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Metropolitan Integration: The Implementation of the BRT System Cuiabá – Várzea Grande (BRAZIL)

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ABSTRACT
The Bus Rapid Transit (BRT) project for the Cuiabá – Várzea Grande projetc was developed with the objective of integrating the public transportation system within the Metropolitan Region of the Cuiabá River Valley (RMVRC). The methodology included an in-depth analysis of existing routes, a review of prior transportation studies in the region, and the proposal of a network structured around two main corridors, supported by primary terminals and connection stations. The discussion highlighted the importance of utilizing electric vehicles and dedicated infrastructure to enhance urban mobility. The findings point to an integrated, efficient network designed to meet metropolitan demands, incorporating distinct operational models such as stop-and-go and semi-express lines. The implementation of the BRT system is expected to significantly reduce travel times, increase transportation capacity, and promote sustainability in the region's public transport network.

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I. INTRODUCTION

Cuiabá, the capital of the state of Mato Grosso, and its neighboring city, Várzea Grande, form the core of the Metropolitan Region of the Cuiabá River Valley (RMVRC). Together, these cities play a central role in the economic and social development of the region, hosting a growing population and facing challenges related to urban mobility and the integration of public services. With the continuous expansion of these urban areas, the need for an efficient and interconnected public transportation system has become a key topic of discussion to ensure the quality of life for residents and promote the development of local urban mobility.

In the early 2010s, a Light Rail Vehicle (LRV) system was proposed to connect Cuiabá and Várzea Grande, aiming to modernize public transportation and alleviate traffic on the main roads during the 2014 World Cup. The implementation of the LRV (Light Rail Vehicle) in Cuiabá and Várzea Grande was marked by high financial costs, initially estimated at approximately R$1.477 billion, but which quickly increased due to delays, design modifications, and contractual issues. The project was never completed, resulting in a waste of public resources and negative impacts on the population (Silva, 2016).

With the abandonment of the project, it became necessary to reverse the investment, dismantling part of the already installed tracks and deconstructing the built infrastructure, which led to additional costs and widespread frustration. The reversal of the project not only represented a significant failure in modernizing local public transportation but also left physical and economic scars on the region, which is now seeking a more viable solution with the implementation of the BRT system.

Considering this situation, state and municipal authorities turned to a more viable and flexible alternative: the implementation of a Bus Rapid Transit (BRT) system. The BRT, known for its capacity to transport large volumes of passengers quickly and efficiently, was chosen as the ideal solution to replace the LRV. This system offers the advantages of lower implementation and maintenance costs, as well as being adaptable to existing road infrastructures, which facilitates its integration with other public transportation modes (Mato Grosso, 2012).

The construction plan for the BRT in the Metropolitan Region of the Cuiabá River Valley includes the creation of exclusive lanes, integration terminals, and a network of lines connecting the main urban areas of

Cuiabá and Várzea Grande. The main objective of this project is to solve the mobility issues left unresolved by the failed LRV project, while also significantly improving the quality of public transportation in the region. The expectation is that the BRT will provide a swift solution, meeting the demands of a continuously growing population (Silva, 2016).

With the implementation of the BRT, the cities of Cuiabá and Várzea Grande will be able to progress towards greater metropolitan integration, offering their residents more efficient and accessible public transportation. Additionally, the success of the BRT could serve as a model for other regions in Brazil facing similar challenges in modernizing and expanding their public transportation systems.

The objective of this research is to analyze the challenges and impacts related to the transition from the originally proposed transportation system for Cuiabá and Várzea Grande, from the Light Rail Vehicle (LRV) to the Bus Rapid Transit (BRT). The research aims to understand the factors that led to the failure of the LRV and assess the feasibility, benefits, and limitations of the BRT as an alternative solution to improve urban mobility in the Metropolitan Region of the Cuiabá River Valley.

II. MATERIAL AND METHODS

The methodology for studying the transition from the LRV to the BRT in Cuiabá and Várzea Grande was organized into interconnected stages.

Phase I: Document Review
A comprehensive review of relevant documents was conducted, including reports provided by the Mato Grosso State Infrastructure Department (Sinfra). These documents consisted of minutes from public hearings in Cuiabá and Várzea Grande, descriptive reports of the preliminary design, budget spreadsheets, and detailed engineering projects of the originally proposed LRV route. This phase aimed to understand the context and reasons behind the LRV project’s failure.

Phase II: Cost Analysis
A detailed financial analysis was performed to assess both the initial investments required for BRT implementation and the costs associated with the dismantling of the LRV infrastructure. This phase evaluated the financial implications of abandoning the LRV project, including contract indemnifications, removal of structures, and reintegration of affected urban areas. These values were compared with the estimated costs of the BRT system, including necessary investments for infrastructure adaptation, vehicle acquisition, station installation, and operational and maintenance expenses.

Phase III: Technical Feasibility Assessment
The technical feasibility of the BRT system was evaluated using advanced traffic modeling and simulation techniques. The performance of the BRT was projected under various urban scenarios, considering factors such as population density, traffic flow, and land-use patterns. The system’s capacity was analyzed in terms of passengers per hour, vehicle frequency, and its ability to handle peak-hour demand.

Phase IV: Socioeconomic Evaluation
An extensive evaluation of the BRT’s socioeconomic benefits and limitations was conducted. This phase focused on potential travel time reductions, efficiency on critical routes, and overall contribution to improved urban mobility. The analysis aimed to assess the BRT’s impact on the region’s public transportation system and its capacity to address the mobility demands of a rapidly growing population.

III. THE SELECTION OF CUIABÁ AS A WORLD CUP HOST CITY AND THE IMPLEMENTATION OF THE LRV

Of the more than 27 billion reais allocated by the Federal Government to the host cities of the 2014 World Cup, Cuiabá received a substantial share, with over 2.394 billion reais earmarked for various infrastructure projects. The bulk of this funding, approximately 71%, was channeled into urban mobility initiatives, reflecting the strategic emphasis on improving transportation systems. These projects were seen as crucial not only for handling the anticipated surge in demand during the World Cup but also for addressing longstanding deficiencies in the city's infrastructure. By investing in sustainable and modern transportation solutions, the government sought to create a long-lasting impact on Cuiabá’s urban landscape (Silva, 2016).

The focus on urban mobility was part of a broader goal to enhance the daily lives of residents by reducing traffic congestion, improving access to different parts of the city, and promoting economic growth through improved connectivity. It was expected that the investments would lead to a more integrated public transportation system, fostering social inclusion by connecting underserved neighborhoods to the urban core. The government's vision extended beyond the immediate needs of the World Cup, aiming to leave a transformative legacy that would contribute to the city's future development (Figure 1).

	Ações	Mobilidade (R$)	Estádios (R$)	Aeroportos (R$)	Portos (R$)	Turismo / Instalações complem.(R$)*	Total (R$)	%
Belo Horizonte – MG	24	1.348.200.000	695.000.000	430.090.000	0	48.925.522	2.522.215.552	9,28
Brasília – DF	12	44.200.000	1.403.300.000	651.370.000	0	31.340.000	2.130.209.901	7,84
Cuiabá – MT	16	1.719.400.000,00	570.100.000,00	101.210.000,00	0	4.049.226	2.394.759.226	8,81
Curitiba – PR	24	466.200.000	326.700.000	157.260.000	0	18.140.000	968.296.516	3,56
Fortaleza – CE	25	575.167.960	518.606.000	171.110.000	202.600.000	115.125.134	1.582.609.094	5,82
Manaus – AM	12	0	669.500.000	445.070.000	89.400.000	7.970.018	1.211.937.018	4,46
Natal – RN	22	472.247.997	400.000.000	572.550.000	72.500.000	66.954.179	1.584.252.176	5,83
Porto Alegre – RS	17	15.872.222	330.000.000	87.720.000	0	34.198.462	467.790.683	1,72
Recife – PE	35	890.672.974	532.600.000	0	28.100.000	388.265.577	1.839.638.550	6,77
Rio de Janeiro – RJ	27	1.866.600.000	1.050.000.000	443.650.000	0	941.518.900	4.301.768.900	15,83
Salvador – BA	35	20.624.336	689.400.000	112.930.000	40.700.000	140.129.507	1.003.783.843	3,69
São Paulo – SP	20	548.507.000	820.000.000	3.107.600.000	154.000.000	55.745.128	4.685.852.128	17,25
Nacional	55	0	0	0	0	0	2.477.071.590	9,12
Total		7.967.692.489	8.005.206.000	6.280.560.000	587.300.000	1.852.355.100	27.170.185.180	100

Figure 1: Investments Made by the Federal Government in the Cities Chosen for the World Cup

The analysis of investments made by the Federal Government in the host cities of the 2014 World Cup reveals a significant distribution of resources, reflecting the strategic priorities and specific needs of each location. In total, more than 27 billion reais were allocated, distributed across different categories such as urban mobility, stadiums, airports, ports, and tourism/complementary facilities.

Cuiabá stands out for receiving a total investment of approximately 2.394 billion reais, representing about 8.81% of the overall amount allocated to the host cities. Most of this amount, around 71%, was directed towards urban mobility, with an investment of 1.719 billion reais.

In comparison with other host cities, Cuiabá received fewer investments in stadiums, airports, and ports, indicating a strategy more focused on urban mobility. This contrasts with cities like Brasília and Rio de Janeiro, where investments in stadiums and airports were significantly higher, reflecting both the importance of these facilities for the event and the role of these cities as national and international hubs (Silva, 2018).

The prioritization of urban mobility projects in Cuiabá, including road expansions, avenue duplications, trench and viaduct construction, and the implementation of the LRV, was predominantly concentrated along the central axis of the city, where medium- and high-rise buildings are more densely located.

Nevertheless, the planned route of the LRV demonstrates an effort to reach areas with higher population density, passing through several neighborhoods outside the central axis. This initiative suggests an attempt to expand access to a modern and efficient transportation system, connecting more distant areas to the city's economic and administrative center. However, the effectiveness of this approach depends on the complete implementation and operationalization of the LRV, which continues to face significant delays and challenges, compromising the potential positive impact it could have on the more underserved regions (Figure 2).

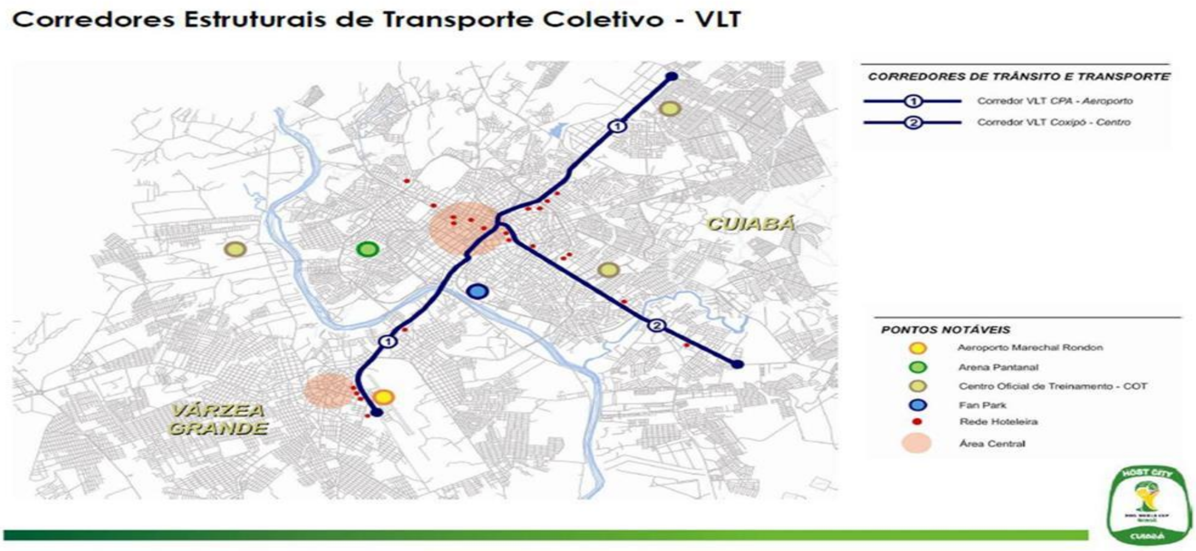

Figure 2: Planned Route for the LRV Circulation in Cuiabá and Várzea Grande

In Cuiabá, the widening of public roads in central areas and various neighborhoods caused significant social impact, being one of the main factors leading to forced evictions and displacements. A notable example is the Avenida da FEB, an important corridor connecting Marechal Rondon Airport to the capital. In this area, many businesses were severely affected, and numerous families, some of whom had lived in their homes for over 25 years, were forced to leave their residences (Secopa, 2018).

In many cases, these families did not receive social rent or immediate compensation due to disputes over land ownership. In response, the government deposited compensation amounts in court, which resulted in financial restitution for the residents only after the eviction, leading to prolonged suffering and housing insecurity.

The construction work carried out in this region not only promoted the widening of roads but also contributed to significant real estate appreciation. However, this appreciation was accompanied by the relocation of residents to peripheral areas, often lacking basic infrastructure and far from essential services and economic opportunities they previously had access to. This forced displacement not only weakened the social fabric of the affected communities but also exacerbated urban inequalities, widening the gap between the valued central areas and the marginalized peripheries (Siqueira, 2012).

According to data released by the Secretariat of Administration of the World Cup-MT (SECOPA), the total number of evictions in Cuiabá because of the 2014 World Cup construction works reached 770 cases (Mato Grosso, 2016). This significant number highlights the magnitude of urban interventions and their direct consequences on the population, raising questions about the ethics and social responsibility of the public policies implemented.

The massive allocation of public and private investments in works and megaprojects related to the 2014 World Cup generated great expectations among the local population regarding real estate appreciation and spatial reconfiguration. This capital injection sparked an intense process of real estate speculation, especially in areas near event sites, where the perceived increase in property values led to various reactions and perspectives among residents and investors (Silva, 2016).

Among the projects planned for Cuiabá, initiatives such as improvements in urban mobility, expansion and renovation of Marechal Rondon Airport, construction of Arena Pantanal, implementation of the Light Rail Vehicle (VLT) system, and the construction of trenches and overpasses stand out. These projects, considered essential for the modernization of the city, triggered a rush for properties, fueling speculative capital widely exploited by various economic and real estate agents in the city (Siqueira, 2012).

However, the reality of executing these projects revealed a series of challenges and setbacks. Of the 62 works planned for Cuiabá for the 2014 World Cup, none were completed within the stipulated timeframe. Furthermore, all of them faced significant problems during construction, from delays to technical and financial issues, compromising the schedule and quality of the deliveries. This scenario left the city, even years after the event (until 2018), as a true unfinished construction site.

The situation raised criticisms regarding the effective management of resources and transparency in the project execution process. The initial expectations that the World Cup would bring a positive and legacy to the city were frustrated by poor management and delays, leaving deep marks on Cuiabá's urban and social fabric. Speculative capital, initially driven by the promise of modernization, contributed to the gentrification of certain areas, while other regions were left in a state of neglect, exacerbating inequalities and causing discontent among the local population (Mato Grosso, 2016).

3.1 Transition from the Implementation of the Light Rail Vehicle (LRT) to the Bus Rapid Transit (BRT) in Cuiabá-Várzea Grande

The implementation of the Light Rail Vehicle (LRT) in Cuiabá was originally conceived as a modern and efficient solution to the city's urban mobility problems, especially in preparation for the 2014 World Cup. However, the project faced a series of challenges and failures that prevented its completion and operation, resulting in one of the largest infrastructure failures in the city’s recent history.

From the outset, the LRT project suffered from planning flaws. The choice of this transportation system was made without sufficiently deep analysis of local conditions, the specific needs of the population, and the costs of maintenance and operation. Initially budgeted at approximately R$1.477 billion, the project quickly exceeded this amount due to adjustments and unforeseen circumstances, highlighting the lack of realistic financial planning.

Moreover, the execution of the LRT works was marked by a series of issues, including constant delays, misappropriation of funds, and management failures. The company responsible for construction encountered technical and operational difficulties, which compromised the project's progress. Corruption and allegations of irregularities in the project's bidding process also led to the halt of construction in 2014, with only about 50% of the project completed (G1, 2024).

The LRT project also fell victim to political conflicts between different levels of government and between the government and the contracted company. The involvement of the project in legal disputes contributed to the suspension of the works, further increasing uncertainty about the future of the system and eroding public confidence in the project. Over time, it became increasingly evident that completing the LRT would require significant additional investments that the state government was not able to support. Estimates indicated that completing the project would demand billions of additional reais, as well as high operation and maintenance costs (Figure 3), which led the government to reconsider the feasibility of the system (Silva, 2018).

Figure 3: Abandoned train parking yard in Cuiabá

Faced with the failure of the LRT and the growing demand for mobility solutions, the state government decided, years later, to implement a new transportation system: the BRT. This decision was based on several factors. The BRT has a significantly lower implementation cost compared to the LRT, both in terms of construction and operation and maintenance. Additionally, the BRT is considered more flexible and adaptable to Cuiabá's urban traffic conditions, making it a more practical and economically viable solution.

Another relevant factor is the speed of implementation. Unlike the LRT, which would require complex and lengthy construction to be completed, the BRT can be implemented in a much shorter time frame, allowing the population to benefit from mobility improvements sooner. This was a decisive factor for a government under pressure to deliver tangible results after years of failures.

The BRT is better suited to the urban reality of Cuiabá and Várzea Grande, efficiently meeting passenger demand with less impact on the existing infrastructure. This adaptability was crucial in choosing the system, considering the history of problems faced by the LRT.

In 2020, it was reported by the G1 website that the governor of Mato Grosso sent a letter to the Minister of Regional Development requesting the replacement of transportation systems in Cuiabá and Várzea Grande. This request was based on a study conducted by a technical group from the National Secretariat of Urban Mobility, which concluded that continuing the LRT project was unsustainable and would result in a completion time of more than six years. The study also highlighted that the projected fare for the LRT would be R$5.28, significantly higher than the R$4.10 fare used for public transport in the Baixada Cuiabana region.

On the other hand, the implementation of the BRT would have an estimated fare of R$3.04. Furthermore, the annual subsidy cost to operate the LRT would be R$23.2 million, while the BRT would require an initial investment estimated to take up to 22 months from the signing of the service order. In terms of cost, implementing the BRT is considerably more economical: while the LRT would require an additional expenditure of R$763 million, on top of the R$1.08 billion already spent, the BRT is budgeted at R$430 million, including the purchase of 54 electric buses. The Government of Mato Grosso also plans to file a lawsuit against the responsible consortium to hold the involved companies accountable for R$676 million in damages (LRT Consortium, 2014).

IV.RESULTS

The BRT project for Cuiabá and Várzea Grande was developed through a partnership between the state government and the Integração Consortium, which won the bid to take on the execution of the works and the management of the system once completed. The documentation related to the project, available on the website of the Infrastructure Secretariat (Sinfra), is organized into three main categories.

The first section covers the minutes of public hearings held during the project's planning process. These minutes document the discussions and public deliberations, offering a detailed view of the community's concerns and suggestions regarding the BRT.

The second section deals with the preliminary engineering designs and the budget associated with the BRT project. These documents are technical in nature and detail the infrastructure proposals, including specifications for roads, stations, integration with other transportation systems, and solutions to minimize environmental and social impacts. Additionally, they provide a complete financial estimate, including costs for the construction, operation, and maintenance phases of the transportation system.

Finally, the third category consists of feedback from local residents about the project. These contributions reflect the opinions and concerns of the local population, as well as suggestions for improvements to the project, highlighting the expected impact of the BRT on the communities of Cuiabá and Várzea Grande.

The Proposed Network Description in the BRT Cuiabá–Várzea Grande project document details the planning of an integrated public transportation network designed to serve the Metropolitan Region of the Vale do Rio Cuiabá (RMVRC). This network was conceived to unify public transportation services, based on two major structural corridors: the CPA–Várzea Grande Corridor, extending in a Northeast-Southwest direction, and the Coxipó–Center Corridor, in a Southeast-Center direction.

The definition of the network was based on analyses of existing routes up until 2021, previous studies such as the LRT proposals from 2013 and 2020, and contributions from the municipal administrations of Cuiabá and Várzea Grande. The operation of the integrated network will be facilitated by the Electronic Ticketing System (SBE), which will allow users to access municipal and intermunicipal transportation services with a single fare payment.

To ensure the efficiency of the network, three main terminals have been designated as integration points: the André Maggi Terminal in Várzea Grande, which will be rebuilt, and the CPA and Coxipó terminals in Cuiabá, which will be constructed specifically to meet the demands of the BRT (Figure 4).

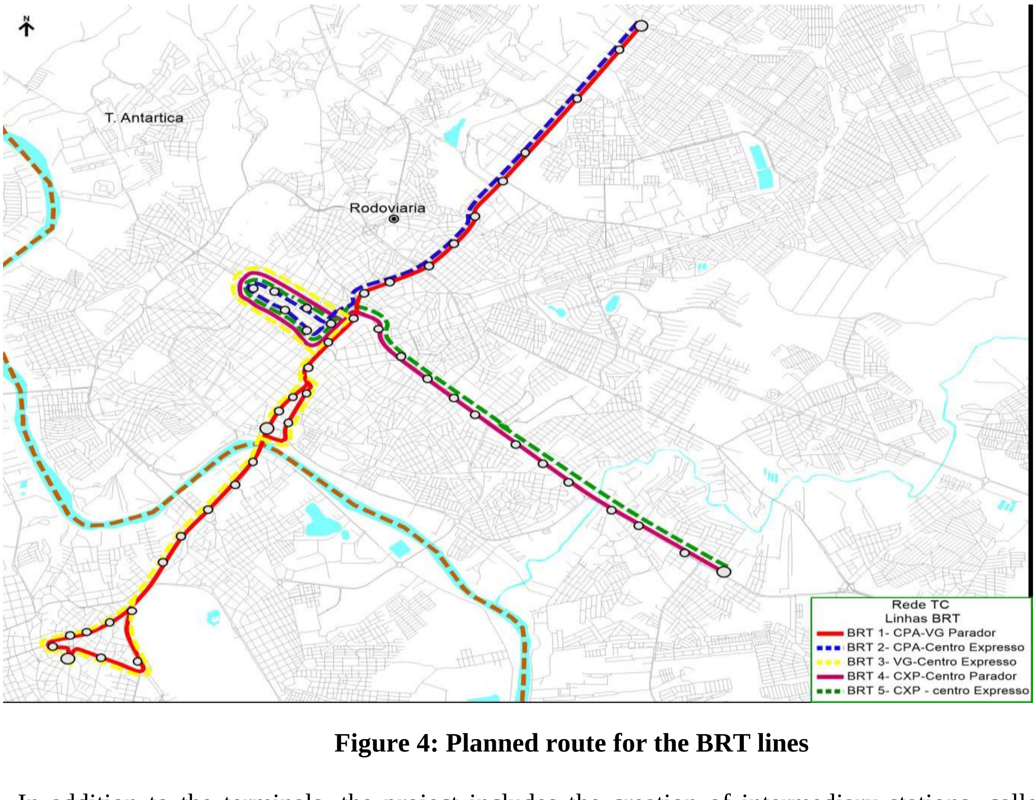

Figure 4: Planned route for the BRT lines

In addition to the terminals, the project includes the creation of intermediary stations, called "BRT Connection Stations." These stations, such as the Centro Político Station and the Porto Station on the CPA–

Várzea Grande corridor, and the UFMT Station on the Coxipó corridor, will have smaller infrastructure but play a crucial role in integrating transport lines, serving specific areas of influence.

The main lines of the BRT corridor were designed to meet metropolitan demands, with two distinct operational models: the "local service," where buses stop at all stations, and the "semi-express," where stops occur only at stations with higher demand. The vehicles operating on these lines will be electric-powered, a requirement set by the State Government to promote a more sustainable operation.

The lines were designed to address metropolitan demands, fully utilizing the BRT corridors with electric vehicles and operating under a specific operational regime and centralized control. There are five main lines, each with a defined route to maximize system coverage and efficiency: BRT Line 1 connects the CPA Terminal to the André Maggi Terminal using the "local service" model, while BRT Line 2 connects the CPA Terminal to the central area of Cuiabá in "semi-express" operation. BRT Line 3 runs between the André Maggi Terminal and downtown Cuiabá, also in the "semi-express" model (Figura 5).

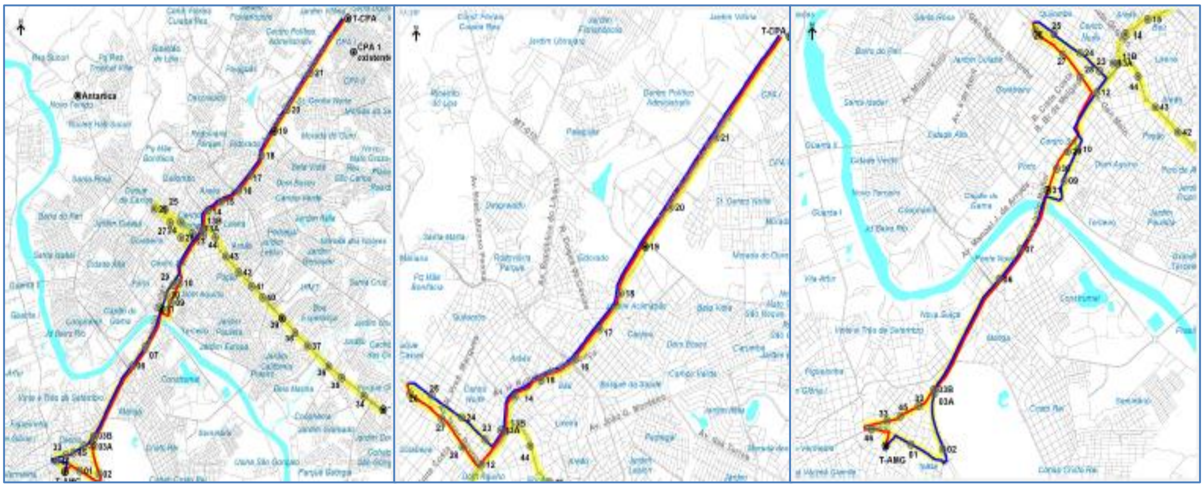

Figure 5: Routes of BRT Lines 1, 2, and 3

The total length of BRT Line 1 is 15.16 km on the route from the CPA Terminal to the André Maggi Terminal, and 16.63 km on the reverse route. Line 2 covers 8.71 km on the route between the CPA Terminal and downtown Cuiabá, and 9.07 km in the opposite direction. Line 3 spans 10.40 km from the André Maggi Terminal to downtown Cuiabá, and 9.26 km in the reverse direction.

BRT Lines 4 and 5 play complementary roles in connecting the Coxipó Terminal to downtown Cuiabá. BRT Line 4, characterized as a "local service" line, stops at all stations along the route, providing comprehensive access to various urban areas and enabling more access points to the system. In contrast, BRT Line 5 is classified as "semi-express," meaning it makes fewer stops, offering a faster journey between the Coxipó Terminal and the city center (Figure 6).

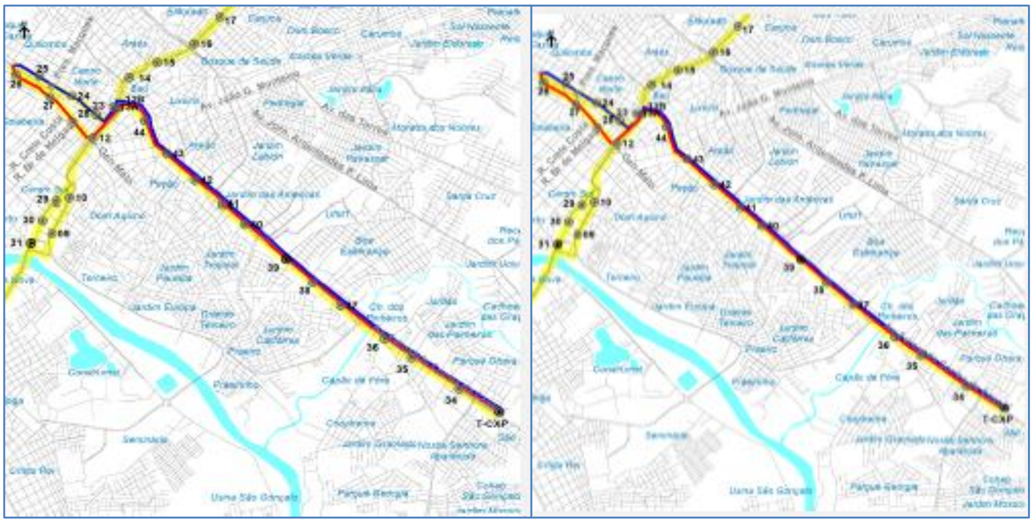

Figure 6: Routes of BRT Lines 4 and 5

These lines were strategically planned to meet the different needs of passengers and optimize user flow in the main urban areas. BRT Line 4 serves a passenger profile that values accessibility and proximity to various points along the route, while BRT Line 5 focuses on efficiency and reducing travel time for those who prioritize a faster journey.

Regarding the operation of the BRT corridor, it is stated that the system will operate exclusively on the roads of Várzea Grande and Cuiabá. The system's operation will be supported by dedicated infrastructure, which includes two main functional solutions: the BRT Lane and the Exclusive Lane. The BRT Lane consists of a physical structure built in the central median of the roads, dedicated exclusively to the circulation of BRT buses, with central stations positioned on the left side of the vehicle's operating direction.

On the other hand, the Exclusive Lane is a part of the road marked by specific signage, located on the right side of the roads, designated for the exclusive circulation of buses, where side stations will be implemented (Figure 7).

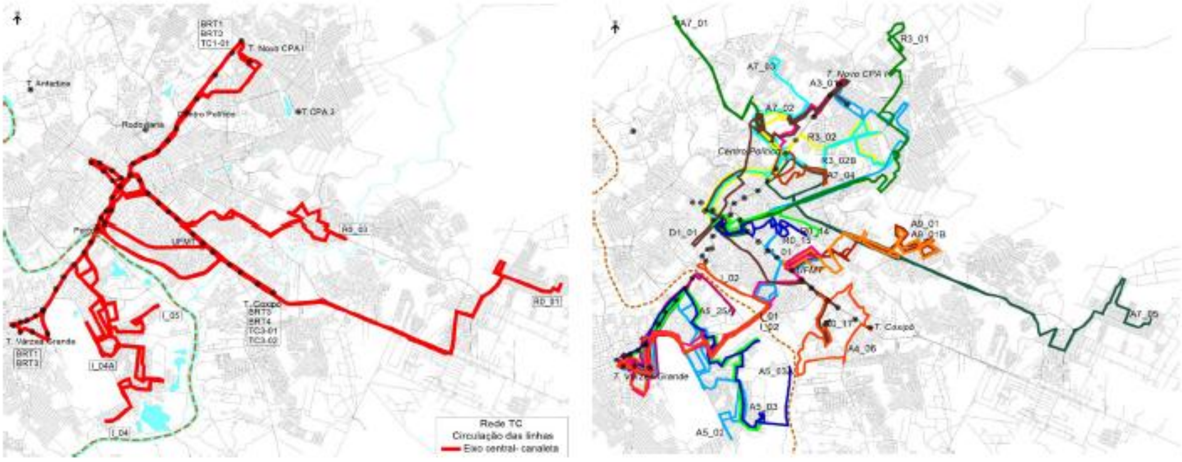

Figure 7: Lines of circulation of BRT

It is important to highlight that some sections of the road system, where the BRT infrastructure will be implemented, will be shared by certain lines as part of their route. In these sections, buses will operate in general traffic lanes and make stops at conventional points located on the sidewalks. However, these segments are relatively short within the overall routes of the lines.

This approach was adopted to minimize the need for complex and unnecessary integrations within the transportation network, facilitating operations and ensuring greater fluidity in the system. The strategic integration of these segments allows for better optimization of resources and a more efficient travel experience for passengers.

The lines operating within the BRT system are classified into three categories: BRT Corridor Lines, which use the dedicated infrastructures either fully or partially; BRT Passage Lines, which circulate on the BRT Lane due to the characteristics of their routes and require vehicles with doors on both sides; and Lines that use the general traffic lane, which partially use general traffic lanes and require buses with doors only on the right side. These definitions ensure that the operation of the BRT system is efficient and well-coordinated, integrating appropriately with the rest of the public transportation network in the region.

Regarding the daily numbers to be served, a simulation methodology was established using TransCAD software, based on the road network and the public transportation system employing previous planning studies. The simulation network includes a total of 31,104 nodes, of which 30,830 are segment start nodes and 574 are centroid nodes. Additionally, the network comprises 47,036 segments, with 45,988 being road segments and 1,048 being access segments.

The information related to the public transportation lines represented in the model was provided by the Infrastructure Secretariat (SINFRA), with data collected from the municipalities of Cuiabá (SEMOB) and Várzea Grande (Public Services and Urban Mobility), as well as from the State Agency for the Regulation of Delegated Public Services (AGER).

Through simulation, it was possible to arrive at the value of 15,200 boardings during the morning period, with a maximum loading sum of 5,800 passengers at the same time across the system. Regarding the BRT Passage Lines, it is estimated that during the morning peak, there will be 2,200 passengers in total maximum load, with 4,500 passengers transported.

To facilitate data consultation, the values were synthesized into tables, with Table 1 indicating the boardings on the Lines.

Table 1: Allocated demand results for the main periods - Boardings

Period	BRT 1	BRT 2	BRT 3	BRT 4	BRT 5
Morning	6105	1140	652	6200	1107
Evening	4635	647	119	4791	477
Night	5657	1051	158	5290	760
Total	**16397**	**2838**	**929**	**16281**	**2344**

Table 2: Allocated demand results for the main periods - Boardings

Period	BRT 1	BRT 2	BRT 3	BRT 4	BRT 5
Morning	1621	570	562	2149	894
Evening	1015	308	89	1070	295
Night	1700	588	96	1635	613
Total	**4336**	**1466**	**929**	**4854**	**1802**

The demand during the morning period significantly exceeds the maximum capacity of the BRT lines, highlighting a concerning gap between transportation needs and available infrastructure. Specifically, the BRT Line 1, which has a demand of 6,105 passengers, only has a capacity of 1,621 passengers.

This discrepancy reveals a substantial overload, indicating that the BRT system is operating far beyond its designed capacity. Consequently, this situation may lead to chronic overcrowding, frequent delays, and an overall negative experience for users, compromising both the system's efficiency and passenger satisfaction.

It is important to note that this demand in the simulation is based on a high-demand scenario, which may not reflect the actual daily use in the cities in question. However, this assessment is crucial as it provides a clear view of the challenges the system would face under maximum demand conditions. For successful and sustainable implementation, it is essential to consider the transportation capacity consistently over time, ensuring that the system is robust enough to handle demand variations without compromising efficiency or service quality.

This simulation allowed for the transformation of the data into visual information represented in Figure 8, showing the thickness of the route based on passenger load capacity.

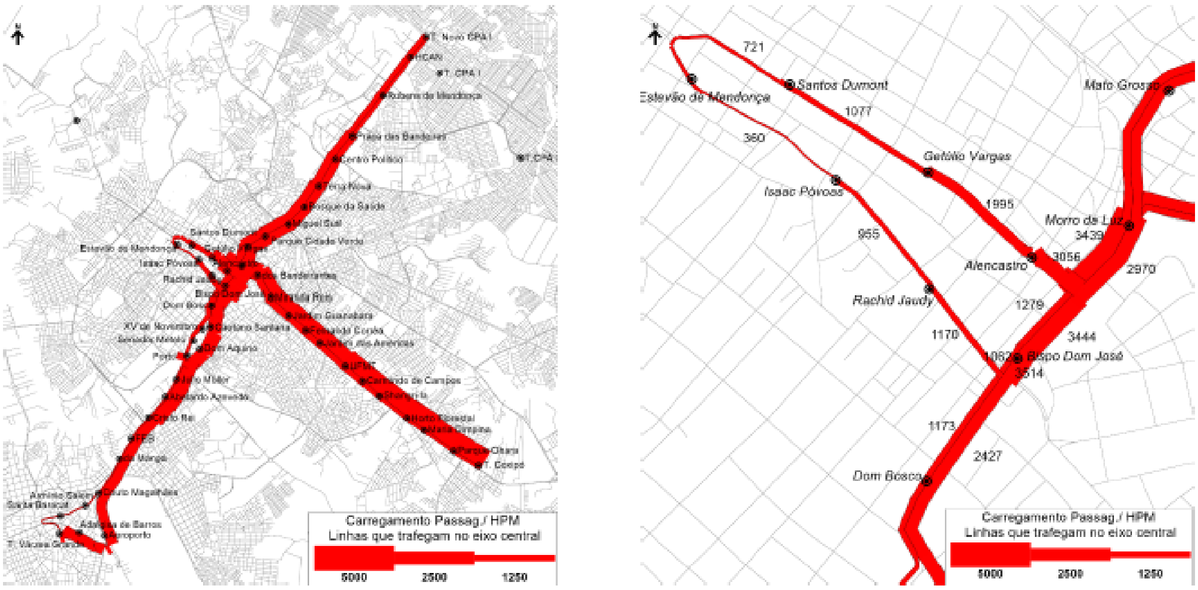

Figure 8: Loadings of the BRT Axis lines during the morning peak hours

In the image on the left, the roads converging toward the city center have a greater thickness, reflecting high demand and loading capacity typical of central transport corridors. This indicates that these routes are critical for passenger flow, especially in central areas where demand concentration is higher.

In the image on the right, a similar scenario is shown, with different roads displaying varying thicknesses according to their passenger loading capacity. The thicker areas suggest high usage and the need for robust infrastructure to accommodate passenger flow.

The operational schedule of the BRT has been defined to run from 4:30 AM to midnight every day, allowing for broad coverage to meet user demand. However, it is important to note that there is no planned operation during the overnight hours. This inactive period is essential for conducting maintenance and heavy cleaning activities for fixed facilities, such as stations and dedicated lanes. These activities are crucial to ensure the safety and efficiency of the system during operational hours.

The distribution of the supply of trips by time slot has been planned based on the current demand profile of the lines and a standardized operational pattern compatible with a robust and efficient structural service. This means that the planning considered existing demand and adapted the supply to ensure that user needs are met effectively, minimizing wait times and maximizing transport capacity during peak hours.

Specifically, the calculation report of the supply and fleet for the BRT Axis lines indicates that, during the morning peak hour, 45 trips are made. Of these, 31 are operated with articulated buses, which have a higher passenger capacity, and 14 with standard buses, which offer lower capacity but are equally essential to complement the supply and ensure service fluidity. This fleet sizing is the result of a detailed demand analysis aimed at ensuring the BRT operates efficiently and reliably, even during peak load times.

The document provides a detailed view of the simulation model adopted, including zoning and public transport matrices based on 2019 data. However, the use of historical data raises questions about the accuracy of projections, especially considering dynamic changes in travel behavior and urban mobility needs.

The simulations generated estimates of travel times, operational speeds, and sizing of the integrated network. However, the reliability of these results may be limited by the lack of consideration for variables that could impact the actual performance of the transport system under the various projected time scenarios.

It is worth noting that the BRT construction began in January 2024 and is already experiencing significant delays. The Infrastructure Secretariat (Sinfra) has notified the responsible company to readjust the schedule, ensuring completion within the expected timeframe of 2025. In Várzea Grande, the concreting of sections has not yet been completed, and in Cuiabá, construction started nine months late due to a lack of municipal authorization. These delays are concerning, especially given the complexity of the planned corridors and the impact on urban mobility.

V. DISCUSSION AND CONCLUSION

The implementation of the BRT system in Cuiabá and Várzea Grande emerges as a necessary response to the historical challenges faced by urban mobility in the region, especially following the failure of the VLT project. However, the project already shows concerning signs of delays and execution difficulties, which may compromise the system's effectiveness. The delays in concreting in Várzea Grande and the nine-month holdup in the start of construction in Cuiabá indicate structural problems that need to be addressed to ensure the BRT's success.

Additionally, the reliance on historical data and the lack of adaptations to new urban mobility dynamics raise serious questions about the accuracy of the projections made for the system. The saturation already identified in simulations points to the need for significant revisions in planning so that the BRT can meet future demands without repeating the mistakes that led to the VLT's failure.

In conclusion, while the BRT represents a more flexible and economically viable alternative, the success of its implementation depends on efficient management and a real capacity to adapt to the dynamic changes in urban mobility. Without this, the BRT risks following the same path as the VLT, resulting in yet another incomplete infrastructure project that fails to meet the needs of the population in the Metropolitan Region of the Vale do Rio Cuiabá.

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