFF NO: 9385
TELEPHONE: HOME:		4. DATE SUPPLY REQUIRED:	
OFFICE:			

5. I HAVE RECEIVED THE CONDITIONS OF SUPPLY AND WILL COMPLY WITH THE CONTENTS THEREOF.

6. SIGNATURE OF APPLICANT: _____ Date: 11/11/1997

Figure 22: A report from IMS (Electricity Supply Application Form)

4.5.4 Stage 4 - Construction

The system code was developed with Microsoft Visual C++ 5.0 using Microsoft Foundation Classes (MFC). The data was stored in a Microsoft Access 97 database and was accessed using Data Access Objects (DAO).

4.5.5 Stage 5 - Integration and Testing

Data from the project at Weltevreden Valley was made available to be used as test data by Indlu Marketing. Due to the pressures to implement the system, most of the testing was in fact completed with live data.

4.5.6 Stage 6 - Installation and Acceptance & Stage 7 - Implementation

An early version of the system was deployed on-site at the Delft office for testing in mid-1997. This was used by staff of Indlu Marketing cc who provided feedback on the usability of the system. As the software evolved, upgrades were installed on-site. At the time of writing, all the applicant information could be captured, and reports could be produced to recreate all the necessary documentation.

As a result of the short time frame in the development of the system, it was not possible or feasible to run the new system in parallel with the superseded processes.

4.5.7 Stage 8 - Post-implementation Review

It is planned to review the system once it has been in operation for some time.

5 FINDINGS AND ANALYSIS OF FINDINGS

5.1 IRREGULAR SETTLEMENT INFORMATION SYSTEM ISSUES

Many issues need particular attention when dealing with Irregular Settlements.

The first is the relationship between the changing settlement over time, and having an up-to-date, accurate database. This relationship is 'inversely proportional' in that the faster the change, the more often updating is required, which implies a greater cost factor. If one wishes to maintain an up-to-date set of information, regular updates to the database will need to be realised because of the changing nature of Irregular Settlements.

To quote an example from the Marconi Beam case study, between May 1996 and December 1996, approximately 60 new structures out of a total of 1252 (an increase of about 7% per year) were erected. Marconi Beam is also a 'mature' irregular settlement, without much physical space for expansion, and there are agreements in place, which forbid the influx of new inhabitants, so this could be seen as a minimum figure for irregular settlements.

There have been cases of entire settlements moving location overnight. The interval at which the database needs to be updated will therefore need to be guided by the final applications of the information system and the nature (rate at which it changes) of the targeted irregular settlement. Of course, the overriding factor of both of these will be the size of the budget set aside for data capture.

If the time taken for the capturing of data takes too long a time, the situation on the ground may have changed to such an extent that it is no longer useful.

Speedy capture of accurate data on the other hand is also far more expensive. A balance therefore needs to be established between speed of data capture, validity of data and monetary cost of data capture.

The method used in this study (see Mason et al, 1997 for details) of capturing digital imagery with a Kodak DCS 420 digital camera from a light aeroplane, which was then rectified and digitised in the GIS, is a quick and cost-effective method of obtaining data which we found sufficiently accurate for the applications we investigated. It would also be practical to make use of differing data quality and types based on needs and suitable applications. In order to allow for subsequent speedy and cost effective data capture, an initial frame, making use of fixed infrastructure and topography (community centres, schools and beacons), should be accurately measured and used as a ground reference data for geo-referencing subsequent epochs of imagery. An accurate mapping base could be developed from there.

The end users of the system, be they the street committee leaders, NGOs or property developers, often have little or no experience in dealing with spatial information. There was also the issue of human laziness and unwillingness to work with the system. There therefore needs to be some driving force in making the system a success. It was found that as soon as a useful application was realised, or as soon as it became clear that the system could help in the speedy provision of houses, there was a greater willingness to be involved in the use of the system. This is not unlike the enthusiasm realised in the development of a business information system, when the users are meaningfully involved in system development. As the users of the system ultimately need to be the people working on-site, sufficient focus needs to be placed on the simplification of user interfaces and training.

The issue of data security, and of security of personal information, is also of utmost importance. In both case studies, the machines on which the data was stored were left on-site. In Marconi Beam this was in the community centre -

in the middle of the irregular settlement and in the iSLP project this was in the new, sparsely populated building site. The data in the information system therefore needs to be regularly backed up, both on and off-site.

Much of existing data pertaining to irregular settlements is sociological attribute data. It is often in paper format, or stored in some form of electronic database. Any new imagery is also in some form of digital image format.

There therefore needs to be put in place suitable technology to take advantage of this data. This may take the form of digitisers, scanners and data links between applications.

Great care needs to be taken when initially deciding on how best to number the 'shacks' in the settlement. As this number, together with ID number and Subsidy Application Number, are unique identifiers; they will often be used in the database relationships to link spatial data to attribute data. It is therefore critical that a consistent method of numbering is decided on – and stuck to.

This was not the case in Marconi Beam, where two numbering systems were used, often leading to great confusion.

Some of the other data types often available included:

- DXF data;
- photographs;
- digital images; and
- socio-economic data in paper, spreadsheet or database format

The DXF data will usually be held by an engineering firm that is involved in upgrading or developing the area. Their data is usually stored in DXF format, so the information system generally needs to have compatibility with DXF

files. The photographic and digital imagery can come from various sources. Some of the data we used was from newspapers that had at some stage taken aerial photographs of the area. We also hired a light aircraft to take dedicated photographs from both conventional and digital cameras of the area. The socio-economic data will come from sources such as DAG who have been involved with questionnaires, and any other groups doing research on the settlements.

5.2 APPLICATION AREAS

It becomes apparent that the system to satisfy all these issues needs to be adequately specific. By this, it is meant that often a generic solution is not sufficient and some degree of customisation to the system will be required. Logical solutions must take the form of focusing on meeting high priority needs.

Analysis, such as that which follows, could be used to prove the benefit of a GIS to users.

It would have been advantageous to analyse in more detail the spatial relationships between communal buildings, schools, crèches, churches, water tap locations etc. in order to assist in the in situ upgrading of existing infrastructure. An additional layer in the GIS illustrating street committees boundaries may have helped analyse in which street committee areas there were problems, giving some form of supervision to the role played by these street committee leaders.

5.3 THE APPROPRIATE INFORMATION SYSTEM

It is important to take into account the irregular settlement situation in its entirety and not just in spatial terms. Many of the information requirements can be addressed by looking carefully at the processes and flows present.

In terms of the situation in the iSLP project, the requirements were very different from the Marconi Beam situation. In their case, they were handling large quantities of socio-economic data that required management. By analysing their needs, it was determined that a combination of an Office Automation and Strategic Information System, with a small cost-effective spatial component was required. The spatial component did also not require the full functionality of a GIS. Consequently, an application costing a fraction of a GIS was utilised. By effectively implementing this system, the processing time required for one applicant had been reduced from 30 minutes to 10 minutes.

5.4 CONCEPTUALISATION OF AN IRREGULAR SETTLEMENT GIS

Database models and design, integration with existing databases and systems, applications development, the cost of the GIS - are all issues that must be comprehended because they directly relate to the decisions that must be made during the GIS selection and implementation process. In addition, these issues will lead to the ultimate success or failure of a system. Many of these are common to all information systems, but attention is focused on the issues relevant to our experiences in the case studies.

An important aspect of a GIS is its ability to use existing information contained in current systems and files. Ideally, there should be no difference between GIS and non-GIS environments from a user point of view. One must aim to satisfy the needs for rapid initial implementation, but allow for updatability and for future refinement to cater for increasingly more needs that are complex.

The initial aim must be low level, immediate solutions - even if this requires the use of quickly acquired coarse data. An increase in application

sophistication of higher levels towards decision support system can be realised at a later stage.

An important criterion in evaluating a GIS is the type of integration with existing systems supported by the proposed system. It will be very important to manage user expectations up front in order to avoid disappointment in cases where such linkages are hard to accomplish.

The organisations must also realise that the state of the art technology does not automatically translate into functionality and productivity. It must also be remembered that the mere 'filling up' of a GIS with data will not automatically provide a solution. It is therefore the responsibility of the organisations to develop, with assistance if necessary, applications within the GIS that will satisfy their needs. The designing and developing of these applications, even when properly managed, well supported by users, and implemented by experienced people, can be lengthy and dangerous. This process can either result in excessive planning and design to accommodate a large number of potential applications, or too narrow a focus. The latter can cause a loss of interest for some organisations that are not seeing benefit from the development process.

The database model used in the Marconi Beam case study was limited to the type of data freely available. This is not an ideal situation. The inclusion of additional data in the database could have served to extend the networking function of the GIS by attracting more users of the system. This narrow focus was one of the many factors that caused the lack of interest in the Marconi Beam system. The use of information derived from the GIS by Rabie is an exception.

To plan for in-situ upgrading it would have been especially important to have had extensive up-to-date information on the:

- physical location of huts, schools, crèches, shebeens, shops etc ...;
- location of services such as underground water and sewage pipes, electricity cables and storm-water pipes;
- accurate number of people per hut - to allow us to accurately gauge the number of people in different areas of the settlement;
- physical locations of roads, rubbish dumps and any other open spaces
- terrain of the area

By placing this information in a layer model, it would have been possible to calculate the areas in which to initially target development as well as making the management of in-situ upgrading easier.

Database design currently has a great influence on applications delivery. It is also important to set critical application objectives during the design, in order that there is a high level of awareness of the expected capabilities of the system. This was especially true in the development of the Indlu System, where the staff did not understand the technical side of the technology, but had the insight to realise that the technology could provide a solution. They often, however, wanted the most difficult (to code) applications first, without the groundwork applications first having been developed.

Another highly important issue is the final output from the system. This needs to be as good as - if not better than - that of any previous system. It is the final product, such as a printout, plot or speed of processing, that will influence peoples attitude to such a system. This ultimately leads to the success or failure of the system.

Multi-media applications could also be used to visually demonstrate the effects of flooding, fires and other such natural disasters.

Education and training at all levels should be an integral part of the implementation strategy. The amount and type of training needed depends, in part, on the level of technology to be used. Besides training hands-on users in the new technology, there is also a need to educate 'managers' about concepts so they can make wise decisions in its use

While GISs are, in principle, well suited to act as interdisciplinary tools, a lack of technical expertise amongst potential users in the irregular settlement environment places special demands on the design of suitable user interfaces. This is particularly relevant if settlement residents, most of who are computer illiterate, are to be involved in data capture. Special consideration must also be given to the education of all interested parties in the potential and functioning of the irregular settlement.

5.5 PARTICIPATION AND THE ROLE OF INFORMATION SYSTEMS

One of the most important benefits of an information system, is this possibility to integrate data from different sources and exchange information between organisations. Duplication of efforts in costly data-collection can be reduced, and discrepancies in the information can be eliminated. The broader information base and easier access to the user can be vital factors in enhancing the efficiency and effectiveness of decision-making.

In the Marconi Beam case, we were presented with data from many different sources, which frequently differed in scale, co-ordinate systems and aerial coverage - from many different organisations. The GIS offered tools for integration of such heterogeneous data sets.

One possible model to further this benefit, would be to set-up a network of information sharing organisations. These organisations would retain responsibility for their own information but agree to share parts that are of

interest to others. In the case of irregular settlements, the co-ordinator of such a system would need to be either an NGO or engineering firm involved in the upgrading, both who have a vested interest - be it financial or otherwise - in co-ordinating and motivating the system, but who also have the possibility of training someone who can use what they have learned in future projects.

Data sharing, and thus networking, could be enhanced by IS techniques. However, to make full use of the potential, it is important to evaluate data exchange capabilities when implementing such a system. The content, quality, format and way data are encoded are all-important technical factors that must be taken into consideration in order to attract the different organisations. It is also important to take into account the institutional barriers that make many organisations reluctant to share information. These are often the main obstacles to data exchange and integration - leading to the success or failure of such a system. This points to some form of standards that would be required.

Although organisational barriers may hinder co-operation initially, an IS provides an excellent vehicle to stimulate co-operative activities.

5.5.1 Data acquisition

Participation can be facilitated by making use of enlarged aerial photography as spatial reference for residents to help capture data for the GIS.

A glossy aerial photograph always attracts much attention in an irregular settlement. Should such a photograph be placed in a prominent position, such as in a community centre, it could be used by residents to indicate such information as rubbish dumps, possible areas of impending expansion, problems with infrastructure, new dwellings, etc.

5.5.2 Participation in data management and analysis

Being exposed to printouts and plots of information represented in the database, the integrity thereof can be challenged by residents of the settlement, which can be used to keep the information as up to date as possible.

The input from residents must also be dealt with carefully. Under the difficult circumstances, their ideas are often politically motivated, and their perspectives on some issues may be influenced by a lack of experience in dealing with the settlement as a whole.

5.5.3 Use of information derived from the GIS

An example of such participation is the way in which the residents of Marconi Beam were employed by Rabie Property development, using information derived from the GIS of Marconi Beam, to assist in the clearing of the settlement.

The street committees could also have been more effective in their management role, given the support of information derived from the GIS.

Given that the street committee members were residents of the settlement, an ethical decision could often not be implemented because of pressures placed on them by other residents in the settlement. If these decisions could be backed up by graphical evidence from the GIS, then ethically fairer decisions could possibly be made to take effect as a result of a wider awareness. This graphical evidence could possibly have taken the form of colourful printouts or plots which could be displayed in a public place - such as the community hall.

5.6 A MODEL USING EMERGING TECHNOLOGIES

With the rapid advances in technological development, and the ever-increasing benefit of Internet-related applications, the concept of a new model making use of the Internet has been conceptualised.

Although this model is not currently practical with today's dial-up Internet connection data transfer speeds, technological advances should soon permit access through some form of connection (ISDN-2 or better), ultimately speedily accessing data of interest without prohibitive cost.

A fundamental problem in the effective use of the GIS emanates from a lack of human resources and skill available with the people involved 'on-site'. A potential solution would be to facilitate the GIS in a central offsite location.

This meant that:

- the data would be safer than being left on-site ;
- the data could be maintained by an experienced operator; and
- queries and views could be predefined and requested without any knowledge of the sophisticated workings of a GIS.

If this is facilitated through an Internet Web-Browser, taking advantage of the developments in the use of Java, and the GIS relates to multiple irregular settlement databases, it is also a cheaper solution because only one licence of the GIS software is required.

The integration of GIS with client/server technology, as is the case with sharing information over the Internet or an Intranet, gives multiple users access to a single centralised database. The data can then be updated and maintained in one place. Server-based data storage provides improved data integrity and security without the duplication of data.

Such technology is better than having multiple on-site GISs as it:

- allows compute-intensive operations to be handled on the server side, instead of pulling data onto the client for geographic analysis. The large amounts of data stored on the server are available for mapping applications at the request of the client; to do a radius search, send a geographic query, work with a data subset, do computations on extremely large tables-all on the server side-then bring the results only down to the on-site computer
- takes advantage of the processing power of the server
- centralises administration and control of data assets

GIS cartographic and attribute files are large and forever changing. If multiple GIS users need access to the most up-to-date data, it is expensive and burdensome for each to have a copy on their own hard drive. A much better solution is to keep one master copy of each data set on a server and have each person's Internet software point to the latest files dynamically.

This also holds true for non-spatial systems, such as that developed for Indlu Marketing cc. If there were instant access to the very large Deeds Registry database, it would be possible to determine whether or not an applicant had previously owned property. This would provide a fast and cost effective measure of screening applicants early in the process.

6 CONCLUSIONS

Many information systems are currently in place in irregular settlement management and in the provision of low-cost housing in South Africa. However, many of these are in the form of 'paper-based' or even just 'people-based' systems. There are also many requirements which are currently being poorly addressed, or not addressed at all, because of a lack of appropriate tools and awareness of which technology could be used and how to use it.

Some important issues need to be taken into account when considering the use of a computer based information system in relation to irregular settlements management and processes for it to be successful.

The first is the relationship between the changing settlement over time, and having an up-to-date, accurate database. Some irregular settlements are renown for their rapid transformations. The faster changes take place, the more often the information system needs to be updated to stay up-to-date and thus 'useful'. This implies a greater physical cost in employing people to capture data and make changes.

The complexity and variety of data captured, as well as the method used to capture this data also has far reaching consequences in terms of cost and time.

The end users of the system often have little experience in dealing with computers. There was also the issue of human laziness and unwillingness to work with such systems. There therefore needs to be some driving force in making the system a success. The demonstration of relevant applications in a system has far reaching implications in motivating the use of a system.

The issue of data security, and of security of personal information, is also of utmost importance.

Existing data pertaining to irregular settlements often comes from many sources. These include information written or stored in paper format, in a variety of relational databases, in spatial files (e.g. DXF), photographs or in digital image formats.

Suitable technology therefore needs to combine all these data into a form that can be easily used.

Some of the specific application areas in which solutions were offered included:

The identification of people in Marconi Beam directly affected by the fire that swept through the settlement in October 1996. By quickly mapping the area with a GPS, and importing this data into the GIS, we were able to quickly identify the huts and thus families that were affected.

The residents who would be affected by the construction of a new road through the one area of the settlement could be identified. We could then supply a list of the Hut numbers and residents names to Rabie Property Development and the MBDT, in order that they could notify these people of their obligation to move.

A system of tracking the internal moves of residents was devised by which we were able to maintain a record of the internal movements of residents whilst the system of the lottery was in place. This was, however, never utilised in practise due to problems with its physical implementation on the ground,

The system of tracking internal moves was later adapted to what became known as the "Block System". It facilitated the identification of residents

who were next in line to have their applications for new houses processed as a result of their spatial location in the settlement. The use of this system is still ongoing (September 1997).

The Indlu Management System resulted from the need to keep track of large amounts of socio-economic data in order to speedily process the large number of applicants applying for national housing subsidies. As a result of this system, the processing times per applicant have been reduced from 30 minutes to 10 minutes per applicant.

The case studies at Marconi Beam and the Integrated Services Land Project have shown that, in certain situations, there is a definite role to be played by information systems in relation to the management of irregular settlements and the provision of low-cost housing.

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**APPENDIX I – TABLES FROM DESIGN OF INDLU
MANAGEMENT SYSTEM**

Table	Field	Type	Length
Applicant	APPLKEY	Number (Long)	4
Applicant	PROJCODE	Number (Long)	4
Applicant	APPLNUMBR	Number (Long)	4
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Applicant	CONVEYCODE	Text	8
Applicant	IDNTNUBR	Text	13
Applicant	APPLSTAT	Text	1
Applicant	FIRSTNAME	Text	60
Applicant	SURNAME	Text	30
Applicant	PREVNAME	Text	30
Applicant	INITIALS	Text	10
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Applicant	TELNO	Text	12
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Applicant	RESADDR3	Text	30
Applicant	RESADDR4	Text	30
Applicant	POSTADDR1	Text	30
Applicant	POSTADDR2	Text	30
Applicant	POSTADDR3	Text	30
Applicant	POSTADDR4	Text	30
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Applicant	LANGUAGE	Text	1
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Applicant	SPPREVNAME	Text	30
Applicant	SPFIRSTNAME	Text	60
Applicant	SPINITIALS	Text	10
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Applicant	SPIDENTNUMBR	Text	13

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Applicant	DP2FIRSTNAME	Text	30
Applicant	DP2RELAT	Text	1
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Applicant	DP3ADDR3	Text	30
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Applicant	DP5ADDR3	Text	30
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Applicant	FINOBLIG	Currency	8
Applicant	COMMREC	Currency	8
Applicant	BENEFITS	Currency	8
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Applicant	SPBUSADDR4	Text	6
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Applicant	SPTURNOVER	Currency	8
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Applicant	SALEDATE	Date/Time	8
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Commissioner	COMMCODE	Number (Long)	4
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Commissioner	SURNAME	Text	30
Commissioner	CAPACITY	Text	30
Commissioner	ADDR1	Text	30
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Commissioner	ADDR4	Text	6
Commissioner	AREA	Text	30
Commissioner	REF	Text	30

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Marital Status	STATDESC	Text	50

Marital Status	FFCODE	Text	1
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Project	BOARDNAME	Text	30
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Project	GOVTOFFADDR3	Text	30
Project	GOVTOFFADDR4	Text	12
Project	REFPREFIX	Text	2
Project	PLUMBERCOMP	Text	30
Project	PLUMBERNAME	Text	60
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Project	PLUMBERB	Currency	8

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Property Type Code		TYPEDESC	Text	50

Relationship Code		RELCODE	Text	1
Relationship Code		CODEDESC	Text	50

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