APPLICATION OF GEOGRAPHICAL INFORMATION SYSTEMS (GIS) IN GAUTRAIN OPERATIONS

GAUTRAIN
FOR PEOPLE ON THE MOVE
GAUTRAIN MANAGEMENT AGENCY

INDEX

1. HISTORY OF THE USE OF GIS BY THE GAUTRAIN PROJECT

The use of GIS technology in the Gautrain Project can be traced back to early 2007, during the early stages of the development phase. Although initially the use of GIS was limited to the production of maps for stakeholder consultation and reporting purposes, it grew over time to include a wider scope.

The first GIS enabled website was developed towards the end of 2007, with the primary objective being to engage stakeholders and keep them up to date with the latest developments around the project. GIS was also used, to a limited extent, to plan the initial layouts of feeder distributor routes for the various train stations. Google Maps was used to get the traffic congestion information and this data then helped in performing real time analysis and general capacity studies.

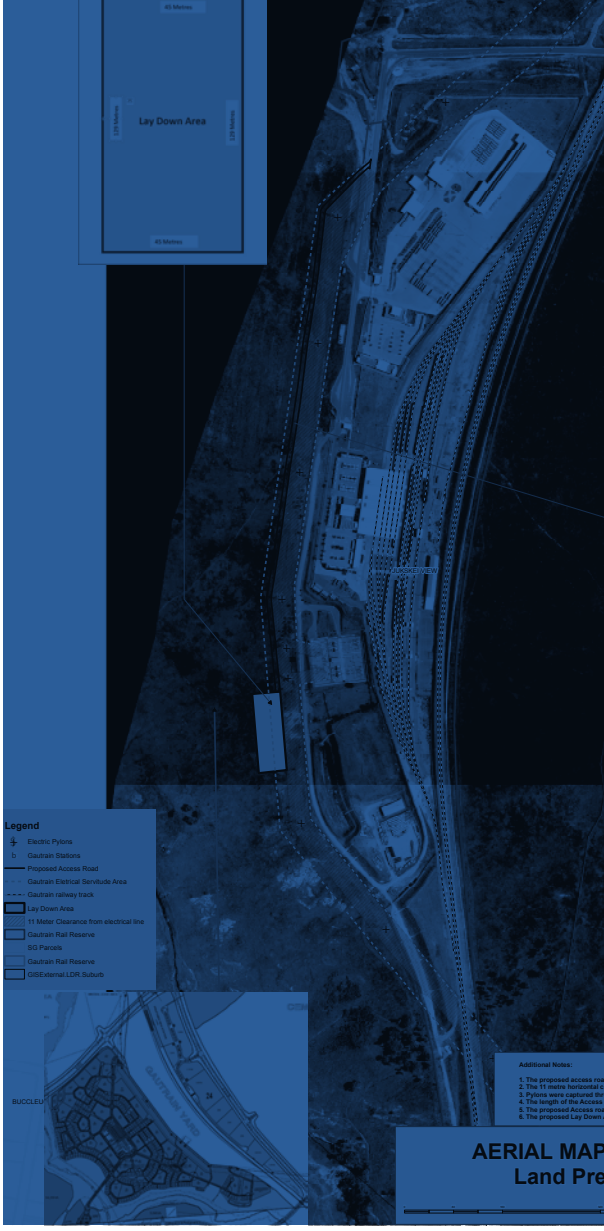
GIS was also used, to a limited extent, to plan the initial layouts of feeder and distribution routes for the various train stations. However great strides have been made to make up for this loss within a relatively short period of time, in terms of adopting GIS as a planning and decision making technology for the Gautrain.

The growth of the GMA over time, from when it was established in 2006 by the GMA Act, saw a large increase in human resources. This was because the agency needed diverse and sometimes rare skills and expertise, to enable it to deliver on its mandate. GIS capacity was among those earmarked within the technical services to support the transport planning and integration programmes. As a result, GIS was formally introduced as a functional project area in the 2013/14 financial year.

2. GIS TECHNOLOGY

Transport systems like the Gautrain Rapid Rail rely on making use of continuous improvements in equipment engineering and design, as well as advances in technology, in order to keep the system operating in the most efficient way.

Rail organisations around the world have pioneered the application of geospatial technology to rail infrastructure and operations, using technologies like Integraph and ArcGIS, among others. Geographic Information Systems (GIS) can be integrated with other systems such as transport planning and demand management, enabling rail engineers and other professionals to gain clear insight into asset performance, helping them improve efficiency and safety in operations.



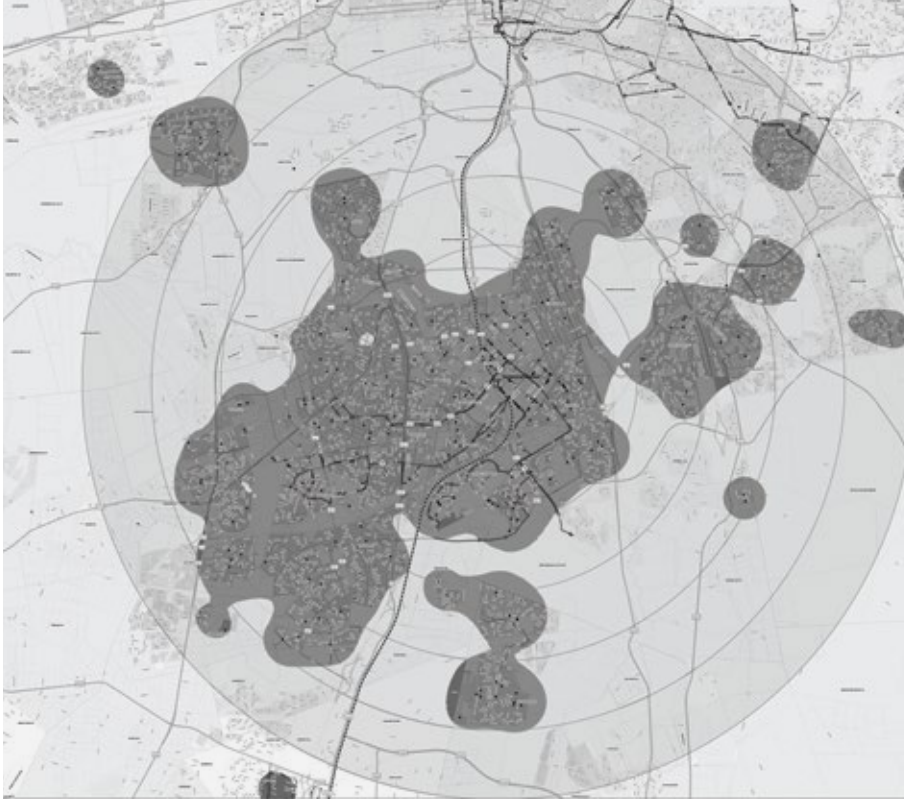
Other key applications of GIS in a business context include:

- Security and incident response
- Noise mapping and control
- Environment management
- Property Development and Land Title Management
- Route Planning & Optimisation

The use of GIS as one of the technological tools to support decision making, planning and operations can be viewed as one of the key factors that has contributed to the success of the Gautrain System.

This case study provides an outline of how GIS was introduced, including the steps taken to implement and integrate it into daily project work. The main focus of this case study is how GIS is used currently to support operations and planning for future extensions and expansions of the Gautrain System.

There is an interesting parallel that can be drawn between the main components of a GIS and some of the requirements of an efficient rail system. These are detailed in the table below:



COMPONENT	GIS	RAIL
PEOPLE	Highly skilled and knowledgeable personnel.	Highly skilled and knowledgeable personnel in the different facets of rail.
HARDWARE	Equipment required to perform the task i.e. GIS server, desktop computers and mobile gadgets.	Machinery: engineering required for the manufacture of such equipment.
SOFTWARE	Technology Tools, Graphic User Interface (GUI), Database Management Systems etc.	Rail technology for various components such as signalling, communications etc.
PROCESSES	Well-designed plan and business rules, which are the models and operating practices.	Strategies, plans, tools and techniques applied in rail.
DATA	Spatial and attribute data.	Transport and Asset Data.

GIS provides a framework for gathering and organising spatial data and any related information.

> *"Since transportation is inherently a spatial activity, GIS is particularly well suited as a platform for managing most of the data used in transportation applications", says Mr Siyabonga Mabaso, Executive Manager: Transport Integration and Planning.*

Because of this, the Gautrain mobile application uses and is supported by the GIS, enabling users to view bus routes in relation to their location, as well as determine the train schedule on the route for example.

3. BENEFITS OF A GIS SYSTEM

GIS has the potential to improve and increase public transportation in multiple ways. GIS also helps existing transit systems to monitor and manage transportation networks. Below are some of the key benefits of using a GIS:

RESOURCE PLANNING

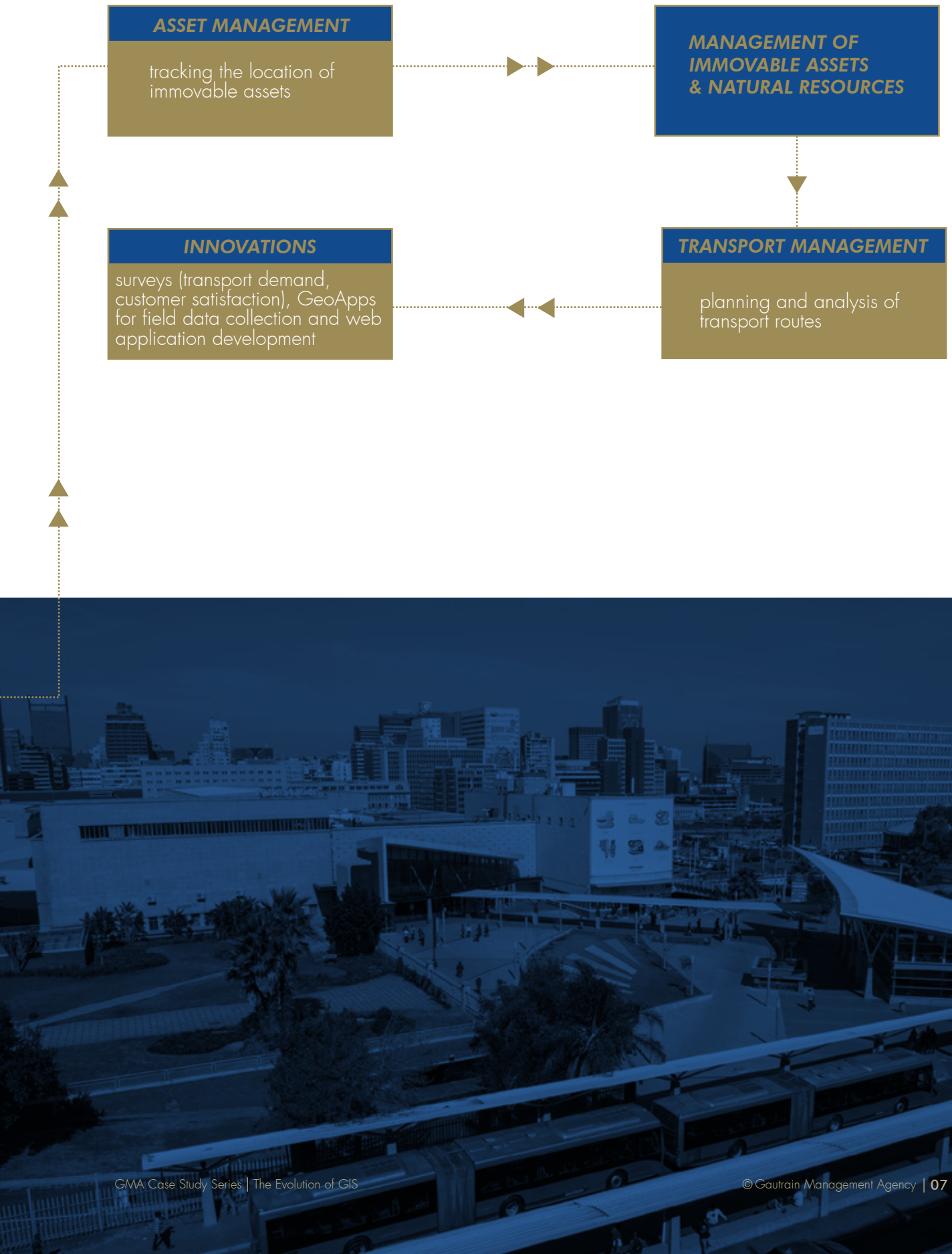
improving the allocation of resources and planning

RISK PROFILING

identifying risks areas through spatial relationships

DECISION MAKING

placing complex data on top of each other to drive improved decision making



4. IMPLEMENTATION OF THE GIS SYSTEM

The introduction of GIS usage in the GMA was done using a project approach.

The GIS project was completed in four phases:

1. System development/design

2. IT infrastructure procurement

3. Spatial data procurement

4. Data capturing and verification

Acquiring spatial data was critical in order to develop the base data layers for the GMA GIS. These datasets that form the base data are: roads, municipal boundaries, cadastral, rivers, etc.

CATEGORY	BASE LAYER	DESCRIPTION
TOPOGRAPHICAL	• Rivers	Perennial and non-perennial rivers
TRANSPORT	• Roads (street centrelines)	National, provincial and municipal roads
ADMINISTRATIVE	• Provincial Boundaries • Municipal Boundaries	Provincial and municipal boundaries as per Municipal Demarcation Board
CADASTRE	• SG Approved parcels • Township boundaries • Farm boundaries • Agricultural Holdings (AH)	Approved parcel, township, farms and AH boundaries as per Survey or General Office
OTHER	• Expropriation or Proclamation Notices	The extent and location of the Gautrain Rail Reserve (i.e land rights)

It's important to note that the GMA depends heavily on agreements and partnerships with other government departments and municipalities in order to obtain base-map related data such as cadastral data and street centrelines.

After accumulating base data layers, Gautrain specific data layers had to be captured, such as bus routes, rail reserve, bus stops, stations, GTIA application areas and Rail Reserve Events, which are events happening in and around the Gautrain track and boundary. Quality assurance was a critical step during this phase of the project, to ensure that the integrity of all the datasets was not compromised in any way.

As explained later in this case study, data accuracy is crucial for the analysis and modelling needed for planning and reporting. Because of this, the GIS manager spent a considerable amount of time performing data verification exercises. Below are some of the data capturing exercises that had to be verified for accuracy:

EXERCISE	TECHNIQUE USED
Gautrain Rail reserve mapping	X,Y coordinates data entry
Gautrain route mapping	Export/import method (CAD to GIS)
Bus and midibus route mapping	Heads-up digitising
Bus stop allocation and mapping	Heads-up digitising/X,Y Coordinates
Security incident mapping	X,Y coordinates & digitising based on spatial relationships
GTIA applications mapping	X,Y coordinates & digitising based on spatial relationships

5. HOW GIS SUPPORTS GMA OPERATIONS

Even though GIS is used solely for the purposes of the GMA and therefore not integrated with the Concessionaire's systems, it is instrumental in supporting operations and overall management of the Gautrain system in the following areas:

- Land management
- System security
- Route planning and analysis
- Asset management
- Environmental management and planning
- Marketing
- GTIA applications: capturing of GTIA application location and attributes, as well as assessment of applications to determine spatial relationships.
- Origin and Destination studies

GIS is currently used to map all the incidents reported around the rail reserve. The mapping provides not only a spatial view of the incident, but also any progress on rectifying the incident, as well as which interventions helped in mitigating the problem.

The GIS software provides highly accessible and usable GIS applications for GMA staff. The GMA GIS has four licenses for users, allowing them to access and maintain GIS datasets. These datasets are detailed in the table below.

DATA TYPE	DESCRIPTION	DETAIL
POLYGON	• Land parcels	• Contains Land Information Register (LIR)
LINE	• Rail Route • Rail Reserve • Bus Routes • Midibus Routes	• Contains rail track position within the reserve • Contains the boundary of the rail reserve, as per proclamation notice • Contains bus/midibus network and route information data
POINTS	• Bus Stops • Train Stations • GTIA Applications • Rail reserve incidents • Rail immovable assets i.e. mastpoles, CCTV cameras etc.	

6. CHALLENGES

Below are some of the challenges faced before the introduction of GIS when processing GTIA applications:

- A lengthy applications process because of unavailability of GIS to point out accurate locations of applications.
- Difficulty spatially referencing applications during the initial stages of evaluating applications. Maps were not readily available to start processing applications.
- Use of paper-based separate spatial referencing maps as and when applications were submitted. This resulted in less-attractive manual hand drawn and written annotations on maps.
- Mapping cumulative cause and effect of applications around impacted areas.
- Mapping impacts of the Gautrain system on spatial planning.
- Tracing previous applications on maps.
- Distinguishing on matters of expropriation and proclamation – i.e. showing the distinction on a map.
- Tracing environmentally sensitive areas.

Since GIS was not applied during the process of evaluating GTIA applications prior to 2014, the team were confronted with the above listed challenges frequently.

7. LESSONS LEARNT

Many lessons were learnt during the implementation and usage of the GIS:

1 GIS IN TRANSPORT PLANNING

GIS plays an important role in transport planning and operation for mapping data management.

2 GIS IN GTIA APPLICATIONS

The introduction of GIS in processing GTIA applications has helped address the challenges mentioned above, regarding the processing of GTIA applications prior to 2014. The applications can now be rapidly processed with accurate spatially referenced data (maps). The cumulative impacts that the Gautrain System has on development areas around the system can now be traced and reported using GIS.

3 MANAGEMENT BUY-IN/CHAMPION

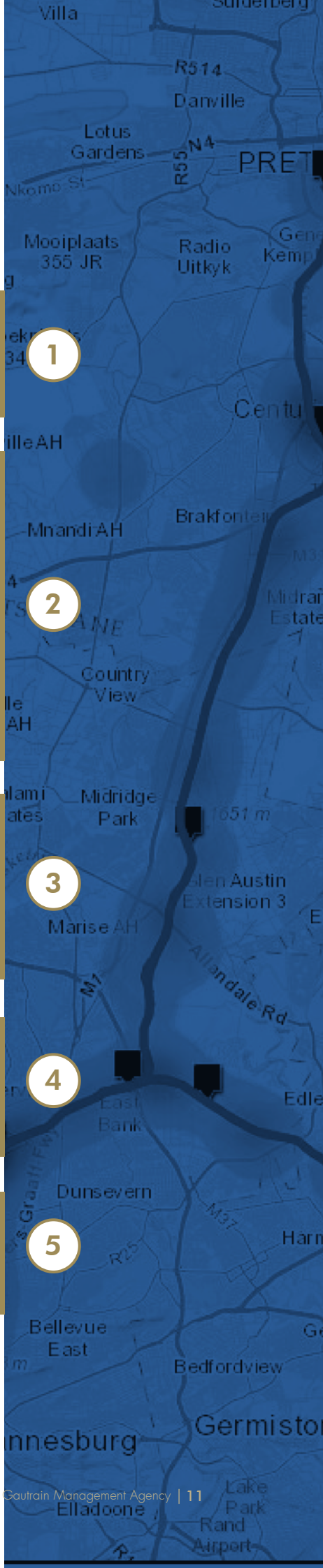
There's also a need to explore the GIS to make the management of train operations more efficient. Management awareness is also required to equip them on how to use the GIS effectively as a decision making tool.

4 DATA

Poor data quality leads to poor planning and decision making. Decisions made based on inaccurate data are very costly and sometimes irreversible.

5 EARLY ADOPTION

Had the GIS been implemented fully during the development phase, the level of GIS maturity would have been better.



8. MOVING FORWARD

The GMA will continue to make use of GIS technology to support operations, planning and strategic decision-making. The focus for GIS usage in operations is to continually improve operational efficiency but GIS can also complement other technologies such as business intelligence and Big Data, and integrating it will be key in the transport system's future success.

The GIS team is currently implementing a Mobile GIS Solution, aimed at improving asset maintenance and rail reserve inspections reporting, by using location based services and instant database reporting technology features. The capturing and reporting will enable the Transport Planning Integration and Assets and Maintenance Teams to have accurate, instant information on the go, enabling them to implement remedial interventions when and where they're needed.

The Mobile GIS Application is also supplemented by business intelligence reporting capabilities. This feature allows for management to have a dashboard view of crime and other incidents around the rail reserve, as well as related matters.

How GIS is helping with various sectors of the business:

BUSINESS INITIATIVE	GIS INTERVENTION
Operational efficiency	Mobile GIS will be used to assist with field data capture and inspection of the rail reserve and high level system assets.
Management and reporting	Business intelligence
Strategic decision making	Planning and analysis
Strategic alignment	A GIS strategy will be reviewed, given the broader scope that has now been identified for GIS.
Marketing research	Inclusion of GIS in research projects
Transport demand survey	Development of GeoApps to conduct contactless surveys

9. Conclusion

The use of GIS is going to be critical in the planned expansion and extension projects of the Gautrain Rapid Rail System. In planning for adequate resourcing of GIS and redefining the mandate to align with that of the GMA's business strategy, an amendment of the current GIS strategy is definitely planned for the future.

GAUTENG PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

SMS "Alert" to 32693 for service updates

44 Grand Central Boulevard Grand Central ext. 1 Midrand 1682 |
PO Box 1266, Kelvin, Johannesburg, 2054 | Telephone: +27 (0) 11 086 3500 |
Email: info@gautrain.co.za | www.gma.gautrain.co.za

FRAUD HOTLINE:
Toll free: 0800 637 283 (0800 6 FRAUD) | SMS "FRAUD" to 33 000 |
Email: fraudhotline@nkonki.com