

USING DATA SMARTLY – MOVING TOWARDS A SMART CITY

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ABSTRACT

The eThekweni Transport Authority (ETA) is currently developing and pursuing smart city strategies and interventions to make eThekweni more caring and liveable. A key component of smart cities is to use data smartly. This includes measuring, monitoring and evaluating the effectiveness of current projects and programmes. To this end a GIS based tool comprising databases from various sectors has been developed to allow the ETA to research and evaluate the effectiveness of past and current management, maintenance and sector specific strategies.

1. INTRODUCTION

The eThekweni Municipality's vision is to be Africa's most caring and liveable City, where all citizens live in harmony by 2030 (eThekweni Transport Authority; Integrated Transport Plan: 2.4).

The ETA is in the process of exploring various initiatives in line with the objectives of a Smart City to enable the eThekweni Municipality to manage some of its operations and maintenance more efficiently and effectively. The first initiative that has been successfully delivered is the development of a GIS based tool comprising databases from various sectors such as road accidents, traffic signal faults, schools and street lighting. The tool allows for research and analysis of the data in order to identify opportunities to improve the management of some of the ETA's functions and to work with other Departments to inform decision making and improve service delivery. This paper focuses on this GIS based tool.

The paper will reflect on:

- The concept of smart cities for contextual purposes;
- The objectives of smart cities;
- The GIS based tool that has been developed, which is the primary focus of this paper;
- The benefits the ETA has realised to-date from utilising the GIS based tool
- The potential for future functionality, and
- Guidelines for other local councils to develop similar analysis tools.

In line with the conference theme, this analysis tool will greatly assist the ETA to provide effective and efficient transport solutions to improve service delivery.

2. WHAT IS A SMART CITY

The key objectives of Smart City initiatives is to explore how best ICT can be utilised to address some of the challenges to improve City operations, service provision, quality of life and local economic development. This includes exploring ways to:

- Make better use of the data available in the City to improve service delivery and the quality of life of the citizens;
- Provide opportunities for SME's to develop new products or enhance existing products by providing them with available data;
- Encourage sharing of data and resources across sectors such as transport, energy, ICT and Environment to enhance service delivery, run more efficiently and achieve overall objectives of the city, and
- Provide citizens with the ability to receive accurate and up to date data on time and when required and the facility to provide data to the City to improve the quality of life of the citizens and enable them to take ownership of their environment.

From the research that was conducted and papers that were reviewed, some of the key challenges facing growing cities were distilled, particularly in developing countries.

These are:

- Pollution – air and water
- Traffic congestion
- Increase in urban poverty and unemployment
- Environmental and climate change issues
- Deteriorating transport systems
- Road safety
- Pressure on public finances
- Access to housing
- Access to quality education and healthcare
- Water supply
- Energy supply

Technology is advancing at a rapid rate and can potentially assist in developing solutions for the provision of new services toward a more efficient and innovative environment. The various digital platforms, technologies and networks has enhanced digital connectivity and the ability to collect, analyse and use data in various. This platform, within the context of municipal governance, provides opportunities for systems improvements for services to run more efficiently, SME's to explore development of innovative new products and the integration of information across departments and for two way communication with the public and external stakeholders to enhance service delivery.

The Smart City Readiness Guide, developed by the Smart Cities Council, defines a Smart City as a city that “uses information and communications technology (ICT) to enhance its liveability, workability and sustainability” (Smart City Readiness Guide, 2015).

According to Wikipedia “A smart city uses digital technologies or information and communication technologies (ICT) to enhance quality and performance of urban services, to reduce costs and resource consumption, and to engage more effectively and actively with its citizens” (Wikipedia, Smart City, 2015).

Cities around the world are implementing Smart city initiatives in order to meet the challenges of growing cities (currently half the world's population lives in Cities and by 2050 this is expected to grow to two thirds of the population).

In a “Smart Cities Technology Report” prepared by Deloitte in 2014, it was stated that “according to a study performed in October 2013 by the United Kingdom Department for Business Innovation & Skills, six cities were assessed as to how they were working towards delivering new digital services, or ‘Smart Services’ to their citizens.

Interestingly that while all of the cities faced different challenges and drivers from the outset, there were an additional three themes that presented themselves.

- All inclusive risk management structures and mechanisms to support pioneering innovation;
- Procurement procedures being reviewed to support smaller local companies thus encouraging local business growth; and
- **Data Analytics** is integral in enhanced service delivery.

The six cities assessed are: Chicago; Rio de Janeiro; Stockholm; Boston; Barcelona; and Hong Kong.”

In the ISO/IEC JTC1 Information Technology, Smart Cities Preliminary Report 2014 it discusses the role of Smart City standards as being focused on “enabling the integration and interoperability of city systems in order to provide value, both to the city as a whole and to the individual citizen.” Some of the characteristics required to make this happen include aggregation of data from different sources and city systems, analytics of the data and presenting the data in a format that can be visualised and accessed more easily.

This report is focussed on how the aggregation of data across various sectors and data analytics can provide value to the city and to the individual citizen through smarter management of resources to enable effective service delivery.

3. ETA'S SMART CITY OBJECTIVES

The ETA has embarked on a Smart City initiative that enables the Department to conduct research and analyse data in order to more effectively manage the Department and facilitate better decision making.

The primary goals of the Smart City initiative are to:

- Make data available to the public to provide businesses with the opportunity to enhance their existing products or develop new products that could be of interest and benefit to communities. The ETA has one of the most comprehensive accident databases in the country. By making this data available to the private sector it could allow for the creation of innovative new products and services to improve the safety and security of the citizens of the City.

The following proposals could enhance collaboration between the municipality and the private sector:

- Vehicle Tracking and Navigation companies could be interested in integrating the accident data with their data to provide alerts to drivers when they are entering a high accident zone. The best options need to be explored to make the GIS information available to the car navigation system companies to the benefit of the road users.
- Insurance companies could utilise the data to assess their risk exposure in certain areas. There could also be a reciprocal arrangement with the Insurance Companies to receive the accident data from the companies with information on the exact accident location, cause, number of vehicles involved, type of vehicles and related information to further improve the ETA's accident data base.
- Enable the ETA to get better and smarter at managing infrastructure assets and decision making systems and processes. For example, the ETA has a database with traffic signal faults which are geo-referenced. By overlaying the traffic signal faults with the accident data the approach enables analysis to be conducted in order to assess the intersections where the accident rate increases in direct proportion to the timing of the traffic signal fault particularly when the fault is an all-out. This enables the ETA to know which traffic signals are high risk and should be prioritised for repair in the event of a fault.

4. OVERVIEW OF THE ETA SMART CITY PORTAL

The ETA Smart City Portal is a spatially enabled GIS (Geographical Information System) portal which is hosted on the ESRI ArcGIS Online (AGOL) platform. ArcGIS Online is a cloud-based solution providing a platform which allows for the rapid and easy creation of maps, multi-user collaboration, and sharing of information with other users. This user friendly web-based interface provides a non-GIS user with access to technical data and spatial information with limited knowledge of the application itself. The user has access to view, update and edit maps while deriving the benefit from the interactive display of spatial information. The ETA portal has been developed to

include built-in analytical tools and algorithms used for the purpose of complex analysis using both static and live data. Quick trends and graphs can be generated on the fly to determine a more intelligent view of data.

In the initial phase and setup of the portal, various datasets were acquired from internal departments within the eThekweni Municipality. This was then converted into shape files allowing for non-spatially referenced data to be geo-referenced. It was then checked, cleaned and further analysed using the analytical tools developed within the portal. These were then imported and published using ArcGIS Online maps.

Various maps and views of the data were created using AGOL, each representing an additional level of analysis and modelling. Depending on the requirement of the user, layers can be added and removed with different filters being applied. In this instance, hotspot displays were generated to draw specific conclusions from the data and were designed fit for purpose within the ETA and in the context of transportation. Hotspot displays help identify priority areas for detailed investigation resulting in better management and allocation of resources for remedial measures.

The following data sources form the basis of the Portal:

- Traffic Signal Faults – the database indicates the geographical location of the traffic signal and description of the intersection by road names, the date and time the fault occurred, the type of fault (e.g Flashing, all out) how long the fault took to repair and what the actual fault on inspection was.
- Motor vehicle and pedestrian accidents – the database indicates the geographical location of the accident, the date and time the accident occurred, the type of vehicle, the number of passengers or pedestrians and the severity of the accident (e.g. no injuries, injuries, fatalities) (eThekweni Transport Authority: Road safety Plan, 2010).
- Schools – All schools in eThekweni by geographic location.
- Slope analysis – shows the gradients of roads and parcels of land.
- Traffic counts – Traffic counts by vehicle type at the main intersections in eThekweni.
- CCTV cameras – Geographic location of all CCTV Cameras in eThekweni.
- Integrated Rapid Public Transport Network (IRPTN) stations – Geographic location of the stations that are currently in progress along the first corridor that is being developed.
- IRPTN routes – All 9 corridors proposed for the IRPTN.
- Bus and Taxi Ranks – Geographical location of bus and taxi ranks in eThekweni.
- Street lights – Geographical location of all street lights in eThekweni
- Slip failure zones – shows areas of potentially unstable soil.
- Signal cable points – Geographic locations of the signal cable points within eThekweni.
- Roads dataset – map of all the roads within the eThekweni.
- Provision made for the capturing of road maintenance, projects and events that impact on road closures – this data will be collected by geographical location with the start and end date of the road closure and reason for the road closure.

From this data source the following spatial data layers have been created:

- All signal faults.
- Number of signal faults per signal.
- Number of accidents during signal faults.
- Type of signal faults causing accidents.
- Heat map of signal faults.
- Number of pedestrian accidents per location.
- Schools.
- Schools with pedestrian accidents within 200m.
- Schools with pedestrian accidents within 500m.
- Heat map of pedestrian accidents occurring during day time light conditions.
- Heat map of pedestrian accidents occurring during night time light conditions.
- Location of pedestrian accidents at night.
- Location of all heavy vehicle accidents.
- Number of heavy vehicle accidents per location.
- Heavy vehicle accident rate.
- Number of heavy vehicle accidents Involving pedestrians.
- Heat map of heavy vehicle accidents.
- EAN weighting of accidents.
- Accidents per million vehicles.
- CCTV cameras.
- IRPTN stations.
- IRPTN routes.
- Slope Analysis.

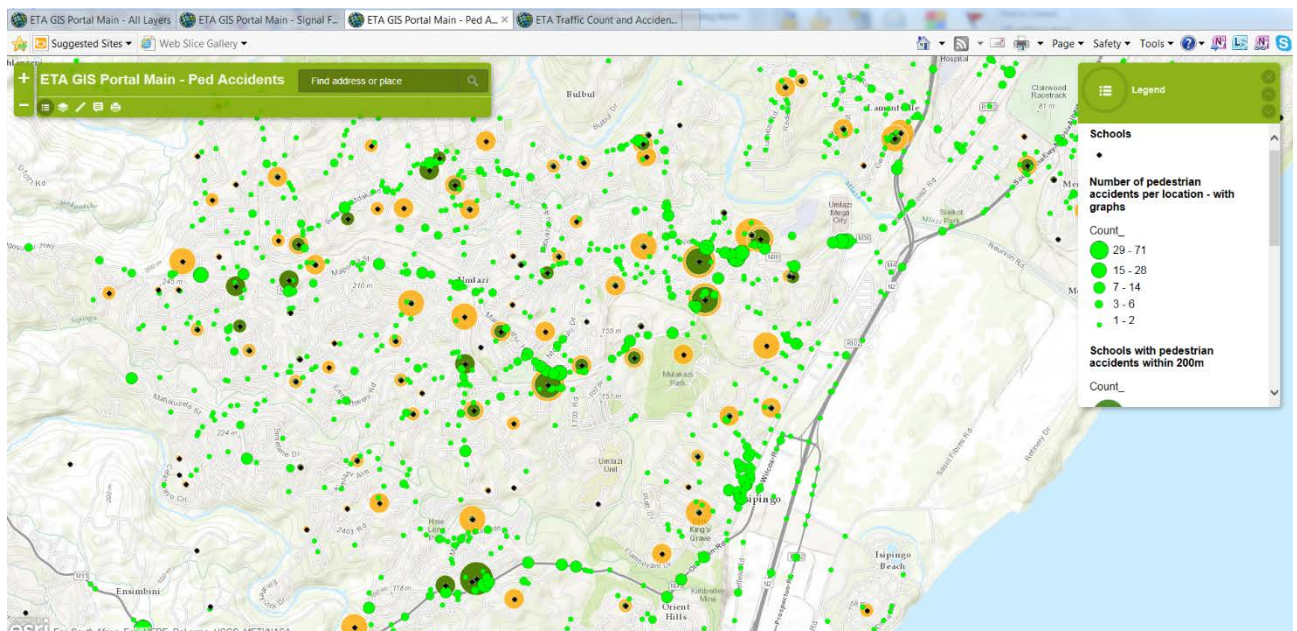


Figure 1 – Map with various analysis of pedestrian accidents

5. PRACTICAL BENEFITS ALREADY EXPERIENCED

To date the Smart City Portal has yielded the following benefits for the ETA:

- Identify intersections with high incidents of traffic accidents and assist when prioritising repairs and maintenance of faulty traffic signals. An example of this was for a particular intersection as indicated in figure 2 below. The analysis on the portal indicated that when a traffic signals fault at a particular intersection was “arrow-off” the incidence of accidents increased substantially. This has assisted and enabled management to prioritise this intersection for maintenance and take management decisions to minimise the downtime at the particular intersection.
- Geo-referencing traffic signal fault data has helped to identify locations for proactive maintenance and related management decisions to improve efficiencies and effectiveness.
- Visual spatial display of accident data has helped to improve the road safety plans. This has included children pedestrian accidents within 200m and 500m of schools, heavy vehicle accidents, dusk and dawn accidents where there is no street lighting, high accident frequency areas by: accident type, time of day, vehicle type.
- The portal has demonstrated to senior management within the ETA the benefit of Smart City initiatives in terms of Management Information that can improve both management and maintenance.

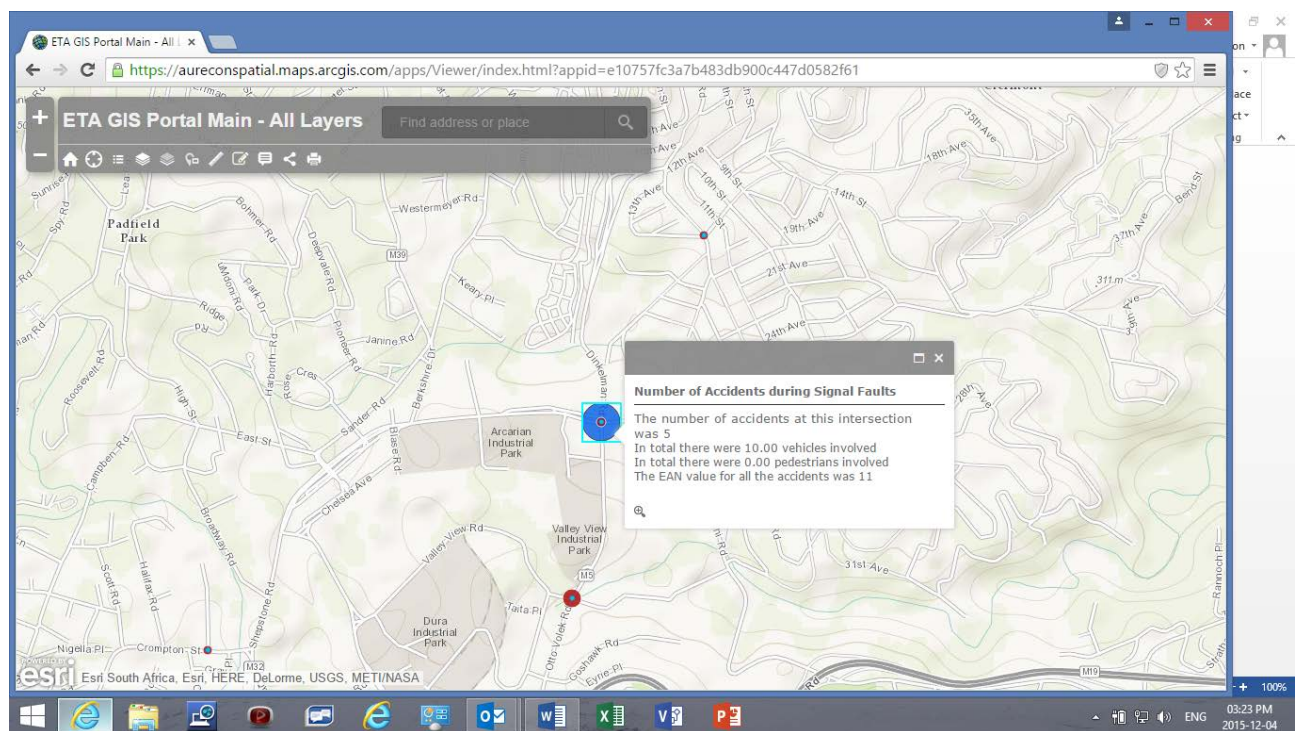


Figure 2 – Analysis of traffic signal faults and associated motor vehicle accidents

6. POTENTIAL ADDITIONAL FUNCTIONALITIES OF THE SMART CITY PORTAL

The ETA intends to further develop the Portal to enhance the functionality and usefulness of the Portal for use by the various departments within the ETA as well as other sectors. Some of the additional functionality includes the following data analyses and value outputs:

- Details of when road maintenance and major events occurred, that required road closures, with specific dates, times and geographical locations to overlay with accident data to determine if the accident rates increase at the time of road maintenance. This will assist with improving on road safety management and operational plans during road maintenance.
- Using a combination of live traffic data and weather patterns data from air quality stations could be analysed to predict when CO2 emissions are likely to be high and share the dynamic information with the public via mobile devices.
- Investigate the option to source probe data from cell phone companies and vehicle tracking companies in order to record traffic volumes and establish average speeds and journey times.
- Integrate our accident data and emergency response data and analyse this accident data to predict where accidents are most likely to occur to improve proactive emergency services management plans. This technique could enable faster responses to accidents, particularly within the golden hour, the hour immediately following traumatic injury in which medical treatment to prevent irreversible internal damage and optimize the chance of survival is most effective.
- To review and assess whether the implementation of speed humps on a particular road have had an impact or influence on the accident rate. This could be understood by conducting and analysing data before and after installation of the speed humps on the respective road.

7. GUIDELINES FOR OTHER LOCAL COUNCILS

The following guidelines will assist other local councils interested in developing a similar tool and are intended to improve Municipal governance and effectiveness through the smart use of data:

- There is likely to be a large amount of data available in the organisation that is not being utilised. For example much of the data used in the ETA Portal was already available but not being analysed effectively. Meetings should be held with all the various departments to see what systems are being utilised and what data is being collected. The use of existing data is a cost effective way of improving efficiencies.
- It is likely that the data being collected is not in the correct format. It is critical to get data that is geographically referenced so that it can be viewed on a GIS

platform. This may require some changes to the databases that the data is collect on.

- The ETA developed their own customised databases to collect Accident Data and Traffic Signal Fault data. This has enabled the ETA to better understand the impacts of transport interventions and further prioritise resource allocations.
- In order to ensure that the Portal is being utilised effectively in order to improve service delivery and make strategic management decision, it requires an internal team to take responsibility for the ongoing management and development of the Portal. The ETA has established a Research Forum that meet on a quarterly basis to agree on topics for research and papers that can be prepared in order to meet specific management outcomes and add value to the organisation. The Research Forum ensure that the momentum is maintained and that there is follow-through to achieve the objectives. This type of research must become part of the culture of the organisation.

8. CONCLUSION

The development of the Smart City Portal has enabled the ETA, through the smart use of existing data, to fulfil some of the characteristics of a Smart City. This has been achieved by maximising the use of departmental and city-wide data that is geo referenced and spatially displayed to deliver a more dynamic and informed planning process across the short, medium and long term. This has already assisted the ETA to make some of its business processes more efficient and effective and improve overall service delivery. The ETA's Research Forum intends to continue to explore the inclusion of additional data to further enhance the effectiveness of the Portal and enable meaningful research and analysis to be conducted that will provide value to both the City and its citizens.

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