

THE INTEGRATION OF SMART MOBILITY SYSTEMS ON THE REVISED TAXI RECAPITALISATION PROGRAM AS A STRATEGY TO MODERNISE THE TAXI INDUSTRY

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ABSTRACT

This research was about establishing the extent to which digital technologies have impacted the institutional arrangements, efficiency of operational procedures, and coverage of the Revised Taxi Recapitalisation Program. However, the approach in executing this study consisted of two aspects, the first one entailed conducting field investigations to determine the geographical locations of taxi rank facilities within the study area and the categories of minibus taxis thereof, whilst establishing the type of technology systems used to manage the infrastructure and fleet within this sector. The second aspect was to assess the methods used to apply for the taxi scrapping subsidy and reviewing the government's annual performance reports regarding the Revised Taxi Recapitalisation Program. Based on data obtained from these two approaches and using *The Open Group Architecture Framework*, a Taxi-Vehicle Monitoring System conceptual framework was developed. This system is anticipated to serve as a basis for incorporating and integrating smart mobility systems within the taxi industry to keep this sector competitive in the rapidly evolving digital transformation era. In addition, it is further envisaged that this system will enable the taxi industry to migrate from the current traditional methods to technology-based platforms that are integrated and efficient, thereby expediting the taxi scrapping program whilst expanding its scope to cater for all categories of taxis that transport commuters and to unlock additional government subsidies that can be introduced as a strategy to attract and enhance public-private partnerships.

Keywords: Revised Taxi Recapitalisation Program, Taxi-Vehicle Monitoring System, Smart Mobility Systems, Digital Transformation.

1. INTRODUCTION

1.1 Background

Mobility is defined as the transfer of people, from origin to destination, to fulfil their purpose of the journey (UITP, 2019). These journeys are taken by commuters using various types of private and public transport modes, namely: private cars, minibus taxis buses, rail, airplane, and non-motorised transport. The factors that influence the mode choice are travel time, travel cost, availability of mode, flexibility, and personal safety (NHTS, 2020). Furthermore, a South African report published by the National Department of Transport (NDoT, 2019) revealed that there are approximately 15 million motorised daily trips taken

by commuters, where 68% of these trips are completed using minibus taxis. This means that this mode plays a huge role in public transport mobility and in the economic development of South Africa.

To ensure the safety of minibus taxi commuters, a strategic Taxi Recapitalisation Program (TRP) was introduced in 2005. The aim of the TRP was to scrap 135,894 Old Taxi Vehicles (OTVs) and replace them with New Taxi Vehicles (NTVs). By 2018, it is reported that 72,653 minibus taxis were scrapped, and the remainder was to be scrapped through the Revised Taxi Recapitalisation Program (RTRP) that was launched in March 2019. This strategy, however, does not consider the impact technology has had on mobility habits; where several commuters (0.8% of total annual trips in S.A) were reported to be using e-hailing services such as Uber, Bolt and Taxify as their alternative transport mode (NHTS, 2020). This preference is reported to be influenced by the availability of the mode and the convenience of booking and accessing these modes.

In addition, the (UITP Report, 2019) revealed that countries worldwide are shifting towards integrated mobility platforms such as Mobility-as-a Service (MaaS), to provide transport stakeholders with technology driven, integrated, reliable, affordable, and sustainable mobility options. The objective of this study, therefore, is to improve the management and performance of the traditional taxi industry by developing a real-time smart mobility system called the *Taxi-Vehicle Monitoring System (TVMS)* that can be integrated into the RTRP to achieve the following:

- Create a digital database for the identification, registration and scrapping of all categories OTVs and ageing NTVs.
- Create an integrated online register for taxi drivers, associations, operators, and regulators.
- Enhance the financial viability of the taxi industry.
- Sustain the taxi industry within the current technologically advanced mobility trends.

1.2 Problem Statement

The main problem that this research aimed to address was based on an article by (Bick, 2019) where it was outlined that the real-time technology platforms that are currently used by commuters are disrupting the minibus taxi industry and that this disruption increases the level of risk on the institutional operating procedures, job security, financial viability, and regulation of the traditional minibus taxis. In addition, the *discussion document* of the national taxi lekgotla in 2020, indicated that 31% of the two-hundred thousand minibus taxis in South Africa, operate outside the normal legislative requirements and use receipts or proof of payment as proof of operating license application. They claim their licences have not been issued to them due to a backlog at the offices of the transport authorities. Furthermore, data obtained from the (NHTS, 2020), indicated that there are three additional categories of taxis that transport commuters but are not included in the scope of the TRP and are difficult to regulate and account for. These categories are: (1) township meter taxis; (2) operators that use Joint-Venture agreements and; (3) e-hailing services (Uber, Taxify, Bolt, etc). In addition, research conducted by (de Souza et al., 2018) emphasised that there is still a legal challenge of regulating e-hailing services because such services are not clearly defined.

It can be concluded, from the literature, that there is a need for a real-time integrated technology system. This system will enable the taxi industry to account for and regulate all

categories of taxi vehicles that transport commuters, enhance the scope and financial viability of the RTRP and to modernise the operating procedures through digital transformation.

1.3 Research Study Area, Aim and Scope

This study focused on analysing existing data regarding taxi infrastructure, categories of taxis, public transport demand, funding models and the operating procedures within the area of Kwa-Thema, Tsakane and Duduza townships in Ekurhuleni as per Figure 1 below. The aim thereof was to identify gaps and develop a conceptual framework for the proposed Taxi-Vehicle Monitoring System using *The Open Group Architecture Framework* (TOGAF). This system is anticipated to serve as a real-time integrated technology platform for all categories of taxis that are used to transport the public. The scope of this research was only limited to enhancing the reliability of data used within the RTRP by taxi associations, government authorities and entities to promote collaboration, innovation and initiate the discussion on the concept of shared economy within the public transport sector (Metz, 2017).



Figure 1: Kwa-Thema, Tsakane and Duduza locality map (<https://maps.google.com>)

2. LITERATURE REVIEW

2.1 Approach for Conducting Literature Review

The approach that was used is the Qualitative Systematic Literature Review (QSLR) approach. QSLR is a scientific method that analyses and interprets relevant research results to answer a research question (Kitchenham & Charters, 2007). The approach followed the three main phases of systematic literature review, namely planning, conducting, and reporting as per Figure 2 below.

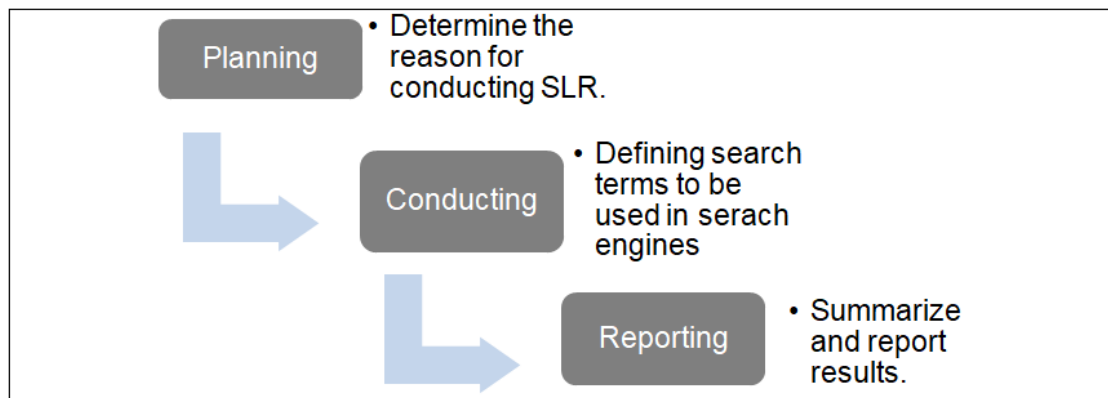


Figure 2: Phases of a systematic literature review (Kitchenham & Charters, 2007)

2.2 Conducting the Literature Review

The articles that were reviewed, were screened, and selected using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the categories of articles covered topics on the evolution of the taxi industry, from inception to emerging trends (e-hailing, MaaS, etc.) with the aim of guiding the reader throughout the literature (Leedy & Ormrod, 2015).

2.3 Articles Reviewed

The categories of articles that were reviewed during this research provided an overview of the progress made within the TRP and the entire taxi industry in general, from inception to current trends. These are discussed in detail on the subsections below as follows:

2.3.1 Inception of Taxi Recapitalisation Program

The minibus taxi industry is reported to have gained prominence in the 1970s after they capitalised on an ambiguity in the Road Transport Act of 1977 which did not clearly define the word taxi (van Schalkwyk, 2011). In addition, the author indicated that a National Taxi Task Team was established in 1995 to investigate the high rate of minibus accidents, non-roadworthiness of taxi vehicles and the level of violence in this industry. This team then made a recommendation to cabinet that a Taxi Recapitalisation Program needs to be approved and implemented as an intervention to the problems identified. As a result, this recommendation was affected in 1998. Thereafter, the National Land Transport Act 22 of 2000; National Land Transport Transition Amendment Act of 2006 and the National Land Transport Bill of 2008 described the recapitalisation policy as a strategy to formalize, regulate and economically empower the minibus taxi industry.

2.3.2 Taxi Transport Challenges

The main challenge in the taxi industry is that it uses traditional methods for permit renewals, fleet management, infrastructure management, passenger onboarding, fare collection and taxi driver registries. In addition, this industry is still partially unregulated in terms of revenue and route management because it is perceived as a complex and uncontrollable public transport sector due to its historical violence over route ownership and invasions (Baloyi, 2012). Furthermore, the (NHTS, 2020) outlined that the taxi industry is still facing transport challenges in various provinces, that are associated with the non-provision of a quality public transport system in terms of availability, affordability, appropriateness, service intervals, safety, and a comfortable environment. It is, therefore, crucial for all stakeholders in this industry to consider leveraging on the use of current technologies that can improve efficiency, reliability, and accountability.

2.3.3 Impact of Digital Transformation on Public Transport

(Briseno et al., 2020) indicated that continuous changes in commuter habits, technology advancements and the recent impact of Covid-19 on travel restrictions exposed that the minibus taxi industry needs to be incorporated into the smart mobility ecosystem so that it can remain sustainable and competitive within the current trends of the public transport market. These trends include the following: smart mobility; autonomous cars; automated traffic control and intelligent transport systems. Furthermore, research conducted by (Nguyen & Mogaji, 2022) indicated that there is a need for the public transport sector to adopt these technologically innovative ideas as a strategy to address transport challenges such as lack of efficiency, incoordination, unreliability, and inadequate infrastructure investment within african countries, since the western European societies have advanced in resolving such challenges. It can be concluded, from the literature, that the South African minibus taxi industry needs to improve its incompatible infrastructure, operating procedures, institutional arrangements, efficiency, and coverage through technology. Hence this research focused on developing and recommending a conceptual framework using the RTRP as a starting point for incorporating smart mobility systems that can be used to collaborate all type of operators, regulators, authorities, and tech developers.

2.3.4 Financial Viability

The taxi industry, since inception, has been solely dependent on fare collection as its main source of funding. This has remained despite the TRP, being introduced as an empowerment program where the taxi owners could benefit from various streams of revenue such as the scrapping fee (which could be used as a deposit for procuring NTVs); the creation of job opportunities such as vehicle manufacturing, maintenance, electronic fare collection and on-road electronic fueling technology. The challenge with accessing the identified opportunities (except for the scrapping fee) is due to the taxi industry still being partially informal and unregulated. This is why the proposed TVMS aims to create a real-time database for the taxi industry that can assist in expediting the formalisation process which can be used to unlock more funding opportunities. Additional data reviewed was sourced from the Division of Revenue Bill of 2022 (DoRA, 2022); this data indicated that the provincial and municipal departments have been allocated government grants which can be used for subsidising public transport operations and infrastructure. The summary of the grants is outlined on Table 1 and Table 2 below:

Table 1: Provincial government transport grants (Division of Revenue Bill, 2022)

Name of Grant	Beneficiary	Grant Purpose	Proposed Subsidy Program
Provincial Roads Maintenance Grant (PRMG)	Provincial Department of Transport	To supplement provincial investments for road infrastructure maintenance and safety	Subsidies for tech developers that specialise in transport safety systems
Public Transport Operations Grant (PTOG)		To provide supplementary funding towards public transport services provided by provincial department of transport	Taxi Drivers and que marshals' employment benefits (salaries, medical aid, bursaries)

Table 2: Local government transport grants (Division of Revenue Bill, 2022)

Name of Grant	Beneficiary	Grant Purpose	Proposed Subsidy Program
Public Transport Network Grant (PTNG)	Municipal Department of Transport	To provide funding for accelerated construction and improvement of public and non-motorised transport infrastructure, including planning, regulation, control, management, and operations of public transport network services	Taxi vehicle maintenance program where local suppliers of spare parts and fuel can be subsidised to provide accredited products and affordable fuel supply
Rural Roads Asset Management Systems Grant (RRAMSG)		To assist district municipalities to set up Rural RAMS in line with the Road Infrastructure Strategic Framework for South Africa	Installation of digital asset and fleet management systems at taxi rank facilities

2.4 Literature Conclusions

Based on the literature reviewed, it is evident that the taxi industry remains the most dominant public transport mode of choice for South African commuters despite the difficulty in achieving optimum regulation, collaboration and cooperation with government legislative mandates and programs. In addition, the continuous use of traditional operating procedures tends to disadvantage the profitability of this mode as more people are now opting for e-hailing services due to their smart mobility features such as real-time trip booking, payment, route information and driver identity. Therefore, it is on these bases that this research aimed to close the identified gaps through a technology model such as the proposed Tax-Vehicle Monitoring System as a strategy to modernize the taxi industry and enhance interventions from national government such as the Revised Taxi Recapitalisation Program.

3. RESEARCH METHODS

3.1 Research Approach

An ethnography research design was used during this research, as it focuses on establishing an in-depth understanding regarding explicit ways that the taxi industry has been executing their daily operations since its inception and how these factors impact the Revised Taxi Recapitalisation Program (Leedy & Ormrod, 2015).

3.2 Data Collection Methods and Findings

3.2.1 Method 1: Determine the number of taxi ranks within the study area, their status, and the categories of all existing taxi vehicles (including estimated volumes)

- Data Collection Method: Field Investigations were conducted to collect data regarding the location and number of taxi ranks, as well as the categories of taxi vehicles within the study area and their travel patterns.
- Gaps: The informal taxi ranks are operating at optimum, whilst some formal taxi ranks are redundant and thereby nullifying the existence of these formal facilities. In addition, onsite investigations indicated that taxi associations use stickers to mark their affiliated taxis and that there are other categories of old taxis that are transporting commuters within the study area but are not included in RTRP.

3.2.2 Method 2: Analysing data obtained from websites of transport authorities and government documents regarding the existing regulatory prescripts and processes for the RTRP

- Data Collection Method: The website for Taxi Recapitalisation South Africa (TRSA) was analysed to establish the scrapping process, statistics of old taxi vehicles scrapped under the RTRP and gaps thereof.
- Gaps Identified: There is room for the RTRP to be elevated to a completely online system as per the proposed TVMS, that will attract more OTV owners and enhance the accuracy of annual DoT targets, budgets and unlocking commercial benefits.

3.2.3 Method 3: Develop a Taxi-Vehicle Monitoring System Framework

(Al-Turkistani et al., 2021) indicated that Enterprise Architecture Framework (EAF) is a methodology that enables various stakeholders of the organisation (taxi industry) to manage their daily operations and collaborate through their internal or external networks. As a result, The Open Group Architecture Framework (TOGAF) was used as a process baseline (Figure 3) to tailor the identified gaps of the RTRP system and develop a conceptual framework for the proposed Taxi-Vehicle Monitoring System.

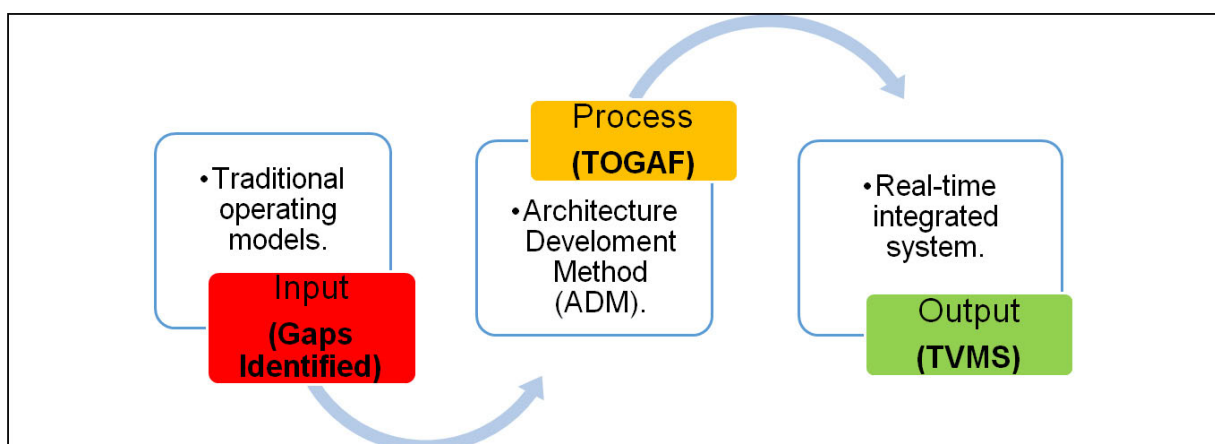


Figure 3: IPO diagram for tailoring taxi industry gaps (INCOSE Handbook, 2015)

4. DATA ANALYSIS AND CONCLUSIONS

4.1 Method 1 Data Analysis

Figure 4 below shows the geographical locations of all formal and informal taxi ranks within the study area, whereas Table 3 shows a detailed report on the operational status of taxis ranks and categories of existing taxi vehicles. The main challenge is that there is still a high level of informality in terms of taxi operators deciding to establish illegal taxi ranks and neglecting the formal ones. This might be due to poor stakeholder engagement and collaboration between government, taxi industry and community in developing the needs analysis report for public transport infrastructure within this study area. In addition, the taxi marshals still use manual books to record their daily operations and stickers from taxi associations to verify and manage their fleet.

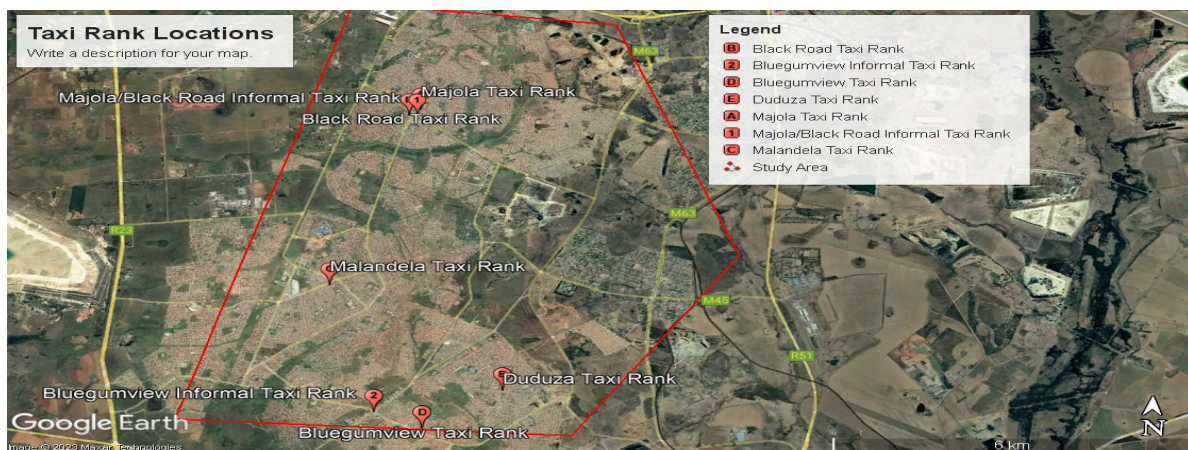


Figure 4: Locations of formal and informal taxi ranks within study area (<https://earth.google.com>)

Table 3: Operational status of taxi ranks (City of Ekurhuleni: Transport Department, 2022)

Taxi Rank Name	Taxi Rank Status	Name of Taxi Association	Type of Existing Taxis
A: Majola Taxi Rank	Operational	Greater Springs	Quantum, Siyaya, Nyathi, Ingwe, Ibhubezi, Amandla, Impendulo, 4 plus 1 and ventures.
B: Black Road Taxi Rank	Operational	Greater Brakpan	Quantum, Siyaya, and Nyathi.
C: Mandela Taxi Rank	Redundant	Greater Brakpan	None
D: Bluegumview Taxi Rank	Rejected	Greater Nigel	None
E: Duduza Taxi Rank	Abandoned	Greater Nigel	None
1: Majola/Black Road Informal Taxi Rank	Operational	Greater Brakpan/Springs	Quantum, Siyaya, Nyathi, Ingwe, Ibhubezi, Amandla, Impendulo, 4 plus 1 and ventures
2: Bluegumview Informal Taxi Rank	Operational	Greater Nigel	Quantum, Siyaya, Nyathi, Ingwe, Ibhubezi, Amandla, Impendulo, 4 plus 1 and ventures

4.1.1 Conclusions

Based on Figure 4 it can be concluded that there is a need for government authorities and all taxi operators (including e-hailing) to collaborate through stakeholder consultation meetings, where they will focus on how to share the space in which they operate in, to reduce the level of informality that affects the optimum performance of the transport system in this area. From Table 3 it is evident that the municipality and the taxi associations needs to review their asset management systems and develop strategies on how to subsidise the maintenance cost of these taxi rank facilities to encourage their optimum use. In addition, the existence of old metered taxis; 4 plus 1 and ventures indicate that there is a need for the National Department of Transport to consider expanding the scope of the RTRP, to attract all categories of taxis, including those operated through e-hailing, as a strategy to reduce OTVs and unlock demand-driven business opportunities for these operators.

4.2 Method 2 Data Analysis

The application process for the scrapping of OTVs is still conducted using manual submissions and relies on the taxi owner's discretion to apply for such a subsidy as per Figure 5 below, whereas Figure 6 shows that between the year 2019 and 2021, the National Department of Transport has been struggling to achieve their annual targets for the RTRP. The factors that contribute towards this annual non-performance, were highlighted by some taxi operators, to be the following: inadequate subsidy amount; high purchase prices of NTVs; prolonged turnaround time for obtaining permits; lack of interest to participate in this program as it has not unlocked business opportunities for local entrepreneurs that deal with maintenance of minibus taxis.

4.2.1 Conclusions

Based on Figure 5 it is evident that the current application process for the scrapping subsidy needs to be migrated to a completely digital platform as a way of fast-tracking the turnaround time for issuing these subsidies; improving customer satisfaction and enabling seamless real-time information sharing. Whereas, from Figure 6 it can be concluded that there is a need for the National Department of Transport to review their strategies on how to attract more taxi operators to this subsidy program thereby improving the accuracy of their annual performance targets for the RTRP.

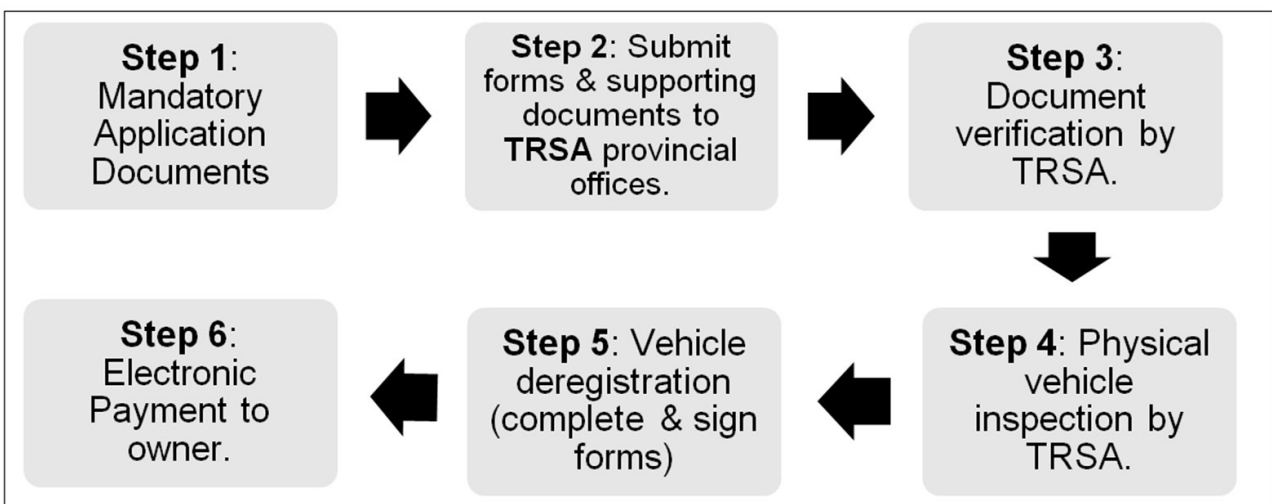


Figure 5: Taxi scrapping application process (<https://www.taxirecap.co.za>)

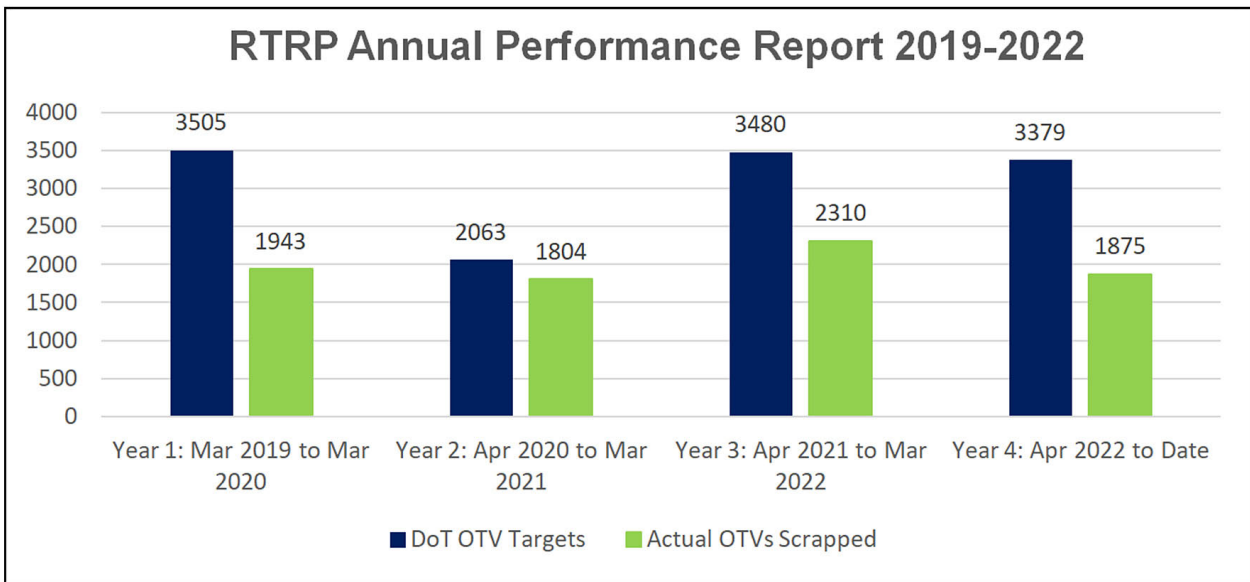


Figure 6: RTRP annual performance report 2019-2022 (<https://www.taxirecap.co.za>)

5. RESEARCH RESULTS AND RECOMMENDATIONS

Figure 7 below shows the framework for the proposed Taxi-Vehicle Monitoring System that can be used by all stakeholders within the taxi industry to collaborate, manage their asset and fleet registers online, migrate the process of RTRP applications to a fully online platforms and enable transport authorities to develop additional subsidy programs that will unlock funding opportunities for taxi operators and employees. These benefits can be realised by sharing real-time information through a digital platform (TVMS), to enhance the reliability of data used for RTRP and to migrate the industry to technology-driven platforms.

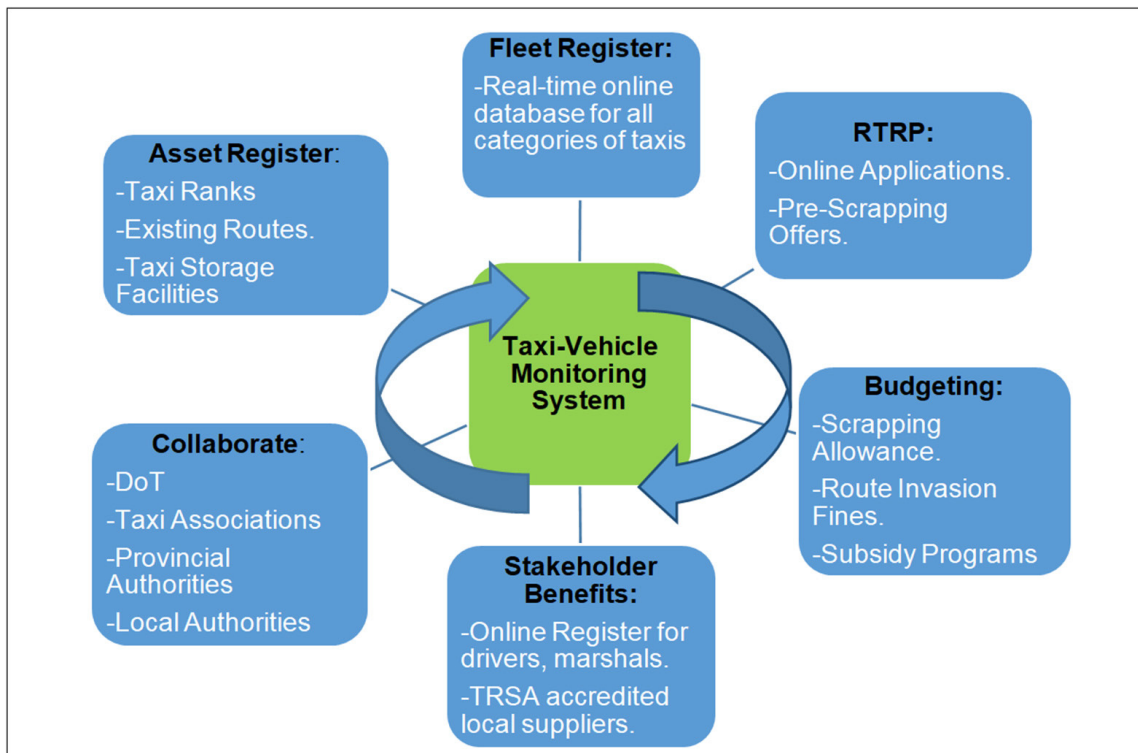


Figure 7: The proposed Taxi-Vehicle Monitoring System (TVMS) framework

5.1 Research Benefits

This research is anticipated to benefit public transport authorities, operators, tech developers and employees with a reliable, efficient, and integrated digital platform. This platform will enhance the implementation and better management of the RTRP including modernising the daily operations of the taxi industry.

5.2 Future Research

This research only focused on the development of a conceptual framework for the proposed Taxi-Vehicle Monitoring System, as it will enable the taxi industry; government and e-hailing to collaborate through integrated smart mobility systems and on the RTRP. However, there is room for future research on developing and testing the actual system after obtaining approval from all stakeholders.

5.3 Recommendations

It is therefore recommended that the Minister of Transport adopts the proposed TVMS framework as an integrated standard operating system for the taxi industry and that it be implemented by the relevant entities such as Taxi Recapitalisation South Africa (TRSA), Road Traffic Management Corporation (RTMC) and Road Traffic Infringement Agency (RTIA) to enhance the planning, budgeting, and implementation of the RTRP.

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