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Assessing the Role of Planning and Considerations in the Sustainability of BRT-PPP Projects: A South African Case

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Abstract: The development of bus rapid transit (BRT) systems is essential to African cities' economic vitality through accessibility and expansion of urban mobility. Several studies have investigated the deployment of such transportation systems. However, the role of a delineated planning stage of BRTs has been given limited attention. This study examined the role of planning in ensuring the sustainable performance of BRT systems. A qualitative approach using interviews with experts and BRT users in the Gauteng Province of South Africa was adopted. Findings indicated that planning should extensively encompass projections of the intended or future performance outcomes. These include institutional arrangements, existing characteristics and impact, service reliability and quality, technical analysis of infrastructural integration, demand, environmental performance metrics and life cycle costs. This inductive research advances the theory of critical factors that could potentially hinder the delivery of PPP-based BRT projects. The findings are envisaged to be beneficial to transport policymakers and stakeholders in the assessment of BRT systems. Failures surrounding the BRT in Gauteng result from an omission of critical factors at the planning stage. This presents a critical lesson for future BRT projects in South Africa and other developing countries, to be meticulous and consider critical factors at the planning stage.

Keywords: BRT, South Africa, Planning, Performance, PPP, Success factors

INTRODUCTION

With the growing urbanisation and the need to access opportunities, sustainable transportation infrastructure is paramount. The rapidly increasing demand, costs and inefficiencies of transportation infrastructure pose challenges to developing sustainable projects (Sy et al., 2016). In many developing countries, the transportation sector is characterised by disorganised systems where demand outstrips supply. Thus congestion, poor functionality, lack of accessibility and insufficient productivity levels are prominent (Otunola, Kriticos and Harman, 2019). Therefore, many cities have sought solutions to deliver more affordable, safe and reliable networks for the populace, such as the bus rapid transit (BRT) system.

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BRT is "a high-quality bus-based transit system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, excellence in marketing and customer service" (Kermanshahi, Shafahi and Bagherian, 2013). The provision of public transportation infrastructure, such as the BRT improves accessibility to daily opportunities and aligns with Sustainable Development Goal (SDG) 11, which focuses on making cities and human settlements inclusive, safe and sustainable (United Nations, 2020).

However, the success stories of BRT systems differ among countries. The sustainability of BRT systems partly depends on the nature of the planning process. In particular, the feasibility part of the planning process determines the BRT's success in terms of its accuracy and forecasts (Casello et al., 2014). The delivery of sustainable BRT systems partly depends on the mechanisms that have been put in place to apportion and manage associated costs and risks in the design, procurement and implementation of such schemes.

Many cities worldwide have turned to public-private partnership (PPP) models to deliver urban transit systems, leveraging PPP methods' resources and expertise (Menzies and Mandri-Perrott, 2010). Transportation projects have been successfully delivered through PPP projects in England, Australia, Asia and some African countries (Menzies and Mandri-Perrott, 2010). However, some BRT systems, delivered through PPP, are rife with obstacles and risks that affect performance at all levels: project, organisation and environment. The risks are often beyond the private sector's ability to eliminate or mitigate those (Klopp, Harber and Quarshie, 2019). The significant risk factors to BRT projects' performance include preliminary feasibility studies, acquisition or compensation issues, finance market issues, assessment methodologies and legal challenges (Sy et al., 2016).

Most of the issues identified above are prevalent at the BRT projects' planning stage, which, unfortunately, few studies have critically reviewed. Several studies have looked at critical success factors, institutional frameworks and regulations (Menzies and Mandri-Perrott, 2010), procurement-related factors (Tang et al., 2015) and the performance of BRT systems (Adewumi and Allopi, 2013). With growing uncertainties and the increasing demand for sustainable infrastructure, the need for more diligence in the feasibility studies on BRTs' performance is critical. Consequently, the current study sought to identify critical factors for successfully delivering sustainable PPP-delivered BRT systems.

The study adopted an inductive approach to unravel critical factors of feasibility studies to BRT performance. A case study of a BRT system in South Africa was used in the study. The article's succeeding sections contain background on the BRT system, a review of the literature on the performance of BRT projects and feasibility study considerations for BRT projects.

BACKGROUND ON THE BRT SYSTEM IN SOUTH AFRICA

Despite the formal conclusion of apartheid, which left most of the low-income groups in settlements far away from the city centre, the mass transportation system is still insufficient in meeting the needs of all the people. The existing public transport system, which includes commuter rail, minibus taxis and urban buses, suffers various deficiencies, including slow travel times, safety, image and cost (Lewars et al., 2007; Wood, 2017). The public transport system in South Africa is faced with social and spatial challenges of mobility in the post-apartheid city. The affinity for automobile-dependent development has been exacerbated by the unimpeded development of informal minibus taxi services matched with chronic underinvestment in rail systems, unreliable bus routes and an ambiguous delineation of government responsibility (Wood, 2017). As a result, mass transit investments were deemed essential leading to the development of the BRT, defined as high-quality bus-based services operating similarly to rail that delivers rapid mobility through the provision of segregated right-of-way infrastructure with special stations and modern control systems and frequent operations" (Lewars et al., 2007; Klopp, Harber and Quarshie, 2009; Kermanshahi, Shafahi and Bagherian, 2013).

In the 1970s, BRT systems' development was limited to the North and South American continents (Adewumi and Allopi, 2013). The success of the 1974 large-scale development in Curitiba, Brazil inspired other cities to build similar infrastructure. In the late 1990s, the replication of the BRT concept gained momentum and BRT systems were opened in Quito, Ecuador (1996), Los Angeles, USA (1999) and Bogotá, Columbia (2000). The TransMilenio project in Bogotá started operation in 2000 and its success as a state-of-the-art BRT system drew attention from around the world. As of 2005, there were 70 such systems worldwide, based on one definition of BRT (Adewumi and Allopi, 2013). Successful systems now exist in many European cities, including Paris, Nantes, Rouen, Madrid and Amsterdam (Ingvardson and Nielsen, 2017).

The BRT has become a popular means to alleviate congestion and streamline public transit in African cities (Aleshinloye, 2015). The BRT in South Africa is one of the initiatives of the Department of Transport's (DoT) plans to implement high-quality Integrated Rapid Public Transport Networks (IRPTNs) in 12 cities. The BRT concept was explored after an exposition at a South African Transport Conference in 2006, through a video from Brazil, showing the potential to alleviate public transport problems of accessibility, affordability and efficiency. The system was promoted by the city of Johannesburg (CoJ) member of the mayoral committee for transport as being capable of delivering an integrated public transport system that is responsive to the mobility needs of citizens and provides the basis for economic growth (Moodley, 2012). It was also believed to be implementable in a short time frame. With funding at hand to address infrastructure and vehicle issues, the DoT embarked on BRT projects as a solution for the severe traffic congestion and persistent mobility problems in South Africa.

The DoT's plan was thus initiated and approved in 2007 in the Public Transport Strategy (2007–2020) and Action Plan, with financing from the National Treasury's Public Transport Infrastructure Systems (PTIS) Grant Funding (Republic of South Africa, 2020). The operator, however, was private. The project was implemented as a concession contract, whereby private companies entered into a contractual agreement with the government to operate the service. The implementation efforts entailed thorough negotiations with the mini-bus industry representatives (Venter, 2009; Moodley, 2012). The government builds and maintains the infrastructure, stations, depots, control centres and fare collection system.

In contrast, private operators own and manage the buses, hire staff and provide service on a long-term contract entered into with the relevant municipality. The Public Transport Strategy's overarching vision was to continuously upgrade the current public transport service to an upgraded modal service and then an integrated rapid transport network, which will maximise accessibility (including for the disabled) and promote non-motorised travelling (Pillay and Seedat, 2007). The

Integrated Rapid Public Transport Network (IRPTN) was also planned to integrate with existing modes of transport (metered taxis, mini-buses, etc.), promote greater social cohesion and provide alternatives for maximum interconnectivity (Pillay and Seedat, 2007). The BRT system is unique, having state-of-the-art stations, automatic fare mechanisms, dedicated and exclusive roadways and technical aspects of a centralised rail-based mass transit system.

Gauteng has three BRTs (in Tshwane, Ekurhuleni and Johannesburg), built at approximately USD678,189,000 (Venter, 2018). Phase 1 of the BRT system, which linked Soweto to Johannesburg's centre, came into effect on 30th August 2009. There are also functioning BRT systems in Cape Town, Port Elizabeth and Pretoria (Adewumi and Allopi, 2013). The BRT in Johannesburg, the *Rea Vaya*, links central nodes – the universities, the hospitals and travel and exchange stations. Major shopping malls had an additional objective: to meet the hosting of the 2010 Soccer World Cup obligations. It conveys 16,000 passengers per day (Adewumi and Allopi, 2013). The BRT in Tshwane (Pretoria), formally known as *A Re Yeng*, integrates with the rail network at five key railway stations, including Kopanong, Wonderboom, Pretoria Station, Hatfield as well as Denneboom. This network connects the industrial communities of Rosslyn, Hermanstad and Waltloo to commercial and business nodes such as Menlyn, Hatfield, Akasia, Montana and the Pretoria CBD and provides access to significant land use, such as Pretoria Zoo, University of Pretoria, Tshwane University of Technology, Menlyn Park Shopping Centre, Church Square and Steve Biko Academic Hospital. Access to these nodes is also intended to provide the system with balanced demand in terms of peak and off-peak variance and provide an alternative to car usage.

PERFORMANCE EVALUATION OF BRT-PPP PROJECTS

Conventional *ex-post* evaluation of projects being used to measure PPP projects generally focuses on meeting budget and predetermined project duration (Liu et al., 2015). However, due to their complexity, long-term processes and involvement of multiple stakeholders, there is a need to incorporate more indicators in the assessment framework (Liu et al., 2015; Klijn and Koppenjan, 2016). However, Hensher (2007) argues that while BRT typically has low operating costs, a range of costs that impact BRT should be evaluated to ensure long-term performance and sustainability. Performance assessment should be based on the objectives for which the projects were provided in the first place, thus checking how goals formulated ex-ante are realised (Klijn and Koppenjan, 2016). These may include the integral nature of the solution (sufficient connection of different environmental functions), the effectiveness of the solution (solutions developed to deal with the problems), the durability of solutions in the future, support for solutions (sufficient support by the involved organisations) and cost-benefit ratio.

Regarding BRT systems, in particular, optimisation problems in public transit attract attention due to the systems' size, complexity and practical importance (Kermanshahi, Shafahi and Bagherian, 2013). According to Hensher (2007), BRT systems' optimal performance could be measured against the service speed and reliability, operating costs, greater patronage (as a result of the level of services), high capacity and operational flexibility. The performance of BRT systems in South Africa was evaluated using on-site assessments of physical and environmental facilities accommodated by the system. It excluded performance regarding capital structure, demand and service quality given the nature of delivery (PPP) (Adewumi and Allopi, 2013). According to Menzies and Mandri-Perrott (2010), creating the right balance between private and public sector partnerships and a sound performance management system measures urban rapid transit system performance.

In similar studies, Huo et al. (2015) identified the level of service and operational flexibility as measures of BRT systems' efficiency. The study evaluated different levels of service quality using cluster analysis of delays at the intersection and stations and related service quality levels to users' perceptions. The study emphasised the importance of users' perspectives during performance assessments, which aligns with the Sustainable Development Goal (SDG) 11. This goal requires governments to provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, such as persons with disabilities (United Nations, 2020: online). These views were supported by Oviedo et al. (2019), in which the authors argued that accessibility to job opportunities viz-a-viz travel time and efficiency were important. Likewise, excellence in India's BRT systems was indicated by accessibility, passenger comfort and safety, information (route maps) and driver-friendliness (Kathuria et al., 2016).

Case Studies: African Context

The performance of notable BRT projects in African countries was further reviewed for information on the performance of BRTs. These include the Lagos BRT in Nigeria and the Dar es Salaam city BRT in Tanzania. These are notable because the former was the first BRT system in Africa and the latter was acclaimed as the "gold standard". Also, they were delivered through the PPP mechanism and the projects were deemed to be successful, partly due to considerable attention to potential risk factors during the feasibility study, as presented hereunder.

Nigeria: Lagos BRT

Mobereola's (2009) study reveals that Africa's first BRT system is located in Lagos, Nigeria. This system opened in 2008 with two lanes covering 35.5 km of a bus lane for buses and carries over 350,000 commuters daily. Amiegbebhor and Boluwatife (2018) state that the Lagos BRT system has been upgraded to introduce Electronic Ticketing and Intelligent Transport System. As of 2018, the system had 44 bus shelters in both directions, five terminals, 19 intersections and two bus depots that house a maintenance bay, a fuel dump, an automatic washing bay and administrative offices. The system was implemented to alleviate transportation challenges, including lack of safety and security, limited regulation, violation of traffic laws, low quality and high costs, congestion and poor maintenance (Otunola, Kriticos and Harman, 2019). The project was financed by the World Bank, with a contribution of USD100 million and the Lagos State Government contributed USD35 million (Aleshinloye, 2014). Institutional arrangements (operational dynamics with the private partner involved), costs, route delineation and design based on traffic projections were considered during the planning stage (Orekoya, 2010). Government inter-agency cooperation enabled the delineation and enforcement of roles regarding implementation/construction, management of operations, regulations and financing responsibility. Further, encouraging buy-in from private vehicle owners and bus operators was deemed critical. Although challenges with the enforcement of traffic rules and shortage of buses at peak periods exist, the benefits after introducing the BRTs were welcomed. This is according to the World Bank Independent Evaluation Group (n.d.) and Otunola, Kriticos and Harman (2019). These include:

1. Improved safety (reduction in accidents from 139 to 96 accidents per 100,000 vehicles exceeding the target of 112 accidents per 100,000 vehicles),

2. Impact concerning employment provision (2,000 direct new employment opportunities for bus drivers, ticket sellers, cleaners and mechanics),

3. Financial sustainability (operators deliver service without relying on financial assistance from the government and the system is self-sustaining even with the 30% reduction in fees by the user),

4. Reduced congestion (average vehicle journey times were reduced by 40% and waiting times by 35%), affordability (one-off fares decreased by 30% and therefore accommodated low-income passenger groups) and

5. Environmental benefits (reduction in CO_2 emissions and greenhouse gases).

Moreover, the stakeholders are making a conscious effort to improve the BRT system through digitisation and improved infrastructure and operations. According to Ogunlesi (2012), it is important to state that, like many emerging public infrastructure projects in Lagos, the BRT is being implemented as a PPP scheme.

Tanzania: Dar es Salaam City BRT

In Tanzania, Dar es Salaam's BRT is serviced by 140 golden dragon buses, providing express and local service from 5.00 a.m. to 11.00 p.m. daily (Chengula and Kombe, 2017). BRT rating has a capacity for more than 300,000 people per day and costs about USD150 million. Before developing the BRT, the transport system was inadequate to provide a reliable, safe and efficient public transport system for the estimated five million Dar es Salaam city inhabitants. They generate about 60% of the country's revenue and account for 70% of the city's public transport users. Therefore, it was implemented to improve urban mobility and accessibility by providing enhanced transport facilities that are reliable, safe/efficient and cost-effective, thereby supporting economic and social development and strengthening the competitiveness of the city and boosting tourism (AfDB, 2015b).

The project planning stage considered the impact on the environment and local air quality, user satisfaction and service level (reduction in travel time, long queues and fare system) (AfDB, 2015a). The system's performance was a concern after the implementation of Phase 1 of the project. Consequently, Phases 2 and 3 of the BRT project and rapid transit system (DART) were conceived, with the expectation of carrying up to 495,000 passengers per day and reducing travel time. Also, modern BRT buses, which use cleaner fuels, significantly reduce the roadside concentration of greenhouse gas emissions, thereby improving air quality and subsequently safeguarding people's health, were implemented (AfDB, 2015b).

However, the DART BRT service is also reportedly running at a substantial loss and has not reached peoples' expectations (Jennings, 2017). Although it won international acclaim, it is not affordable to the low-income passenger group (Rizzo, 2019). Despite investments of USD150 million for the first phase of BRT, the poor are still stuck in traffic on cheaper buses every day as a result of fare increases (Rizzo, 2019). Moreover, some argue that the BRT may not be as self-sufficient as it claimed to be because it is not sustainable without public subsidies, as elsewhere in the world, even with the current high fares (Rizzo, 2019).

Therefore, the performance of the above BRTs can be measured in terms of financial sustainability, technical performance, institutional/regulatory frameworks and service quality. Factors considered in the planning stage of the projects included the partners' roles, costs, design specifications and expected revenue. The stakeholders' expectations or partners on the project should be taken into account during the planning of BRT projects to ensure long-term performance.

ROLE OF PLANNING IN PPP PROJECT DELIVERY: BRT SYSTEMS

Poor project performance can, in most cases, be traced to decisions made before requirements are settled and before the implementation phase. The underperformance of transport projects is partly attributed to poor planning and inadequate feasibility studies where wrong and misleading predictions are put forward to support the viability of proposed projects (Okoro, Musonda and Agumba, 2021). The briefing (project initiation) stage is important for PPP projects, which are more complex because of the increased numbers of parties, the involvement and responsibilities of stakeholders and the long periods involved (Tang et al., 2015). The ultimate success or failure of a given transportation project and the entities intending to invest depend largely on the feasibility study process' outcome that reveals the projects' expected (future) performance (Salling and Leleur, 2017). The feasibility study is a multi-phase evaluation process that considers uncertainty and risk factors, based on which the project's viability is attested (Kühn and Visser, 2014). A detailed cost-benefit analysis, technical feasibility, social support and local financial market assessments contribute significantly to healthy profit margins, quality performance and appropriate risk allocation, leading to achieving objectives (Almarri and Boussabaine, 2017).

A plethora of studies reveal factors that should be considered at the feasibility stage of transportation projects delivered through the PPP mechanism. The study by Tang et al. (2015) identified factors that should be considered in the initial stages of PPP projects, including adequate time for planning and documentation with clear goals and objectives, priority setting, feedback from completed projects, identification and thorough understanding of stakeholder requirements and consensus-building. Berezin, Sergi and Gorodnova (2018) identified that factors affecting the successful implementation of PPP projects include institutional environment quality, the existing practice of innovation projects implementation, the level of readiness of government authorities and political support, private organisations, the population for successful implementation of PPP implementation, as well as existing legislation on PPP issues. Transportation reform should typically incorporate four broad aspects, including the infrastructure itself, enabling frameworks and finance and the operations and maintenance systems in place for the long-term delivery of intended objectives (Otunola, Kriticos and Harman, 2019).

Moreover, factors such as institutional frameworks, detailed life cycle financial analysis, operational studies, political support and governance dimensions of infrastructure investment should be considered in the conceptual and planning phase to ensure a sustainable and feasible PPP project (Lewars et al., 2007). According to Wood (2015), both governmental and personal alignments were the driving forces for BRT adoption in South Africa and thus fraught with partisan contestation between rival parties, limited financial resources and insufficient technical expertise. This highlights the importance of the consideration of appropriate institutional arrangements for the development of transport projects.

Additionally, feasibility assessment should pay attention to the physical sustainability of projects and influence the people (both present and future) for which the infrastructure is planned (Lewars et al., 2007). This is because externalities are engendered by the users themselves (intra-sectoral externalities, such as congestion), the environment and shifted or imposed on the society (pollution and accidents, for instance) (Raicu et al., 2019).

Typically, the planning process begins by undertaking a detailed assessment, identifying multiple alternatives to the proposed investment (Casello et al., 2014). For BRTs, the benefits derived from this feasibility process depend heavily on the quality of the forecasts. Kermanshahi, Shafahi and Bagherian (2013) suggested that the system's sustainability would depend on the service quality, optimal design and operational success. Consideration of inputs during the planning process as expected outcomes is of utmost importance at the operational stage. In a study by Umlauf et al. (2016), the authors opined that ridership could, in most cases, determine the economic feasibility of a proposed BRT system since it can be used to determine the revenue forecast, vehicle capacity and service headway.

Further, Casello et al.'s (2014) model demonstrates the evaluation of life cycle costs for BRT and light rail transit (LRT) over various demand levels and revealed the variations of costs and impacts considered in planning for different service levels for BRT and LRT. These include service life and maintenance costs, construction and infrastructure cost, speed and reliability, vehicle capital and labour costs and labour and energy costs. However, as Kermanshahi, Shafahi and Bagherian (2013) argued, an amalgamation of these costs should be within the estimated budget. It should be evaluated in tandem with the expected revenue of the projects. The study examined route potentials based on trip delineation and analysis of scenarios for maximum returns at minimum costs. It was emphasised that if the combined costs of developing particular routes exceed the budget, they are not feasible. Concerning the revenue, expected traffic demand should be considered as they affect returns accruing to investors. Traffic demand is an aspect of financial analysis that influences the return rate on investment based on the level of usage of the facilities. The issue of pricing is also important to avoid political fallout and ensure the contract's viability for business (Salling and Leleur, 2017). Thus, feasibility studies should have a clear operational focus.

The review presented above highlights a panoply of literature focusing on the critical success factors for developing PPP. However, there is limited literature on the factors considered in the development of BRT projects. A comprehensive feasibility study is one factor that impacts the sustainability of BRT projects delivered through PPP mechanisms, as it plays a significant role in mitigating the risk of failure. The earlier a detailed review is performed in the project cycle, the higher the realisable objectives from the projects in the long run. Therefore, the purpose of the present study was to identify critical feasibility study considerations to ensure BRT systems' sustainability, which is typically delivered through PPP mechanisms. The following research question was posed: "What components should be considered in a feasibility study for PPP transportation projects to increase the odds of BRT project sustainability?" To answer this main question, the researchers utilised the methods described in the next section.

MATERIALS AND METHODS

Study Design

The study adopted a case study design through a qualitative research approach. The qualitative approach was necessary to obtain in-depth information on the process, context and situation linked to the experience of the BRT systems (Kohlbacher, 2006). The BRT system was purposively selected because it availed sufficient data to conduct reliable analysis to arrive at valid conclusions. The BRT systems had been in operation for more than one year. The BRT systems in Johannesburg and Tshwane were selected for the study. Given the sensitivities regarding such projects, the researchers ensured that the study was granted ethical clearance before data collection. The case study followed a qualitative approach adopting interviews as the method for primary data collection, after literature synthesis.

Collection of Information

An integrative literature review was conducted (Rowley and Slack, 2004). This entailed a characterisation of BRT performance and feasibility study process and components being undertaken to gain insight on existing knowledge on feasibility studies for PPP-based BRT systems, process and considerations, identify its components (factors) and role in ensuring the sustainability of PPP transportation infrastructure projects (Rowley and Slack, 2004). This review process drew on different sources, including journals, conference proceedings, books, government reports and publications and news articles. Various databases, including Google, UJoogle, EbscoHost, Emerald Insight, Academic Search Complete and Scopus, were used to identify literature on BRT feasibility studies. Keywords including "feasibility study", "sustainability" and "project performance" were used in conjunction with the terms such as "infrastructure" and "transportation projects". Further, the review revealed notable BRTs in Africa, from which relatable lessons were drawn.

Following a detailed literature review, semi-structured interviews were conducted to investigate how feasibility studies were undertaken on specific projects and the performance of BRT systems. The interview guide contained questions that sought information on the feasibility study process used during the planning of the BRTs. Other sections on the BRTs' performance were included. The pre-determined questions were open-ended and allowed for an in-depth relay of how the feasibility study, if any, was undertaken and the performance of the project (Zohrabi, 2013). It was, therefore, possible to draw important theoretical perspectives on the role of planning the BRT PPP projects from the participants.

The participants were identified using non-probability purposive and convenience sampling techniques. Purposive sampling was used to include Built Environment professionals and stakeholders who had been involved in the planning and management of the BRT projects (Sreedhara et al., 2016). Seven experts were involved in the study (as shown in Table 1). The experts were from different government and private entities, including engineers, strategic advisors, senior transport economists and consultants and project/programme managers, spanning between 9 to 25 years of experience, with an average of 16 years.

Other respondents included ten users, who were identified using convenience sampling. Convenience sampling was used to include end-users of the BRT transit system. Although this method of sampling is inclined to be biased and undermine generalisability, it was possible to include key participants close to the BRT facilities under investigation in the Johannesburg area (Luke and Heyns, 2020). The users' personal information was not requested for anonymity and confidentiality purposes. Further, an effort was made not to include vulnerable participants and people under 18 and over 65 years old. The interviews were conducted in Johannesburg; however, the end-users included residents of Sandton and Tshwane who also use the BRTs in Johannesburg and Tshwane occasionally. Johannesburg was chosen as the location for the interviews based on the convenience sampling strategy, owing to the geographical closeness and ease of data collection where the Johannesburg BRT facilities are located (Luke and Heyns, 2020). As indicated in Table 2, the ten end-users involved included residents in Soweto, Sandton and Tshwane, who were regular (7) and non-regular (3) BRT users. There were six male and four female participants with occupations as students (2), shop attendants (2), shop owners (1), delivery guy/biker (1), receptionist (1), construction manager (1), self-employed (1) and teacher (1).

Table 1. Profile of the experts involved

S/No.	Position in Organisation	Department in Organisation	Type of Entity	Years of Experience	Stage Involved in the Project
1	Engineer	Transport integration and planning	Public	9	Planning and operations
2	Strategic advisor	Advisory/steering committee on the Gauteng Master Plan study	Public	25	Planning
3	Chief director design engineering services	Design department	Public	10	Design
4	Senior Transport Economist and consultant	Transport integration and planning	Private	12	Planning
5	Feasibility study specialist/ consultant	Design and planning	Private	12	Design
6	Project/ programme manager	Transport planning	Private	11	Planning (feasibility)
7	Project manager	Roads project asset management systems	Public	22	Implementation

Table 2. Profile of the end-users interviewed

ID	Gender	Resident/Location of Interview	Occupation	Frequency of BRT Travel
1	Female	Soweto resident	Scholar/student	Regular (previously)
2	Male	Soweto resident	Shop attendant	Regular
3	Female	Soweto resident	Admin staff/receptionist	Regular
4	Male	Soweto resident	Shop attendant	Regular
5	Male	Sandton resident interviewed in Soweto	Self-employed	Non-regular
6	Male	Soweto resident	Delivery guy/biker	Non-regular
7	Male	Soweto resident	Shop owner	Regular
8	Female	Tshwane resident/ Johannesburg commuter	Full-time employee/ Construction manager	Non-regular
9	Male	Soweto resident	Scholar/student	
10	Female	Tshwane resident/ Johannesburg commuter	Full-time teacher	Regular

The interviews were verbally administered in the English language. For the field interviews with end-users, two research assistants were recruited to assist with data collection in Zulu, one of the vernacular languages in South Africa, for some of the participants to understand why we were conducting the study, what it was all about and then express themselves freely. The participants were also informed that their names were not required, their responses will be kept confidential and only the researchers would have access to the data. For all the participants, including the expert interviews, informed consent was granted verbally before the interview sessions commenced (Sreedhara et al., 2016). Permission was also sought to audio-record the sessions for reference purposes.

The sample size of 17 participants, although limited, was observed to be sufficient since the goal of this inductive study was not to generalise but to provide a detailed, contextualised description and understanding of the phenomenon under investigation (feasibility studies and project performance in this case) through the intensive study of a particular case (Polit and Beck, 2010). Small samples have been used in transport studies. A study on transport impacts in strategic planning by Still, May and Bristow (1999) supports smaller samples that consist of experts and therefore argue that more realistic information is likely to be provided even from small samples of experts (as low as 8 to 12) than from larger samples of "lay" persons, a view supported in Amara and Lipinski (1972). Further, Kaliba, Muya and Mumba (2009) justified using a smaller responsive sample of 26, stating that although the study sample size was small, it encompassed the key players in the road sector who helped provide preliminary insights into the challenges faced by the sector. Galvin (2015) equally added to the subject by revealing that it was possible to attain saturation of data with 12 interviewees that have expert or deep knowledge of the areas under research. Participants who made at least one free-text comment on the a priori themes were included (Cunnigham and Wells, 2017). Thus, what was required was one occurrence of a piece of data, or a code, to ensure that it became part of the analysis framework to provide an understanding of the relationship between a feasibility study and the performance attributes of the project studied (Mason, 2010).

Data Analysis

Thematic analysis was used to analyse and interpret data from the secondary and primary research. This method identifies what is common to the way a topic is talked or written about and makes sense of those commonalities (Braun and Clarke, 2012). In analysing the selected materials for the literature review research phase, careful and detailed scrutiny of materials about the BRT systems planning, implementation and operations (performance) was undertaken to identify patterns and attributes connected to the outcomes (Nowell et al., 2017).

The recorded interview sessions were transcribed. The transcriptions were coded according to the a priori themes from the literature review on the feasibility study methods and processes employed and what factors were considered in the evaluation of the BRT project's feasibility and performance. The researchers referred to published works in the relevant area and derived categories from statements or conclusions found in the literature of other researchers who investigated a similar phenomenon (Vaismoradi et al., 2016). An object-oriented approach was adopted to interpret the data in a deductive way. The researchers used this 'top-down approach to code and interpret the data using a series of pre-established concepts or ideas (Braun and Clarke, 2012). The goal was to understand how feasibility studies were conducted on the BRT project, the sequence of actions, features and traits. Key features from the data set were identified and summarised in an organised and systematic manner (Nowell et al., 2017).

A six-phase approach to thematic analysis was adopted as prescribed by Braun and Clarke (2012). This included:

> Phase 1: Familiarising oneself with the data – This entailed repeatedly immersing and reading the transcriptions and notes to absorb and understand the meaning of the words, in line with the research question.
>
> Phase 2: Generating initial codes – This step entailed identifying codes relevant to answering the research question. The related text or quotes were collated accordingly.
>
> Phase 3: Searching for themes – This entailed identifying issues around which the codes cluster, that is, codes that seem to share some unifying feature, so that they reflect and describe a coherent and meaningful pattern in the data.
>
> Phase 4: Reviewing themes – This phase entailed checking the themes against the collated extracts of data, exploring whether the themes 'work' in relation to the data and further refining and reviewing when necessary to capture the data adequately. This step ensured that the themes captured the most important and relevant elements of the data and the overall tone of the data, concerning the research question and a priori codes.
>
> Phase 5: Defining and naming themes – The aim was to examine the themes to ensure that each was fit for purpose. The analyst ensured that they were not overburdened or overly complex. This

ensured that adequate and equal attention was given to the data to capture many realities and provide accuracy (Umeokafor et al., 2021). The data was interpreted and connected to the broader research question and existing scholarly fields. The research incorporates a discussion of the literature into the analysis, creating results and a discussion section (Braun and Clarke, 2012).

Phase 6: Write-up – Compiling the report in a logical, clear and convincing manner.

Therefore, the thematic analysis process was useful for summarising key features and perspectives from the large data set using a structured approach to handling data to produce a clear and organised final report (Nowell et al., 2017). The findings from the thematic analysis of the participants' statements related to the a priori themes are presented and discussed in the next sections.

Reliability of the Research

In this study, measures were taken to ensure the reliability of the findings. Reliability in qualitative research aims at ensuring the credibility and trustworthiness of the data and process. The development of a priori insights and relevant themes from existing literature based on the research question helped to enhance dependability (Vaismoradi et al., 2016). In addition, the detailed reporting of the research process, peer debriefing among the researchers during data collection and analysis and triangulation using different categories of participants helped enhance the research's trustworthiness and credibility (Nowell et al., 2017; Umeokafor et al., 2021).

FINDINGS

Planning Considerations for PPP-Based BRT Systems

Results from the review suggest that seven primary components should be considered in planning PPP-based BRT projects. Each component has several factors that should be considered before the project execution. Moreover, these components and factors could be utilised as evaluation metrics throughout the life cycle of a BRT system project to ensure the BRT system's overall health. For instance, while "demand" is a standalone component during the feasibility analysis phase, "ridership" and "patronage" could be measured in the implementation phase as metrics for assessing operational and service performance. Likewise, factors within "institutional arrangement" should be monitored closely through the project's life cycle, given the dynamic climate in most developing countries. A summary of the key components that should be considered in feasibility studies is presented in Table 3.

Table 3. Key components in PPP-based BRT feasibility studies

S/No.	Key components	Factors	Source
1	Institutional arrangement	Regulatory structure, contract management, risk sharing, stakeholder responsibilities, legal exposures	Orekoya (2010), Valentin et al. (2016), Kathuria et al. (2018) and Tyson (2019)
2	Existing characteristics and impact	Accessibility, walkway potential, air quality	Oviedo et al. (2019) and Pezeshknejad, Monajem and Mozafari (2020)
3	Service reliability and quality	Delays, information updating, system reliability, operational flexibility, fare structure, safety and security	Hensher (2007), Casello et al. (2014), Huo et al. (2015) and Kathuria et al. (2016)
4	Technical analysis of infrastructural integration	Dedicated road design, spatial analysis and destination points to enable integration of land use, and vehicle and infrastructure capacity	Hensher (2007), Kermanshahi, Shafahi and Bagherian (2013), Casello et al. (2014), Kathuria et al. (2016) and Pezeshknejad, Monajem and Mozafari (2020)
5	Demand	Ridership, patronage	Hensher (2007), Kermanshahi, Shafahi and Bagherian (2013), Casello et al. (2014) and Umlauf et al. (2016)
6	Environmental performance metrics	Energy and traffic reduction, air and noise pollution	Hensher (2007) Baghini et al. (2014) Nadeem et al. (2021)
7	Life cycle cost assessment	Initiation, vehicle capital, construction, labour and energy, infrastructure and asset maintenance	Kermanshahi, Shafahi and Bagherian (2013) Casello et al. (2014) Salling and Leleur (2017)

Role of Planning in PPP Project Success: BRT Case

This section presents findings from the interview. The respondents' statements on the various aspects revealed mixed views on the BRT system's planning considerations and performance. Two broad themes were identified as planning considerations. These include institutional arrangements and existing attributes and impacts. The evidence concerning the performance of the system was categorised under four themes that emerged from the analysis. The negative responses about BRT failures constituted the majority. The participants highlighted where possible improvement strategies could focus to enhance the experience of the end-users. These are further discussed hereunder. A link between key planning considerations and project performance is highlighted in the discourse.

Institutional arrangements

A stakeholder-involved operating system with the taxi industry was sought after on the institutional arrangements existing for management and operations. This was important to ensure future BRT success. The Action Plan provided that the transport authority will be responsible for the fare revenue and operators were contracted to provide particular services. Private taxi operators were incorporated into the networks as operators (Schalekamp and Klopp, 2018). However, the contracts hugely favoured the contractors as they bear no revenue risk. According to the participants:

> Before the World Cup in 2010, they created the structure where the city purchased the buses; then they transferred the buses to an operating company, a private company, Piotrans, which operates Phases 1A and 1B. They have a 12-year gross contract with the city and a negotiated gross cost contract with the city.
>
> (Expert 2)

> The contractual relationship in phase 1 was very real towards the operator himself, basically no risks to the operator… they have a gross cost contract which is typical of agreements, where the operator has no revenue risk, and they produce the service based on a timetable, they collect the fares and then hand over the fares to the authority and the city pays them rate per km.
>
> (Expert 2)

Further, consultation with stakeholders' active participation to ascertain their needs and incorporate their concerns and priorities in project selection contributes to the acceptability and support of selected projects (Tyson, 2018). However, currently, it appears that this is still being negotiated 12 years down the line.

> The other problems were that it was conceptualised that the taxis on the routes will become the operators, for the drivers to be part of the drivers of BRT system and there is supposed to be no intermodal competition from the taxis, but they have not succeeded in getting the taxis off these routes. Many of the taxi's passengers ought to be on the BRT system based on conceptualisation but enforcing that is difficult.
>
> (Expert 2)

Therefore, although the institutional and funding frameworks to facilitate implementation and manage and regulate the networks were laid out in terms of the Network Plan, they are still facing challenges regarding trust and operator performance (Pillay and Seedat, 2007).

Existing attributes and impact

Assessment of the impact of the development on the users as stakeholders were undertaken since existing businesses and public transport facilities were incorporated into the system.

> We came up with a network and then we did demand studies because BRT depends on the numbers in the catchment areas. Basically, we looked at the businesses that were along a particular chosen route and we had many options. Based on the demand model and also some of the routes that were identified affected the existing public transport networks.
>
> (Expert 6)

Consultation with stakeholders and consideration of existing attributes and impacts on the people or community before implementing proposed transport development is crucial. Therefore, the need for longer-term consultation during feasibility studies and more broadly formulated purposes and priorities for greater coherence to transport policy cannot be over-emphasised.

Demand

The findings indicated that there was low usage of the BRTs. Some of the users are regular users; others use other means of transport such as taxis, uber and bikes (personal transport). There were mixed responses from the respondents as some indicated that they had alternative means of transport:

> I use the BRTs more than taxis.
>
> (User 4)
>
> I have not used the BRT in a long time. I drive now or use taxis when I want to save fuel.
>
> (User 1)
>
> I live in another part of Soweto … I use a taxi and other options… Access is not easy. I find it easier to use taxis – I want to use them but I cannot do so because they do not have stations where I come from. It is about a 45-min walk to access the BRT. It does not make sense for me [to travel that far]… if there could be more routes.
>
> (User 2)
>
> I do not use the BRT… I sometimes use taxis. However, mostly, I use the bike.
>
> (User 5)
>
> It [the system] is not accessible to me because I stay a bit far out. I have to come down… It is extra cash, so I might as well use a taxi.
>
> (User 6)

The shortage of passengers for the routes appeared to be a concern. On ridership and revenue accruing from demand, revenue from ticket sales ranges from R4.3 to R6.5 million per month (Goondiwala, 2014). However, this is not acceptable. Ridership or demand for the services is not great (Venter, 2018). This can also be construed from a respondent's statement:

> The systems are not getting the passenger volumes that they thought they would be getting…you must first have the passenger volumes on the route. The more people pay, the fewer subsidies you would need, so they cannot be able to get the passengers off the route.
>
> (Expert 2)

Further, the shortage of passengers for the routes appeared to be attributable to the densities in urban cities in South Africa. A respondent stated:

> The more fundamental issue here is that our urban densities are very low. So, it is a structural issue that these BRTs are not selling. If you look at Sao Paulo as a city of 22 million people with high-rise buildings everywhere and have these BRTs around there, they can operate without subsidies, it is possible and they sell 6 to 7 times a day. We do not have urban densities… we have not got passenger volumes, etc. … but the fare is quite low as well, so if you have more passengers, they can increase the revenue.
>
> (Expert 1)

The feedback suggests that various factors could be responsible for low ridership. In addition to the availability of alternative means of transport, the distance to the BRT stations and the number of drops to get to the nearest station were highlighted.

Service quality: Fare system and structure (pricing and revenue)

Implementation of a fare system through a common electronic fare system was laid out in the Network Plan and the conceptual phase. However, the adequacy of the fares and pricing were not contemplated in detail. As a result, the fare was set at a low level, causing the system to be heavily dependent on subsidies (expensive and unsustainable), as suggested by a respondent:

> Some studies showed that they would be able to operate these BRTS without subsidies, but there were always questions at the beginning… because low densities may have about 80 hours of operation. This is part of the lack of feasibility of these BRTs because your entry fare should be at an adequate level because you cannot operate… with the inflation once you are already in the service itself, it is difficult.
>
> (Expert 4)

> They introduced the first one (BRT) here in Johannesburg and pitched the fare too low, at the level of taxis or just below the taxi fares. It was too low; they should have pitched it at a higher level, so that put them on the wrong footing. So, from day one, they needed subsidies.
>
> (Expert 1)

Thus, in addition to the low fares, the BRT systems are expensive to operate since they are heavily subsidised and non-profitable and this is a major concern among stakeholders. In 2017, South Africa's National Department of Transport and the Treasury raised the alarm that the country's BRT systems set up in major metros were making losses "significantly higher than anticipated" (Jennings, 2017). According to expert participants:

> None of the BRTs is making money.
>
> (Expert 7)

> In general, if you look at the cost of the BRTs and the conventional buses and how much we are already spending on the BRTs, which is 26 billion per year, the value for money proposition should be questioned, whether we should go ahead…a major review, for alternative ways of the same type of services but a much lower cost than what we have now.
>
> (Expert 2)

Level of satisfaction with the quality-of-service travel time (delays), service speed and operational flexibility

Complaints regarding travel time with the use of the *Rea Vaya* were reported. As informed by end-users, the BRT is operational, albeit time-consuming:

> There are two BRT stations [in the area]… One is operational; the other is not.
>
> (User 1)

> The *Rea Vaya* is time-consuming… it takes like two and half hours to get home (Soweto) from school (UJ)… when it gets to Thokoza park, I have to wait and then take another taxi… local buses, to get home… although it is safe, it is time-consuming.
>
> (User 9)
>
> There are delays, but it is more efficient in the morning, as there are many buses.
>
> (User 4)
>
> BRT is a struggle right now. It takes a long route and wastes time. It goes to [another location] first and it is sometimes clustered.
>
> (User 3)

Further, it can be deemed that the users were dissatisfied with the system's operational performance, as they reported experiencing challenges with the trip booking and ticketing system.

> Now, they are always offline. Imagine you want to use the bus and you want to book; they are offline, that is the most irritating part of it and sometimes people avoid using it because of that.
>
> (User 4)
>
> The services also – there are technical difficulties – when you tap in at one station, you cannot tap out at the other end in Thokoza. However, we are not bothered by it. We wait.
>
> (User 4)

However, some users seemed to be satisfied with accessibility, as they indicated that they had no complaints about affordability and accessibility to the stations:

> I cannot complain about affordability because everything is going up…so not transport in particular… we have access to taxis."
>
> (User 8)
>
> It is affordable, but to some people, it does not solve their problem…they have to take more than one taxi to get to the *Rea Vaya*.
>
> (User 1)
>
> I am satisfied, we do not have a choice, there is no train station and there are no options. We just have to use what is available even with the increase in taxi prices.
>
> (User 2)
>
> Accessibility for the disabled is ok……. Infrastructure for the disabled is okay and the service is rendered.
>
> (User 3)

Safety and security

Safety and security considerations were taken into account during the planning of the BRT system. Regarding the performance, the expert participants stated:

> Safety is one of the selling points. People walking towards the BRTs are still in the normal environment. However, once they are at the BRT station, there is security; our cameras and the vehicles are supposed to be safer from driving techniques and behaviour that one can say is not good, accidents and things like that.
>
> (Expert 2)

> As part of the agreement that we signed with the taxi operators, operating the BRT system, we have automated, urban traffic control… we can draw a report regarding the behaviour of the driver in terms of breaking and so on. Moreover, if there was an accident, we can see what happened because there are cameras… so they are controlled.
>
> (Expert 6)

On the part of the users, the following were expressed:

> *Rea Vaya* is proper [good]… no safety issues.
>
> (User 4)

> Once you leave the stations and have to walk, it is not safe, especially at dawn or at night.
>
> (User 3)

The participants' mixed positive and negative responses indicated that safety was a concern, albeit not within the buses or the stations.

The performance of the BRTs in South Africa can be deemed to be unsatisfactory. This was evident in the majority of the negative comments received (as shown in Table 4). The negative responses about BRT failures constitute the majority of respondents.

Table 4. Thematic analysis for the BRT performance

A priori Themes	**Selected Comments from the Participants**	**Analysis**
Demand	Positive The fare is quite low as well, so if you have more passengers, they can increase the revenue. Negative The systems are not getting the passenger volumes that they thought they would be getting. You must first have the passenger volumes on the route. The more people pay, the fewer subsidies you would need, so they cannot be able to get the passengers off the route. Our urban densities are very low. So, it is a structural issue that these BRTs are not selling compared to Sao Paulo.	The demand is too low despite the fares being too low. This is a pure case of bad planning. It is about bad routing rather than affordability.

(*Continued on next page*)

Table 4. *Continued*

A priori Themes	Selected Comments from the Participants	Analysis
Accessibility	Positive Accessibility for the disabled is okay. Infrastructure for the disabled is okay and the service rendered. Negative I do not use the BRT… I sometimes use taxis. However, mostly, I use the bike. I drive now or use taxis when I want to save fuel. I live in another part of Soweto… I use a taxi, other options… Access is not easy. I want to use them but I cannot do so because they do not have stations where I come from. It is about a 45-min walk to access the BRT. I cannot use it unless there be more routes closer to where I live. [The system] is not accessible to me because I stay a bit far out. It is extra cash, so I might as well use a taxi.	Access to the BRT stations is a problem. It would be worth asking about the experience of those located close to the stations. Its success depends on access to the high density. BRT is friendly to the disabled.
Service quality (Pricing and revenue)	Positive It is affordable to some people. Accessibility for the disabled is okay… Infrastructure for the disabled is okay and the service is rendered. Negative The first one (BRT) here in Johannesburg pitched the fare too low, at the level of taxis or just below the taxi fares. So, from day one, they needed subsidies. None of the BRTs is making money. There are delays, but it is more efficient in the morning, as there are many buses. They are always offline. Imagine you want to use the bus and you want to book; they are offline. It is affordable, but to some people, it does not solve their problem… they have to take more than one taxi to get to the *Rea Vaya*.	Profits are too low to sustain the BRT. Revenue risk is very high The pricing model requires reconsideration. The BRT has the potential to become more efficient. The technology part of the service fails the system. A more reliable online service is required. BRT still requires some re-planning for it to become sustainable.

(*Continued on next page*)

Table 4. *Continued*

A priori Themes	Selected Comments from the Participants	Analysis
Safety and security	Positive *Rea Vaya* is proper [good]… no safety issues. We have automated, urban traffic control… we can be able to draw a report regarding the behaviour of the driver in terms of breaking and so on. Negative Once they are on the BRT station, the security there, our cameras and the vehicles are supposed to be safer from driving techniques. If there was an accident, we can see what happened because there are cameras … so they are controlled. Once you leave the stations and have to walk, it is not safe, especially at dawn or at night.	The safety on BRT and premises is good. It is not safe as you leave the BRT premises.

DISCUSSION

The above findings are supported by the extant literature, which indicated that the BRT system in Gauteng, South Africa, faces challenges that threaten its sustainability. High capital expenses and subsidies, coupled with low ridership, have tarnished the system, which was once regarded as the silver bullet that would provide fast, affordable public transport for all (Venter, 2018). In 2017, the South African government admitted that the ZAR15 billion Gauteng BRT system is a failure, with ZAR50 million to ZAR70 million being spent on each BRT platform, with no more than 75,000 passengers a day and commuters shunning the system in favour of taxis and conventional buses (Mabena, 2017). However, the BRT system is reliable and safe and provides commuters with a clean, quality transport service. It has bus drivers and taxi drivers in formalised employment systems and has improved the environment using energy-efficient, green buses (Goondiwala, 2014). Therefore, although some operational aspects are acceptable by the users, such as safety and affordability, other aspects that should have been considered during a designated feasibility study contribute to the unsatisfactory performance in terms of returns on the investment and private sector underperformance.

PPP projects such as BRT in South Africa are generally faced with poor institutional arrangements for operations and maintenance, low ridership, expensive stations and high costs of running closed stations, services relocation and operating feeders, legal issues, stakeholder engagement, land expropriation, slow rate of township infiltration, ongoing competition with the taxi industry and unreliable detailed demand modelling (Ferranti et al., 2020).

The need for strong and consistent political support was emphasised in the BRT projects as the government went ahead to build despite strong opposition from the taxi industry operators. As seen from the successful Lagos BRT described earlier, adequate capacity to deliver the project, coupled with the financial strategy and partner responsibilities for the whole system, was considered from the outset, unlike the BRT case system in South Africa. The institutional arrangements to deliver apposite service to the people is a paramount consideration. To create a successful BRT system, strong political will and leadership are required. This is especially important at a localised level as local policymakers and actors are the best champions. While cities may learn of circulated forms of knowledge through innovative and dynamic individuals, a policy is adopted through local actors who are instrumental in cultivating a receptive ground for the application of circulated policy, with governmental support (Wood, 2014). These views were also supported in a recent study by Singla and Modgil (2020), which emphasised that contrasting mindsets among private and public sector partners have to be taken into account in order to overcome their differences and explore common grounds that would bind them together to achieve successful delivery of transport projects. Furthermore, Amadi, Carrillo and Tuuli (2014) emphasised that stakeholder engagement across the planning, development and operations phases ensures consistent service provision.

Public involvement in infrastructure development increases general awareness and acceptability of the project and ensures meaningful participation, central to good decision-making (Aaen, Kerndrup and Lyhne, 2016). Supporting these views, Tyson (2018) added that dialogue with stakeholders, including end-users, should be done early in infrastructure project planning to ensure good performance. A favourable institutional environment ensures the coordination of efforts, delineation of roles/responsibilities (to parties best equipped to handle technical and managerial aspects) and consistent and reliable governance structures, which are essential conditions for sustainable transport systems (Tyson, 2018). Therefore, reaching a sound understanding of the actors' responsibilities and roles, different institutional investors and potential operators were critical at the feasibility stage of the project (Tyson, 2018). Furthermore, close and meaningful engagement with the community can lead to careful management of impacts and delivery challenges that the locals eventually welcomed (Cascetta and Pagliara, 2013).

Costs and affordability were related to the end-user's ability to pay, with an assessment of the household income. Household income and the ability to pay are important related considerations, a view that was shared by the Victoria Transport Policy Institute (2016) and Gwilliams (2017). Affordability may not be due to excessive prices but because the income of the user or household is low or they may be unwilling to pay more towards transit, in which case, poverty and household income and expenditure thresholds (rather than pricing) would be the limitations to the financial sustainability of the BRT system. Thus, some respondents reported that there may be an uptake in the use of other modes of transport like walking and taxis. Therefore, these factors should be considered in economic feasibility studies to achieve the sustainability of the system (Umlauf et al., 2016).

Related to this, revenue from traffic demand and transaction and running costs throughout its life cycle are important feasibility considerations. These findings are consistent with the views expressed in extant literature that cities must strive to achieve a fair revenue to direct operating cost ratio as close to 100% as possible to be sustainable in the long run (Republic of South Africa, 2020). However, these were not considered sufficiently on the BRT projects, which resulted in heavy dependence on government subsidies to operate. This will, in turn, help to forecast the traffic demand, which was not done on the BRT project to gauge the ability of the project to sustain itself.

Further, the low patronage was attributed to walking distance to the stations, transfer and accessibility and availability of alternatives. On the causes of low ridership, urban densities are substantially lower in sub-Saharan cities than in European, Latin American or Asian cities, which typically results in low passenger demand (Jennings, 2017). Additionally, affordability may not be the reason for the BRT system's low patronage in South Africa. Other reasons for the low patronage could be attributed to factors external to the system, including accessibility to job opportunities and preferences of the intended commuting population to use non-motorised transit means or other available alternative means of transport and the economic environment (Nadeem et al., 2021). However, since the initial fares were low for the BRTs, it can be deemed that affordability was not the reason for the low patronage. Therefore, developing and implementing BRTs should have incorporated more data on demand along the proposed routes. Adequate time should have been provided to assess projected demand for the system, considering travel alternatives available and, to a greater extent, the integration of limitations in the local context and environment.

Furthermore, the sampled end-users in Johannesburg, South Africa, reported an abysmal service level regarding travel time, long walking distance and untimely transfers. These were also reported in a similar study in Cape Town, South Africa, which revealed that customers were not satisfied with the transport fare and the availability or accessibility of ticket sale outlets (Ugo, 2014). The study stressed the importance of customer satisfaction in realising the primary objectives and thus the sustainability of BRT transport projects.

Technical difficulties were also reported on the BRT system by the users. This was also the case with the Dar es Salaam city BRT, which had problems with smart cards and long queues (van Mead, 2019). The walking and travel distance to the stations were a concern in the Gauteng BRT, especially among the lower-income residents. By being farther from the city centre, lower-income citizens tend to experience longer travel times due to larger distances to the job and other activity centres, poor local coverage of public transport that leads to long walking times to reach bus stops and transit stations, traffic congestion and more transfers (Kathuria et al., 2016; Oviedo et al., 2019). These views agree with insights highlighted in Gwilliams (2017) that changes in activity location may increase accessibility in terms of what people want from patronising transit services. Notwithstanding, BRT systems can provide higher quality service by avoiding time-consuming transfers and by using modern technology, the vehicles, stations and rights of way of BRT systems. These factors must be considered in a feasibility study during the planning phase of a BRT project.

The above suggests that the BRT systems have encountered significant financial and enforcement troubles. To help manage the risks associated with such projects, explicit management contracts with emphasis on knowledge transfer, risk sharing and partnerships with private operators with proven track records and criteria for partnering with local firms in a bidding process should be assessed at the feasibility stage. Attention to all the risk factors at the planning phase of a BRT project will go a long way to achieving value for money and contribute to attaining SDG goal 11. Therefore, the value for money hoped for when the BRTs in South Africa were rolled out was not achieved. This underlines the importance of adequate and accurate feasibility studies to ensure that all possible factors, which could affect such green-field projects' sustainable performance, are incorporated and given considerable attention, a view supported by the Asian Development Bank (2008). Because there were inadequate time and planning for the feasibility studies, the operation stage problems were inevitable. By undertaking a comprehensive feasibility study, problems can be anticipated and mechanisms to ensure that the desired performance is achieved and sustained. While the 2010 World cup drove the focus of the BRT project, the focus should have been more on the sustainability of the BRT beyond the World cup. The implications of the findings point to the fact that many failures surrounding the BRT in Gauteng result from not incorporating the stated critical factors at the planning stage. This presents a critical lesson for future BRT projects in South Africa and other developing countries that critical factors must be given meticulous attention planning stage before attempting to execute the project. The negative results triggered by a lack of planning for BRT projects may be difficult and expensive to correct, while some may be irreversible.

CONCLUSION

The study sought to identify feasibility assessment factors that contribute to BRT systems' sustainable performance and those that should be considered in planning such schemes. The BRT system in South Africa was chosen as a case study. Using interview data and literature evidence provided in the discourse, the study demonstrated the role of planning and feasibility studies. The study found that institutional arrangements, existing characteristics and impact, service reliability and quality, technical analysis of infrastructural integration, demand, environmental performance metrics and life cycle costs should be taken cognizance of during the planning of BRT systems. BRT systems can effectively improve public transportation services in urban areas if planned and implemented properly. For BRT PPPs to be successful, the government needs to undertake thorough feasibility studies that address delicate issues and consider possible options to meet the stakeholders' needs. Based on the insight from the study, the government must address the issue of cost recovery, engage competition to drive innovation and low prices, define obligations and penalties for the private sector, build effective regulations and regulatory agencies, address possible oppositions and communicate decisions to the public promptly, before implementation as well as during operations.

The study extends knowledge about PPP success and project sustainability criteria, especially within BRT systems. Future studies could adopt a deductive approach to identify critical factors considered in feasibility studies of specific PPP-type projects in other geographical areas. Further work is recommended to establish the impact of these factors on BRT systems' performance using alternative research techniques such as detailed case studies and surveys.

LIMITATIONS AND FUTURE RESEARCH

The study used a smaller sample as already indicated despite deriving significant results. The study could benefit from collecting data from a larger population of users and potential users of the BRT in Gauteng province. Current revenue data trends were not compared with the projected trends. This as well could provide greater insights. A comparative study between the BRT in Gauteng and other provinces could provide additional insights into the common and unique challenges that the BRT projects are presenting in South Africa. The experience of those living close to the BRT stations was not carried out. It would be interesting to find out if their experience was different.

Lastly, the designers and planners of BRT were not interviewed to find out why they did not see the gaps in the design with respect to the challenges that BRT is facing in terms of low usage despite being affordable. The study has, however, provided a good foundation for future studies in this area.

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