ENHANCING INFRASTRUCTURE MAINTENANCE THROUGH TECHNOLOGY-DRIVEN COLLABORATION

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ABSTRACT

Collaborative technologies have transformed information and data sharing within and across organizations. The transformative ease of cross-organization collaboration has amplified the opportunity for inter-governmental collaboration. The South African transport/infrastructure sector can benefit from effective and responsive systems underpinned by collaborative technologies. This paper examines the application of collaborative technology within South Africa's transport sector, focusing on Gauteng Province's partnership with the Council for Scientific and Industrial Research (CSIR) to address road maintenance issues. This partnership resulted in mobile applications, enabling citizens to report road issues directly to authorities and receive responses. The study assesses these technologies as examples of targeted innovation addressing practical needs in infrastructure maintenance. The study concluded with findings suggesting that user-centric app solutions effectively facilitate communication between the public and authorities, demonstrating the power of technology-enabled collaboration to enhance public services and infrastructure upkeep.

Keywords: Collaboration Technologies, Intergovernmental, Mobile Devices, Reporting.

1. INTRODUCTION

Collaboration is the process by which entities communicate information, resources, and responsibilities to cooperatively plan, implement, and assess a sequence of activities aimed at achieving a common goal. To address an issue collaboratively, participants must invest time, effort, and attention. This demands mutual trust (Putnik & Cunha, n.d.). Collaboration must have a purpose, which is commonly translated as a common objective or problem to be solved (Smith & McKeen, 2011). Individual-driven goals are insufficient for parties to collaborate effectively. Collaboration involves mutual consent and acceptance of sharing. During the cooperation process, parties should have the same vision and work together to achieve it. Parties should maintain a common understanding of the problem and communicate their progress (Putnik & Cunha, n.d.).

2. BACKGROUND

2.1 How Technology Enables Collaboration

Within organisations, collaboration technology refers to tools and platforms that enable communication, cooperation, and teamwork among employees and stakeholders. These technologies enable individuals and teams to collaborate more efficiently. According to Smith & McKeen (2011), collaboration on technologies is based on innovation, finding suppliers and customers and well as building inter-organisational relationships. Technology innovation is a great achievement; however, it is not as easy as simply plugging in a piece of technology (Smith & McKeen, 2011). There has been a history of technology being procured which later ends up gathering dust, without any purpose. Therefore, it is important to foster collaboration through technology to address practical and current needs

2.2 Purpose of this Paper

The purpose of this paper is to highlight existing collaborative technologies in South Africa. An example of collaborative technologies is seen in apps developed for the Gauteng Department of Roads and Transport (the Department). The Gauteng Province is the smallest province in South Africa; however, it has the largest population and the highest vehicle population (https://www.natis.gov.za/index.php/statistics/live-vehicle-population/live-vehicle-population-2025). Due to the high vehicle population, the roads in the Gauteng Province are under a lot of strain and as a result, the Department and the Council for Scientific and Industrial Research (CSIR), are collaborating to digitize various aspects of the transport sector in Gauteng. This collaboration led to the development of a mobile application for Gauteng motorists to report potholes and traffic signal outages on the Gauteng road network, and for the Department to respond and attend to the reported issues. The Android version of the PotholeFixGP app was launched on 27 May 2022, while the iOS version was rolled out 29 June 2022. The collaboration between the Department and the CSIR further led to the development of an app for the Department's maintenance teams to report on completed maintenance activities. The GP Maintenance App was launched in October/November 2023.

3. TECHNOLOGY INNOVATION IN TRANSPORT

The introduction of mobile applications in the transport industry has transformed the industry globally. The use of mobile apps has increased efficiency, connectivity and productivity of the industry. The introduction of new modes of transport, like e-hailing, has transformed urban mobility and has made mobile applications more relevant to transport. Applications are also used beyond passenger transport, the logistics industry uses apps to track their cargo in real-time, for route optimisation, and delivery management. Mobile applications have had a profound impact on how motorists and goods move across the globe.

Globally the use of mobile technology has been streamlined to connect road users with road maintenance and road management agencies. Apps have been specialised to allow citizens to report road infrastructure defects such as potholes, missing or damaged signage, and hazards on the roads in real-time. Most of these apps incorporate features like geolocation tagging, capturing exactly where the defect is, and evidence capturing. Apps such as Waze and Google Maps have shown such capabilities.

Waze is an app that allows road users to report various road issues. It is a GPS navigation app that helps motorists get from one place to the next. It is also loaded with features that allow drivers to report different road issues, such as potholes, road construction, traffic, crashes, and many others. Similarly, Google Maps allows for real-time reports of road closures, accidents, police and speed cameras to contribute to a comprehensive understanding of the road conditions.

In South Africa, the use of mobile apps has also gained traction in the transport industry. E-hailing services are also available as a new and convenient mode of transport. The infrastructure space has seen an influx of reporting mobile apps, particularly because of the prevailing issue of potholes. Apps such as My Smart City (to report concerns with your local municipality and track the resolution), the Pothole Patrol app (a joint initiative of Discovery and Avis for reporting potholes in the City of Johannesburg), the Vala Zonke App (developed by SANRAL for the national Department of Transport to report potholes country wide) are examples of apps launched to assist in reporting public infrastructure issues through collaborative partnerships.

4. TECHNOLOGICAL INNOVATION IN SOUTH AFRICA

One of the most significant technological innovations of our time is mobile phones, which are the most popular electronic communication form (Alexander et al., 2013). The mobile phone forms an integral part of the human experience, it has streamlined life and puts information and services at our fingertips.

The early forms of mobile phones had limited features, as the mobile phone was primarily used to call and send messages (Alexander et al., 2013). The emergence of the smartphone took mobile phones and electronic communication to new heights. The smartphone introduced multifunctionality that offers users the opportunity to work, play, and research in an instant. It is noted by that the average smartphone is more powerful than the Apollo 11 spacecraft of 1969 (Alexander et al., 2013). Telecommunications and Retail of Devices in South Africa (2024) confirms that mobile phones are being used for communication, accessing the internet and other services.

App development has increased as people require more services to be available instantly. As demand for mobile apps increases in the business environment, more developers in other industries will find ways of developing applications that will suit their business needs (Alexander et al., 2013). Niemand and Chauke (2017), support the statement by stating that smartphones and app development have provided businesses with a platform to offer products and services in innovative ways.

According to Niemand and Chauke (2017), the South African transport sector is a key contributor to global competitiveness the transport industry may be regarded as an early adopter of technology. South Africa has seen a plethora of mobile apps created in aid of making the transport industry better. The likes of the Gautrain Buddy app, Taxi Live Africa, Taxicab SA, and Khwela.

5. APP DEVELOPMENT FOR THE GAUTENG PROVINCE

5.1 The Need for an App to Report Potholes and Other Issues on the Gauteng Road Network

Railways have played a key role in the economic development of many African countries. According to the Private Security Industry Regulatory (2020), South Africa prides itself on having the most developed railway network in Africa and being among the first countries to achieve railways. Railways have been widely used as an affordable means for passenger and freight transport since about 1825 (Private Security Industry Regulatory, 2020). However, because of the challenge with intermodal transport in South Africa, the freight sector still relies heavily on road transport which in turn has taken a toll on South African roads (Niemand & Chauke, 2017). Due to underinvestment in the rail industry over the years, there is a continuous worrying steady trend of a move from rail to road (RSR, 2024).

At the end of March 2025, 399 534 trucks (heavy load vehicles with a GVM. 3 500 kg) were registered in South Africa, with 37.4% of these vehicles registered in Gauteng (https://www.natis.gov.za/index.php/statistics/live-vehicle-population/live-vehicle-population-2025). The current daily vehicle-kilometres travelled on the Gauteng provincial road network is around 60 million, with heavy vehicles travelling 11.1% of these daily vehicle-kilometres (GDRT, 2025). According to the SAICE 2022 Infrastructure Report Card, paved provincial roads and paved roads in the major urban areas scored a D, while the paved roads of other municipalities score a D-. A score of D indicates the assets are at a risk of failure. The infrastructure is not coping with normal demand and is poorly maintained (SAICE, 2022). This applies to the Gauteng Road network as well, resulting in the proliferation of potholes on the road network.

According to Kwange et al. (n.d.) the 4th industrial revolution triggered the concept of "the Internet of Things", which translates in the transport industry as connectiveness between devices. An app-based solution was required for mobile devices to facilitate the simple reporting of potholes and malfunctioning traffic signals within the province. Additionally, the system was intended to integrate existing road network data collected as part of the project. The system was designed to identify the relevant road authority based on road network data. The system then automatically assigns the reported issue to the relevant maintenance region of the Gauteng Department of Roads and Transport, South African National Roads Agency Limited (SANRAL), or the metropolitan municipality/local municipality. This makes the PotholeFixGP app different to some of the other commercially developed apps that do not have the ability to identify the authority to which the section of road, where an issue is reported, belongs.

5.2 PotholeFixGP and GP Road Maintenance Apps

The PotholeFixGP App was designed to provide the public and the Department with a platform for communication. Potholes and traffic signal failures have been a persistent issue on Gauteng roads however, motorists did not have an easy way to report these issues to the correct authority. The PotholeFixGP app was therefore developed to provide motorists with an intuitive, easy to use mobile app-based tool to report issues like potholes and traffic signal failures. The app provides an integrated platform for reporting potholes and pothole repairs and for the relevant authority to allocate the reported issue to a maintenance team and for the maintenance team to report back when the issue has been attended to. Following the development and implementation of the PotholeFixGP app, the GP Road Maintenance App was developed for the reporting of all road related maintenance activities completed by the maintenance teams of the Department.

The process of how the mentioned apps work and connect is illustrated in Figure 1.

Motorists report issues using PotholeFixGP on their mobile devices. The Department receives the report on the web monitoring dashboard (back-end of the system). The web monitoring dashboard is linked to the GP Maintenance App used by the departmental maintenance teams and contractors responsible for repairing reported issues. Once the departmental teams have repaired the reported potholes or traffic signal, they report the repair on their mobile phones on the GP Maintenance App. The information of the report is easily captured, and a photo is submitted of the repair. Once the report is submitted it will show on the web monitoring dashboard and the status of the reported issue will be changed to “Repaired”, which demonstrates the connectiveness between devices alluded to by Kwange et al. (n.d.).

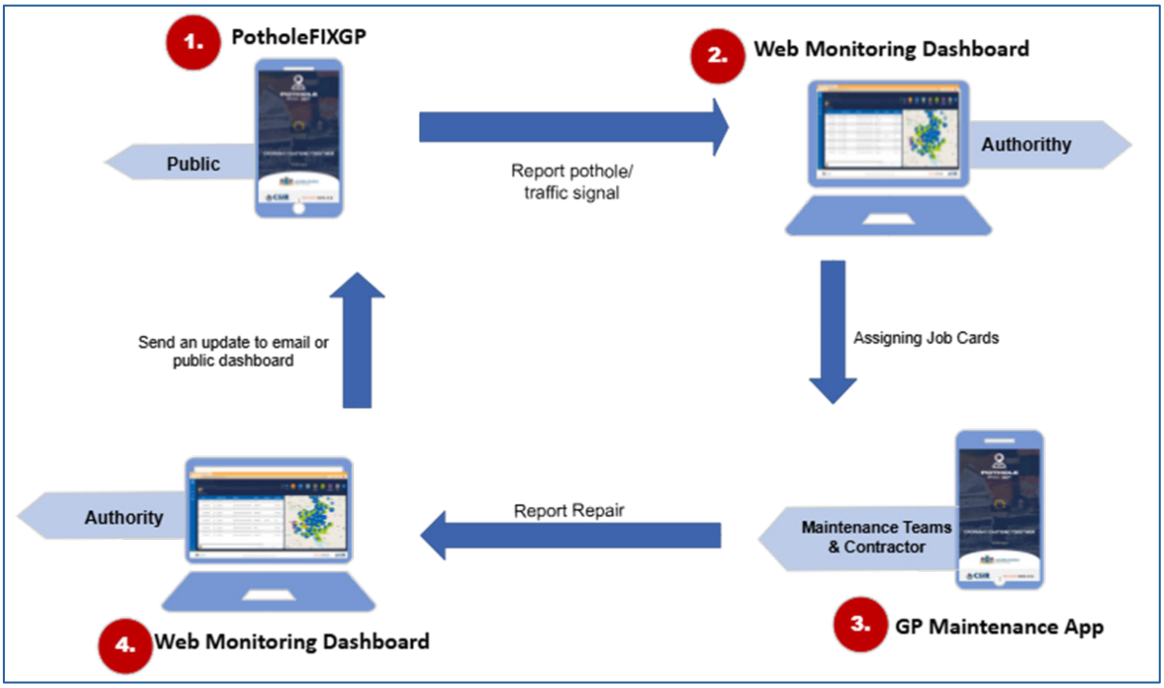

Figure 1: Reporting process flow (Mashaba, 2024)

When dealing with public-reported potholes, there are 7 statuses that a pothole can move through, from when it is reported until it is repaired. Table 1 summarises the status descriptions available on the app.

Table 1: Description of the different statuses of a reported pothole

Status	Description
Reported	A pothole reported by a member of the public
In process	Recently reported potholes that must still be assigned to a repair team
Referred	Potholes on municipal or SANRAL roads are referred to the relevant authority
Assigned	Potholes on provincial roads assigned to a contractor or in-house team for repair
Repair in progress	Pothole assigned to a contractor or in-house team for repair that has not been reported as repaired
Repaired	Pothole assigned to a contractor or in-house team for repair that has been repaired
Road to be rehabilitated	Potholes reported on provincial roads that are in very poor condition and that need reconstruction. Patching of potholes on such roads is not viable
Pothole not found	Potholes that could not be located on the map or that were reported and do not exist on the ground

The back-end process flow that shows the collaborative role of the CSIR is illustrated in Figure 2. The CSIR managed the development of the system and trained the system users to ensure optimal use of the system. The CSIR is responsible for overseeing the functionality of the system and managing its upgrades.

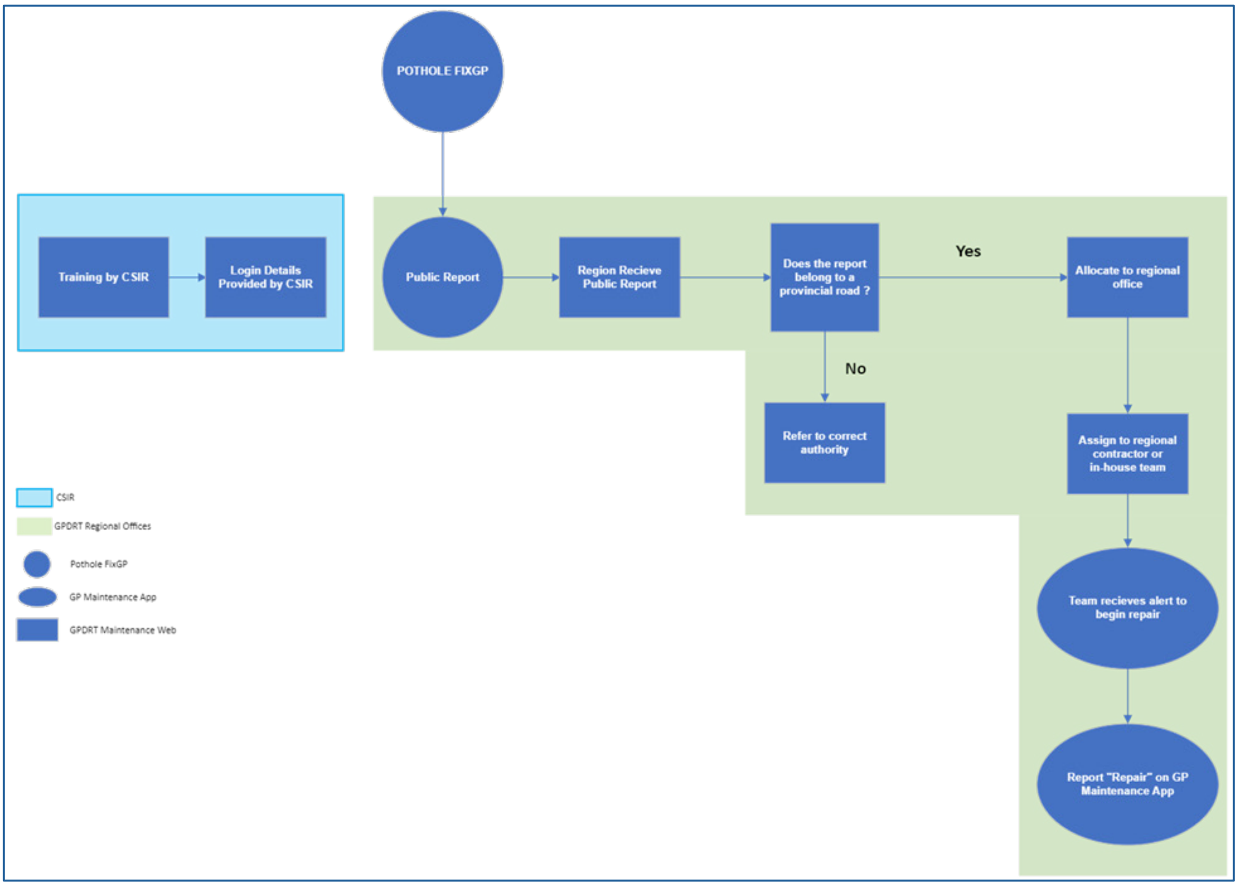

Figure 2: Back-end process flow (Mashaba, 2024)

5.3 Current Status

Since the launch of the PotholeFixGP App, the Android version of the app has been downloaded more than 15 400 times from Google Playstore and the iOS version more than 3 360 times from the Apple App Store. By the end of April 2025, 20 895 potholes have been reported using the PotholeFixGp app. Of these, 3 790 potholes were on provincial roads, 16 804 on municipal roads, and 301 on SANRAL roads. 72% of the potholes on provincial roads have been repaired and if the potholes reported on roads to be rehabilitated are excluded, the percentage of repairable potholes that have been repaired is 76%. By comparison, the total number of potholes repaired on the provincial road network in the same period is 38 423. The potholes reported by the public is approximately 10% of all the potholes repaired by the Department.

The reporting of traffic signal failures was added to the PotholeFixGP app in June 2023 and since then 17 441 reports have been submitted on the app. 441 of these were for provincial traffic signals and the rest (17 000) were for municipal traffic signals.

6. CONCLUSION

The PotholeFixGP and GP Maintenance Apps illustrate how powerful technology can be when it comes to improving collaboration and tackling real-world problems. By bringing together public and government entities, these apps have streamlined communication and sped up the process of repairing Gauteng's roads. This partnership between the Gauteng Department of Roads and Transport and the CSIR highlights how shared goals and teamwork can turn innovative ideas into practical solutions that make a real difference.

These apps are a good example of how digital tools can improve service delivery by making things faster, more transparent, and more efficient. These apps have not only reduced pothole repair times but have also created a better way for people to interact with government – something that could be a blueprint for other industries.

Ultimately, this case shows how important it is to invest in technology and partnerships that address real challenges. With more demand for smarter and more connected solutions, initiatives like this prove that collaboration and innovation are key to improving lives and creating sustainable systems that work for everyone.

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