



Barra do Graças-MT, perspectives from the Connected Smart Cities Ranking

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Barra do Garças-MT, perspectivas a partir do Ranking Connected Smart Cities

RESUMO

Objetivo - analisar os indicadores de uma cidade inteligente para o município de Barra do Garças – MT, devido a sua reconhecida importância no Vale do Araguaia.

Metodologia – adoção do Ranking Connected Smart Cities (RCSC), desenvolvido pela Urban Systems para identificar as cidades brasileiras que apresentam o maior potencial de crescimento a partir de 50 mil habitantes.

Originalidade/relevância – a escolha pelo RCSC, ocorreu por abordar a ISO 37122: Sustainable cities and communities e, consequentemente, a versão brasileira que é a NBR 37122 Cidades e comunidades sustentáveis.

Resultados - Apesar de estar fora dos 100 melhores em 2022 e 2023, obteve boas notas em indicadores específicos, semelhantes aos das pequenas cidades mais bem classificadas. Ao focar nesses indicadores, a gestão pública pode adotar estratégias para melhorar o desempenho e tornar a cidade mais inteligente e sustentável.

Contribuições teóricas/metodológicas – o RCSC possibilitou, a partir dos eixos temáticos e seus indicadores, observar como o município realizou a gestão da cidade entre os anos de estudo.

Contribuições sociais e ambientais – Possibilitou identificar os eixos temáticos com os melhores resultados, sendo urbanismo, saúde e educação, em virtude dos indicadores que evoluíram durante o período analisado.

PALAVRAS-CHAVE: Vale do Araguaia. Indicadores. Cidades Inteligentes.

Barra do Garças-MT, perspectives from the Connected Smart Cities Ranking

ABSTRACT

Objective - analyze the indicators of a smart city for the municipality of Barra do Garças - MT, due to its recognized importance in the Araguaia Valley.

Methodology - adoption of the Connected Smart Cities Ranking (RCSC), developed by Urban Systems to identify Brazilian cities with the greatest growth potential from 50 thousand inhabitants.

Originality/relevance - The choice by RCSC occurred because it addresses ISO 37122: Sustainable cities and communities and, consequently, the Brazilian version, which is NBR 37122 Sustainable cities and communities.

Results - Despite being outside the top 100 in 2022 and 2023, it scored well on specific indicators, similar to those of the best-ranked small cities. By focusing on these indicators, public management can adopt strategies to improve performance and make the city smarter and more sustainable.

Theoretical/methodological contributions – the RCSC made it possible, based on the thematic axes and their indicators, to observe how the municipality managed the city's management between the years of study.

Social and environmental contributions – It made it possible to identify the thematic axes with the best results, being urbanism, health and education, due to the indicators that evolved during the period analyzed.

KEYWORDS: Araguaia Valley. Indicators. Smart Cities.

Barra do Garças-MT, perspectivas del Ranking Ciudades Inteligentes Conectadas

RESUMEN

Objetivo - analizar los indicadores de una ciudad inteligente para el municipio de Barra do Garças – MT, debido a su reconocida importancia en el Valle de Araguaia.

Metodología – adopción del Ranking de Ciudades Inteligentes Conectadas (RCSC), desarrollado por Urban Systems para identificar las ciudades brasileñas que tienen mayor potencial de crecimiento a partir de 50 mil habitantes.

Originalidad/relevancia – La elección del RCSC se basó en la norma ISO 37122: Ciudades y comunidades sostenibles y, en consecuencia, la versión brasileña, que es la NBR 37122 Ciudades y comunidades sostenibles.

Resultados – A pesar de estar fuera del top 100 en 2022 y 2023, logró buenas calificaciones en indicadores específicos, similares a los de las ciudades pequeñas mejor clasificadas. Al centrarse en estos indicadores, la gestión pública puede adoptar estrategias para mejorar el desempeño y hacer que la ciudad sea más inteligente y sostenible.

Aportes teórico-metodológicos – el RCSC permitió, a partir de los ejes temáticos y sus indicadores, observar cómo el municipio gestionó la ciudad entre los años del estudio.

Aportes sociales y ambientales – Permitted to identify the thematic axes with the best results, being urbanism, health and education, due to the indicators that evolved during the period analyzed.

PALABRAS CLAVE: Valle de Araguaia. Indicadores. Ciudades inteligentes.

1 INTRODUCTION

According to NBR ISO 3722, a city can be considered smart when it presents positive results in the social, economic and environmental areas, facing challenges such as climate change, in the face of the continuous urbanization process of cities. Using democratic management as its main instrument, with the involvement of society and the adoption of collaborative leadership methods, acting through disciplined municipal systems which incorporate cutting-edge information and technologies, to provide quality services and improvements in the quality of life of all those involved, both now and in the future.

However, in order to become a smart city, it first needs to become digital, as the process of adaptation requires a telecommunications infrastructure, support from the public administration and the active participation of citizens, with the aim of establishing connectivity of digital services, in order to provide answers to the environmental, economic and social challenges faced today (NICK, PONGRÁ CZ & RADÁ CS, 2018).

Based on this approach, Oliveira (2023) presents some concepts of smart cities from a broader perspective, where the term would be the integration of infrastructure, technology and increasing the quality of life of citizens (GRETZEL et al., 2015; UARI, 2017), thus adding sustainable development.

In this context, the United Nations (UN), through the Sustainable Development Goals (SDGs), has encouraged various entities, governments, non-governmental organizations (NGOs), among others, to invest in the technological structures of cities in order to solve urban challenges. Some of the cities that are already investing in this direction, with the aim of solving not only urban issues, but also making cities smart, are Amsterdam and Barcelona in Europe; Songdo-dong and Masdar in Asia; and BahirDar in Africa (SANTOS et al., 2023).

In the case of Brazil, there is great potential for the development of smart cities, some of which, in the southeast and south, such as São Paulo, Vitória, Curitiba and Florianópolis, already use indicators with the intention of becoming smart.

Corroborating the process of identifying Brazil's smart cities, Urban Systems created the Ranking Connected Smart Cities (RCSC), with the aim of diagnosing cities with more than 50,000 inhabitants and the greatest potential for growth, providing indicators that reflect intelligence, connection and sustainability. The RCSC addresses ISO 37122: Sustainable cities and communities - Indicators for smart cities and, consequently, the Brazilian version which is NBR 37122 Cidades e comunidades sustentáveis - Indicadores para cidades inteligentes. The more than 75 indicators are distributed across 11 research axes: Mobility (MOB), Environment (MAM), Governance (GOV), Technology and Innovation (ICT), Entrepreneurship (EMP), Urbanism (URB), Security (SEG), Education (EDU), Economy (ECO) and Health (SAU) (Urban Systems, 2021), as shown in figure 1.

Figure 1 - Connected Smart Cities Ranking research axes and indicators



Source: Urban Systems

In this scenario, the municipality of Barra do Garças-MT, is considered the main municipality in the Araguaia Valley region in the state of Mato Grosso, as a result of having the highest population concentration, 69,210 inhabitants (IBGE, 2022) and the most economically developed, based on farming, tourism and agriculture, with soybean, rice and corn production standing out (QUINQUIOLO; FIÚZA, 2016). With a GDP of 41,607.18 (IBGE, 2021), the municipality commands a conglomerate of 8 nearby towns, bringing together more than 125,000 inhabitants who travel and trade together on a daily basis. With an HMDI (Human Development Index) of 0.748, it reached a total of R\$385,068,345.89 in gross revenue in 2023.

2 MATERIALS AND METHODS

The research was based on a case study, with the aim of assessing the growth potential of the city of Barra do Garças-MT. To do this, the Connected Smart Cities Ranking was used to establish a comparison between the 2022 and 2023 data.

2.1 Smart connected cities classification – RCSC

In introducing the Urban Lab, Urban Systems created the Connected Smart Cities Ranking and, to this end, a comprehensive data survey was carried out since 2014, through exploratory research into the main publications that discuss topics such as smart cities, connected cities, sustainable cities and related themes, both internationally and nationally.

We researched ISO 37122: Sustainable cities and communities - Indicators for smart cities, as well as its Brazilian version, NBR 37122. This standard, made up of 80 indicators, together with ISO 37120, which contains 120 indicators, offers support to cities in choosing metrics for implementing urban management systems, as well as policies, programs and projects aimed at developing smart cities.

In this way, indicators were identified that could be applied to Brazilian soil, specifically at municipal level. After the data collection and analysis phase, which included information available in the Urban Systems archives and data obtained from new research, the stage of segmenting the indicators and assessing their relevance began.

To create the Connected Smart Cities Ranking, a methodology was used that includes the weighting of various indicators, with the application of the Market Quality Index (IQM). In this scenario,

the data collected varies in nature, complexity and units of measurement. The relevance factors are divided into two categories: the analysis factors, which are information extracted from official research institutions or direct contacts, and the relevant factors, which show the ranking of the smartest Brazilian municipalities, as detailed in each analysis. The relevance items make it possible to evaluate the values observed in relation to their importance to the development of a smart city or to a specific aspect of the research. In this way, the calculation of the weighted value of each factor in each location considering the observed value (whether measured or inferred) in one city compared to the maximum and minimum values found in other cities. The mathematical relationship between these values is then multiplied by the weight of relevance assigned to the respective factor (URBAN SYSTEM, 2021).

In addition, the study considers the connectivity between the various sectors analyzed, considering that the development of a given municipality is achieved when there is connectivity between all the sectors. However, the years 2022 and 2023 were chosen to compare the sectors evaluated, considering the thematic axes: Environment (MAM), Technology and Innovation (TIC), Urbanism (URB), Education (EDU), Economy (ECO) and Health (SAU), as they have not undergone any changes in indicators.

In the 2022 edition, data and information was collected from 680 cities, which were evaluated according to the relevance factors, assigned their appropriate weights and then weighted value calculations were carried out. The ratio between the cities evaluated was distributed as follows: 49 with more than 500,000 inhabitants, 277 with more than 100,000 inhabitants and 350 with more than 50,000 inhabitants, to meet the 11 research axes. The 2023 version included 656 cities, made up of: 41 with more than 500mil inhabitants, 278 with more than 100mil inhabitants, and 337 with more than 50 thousand inhabitants.

2.2 Area of Study

Until the 17th century, the Araguaia Valley area was occupied by the Xavante and Bororo indigenous peoples. The town was founded on June 13, 1924. The colonization process really began with navigation on the Araguaia River, during the Paraguayan War. At that time, the president of the province, Couto de Magalhães, realized the importance of establishing a connection between the Prata and Tocantins river basins, thus linking the south to the north through the central region (MORENO, 1999).

The region's population was made up of people from various Brazilian states, motivated by the exploration of the West in search of gold and diamonds. The area was cleared by Marshal Rondon in the middle of the last century, and later by the Villas Boas brothers, sertanistas who, by opening up trails with the help of the Brasil Central Foundation, contributed to the emergence of several towns along the way (MORENO, 1999).

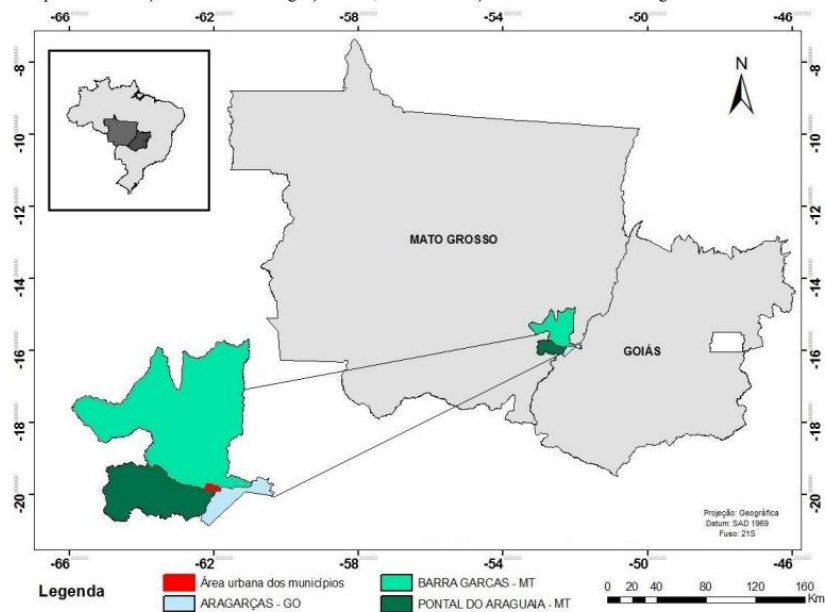
In the 1940s, the seat of the municipality of Araguaiana was moved to Barra do Garças. In this new location, mining stood out as the main economic activity, being carried out in conjunction with agriculture and livestock farming, both aimed at subsistence. This period marked significant growth that culminated in the emancipation of the municipality on September 15, 1948, initially with an area of 212,000 km², later expanded to 273,476 km². At that time, this territory became the largest municipality in the world (MORENO, 1999).

From 1967, with the support of SUDAM, the municipality experienced a third cycle of growth. A significant proportion of the migrants settled in the northern area of the municipality, driven by the current colonization policy, giving rise to new towns such as Água Boa and Canarana, among others.

Today, the urban region of the Araguaia Valley is called Greater Barra, which includes Barra do Garças-MT, Pontal do Araguaia-MT and Aragarças-GO, (MORENO, 1999).

The municipality of Barra do Garças-MT lies at the foot of the Serra Azul, part of the Serra do Roncador, at 318 meters above sea level (SILVA & OLIVEIRA, 2018). It is located in the northeast of the state of Mato Grosso at latitude 15°53'24" south and longitude 52°15'24" west, with a territorial area of 8,363.149km² (IBGE, 2022) and is 515km from Cuiabá-MT. Access to the municipality is via the BR-158 highway, on the border with Aragarças-GO (figure 2).

Figure 2 - Location of Barra do Garças in Mato Grosso - Brazil



Source: REZENDE & ARAÚJO, 2015

The municipality has 53.2% of households with adequate sanitation. In addition, 95.3% of urban homes are located on public roads with trees, and 34.7% of urban homes on public roads have adequate urbanization, i.e. with culverts, sidewalks, paving and curbs. Compared to other municipalities in the state, the municipality ranks 4th out of 142 in terms of sewage disposal, 7th in terms of tree planting and 2nd in terms of urbanization. When compared to other cities in Brazil, its ranking is 2105 out of 5570 in terms of sewage disposal, 861 for tree planting and 980 for urbanization (IBGE, 2022).

The city's infant mortality rate averages 16.02 per 1,000 live births, ranking 50th out of 142 cities. There were 31.8 hospitalizations for diarrhea per 1,000 residents, ranking 53rd out of 142 cities compared to all cities in the state (IBGE, 2022).

According to IBGE statistics, the enrollment rate for children aged 6 to 14, recorded in 2010, was 96.3%, a rate that gave it 95th place out of 142 cities, when compared to others in the state. In terms of IDEB, in 2021, the IDEB for the first years of public primary education online was 5.7 and for the last years it was 4.9. Ranked 34th and 29th out of 142 cities compared to others in the state (IBGE, 2022). Given the importance of the municipality of Barra do Garças in the Araguaia Valley area, it is necessary to analyze its development potential using indicators such as the RCSC.

3. RESULTS AND DISCUSSIONS

This section will present the indicators according to the RCSC for the 2022 and 2023 editions of Barra do Garças-MT, for the following thematic axes and their indicators: Environment (MAM) with 8, Technology and Innovation (ICT) with 6, Urbanism (URB) with 7, Education (EDU) with 11, Economy (ECO) with 7 and Health (SAU) with 6.

The Urban Planning section has 10 indicators, 7 of which are designed for the axis itself (Land Use and Occupation Law, Urban Operations Law, Strategic Master Plan, Temporary Permit [Consultation], Urban Planning Fees, Percentage of Urban Population) Low and medium density, real estate registration). One is for the mobility and accessibility axis (other modes of public transport) and the other 02 is for the environment axis (percentage of urban water and sewage services).

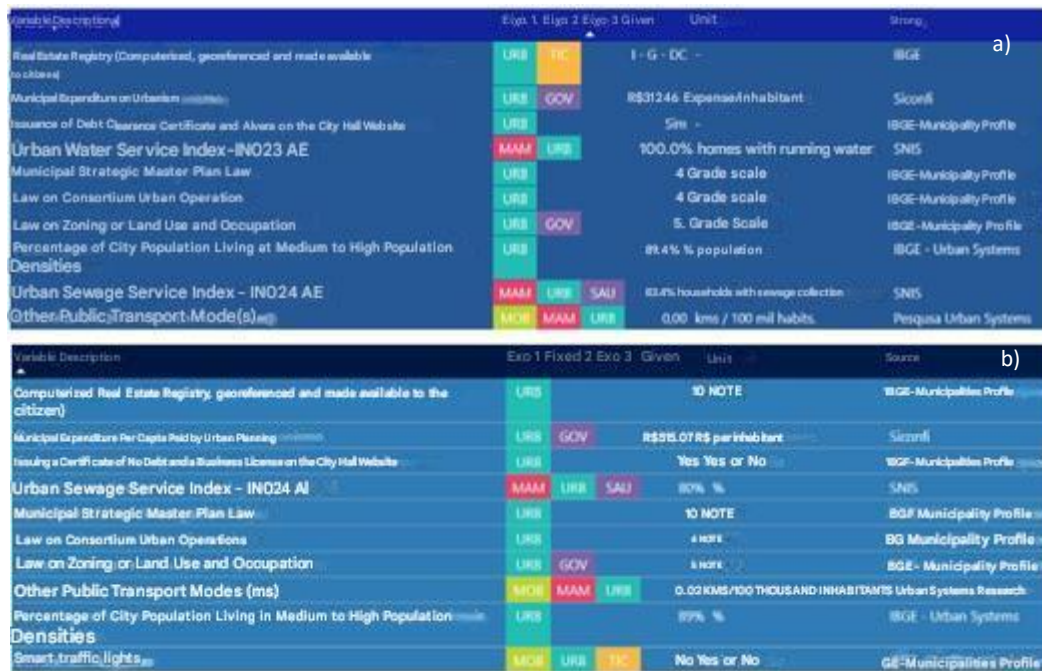
This section has a maximum score of 9.5 points and is made up of the following weights: 1.5 points for urban planning spending per capita (zoning laws, urban operations and strategic planning), 1.0 point for the percentage of the population living with medium and high population density, real estate registry (computerized, georeferenced and provided to citizens), urban water and sewage services. All other indicators are 0.5 points, such as other modes of transport and online license issuance (URBAN SYSTEMS, 2022).

The performance indicators relating to the laws governing urban planning in cities take into account the dates of these laws and are based on two issues: compliance with the requirement to update them, with reviews scheduled every 10 years, and the fact that recent laws are often based on new concepts of urban development, supported by intelligent, sustainable and humane strategies, as well as strategies such as active façades, non-motorized transport and polycentric cities (URBAN SYSTEMS, 2022).

Based on this logic, the municipality has issued permits through the city hall website and a real estate registry (computerized, georeferenced and available to citizens), generating municipal expenditure on urban planning of R\$312.00 per inhabitant in 2022, which increased to R\$515.07 in 2023. The best-placed city in this segment was Santos, with an investment in town planning of R\$ 802.80 in 2022 and R\$ 796.49 in 2023. However, the best-placed small city in this segment was Jaguariúna-SP, with per capita investment of R\$644.99 in 2022 and R\$645.39 in 2023.

However, the scale of scores for the laws on zoning, consortium urban operations and the strategic master plan in 2022 are low, even though they registered an increase in 2023. On the other hand, the percentage of the population of cities living in medium and high population densities is 89% in both years, as shown in figure 3:

Figure 3 - Indicators for the Urbanism axis in 2022 (a) and 2023 (b)



Variable Description	Exo 1	Exo 2	Exo 3	Given	Unit	Source
Real Estate Registry (Computerized, georeferenced and made available to citizens)	URB	TRC			I - G - DC -	IBGE
Municipal Expenditure on Urbanism (milhões)	URB	GOV			R\$31246 Expense/inhabitant	Sizemfi
Issuance of Debt Clearance Certificate and Alvara on the City Hall Website	URB				Sim -	IBGE-Municipality Profile
Urban Water Service Index - INO23 AE	MAM	URB			100.0% homes with running water	SINIS
Municipal Strategic Master Plan Law	URB				4 Grade scale	IBGE-Municipality Profile
Law on Consortium Urban Operation	URB				4 Grade scale	IBGE-Municipality Profile
Law on Zoning or Land Use and Occupation	URB	GOV			5. Grade Scale	IBGE-Municipality Profile
Percentage of City Population Living at Medium to High Population Densities	URB				89.4% % population	IBGE - Urban Systems
Urban Sewage Service Index - INO24 AE	MAM	URB	SAU		82.6% households with sewage collection	SINIS
Other Public Transport Mode(s)	TRC	MAM	URB		0.00 kms / 100 mil habits	Pesquisa Urban Systems

Variable Description	Exo 1	Fixed 2	Exo 3	Given	Unit	Source
Computerized Real Estate Registry, georeferenced and made available to the citizen)	URB				10 NOTE	IBGE-Municipalities Profile
Municipal Expenditure Per Capita Paid by Urban Planning (milhões)	URB	GOV			R\$316.07R\$ perinhabitant	Sizemfi
Issuing a Certificate of No Debt and a Business License on the City Hall Website	URB				Yes Yes or No	IBGE-Municipalities Profile
Urban Sewage Service Index - INO24 AI	MAM	URB	SAU		80% %	SINIS
Municipal Strategic Master Plan Law	URB				10 NOTE	IBGE-Municipality Profile
Law on Consortium Urban Operations	URB				4 note	IBGE-Municipality Profile
Law on Zoning or Land Use and Occupation	URB	GOV			4 note	IBGE-Municipality Profile
Other Public Transport Modes (ms)	TRC	MAM	URB		0.02KMS/100 THOUSAND INHABITANTS	Urban Systems Research
Percentage of City Population Living in Medium to High Population Densities	URB				89% %	IBGE - Urban Systems
Smart traffic lights	TRC	URB	TRC		No Yes or No	IBGE-Municipalities Profiles

Source: Urban Systems

In this segment, the Urbanism axis scored 5.557 in 2022 and 6.270 in 2023, justifying its position outside the 100+ when compared to the municipalities in last place in 2022, such as Catalão - GO, with a score of 6.064 and Candeias-BA, in 2023, with a score of 6.385 in this segment.

The Environment axis is made up of 14 indicators, 8 of which are designed for the axis itself (percentage of urban service and losses in water distribution, sewage treatment, recovery of recyclable materials, percentage of solid waste collection coverage, monitoring of risk areas and percentage of plastic waste recovered). Three for the energy axis (power granted for UFV, wind and biomass energy) and 3 for the mobility and accessibility axis (average age of the vehicle fleet, other modes of public transport, percentage of low-emission vehicles).

The maximum score for this axis is 10 points, made up of the following weights: 0.5 points for the indicators designed for the mobility and accessibility and energy axis; 0.5 points for two of the indicators designed for the environment axis: risk area monitoring and percentage of plastic waste recovered and 1.0 point for the other indicators designed for the environment axis (URBAN SYSTEMS, 2022), as shown in Figure 4.

Three of these indicators measure the entrepreneurship axis (growth of technology companies, technology parks and incubators), two for mobility (electronic ticketing for public transport and intelligent traffic lights), one for urban planning (real estate registry), one that evaluates energy (intelligent lighting system), one for security (control and operations center) and one for governance (citizen service via app or website). The maximum score is 10 points, made up of the following weights: 1.0 point for the indicators designed for the technology and innovation axis, 0.5 point for the indicators designed for the entrepreneurship, security, energy and mobility axis, 0.25 point for the urban planning and governance indicators (URBAN SYSTEMS, 2022).

For the indicators of the axis itself analyzed between the years 2022 and 2023, there was an increase in the average speed of contracted connections, the percentage of formal higher education jobs and the density of fixed broadband. However, there was a decrease in the percentage of jobs in the ICT sector, aggravated by the fact that the municipality does not have 5G coverage and has only four fiber optic operators, as shown in figure 5.

Figure 5 - Indicators for the Technology and Innovation axis in 2022 (a) and 2023 (b)



Source: Urban Systems

The technology and innovation axis obtained a score of 2.536 in 2022 and fell in 2023 with a score of 1.612, far below the last place in the 100+, Porto Velho-GO with a score of 3.180. This measurement may be associated with the lack of registration of the 5G coverage service in the municipality or the low percentage of jobs in the ICT sector, at 1.57%.

On the other hand, the best-placed municipality among small towns was Pato Branco (PR), with a score of 4.481, standing out for having 14.07% of formal jobs in the information and communication technology (ICT) sector, whose average speed of broadband connections contracted was 289.3 mbps and 41.6 inhabitants covered by broadband in 2023 (URBAN SYSTEMS, 2023). In 2022, the municipality that stands out is Jaguariúna (SP), with 24.7% of formal jobs in the information and

communication technology (ICT) sector, with 100% coverage of the population served by the 4G signal and 29.4% of formal jobs held by professionals with higher education (URBAN SYSTEMS, 2022).

The Health axis is made up of 9 indicators, 6 of which are for the axis itself (number of beds and doctors per inhabitant, primary health care, health expenditure, infant mortality and online scheduling in the public network). Two for the environment (percentage of solid waste collection and urban sewage service) and one for mobility and accessibility (cycle paths).

The maximum score in this section is 07 points, made up of the following weights: 0.5 points for the indicators designed for the mobility, accessibility, environment and online appointment scheduling indicators; 1.0 point for the indicators designed for the health axis, being: supply of beds, qualified professionals, care coverage, public investment in the sector and infant mortality (URBAN SYSTEMS, 2022).

Given this, the indicators in the specific axes show an increase in municipal spending on health, as a result of the expansion of the family health team, although there has been an increase in infant mortality and a decrease in beds. When considering the waste collection and sewage indicators, there was a decrease of 82% and 3.4% respectively compared to 2022 (Figure 6).

Figure 6 - Health axis indicators in 2022 (a) and 2023 (b)

Variable Description	ED11	ED22	Edig 3	Given	Unit	Source
Scheduling an appointment in the public health network	SAU			No	-	IBGE
Cicloviária	MOB	SAU			0,00 kms / 100 mil habits.	Pesquisa Urban Systems
Waste Collection Service Coverage - IN015_RS	MAM	SAU			98,1% of homes served	SNIS
Per Capita Health Expenditure	SAU	GOV			R\$1,581.9 Expense/inhabitant	Siconfi
Beds/Thousand Inhabitants	SAU				1,93 Beds/thousand inhabitants	Datasus
Doctors/100,000 inhabitants	SAU				260,93 doctors/100 thousand inhabitants.	CNES
Deaths/Thousand Live Births (Place of Residence)	SAU	GOV			11,9 Deaths/thousand live births	Datasus
Percentage of Population Coverage of the Family Health Team	SAU				0,2% % of the population	Datasus
Urban Sewage Service Index - IN024_AE	MAM	URB	SAU		83,6% of households with sewage collection.	SNIS

Variable Description	Axis 1	Axis 2	Axis 3	Given	Unit	Source
Scheduling an appointment in the public health network	SAU			No	-	IBGE - Municípios Profile
Cycle paths	MOB	SAU			0,00 Km/100 THOUSAND INHABITANTS	Urban Systems Research
Waste Collection Service Coverage - IN015_RS	MAM	SAU			16% %	SNIS
Municipal Expenditure Per Capita Paid for Health	SAU	GOV			R\$1,600.04 R\$ per inhabitant	Siconfi
Urban Sewage Service Index - IN024_AE	MAM	URB	SAU		80% %	SNIS
Beds/Thousand Inhabitants	SAU				1,62 beds/1,000 inhabitants	Datasus
Doctors/100,000 inhabitants	SAU				20920 doctors/100 thousand inhabitants	CNES
Deaths/Thousand Live Births (Place of Residence)	SAU	GOV			17,8 deaths/1,000 live births	Datasus
Percentage of Population Coverage of the Family Health Team	SAU				100,0% %	MEU

Source: Urban Systems

In terms of health, the score was 4.493 in 2022 and fell in 2023, with a score of 3.179, which may be related to a reduction in the number of beds available and an increase in infant mortality. In this sense, the best-placed municipality between 50 and 100 thousand inhabitants in 2023 was Itapira (SP) with a score of 5.046, standing out for having 274.9 doctors per hundred thousand inhabitants, per capita investment in health of around R\$1,152.22 and an infant mortality rate of 4.5 per thousand live births (URBAN SYSTEMS, 2023).

In the Education axis, made up of 12 indicators, 11 of them are designed for the specific axis (public university places, ENEM average, teachers with higher education, IDEB, dropout rate, average number of students per class, education expenditure, average daily class hour, computer/student, workforce employed in the EDU sector and school enrollment in the public network) and 1 for the technology and innovation axis (percentage of formal higher education jobs). The maximum score in this section is 12 points, 1.0 point for each indicator (URBAN SYSTEMS, 2022).

Therefore, comparing the main indicators, an increase in education expenses of R\$538.01 per inhabitant is noted. In the public school ENEM average, the score is 20.4 points and in the IDEB score (final years of public school) it reaches 4.9. However, there is an increase in the dropout rate in the 1st phase of public secondary education, which is 6.70%, although it maintains an average of 24 students per class in the 9th year of public primary education, as shown in figure 7.

Figure 7 – Education axis indicators in 2022 (a) and 2023 (b)

Variable Description	EO1	Axis 2	Axis 3	Given	Unit	Source
Per Capita Expenditure Paid for Education	EDU	GOV			R\$699.27 Expense/inhabitant	Siconfi
Ideb (Final Years) - Public	EDU				4.5 Rating	INEP
Online public school enrollment	EDU				No	IBGE
Average Number of Students Per Class	EDU				24.2 students	INEP
Average Daily Class Hours (Public - 9th Grade)	EDU				42 hours	INEP
Enem Average - Public School Students	EDU				309.3 Average grade	INEP
Number of Computers, Laptops, Tablets or Other Digital Learning Devices Available Per 1000 Students	EDU	ECO			03 per thousand students	INEP
Percentage of the Workforce Employed in the Education and R&D Sector	EDU	ECO			3.82% % of total for mal jobs	RAIS
Percentage of High School Teachers Who Have Higher Education	EDU				83.0% of teachers on secondary school having post-higher education	INEP
Percentage of Formal Workers with Higher Education	TRC	EDU			17.9% % of formal jobs	RAIS
Dropout Rate (1st High School - Public)	EDU				2.90% of 1st year public high school students	INEP
Vagas em Alta Paulista em 2022	EDU				10.44/housand inhabitants aged 18;	INEP / IBGE

Variable Description	EO1	Axis 2	Axis 3	Data	Unit	Source
Municipal Expenditure Per Capita Paid for Education	EDU	GOV			R\$1237.25 per inhabitant	Siconfi
Ideb (Final Years) - Public	EDU				4.9 RATINGS	INEP
Online school enrollment in the public school system	EDU				No Yes cu No	IBGE - Municipality Profile
Average number of students per class	EDU				24.0 Average	INEP
Average Daily Class Hours (Public - 9th Grade)	EDU				4.4 hours	INEP
Enem Average - Public School Students	EDU				409.7 Average	INEP
Number of Computers, Laptops, Tablets or Other Digital Learning Devices Available Per 1000 Students	EDU	ECO			40.9 devices/1000 INEP students	INEP
Percentage of the Workforce Employed in the Education and R&D Sector	EDU	ECO			3.71% %	RAIS
Percentage of High School Teachers Who Have Higher Education	EDU				90.90% %	INEP
Percentage of Formal Workers with Higher Education	TRC	EDU			18.0% %	RAIS
Dropout Rate (1st High School - Public)	EDU				6.70% %	INEP
Vagas em Alta Paulista em 2023	EDU				12.51	INEP / IBGE

Source: Urban Systems

In this way, the maximum score obtained for this axis was 3.502, in 2022 and 4.386, in 2023 relative to the 12 total points. Consequently, the municipality is left out of the 100+ in both years, as the last placed in 2022 was the municipality of Registro -SP with a score of 4.729 and, in 2023, the municipality of Rio de Janeiro-RJ with 5.33 points. It is worth mentioning that the municipality best positioned among small cities in both years was Mineiros-GO with a score of 6.5, highlighted by offering more than 100 places in public universities per thousand inhabitants of PEA age and with a dropout rate in the 1st year of high school of between 0.2 and 0.3%.

In the Economy axis, composed of 14 indicators, 7 of them are designed for the axis itself (growth in GDP per capita, average income of formal workers, growth of companies and jobs,

independence of jobs by sector, employability and municipal revenue not arising from transfers); 3 of them focus on the entrepreneurship axis (growth of technology companies, creative economy and MEI's); 2 deal with the education axis (computer per student and workforce employed in the EDU sector); 1 evaluates the technology and innovation axis (percentage of jobs in the ICT sector) and 1 for the mobility axis (airline destinations). The maximum score in this section is 14 points: distributed with 1.0 points for each of the indicators (URBAN SYSTEMS, 2022).

Therefore, regarding the Independence of the public sector, the best record was in 2022 with 89.51%. The other indicators were better evaluated in 2023, with 8.1% growth in GDP per capita, 4.2% in job growth, and the average income of formal workers was R\$ 2,453.96, the employment index per inhabitants was 1.43 formal jobs and the growth in the number of companies was 5.09%, in addition to 30.25% of revenue not arising from transfers, as shown in figure 8.

Figure 8 – Economy axis indicators in 2022 (a) and 2023 (b)

Indicator	Eixo 1	Eixo 2	Axis 3	Data	Unit	Source
Growth in the Number of Jobs	ECO			0.16%	% of the number of jobs	CAGED
Number of airports with regular flights within a 100 km radius	MOB		ECO	0	Airports (100 km radius)	Horans
GDP Per Capta Growth	ECO			7.33%	% growth	IBGE
Number of Computers, Laptops, Tablets or Other Devices Digital Learning Resources Available Per 1000 Students	EDU	ECO		0.3	per thousand students	INEP
Growth in the number of MEIs	EMP	ECO		19.41%	business growth	Entrepreneur Portal
Growth of Creative Economy Companies	EMP	ECO		-12.50%	business growth	RAIS
Growth of Technology Companies	EMP	TIC	ECO	25.00%	business growth	RAIS
Growth in the Number of Companies	ECO			-1.87%	% of the number of companies	RAIS
Public Sector Independence	ECO			89.51%	of jobs in the private sector	RAIS
Percentage of the Workforce Employed in the Education and R&D Sector	EDU	ECO		3.82%	% of total formal jobs	RAIS
Percentage of the Workforce Employed in the ICT Sector	TIC	ECO		1.59%	% of total formal jobs	RAIS
Average Income of Formal Workers	ECO			R\$2,453.96	average monthly income	RAIS
Employability (Jobs/PEA)	ECO			0.34	jobs per working-age population	RAIS/IBGE
Total Revenue Not From Transfers	ECO			23.06%	of revenue not coming from Siconfi transfers	

Indicator	ED11	ED2 2	Axis 3	Given	Unit	Source
Growth of Creative Economy Companies	EMP	ECO		12.86%	%	RAIS
Growth of Technology Companies	EMP	TIC	ECO	0.0%	%	RAIS
Growth in the number of MEIs	EMP	ECO		14.1%	%	Entrepreneur Portal
Growth in the Number of Jobs	ECO			4.2%	%	CAGED
Growth in the Number of Companies	ECO			5.09%	%	RAIS
GDP Per Capta Growth	ECO			8.1%	%	IBGE
Employability (Jobs/PEA)	ECO			0.32	people/job	RAIS / IBGE
Public Sector Independence	ECO			0.89%	%	RAIS
Number of airports with regular flights within a 100 km radius	MOB	GOV	ECO	0	Airports	Horans
Number of Computers, Laptops, Tablets or Other Digital Learning Devices Available Per 1000 Students	EDU	ECO		40.9	devices/1000 INEP students	
Number of Technology Parks	EMP	TIC	ECO		The Parks	MCTI- 2023 inovated
Percentage of vehicles registered in the city that are low-emission vehicles	MOB	MAM	ECO	0.06%	% of total	Denatran
Percentage of the Workforce Employed in the Education and R&D Sector	EDU	ECO		3.71%	%	RAIS
Percentage of the Workforce Employed in the ICT Sector	TIC	ECO		1.57%	%	RAIS
Total Revenue Not From Transfers	ECO			30.25%		Siconfi
Average Income of Formal Workers	ECO			R\$2,453.96	R\$	RAIS

Source: Urban Systems

If considered that this cut-off encompasses indicators related to the population's income, economic growth of different sectors, economic sustainability of the municipality, source of revenue and proportion of the number of jobs available, the maximum scores of 3.695 in 2022 and 4.877 in 2023 were given. a total of 14 points.

However, it is necessary to consider that the best positioned city was São Paulo-SP with a maximum score of 6.655, in 2022, and Barueri-SP with 8.242, in 2023. In relation to the best positioned among cities with 50 to 100 thousand inhabitants, in 2022, it was Jaguariúna (SP) recording 5,694 points, with a 7.21% increase in job offers and 93.2% independence from the public sector. In 2023 it was Navegantes-SP's turn, recording 7,513 points, standing out for presenting 13.92% growth in the number of jobs and 11.42% growth in the number of companies.

From this perspective, the axes with the worst performance when comparing the scores of the municipalities in 100th position in the years evaluated were: environment, technology and innovation, and economy, approximately 2 points less. However, in the urbanism, health and education axes, they showed records closer to the last positions.

It is worth mentioning that in some indicators, among specific sections, the scores were very close to those of the best positioned small cities, as can be seen in the urbanism axis, where municipal expenditure on urbanism, in 2023, was R\$ 515.07 per inhabitant and the best positioned was Jaguariúna -SP with R\$ 645.39 in the same period. In the environment axis, in 2022, there was a record of 98.1% of household waste collection in Francisco Beltrão-PR and 99.7% in 2023.

4. FINAL CONSIDERATIONS

The RCSC aims to map the cities with the greatest development potential in Brazil, based on indicators that qualify the most intelligent and connected cities in the country. In the 2022 edition, the Central-West region was in 30th position and Barra do Garças -MT recorded a score of 25.057, with a fall in grade in 2023, with a total of 23.741, remaining outside the 100+ in all indicators in both editions.

The results obtained from the RCSC for Barra do Garças-MT of comparative data from 2022 and 2023 according to the thematic axes and their indicators with the worst performance were: environment, technology and innovation and economy. Regarding the environment, it obtained a score of 3.879 in 2022 and 2.911 in 2023, with the maximum score being 10. This result may be related to losses in water distribution and treatment. When considering the Technology and Innovation axis where the maximum score is 10 points, the municipality obtained a score of 2.536 in 2022 and recorded a score of 1.612 in 2023. This result may be associated with the lack of registration of the 5G coverage service in the municipality or the low percentage of jobs in the ICT sector, at 1.57%. Finally, the economy section received the maximum score of 3.695 in 2022 and 4.877 in 2023 out of a total of 14 points, being influenced by the scores obtained in the following indicators: 4.2% in job growth, the jobs per inhabitants was 1.43 formal jobs and 5.09% growth in the number of companies.

On the other hand, the sections, with scores closer to small cities, the best positioned are: urbanism, health and education. In the urbanism axis, the maximum score of 9.5 points, however, it obtained a score of 5.557, in 2022 and 6.270, in 2023, associated with the issuance of a permit through the city hall website and real estate registry, generating a municipal expenditure on urbanism of R\$312,00, in 2022, to R\$515.07 in 2023. However, the small city best positioned on this axis was Jaguariúna (SP), with per capita investment of R\$ 644.99, in 2022, and R\$ 645.39, in 2023. Regarding health, whose maximum score is 07 points, it obtained a score of 4.493 in 2022 and recorded a drop in 2023, with a score of 3.179. In this sense, the best positioned municipality between 50 and 100 thousand inhabitants, in 2023, was Itapira (SP) with a score of 5.046. Regarding the education axis, the maximum score obtained was 3.502, in 2022 and 4.386, in 2023 relative to the 12 total points. It is worth

mentioning that the municipality best positioned among small cities in both years was Mineiros (GO) with a score of 6.5.

In this way, it is possible to infer that the rates in Barra do Garças-MT are still very far from the best positioned municipalities among small cities. However, it is from these indicators that, if used as decision makers by public management, it will be possible to outline strategies to improve performance in each axis, in the search for an intelligent and sustainable city, which can support the 8 surrounding cities of the municipality that constitutes Vale do Araguaia in the portion of the state of Mato Grosso.

5 BIBLIOGRAPHIC REFERENCES

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS (ABNT). NBR ISO 37122 Versão Corrigida - 2021: Cidades e comunidades sustentáveis - Indicadores para cidades inteligentes. Rio de Janeiro: ABNT, 2021.

GRETZEL, U.; SIGALA, M.; XIANG, Z.; & KOO, C. (2015). Smart tourism: Foundations and developments. *Electronic Markets*, 25(3), 179-188.

Instituto Brasileiro de Geografia e Estatística (IBGE). Disponível em: <https://www.ibge.gov.br/cidades-e-estados/mt/barra-do-garcas.html>

MORENO, G. O Processo histórico de acesso à terra em Mato Grosso. *Geosul*, Florianópolis, v. 14, n. 27, p.67-90, jan-jun. 1999.

NICK, G.; PONGRÁCZ, F.; RADÁCS, E. Interpretation of Disruptive Innovation in the Era of Smart Cities of the Fourth Industrial Revolution. *Deturope*, Vol. 10, No. 1, 2018, p. 53-70.

OLIVEIRA, J. G. A aplicação dos indicadores para medições do nível de desenvolvimento dos municípios na periferia metropolitana de Brasília sob a temática de cidades inteligentes: uma abordagem para a gestão municipal. Brasília, 2023. 203f. **Dissertação** (Mestrado em Economia do Setor Público) – Departamento de Economia. Faculdade de Administração, Contabilidade e Economia, Universidade Nacional de Brasília. Brasília, 2023.

Organização das Nações Unidas (ONU). Disponível em: <https://news.un.org/pt/story/2019/02/166070>.

REZENDE, G. B. M.; ARAÚJO, S. M. S. Análise da taxa de impermeabilização e tempo de concentração nas sub-bacias da área urbana de Barra do Garças-MT, Pontal do Araguaia-MT e Aragarças -GO. *Revista Verde de Agroecologia e desenvolvimento sustentável*. V. 10, n. 5, p. 27-37, dez. 2015. ISSN 1981-8203 DOI: : <http://dx.doi.org/10.18378/rvads.v10i5.3727>

SANTOS, L. H. B.; SANTOS, J. F.; SILVA, K. S.; MANITO, A. R. A.; LOBATO, E. P.; FONSECA, W. S.; SILVA, M. O. Cidade Inteligente: análise da evolução dos indicadores de uma Cidade Universitária da região norte a partir da ISO 37122:2020. In: Conference: 2023 15th IEEE International Conference on Industry Applications (**INDUSCON**). 2023. ISBN 979-8-3503-1418-2

SILVA, B. A.; OLIVEIRA, M. F. Ser (Tão) Imaginado: História e Natureza na Ocupação da Região de Aragarças (GO)/Barra do Garças (MT). *HALAC – Historia Ambiental, Latinoamericana y Caribeña*. v.8, n.2 (2018). p. 73-90. ISSN 2237-2717.

Unidade de Assessoria Institucional do Sebrae Nacional (UARI). 2017. Smart Cities – Cidades Inteligentes.

QUINQUIOLO, L.; FIÚZA, A. L. C. Migração e Configuração das Territorialidades no Vale do Araguaia – MT. *Boletim de Pesquisas do Programa de Pós-Graduação em Extensão Rural*. 2016

RANKING Connected Smart Cities. 2022. Disponível em: <https://ranking.connectedsmartcities.com.br/>

RANKING Connected Smart Cities. 2023. Disponível em: <https://ranking.connectedsmartcities.com.br/>

DECLARATIONS



CONTRIBUTION OF EACH AUTHOR

To describe each author's participation in the manuscript, please use the following criteria:

- **Study Conception and Design:** Rosana Lia Ravache
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CONFLICT OF INTEREST STATEMENT

We, Rosana Lia Ravache and Diana Carolina Jesus de Paula, declare that the manuscript titled "*Barra do Garças-MT: Perspectives from the Connected Smart Cities Ranking*" adheres to the following:

1. **Financial Links:**
 - We have no financial ties that could influence the results or interpretation of this work. No institution or funding entity was involved in the development of this study.
2. **Professional Relationships:**
 - We have no professional relationships that could impact the analysis, interpretation, or presentation of the results. No relevant professional relationships to the content of this manuscript were established.
3. **Personal Conflicts:**
 - We have no personal conflicts of interest related to the content of the manuscript. No personal conflicts related to the content were identified.