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Incorporation of Sustainability Criteria in the Developments of the Minha Casa, Minha Vida Program in São Gonçalo/RJ

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ISSN 2318-8472, v. 13, n. 88, 2025

Incorporação de Critérios de Sustentabilidade nos Empreendimentos do Programa Minha Casa, Minha Vida em São Gonçalo/RJ

RESUMO

Objetivo – Analisar a incorporação de critérios de sustentabilidade ambiental em projetos habitacionais do Programa Minha Casa Minha Vida (PMCMV) no município de São Gonçalo (RJ), entre 2012 e 2022, com foco em sua relação com a indústria da construção civil e as diretrizes de arquitetura bioclimática, conforto térmico e eficiência energética.

Metodologia – O estudo baseia-se em revisão bibliográfica sobre sustentabilidade na construção civil, análise de dispositivos legais e normativos do PMCMV, e exame documental de Relatórios de Impacto de Vizinhança (RIV) e Estudos de Impacto de Vizinhança (EIV) apresentados ao poder público municipal pelos empreendimentos analisados. A investigação concentrou-se em cinco variáveis representativas de impacto ambiental no setor da construção: (i) previsão de destinação de resíduos sólidos; (ii) adequabilidade dessas destinações quando previstas; (iii) previsão de ações mitigadoras da poluição atmosférica; (iv) adequabilidade dessas ações; e (v) previsão de medidas mitigadoras do aumento da temperatura local.

Originalidade/relevância – O trabalho contribui para o debate sobre sustentabilidade ambiental em programas habitacionais de grande escala, revelando a importância da normatização para a efetividade das medidas mitigadoras em projetos de habitação popular.

Resultados – Os dados indicam que os empreendimentos analisados tendem a apresentar maior aderência às medidas mitigadoras de impacto ambiental quando estas estão claramente previstas em dispositivos legais e normativos. Em contrapartida, na ausência de regulamentações específicas, as empresas demonstram menor iniciativa em reconhecer e aplicar ações sustentáveis.

Contribuições teóricas/metodológicas – A pesquisa propõe uma abordagem crítica para avaliar a eficácia dos marcos normativos no incentivo à sustentabilidade ambiental na habitação social, além de oferecer uma metodologia replicável para análise de EIVs e RIVs no contexto urbano.

Contribuições sociais e ambientais – Ao discutir a efetividade das práticas sustentáveis no PMCMV, o estudo oferece subsídios para o aprimoramento de políticas públicas de habitação e para a promoção de cidades mais resilientes e ambientalmente responsáveis.

PALAVRAS-CHAVE: Sustentabilidade. Construção Civil. Programa Minha Casa Minha Vida.

Incorporation of Sustainability Criteria in the Minha Casa, Minha Vida Program Developments in São Gonçalo/RJ

ABSTRACT

Objective – To analyze the incorporation of environmental sustainability criteria in housing projects of the Minha Casa Minha Vida Program (PMCMV) in the municipality of São Gonçalo (RJ), between 2012 and 2022, focusing on its relationship with the construction industry and the principles of bioclimatic architecture, thermal comfort, and energy efficiency.

Methodology – The study is based on a literature review on sustainability in civil construction, analysis of legal and regulatory instruments related to the PMCMV, and document analysis of Neighborhood Impact Reports (RIV) and Neighborhood Impact Studies (EIV) submitted by the developments to the municipal authorities. The investigation focused on five variables representative of environmental impact in the construction sector: (i) planned disposal of solid waste; (ii) adequacy of disposal methods when provided; (iii) proposed measures to mitigate air pollution; (iv) adequacy of these measures; and (v) planned actions to mitigate the increase in local temperature.

Originality/relevance – This work contributes to the discussion on environmental sustainability in large-scale housing programs, highlighting the importance of regulations in ensuring the effectiveness of mitigation measures in social housing projects.

Results – The data indicate that the developments analyzed are more compliant with environmental mitigation measures when these are clearly established in legal and regulatory frameworks. In contrast, in the absence of specific guidelines, companies tend to be less proactive in identifying and implementing sustainable actions.

GC Revista Nacional de Gerenciamento de Cidades
National Journal of City Management

ISSN 2318-8472, v. 13, n. 88, 2025

Theoretical/methodological contributions – The research proposes a critical approach to evaluate the effectiveness of normative frameworks in promoting environmental sustainability in social housing. It also presents a replicable methodology for analyzing EIVs and RIVs in the urban context.
Social and environmental contributions – By discussing the effectiveness of sustainable practices in the PMCMV, the study offers insights for the improvement of public housing policies and the promotion of more resilient and environmentally responsible cities.

KEYWORDS: Sustainability. Civil Construction. Minha Casa Minha Vida Program.

Incorporación de Criterios de Sostenibilidad en los Proyectos del Programa Minha Casa, Minha Vida en São Gonçalo/RJ

RESUMEN
Objetivo – Analizar la incorporación de criterios de sostenibilidad ambiental en los proyectos habitacionales del Programa Minha Casa Minha Vida (PMCMV) en el municipio de São Gonçalo (RJ), entre 2012 y 2022, con énfasis en su relación con la industria de la construcción y las directrices de arquitectura bioclimática, confort térmico y eficiencia energética.
Metodología – El estudio se basa en una revisión bibliográfica sobre sostenibilidad en la construcción civil, análisis de instrumentos legales y normativos relacionados con el PMCMV, y análisis documental de los Informes de Impacto de Vecindad (RIV) y Estudios de Impacto de Vecindad (EIV) presentados por los proyectos al poder público municipal. La investigación se centró en cinco variables representativas del impacto ambiental en el sector de la construcción: (i) previsión para la disposición de residuos sólidos; (ii) adecuación de estas disposiciones cuando están previstas; (iii) previsión de acciones para mitigar la contaminación atmosférica; (iv) adecuación de estas acciones; y (v) previsión de medidas para mitigar el aumento de la temperatura local.
Originalidad/relevancia – El trabajo contribuye al debate sobre la sostenibilidad ambiental en programas habitacionales de gran escala, revelando la importancia de la normatividad para la efectividad de las medidas de mitigación en proyectos de vivienda social.
Resultados – Los datos indican que los proyectos analizados tienden a adherirse más a las medidas de mitigación ambiental cuando estas están claramente definidas por normativas legales. Por el contrario, en ausencia de especificaciones normativas, las empresas muestran menor iniciativa en el reconocimiento y la implementación de acciones sostenibles.
Contribuciones teóricas/metodológicas – La investigación propone un enfoque crítico para evaluar la eficacia de los marcos normativos en la promoción de la sostenibilidad ambiental en la vivienda social, además de ofrecer una metodología replicable para el análisis de EIV y RIV en contextos urbanos.
Contribuciones sociales y ambientales – Al abordar la efectividad de las prácticas sostenibles en el PMCMV, el estudio aporta elementos para el perfeccionamiento de las políticas públicas de vivienda y para la promoción de ciudades más resilientes y ambientalmente responsables.

PALABRAS CLAVE: Sostenibilidad. Construcción Civil. Programa Minha Casa Minha Vida.

GC Revista Nacional de Gerenciamento de Cidades
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1 INTRODUCTION

For a long time, nature was seen as a commodity and an inexhaustible source of resources to meet human needs. The slow pace (in more remote times) of its appropriation has made possible that this way of thinking remained valid for a long period, even with the advent of the capitalist mode of production: nature always seen as an "object" for humanity and a never-ending source of (natural) resources.

This view has prevailed until much of the 20th century, when the environmental problems and negative impacts associated with an intense exploitation of natural resources, strongly tied to the intensification of industrial activity and consumption, started to be noticeable.

A milestone in this perception, in international terms, was the occasion, in 1972, of the Stockholm Conference, which made clear for the world the limitedness of natural resources and that the manner and the pace they had been exploited at the time would lead to the unsustainability of the planet.

In this initial moment (of gestating the environmental "question" in the 1960/70's), the broad dissemination of the negative consequences of the industrialization process over the environment has forced the recognition (not without resistance) and the need for responses by part of the international community towards remediating the problem. Such recognition and responses indicatives were substantiated in the report titled "The Limits to Growth", prepared by the Club of Rome following a conference of its member countries in 1971 and published in 1972. The report advocated for a clear necessity of limiting the industrial-economic growth as a means of halting environmental impacts.

Also in 1972, the Stockholm Conference takes place and gets to discuss the analyses, propositions, and recommendations present in the report made by the Club of Rome, contesting them unequivocally. After the Conference's discussions, it was interpreted that the scope presented by the Club of Rome (of growth limiting) was unsustainable from the perspective of capitalism, given the premises/requirements of limiting growth and development and that, therefore, a conciliatory approach was needed.

It's with the Stockholm Conference that the debate about environmental sustainability gains global scale and discussion forums at international level, or at least within the scope of the United Nations (like the United Nations Environment Programme or the World Commission on Environment and Development, UNEP and WCED, respectively).

The conciliatory tone between industrial-economic growth and environmental sustainability gains more and more space at international forums. Therefore, it doesn't take long for the articulation of the international community towards regulation strategies and conciliation of industrial development and consumption growth articulated with environmental impact mitigation, evoking inclusively social arguments.

In this context, in 1987, under the auspices of the WCED, the Brundtland Report, also known as "Our Common Future", is published. Although it has criticized the development model of core countries, highlighting that such model shouldn't be applied on periphery countries due to its high environmental impact, the Report brought as one of its premises the idea that the continuous industrial development and technical progress could offer viable alternatives for

ISSN 2318-8472, v. 13, n. 88, 2025

environmental preservation, without the need of limiting growth (as long as with control and the use of new technologies). In other words, the coexistence of industrial-economic development and environmental crisis was not just acceptable but would also create, in a political consensus context, a new model of capitalist economic development, in which technical progress and more "responsible" market practices would be enough to solve the environmental issue that became prominent.

In its content, the Brundtland Report brought the concept of sustainable development as the one that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). It was not exactly a new idea, since it brought back, although unintentionally, the ideas of Carlos Georg Ludwig Harting, who in 1795 coined, for that historical context, the phrase that has since become a cornerstone of sustainability: "[…] use the forests in such a way that the future generations have the same benefits as the current one" (Boff apud Harting, 2012 *[free translation]*).

It's worth noting that the Report pointed out poverty as highly polluting, a reason for underdevelopment to be quickly overcome. There was an argument for the continuity of the leading role of growth and industrial-economic development in core countries, as a way of supplanting the underdevelopment of the peripheral ones, strongly dependent on the first. That is, it brought a conciliatory tone between industrial-economic growth and environmental preservation, under the umbrella of sustainable development, which ended to be widely susceptible to different interpretations and interests, what would make it difficult to be implemented.

From an eco-technocratic perspective, the concept of sustainable development could be applied through the implementation of management and control tools, relying on environmental planning and managing devices, what demands certain centralization and control by the State, hence bringing along political implications.

It's valid to highlight that following these initial forums, many international conferences and meetings were held, establishing sustainability goals to be achieved by the signatory countries of the agreements made in these conferences, such as Eco-92 (or Rio-92), Rio+10 (in 2002), Rio+20 (in 2012), and the Conference of the Parties (COPs)[1].

Currently, two goals are being promoted: the 2015 one, with the 2030 Agenda, which established the 17 SDGs – Sustainable Development Goals (Figure 1) to safeguard the planet's life, seeking to mitigate social inequity through quality education, good health and well-being, and the eradication of poverty (UN, 2015); and the 2020 one, where the Climate Ambition Summit gathered to reactivate the Paris Agreement, having as headline reaching the goal of net-zero emissions until 2050.

[1] The COPs are more frequent meetings, held by the United Nations Framework Convention on Climate Change. Among some of the most important COPs are COP-3, which resulted in the Kyoto Protocol (1997), and COP-21, which resulted in the Paris Agreement (2015). Brazil is going to host the next conference in 2025 – COP-30, in Belém/PA.

GC Revista Nacional de Gerenciamento de Cidades
National Journal of City Management

ISSN 2318-8472, v. 13, n. 88, 2025

Figure 1 - The 17 SDGs – Sustainable Development Goals

Source: UN (2024).

Thus, actions in favor of sustainable development gain momentum globally, being reinforced, day by day, by the unequivocal signs sent by extreme weather events that, in turn, announce substantial alterations in the planet's climatic conditions – the climate change. Such actions and concerns end up being embraced not only by governmental spheres, but also by diverse economic sectors (not just industrial ones) and by daily life.

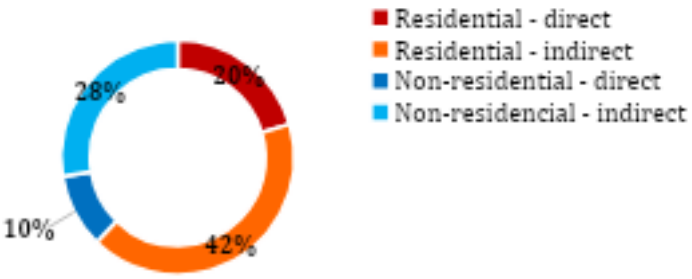
Pointed out as the economic sector that responds for a significant share of environmental impacts in global scale, from expressive carbon consumption to excessive solid waste generation, the construction industry does not escape the movement towards greater sustainability and, for this very reason, starts to play an important role in the mitigation of environmental impacts – whether creating specific discussion forums for implementation of better practices or promoting evaluation processes for buildings concerning energy consumption and efficiency, and sustainability, with the creation of environmental labels and certifications.

Data from the International Energy Agency (IEA) for the year 2022, provided by the Brazilian company Centro de Tecnologia de Edificações – CTE (Center for Building Technology, in a free translation), indicates that buildings are responsible for about 33.4% of global carbon emissions. Of this amount, 62% come from residential buildings, including direct emissions (controllable by the sector/enterprise) and indirect emissions (figure 2). The data also reveals that, historically, residential buildings were the ones that had the least alterations in carbon emission into the atmosphere, maintaining high percentages when compared to the other buildings.

It should be clear that these emissions relate both to the production process and to the occupied building, in a way that choices made during the production process and, especially, in design decisions (regarding materials, site planning, active or passive environmental comfort strategies, etc.) contribute to either increasing or reducing the buildings' share in global carbon emissions.

ISSN 2318-8472, v. 13, n. 88, 2025

Figure 2 - Contribution of carbon emissions from the construction industry by building typology.



Source: Prepared by the authors using CTE data (2022).

The construction sector is also indicated as one of the largest generators of solid waste. The volume of debris generated by the construction and demolition of buildings (*Resíduos da Construção Civil* – RCC) gets to be twice as large as the volume of urban solid waste, and represents around 60% of the total waste produced by cities (AECWEB, 2014).

In terms of waste along with environmental damage, the construction sector also stands out negatively. It is estimated that around 56% of cement, 44% of sand, 30% of gypsum, 27% of conductors, and 15% of PVC tubes and electrical conduits, considering physical losses, are wasted at construction sites (Reis, 2001). Among these wastes, there is also the concern about the exploitation of the most limited reserves in Brazil, such as copper; thus, there is need for long-distance transportation.

Therefore, the expansion of the construction sector and the increasing visibility of the sustainability topic have led to an equally increasing incorporation of building methods at construction sites that aim to mitigate the environmental impacts that, according to Bastos and Barros (2015), promote well-being and social-environmental justice, while also integrating cultural specificities of the region where the project is implemented, thus committing to the establishing of the pillars of sustainable development. Such movement is accompanied by the implementation of environment-oriented public policies.

Data from PAIC (*Pesquisa Anual da Indústria da Construção* – or Annual Survey of the Construction Industry, in a free translation) for the year 2019, released by IBGE in 2021, showed that 25.7% of construction projects concentrated on residential properties, ranking first among construction typologies and surpassing the traditional infrastructure niche (16.2%), which had held the lead until the year 2010, when it represented 42% of the total. PAIC also highlights the growth of mortgage credit and popular housing programs, such as the Minha Casa Minha Vida program (PMCMV), currently named Casa Verde e Amarela, existing at the time, which, along with the increase in families' purchase power, amplified residential construction all over the country.

In the light of the above and given the importance of the residential niche within the construction sector, the present work aims to bring the partial results of ongoing research, regarding the incorporation and application of the concept of sustainability in residential projects financed with public resources from the PMCMV.

ISSN 2318-8472, v. 13, n. 88, 2025

The spatial-temporal scope covers PMCMV projects implemented in the city of São Gonçalo, located in the Metropolitan Region of Rio de Janeiro (RMRJ), from 2012 to 2022.

2 OBJECTIVE

The general objective of this research extract is to analyze the incorporation of sustainability criteria in PMCMV projects in the municipality of São Gonçalo/RJ, during their implementation phases, from 2012 to 2022, considering five main variables related to the developments' project and construction: (i) provision for destination for the construction solid waste; (ii) adequacy of these destinations when provisioned; (iii) provision for mitigation actions against atmospheric pollution due to construction; (iv) adequacy of these actions when provisioned; and (v) provision for measures to mitigate local temperature increase (local microclimate).

It also seeks to contribute to discussions within the thematic axis of Bioclimatic Architecture, Thermal Comfort, and Energy Efficiency.

3 METHODOLOGY

Methodologically, this work is based on revisiting the literature related to sustainability applied to construction, legal instruments related to the implementation of the PMCMV at national and local levels, and on documental analysis of the RIV (*Relatórios de Impacto de Vizinhança* – or Neighborhood Impact Reports, in a free translation) and the EIV (*Estudos de Impacto de Vizinhança* – or Neighborhood Impact Studies, in a free translation), presented by the developments within this study's spatial scope to the municipal administration of São Gonçalo/RJ. These documents were analyzed in light of legal demands and the sustainability criteria established for this analysis: the provision and adequacy of the developments' solid waste disposal; the provision and adequacy of mitigation actions against atmospheric pollution during construction; and the predictability of mitigation actions against local microclimate alteration, especially temperature increase.

The choice of the analysis criteria, for this work, was based on the relevance that solid waste and atmospheric pollution have (as shown) to the construction industry. These criteria were also analyzed due to their potential to generate local impact, that is, in the vicinity of the developments' implementation.

These criteria are among those considered as minimum requirements by the City of São Gonçalo (2018).

To consider the mitigation measures as adequate, the Resolution 307/2002 of CONAMA (National Council for the Environment, in a free translation), which establishes the guidelines, criteria, and procedures for construction waste management, was used. According to this document, the wastes must be classified as Class A, B, C, or D.

Class A is the classification for waste that is reusable or recyclable as aggregate. As Class B, must be classified waste that is recyclable for other purposes, as, for example: plastics, paper, cardboard, metals, glasses, woods, empty construction paint containers, and gypsum (as amended by Resolution 468/2015). Class C encompasses waste for which no technologies or

ISSN 2318-8472, v. 13, n. 88, 2025

economically viable applications that enable their recycling or recovery have been developed. Lastly, Class D covers hazardous waste that comes from the construction process, such as paints, solvents, oils, and other substances, or those contaminated or harmful to health coming from demolition, renovations, or repairs of radiological clinics, industrial facilities, and others, as well as roof tiles and any other objects and materials containing asbestos or other harmful substances.

According to CONAMA's Resolution 448/12, after screening, waste must be disposed of in accordance with its classification:

- Class A waste must be reused or recycled as aggregate, or sent to reservation landfills of Class-A material for future use;
- Class B waste must be reused, recycled, or sent to temporary storage areas, placed in a way that allows its future use or recycling.
- Class C waste must be stored, transported, and disposed of in accordance with specific technical standards.
- Class D waste must be stored, transported, and disposed of in accordance with specific technical standards.

Thus, to determine whether the mitigation measure was adequate, the types of waste disposal from the project were verified, which couldn't be disposed of in urban solid waste landfills, "dumping" areas, slopes, water bodies, vacant lots, or areas protected by law.

Regarding the adequacy of atmospheric pollution mitigation actions, it was taken into consideration IBAMA's Ordinance 85/1996, which addresses the adoption of an internal self-monitoring program for companies using diesel-powered vehicles, CONAMA's Resolution 18/1986, which establishes the acceptable limits for pollutant concentrations in the atmosphere associated with an exposure interval, and the Federal Law 6,938/1981 (BRAZIL, 1981), which establishes the air quality standard.

Finally, it was verified the existence or absence of mitigation measures against the increase in local microclimate temperature, from the project implementation to its urban-construction characteristics (soil permeability rate, vegetation, etc.).

It is important to highlight that the data on the developments were also sourced from the PLHIS (Local Plan for Social Housing, in a free translation) of São Gonçalo/RJ, which was only approved in 2022. The São Gonçalo City Hall (2023) presents data on condominiums names, number of housing units, neighborhoods, construction companies, and years of inauguration. This is where the temporal scope of this research comes from, given that in the year 2012, the first MCMV project was implemented in the city, and, in 2022, the most recent one.

Table 1 shows the list of developments financed under the scope of the MCMV Program in the municipality, by neighborhood, from 2012 to 2022 (the temporal scope of this study). All of them are designated for income brackets I, II, and II of the Program, which are addressed to families with a gross monthly income of up to R$ 2,640.00, from R$ 2,640.01 to R$ 4,400.00, and from R$ 4,400.01 to R$ 8,000.00, respectively.

Of this total, we have obtained access, so far, to the EIVs (Neighborhood Impact Studies) and RIVs (Neighborhood Impact Reports) of only 10 developments (with 3,388 housing

ISSN 2318-8472, v. 13, n. 88, 2025

units), specifically those that have not yet been delivered, so the analyses were focused on these developments (Frame 1).

Frame 1 - PMCMV developments in the municipality of São Gonçalo/RJ.

DELIVERED PMCMV DEVELOPMENTS				
Neighborhood	**Development**	**Number of Housing Units**	**Construction Company**	**Inauguration**
Arsenal	Bela Vida 1	164	Raro Engenharia	2012
	Bela Vida 2	240	Raro Engenharia	2013
Guarani	Vista Alegre 1	360	ILE	2014
	Vista Alegre 2	360	ILE	2014
Galo Branco	Galo Branco	300	Edificar CS	2016
Jockey	Araras	499	MRV	2016
	Aruba	240	CURY	2016
	Bem-te-vis	499	MRV	2016
	Cozumel 1	240	CURY	2016
	Cozumel 2	280	CURY	2016
	Cozumel 3	200	CURY	2014
	Gaivotas	433	MRV	2015
	Sabiás	310	MRV	2015
Venda da Cruz	Venda da Cruz 1	1,240	Sertenge S/A	2018
	Venda da Cruz 2			
	Venda da Cruz 3			
	Venda da Cruz 4			
	Venda da Cruz 5			
Marambaia	Campo Belo 1	240	CAC	2022
	Campo Belo 2	260	CAC	2022
TOTAL		**5,865**		
PMCMV DEVELOPMENTS UNDER CONSTRUCTION				
Neighborhood	**Development**	**Number of Housing Units**	**Construction Company**	**EIV**
Mutondo	Residencial Jardim Central 2	522	M&P	2019
Patronato	Residencial	738	M&P	2021
Tribobó	Rio Lago	520	Rio Largo Empreend.	2019
Maria Paula	Resid. Alfredo Volpi	194	CAC ENGENHARIA	2021
Lagoinha	Reserva dos Manacás	260	MRV	2020
	Residencial Mauá	360	MRV	2022
Trindade	Flores de Aracajú	32	RJ Engenharia	2022
Sacramento	Residencial Riviera	330	GOR CONSTRUÇÕES	2019
Neves	Viva Mais São Gonçalo	400	Habitarq	2019
Galo Branco	Resid. Flores de Maricá	32	RJ Engenharia e Construções Eireli	2021
TOTAL		**3,388**		
GRAND TOTAL		**9,253**		

Source: The São Gonçalo City Hall (organized by the authors).

ISSN 2318-8472, v. 13, n. 88, 2025

It is also valid to highlight the importance of the spatial scope chosen within the context of the MCMV Program and of the Metropolitan Region of Rio de Janeiro. According to IBGE data, São Gonçalo/RJ has an estimated population of 960,652 inhabitants for the year 2024, distributed in 91 neighborhoods, grouped into 5 large administrative districts: São Gonçalo (the city center), Ipiíba, Monjolos, Neves, and Sete Pontes. The population density is 3,613.57 inhabitants/km². It is the second most dense municipality in the state of Rio de Janeiro, and in the Metropolitan Region, second only to the city of Rio. Nationally, São Gonçalo ranks 18th among the most populous cities (IBGE, 2024).

In absolute terms, the Services sector plays a major role in the municipality's economy, generating a Value Added of R$ 8,725,199.28, followed by the Industrial sector, which generates R$ 2,003,956.57, and the Agricultural sector (R$ 81,571.44), maintaining the same state-level pattern of economic activity participation in the municipal GDP.

Despite the high GDP per capita (R$ 18,504.81), the socioeconomic and socio-spatial inequalities present in the municipality also follow the same pattern found in large Brazilian cities and metropolitan regions.

Data from the PLHIS indicates a housing demand (for 2021) of 31,501 units, considering factors such as housing precariousness, cohabitation, excessive rent burden, and the demographic demand. These data justify the implementation of diverse housing developments addressed to the low-income population in the municipality, such as those under the MCMV Program, which began in the year 2012 and has continued, with developments being delivered by the Program in virtually all the analyzed years.

4 RESULTS

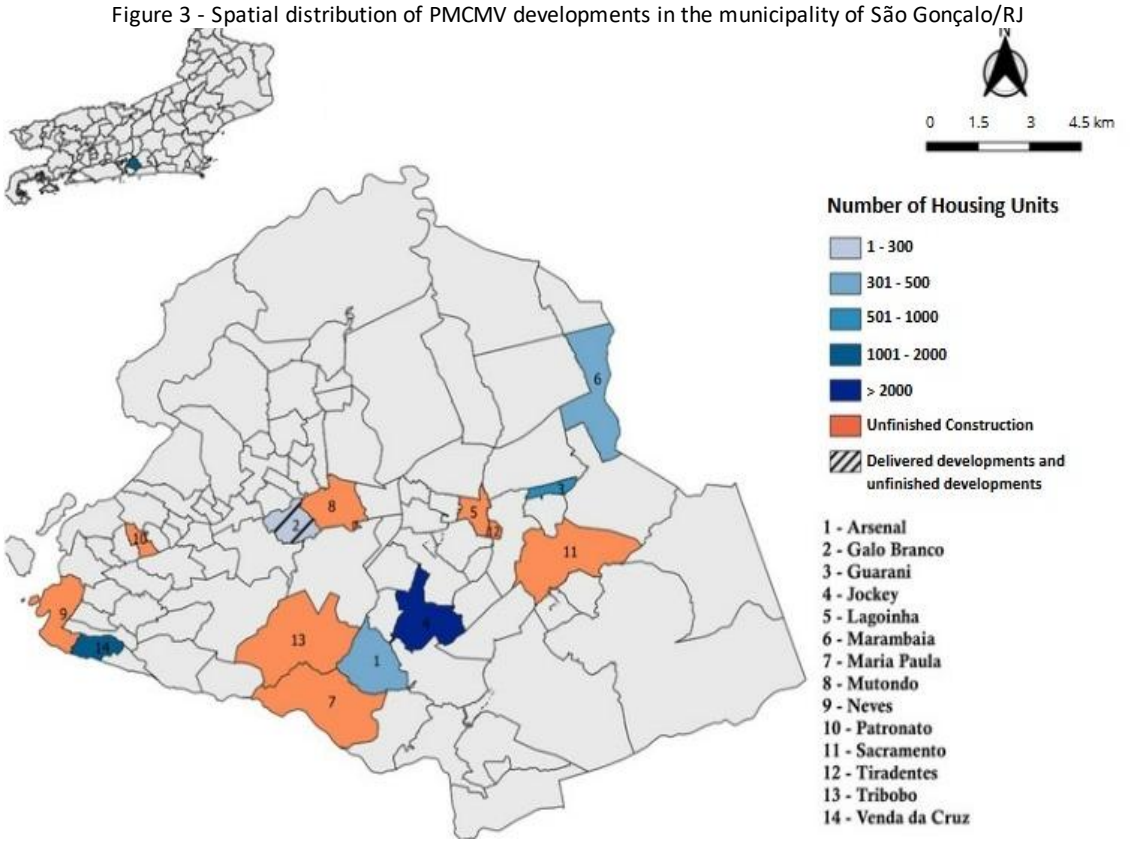
As indicated, São Gonçalo has received, so far, 30 developments under the MCMV Program, what totals 9,253 housing units (HUs). Of this total, 10 developments, all in the implementation phase, were analyzed. These developments total 3,388 HUs or about 37% of the total HUs planned for the city.

Figure 3 shows the spatial distribution of the 30 developments by neighborhood, revealing a concentration in 14 neighborhoods of the second and fifth districts (Ipiíba and Sete Pontes, respectively).

GC Revista Nacional de Gerenciamento de Cidades
National Journal of City Management

ISSN 2318-8472, v. 13, n. 88, 2025

Figure 3 - Spatial distribution of PMCMV developments in the municipality of São Gonçalo/RJ



Source: Prepared by the authors based on data from the São Gonçalo City Hall.

The results related to the solid wastes variable are presented in the subsequent Table 1. The aggregated analysis shows that in only 1 of the 10 developments analyzed, the EIV was either not presented or did not include mitigation measures against environmental impacts concerning solid waste.

It is interesting to note that the developments by the construction company M&P showed different results. The condominium in the Mutondo neighborhood showed inadequate disposal according to the CONAMA's criteria. On the other hand, for the condominium in the Patronato neighborhood, the company developed a Construction Waste Management Plan, being considered adequate.

GC Revista Nacional de Gerenciamento de Cidades
National Journal of City Management

ISSN 2318-8472, v. 13, n. 88, 2025

Table 1 - Generation and Disposal of Solid Waste in the Minha Casa, Minha Vida Program in São Gonçalo.

Predictability of Mitigation Measures and Their Adequacy – Solid Waste					
Neighborhood	**Development / Construction Company**	**Solid Waste Generation?**	**Mitigation Measures?**	**Which ones?**	**Adequate?**
Mutondo	Residencial Jardim Central 2 / M&P	Yes	Yes	Disposal in landfills	No
Patronato	Residencial (sem nome) / M&P	Yes	Yes	Construction Waste Management Plan	Yes
Tribobó	Rio largo empreendimentos imobiliários ltda/ Rio Lago	Yes	Yes	Construction Waste Management Plan	Yes
Maria Paula	Residencial Alfredo Volpi / CAC	Yes	Yes	Adequate Storage and final disposal	Yes
Lagoinha	Reserva dos Manacás / MRV	Yes	Yes	Separation of waste by classification	Yes
	Residencial Mauá / MRV	Yes	Yes	Construction Waste Management Plan	Yes
Trindade	Flores de Aracajú / RJ Eng.	Yes	Yes	Construction Waste Management Plan	No
Sacramento	Residencial Riviera / GOR Con.	Yes	Yes	Separation of waste by classification	Yes
Neves	Viva Mais São Gonçalo / Habitarq	Yes	Yes	Construction Waste Management Plan	Yes
Galo Branco	Residencial Flores de Maricá / RJ Eng.	Yes	Yes	Minimized solid waste generation to maximum reuse of materials and adequate disposal of non-reusable items	Yes

Source: Prepared by the authors based on data from the EIVs of the developments (2024).

Table 2 presents the results related to the atmospheric pollution variable (the development's contribution to local air pollution). The aggregated analysis indicates that of the 10 developments analyzed, only the development Residencial Flores de Maricá, by the company RJ Engenharia, did not include in its EIV mitigation measures against the atmospheric pollution variable, causing it to be also considered inadequate. Four other developments showed partial mitigation measures, addressing only part of the required by the environmental resolutions as minimally mandatory. They are: Residencial, in the Patronato neighborhood, by M&P; Rio Lago, in the Tribobó neighborhood, by Rio Lago; Residencial Alfredo Volpi, in the Maria Paula neighborhood, by CA; and Residencial Riviera, in the Sacramento neighborhood, by GOR Construções.

GC Revista Nacional de Gerenciamento de Cidades
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ISSN 2318-8472, v. 13, n. 88, 2025

Table 2 - Generation of Atmospheric Pollution in the Minha Casa, Minha Vida Program in São Gonçalo.

Predictability of Mitigation Measures and Their Adequacy – Atmospheric Pollution					
Neighborhood	**Development / Construction Company**	**Impact Generation?**	**Mitigation Measures?**	**Which ones?**	**Adequate?**
Mutondo	Residencial Jardim Central 2 / M&P	Yes	Yes	Moistening of construction sites, conducting Ringelmann Scale tests on all heavy vehicles, and requiring their periodic maintenance.	Yes
Patronato	Residencial (sem nome) / M&P	Yes	Yes	Moistening of construction sites, promotion of the wetting of the projects internal roads	Partially
Tribobó	Rio largo empreendimentos imobiliários ltda/ Rio Lago	Yes	Yes	Keeping excavation materials always moist and covered.	Partially
Maria Paula	Residencial Alfredo Volpi / CAC	Yes	Yes	Keeping excavation materials always moist and covered, installing wheel washers at truck exits, and properly storing materials.	Partially
Lagoinha	Reserva dos Manacás / MRV Residencial Mauá / MRV	Yes	Yes	Performing periodic water spraying within the construction site, covering trucks, washing truck wheels on-site, and conducting regular maintenance of trucks and diesel-powered machinery.	Yes
Trindade	Flores de Aracajú / RJ Eng.	Yes	Yes	Keeping excavation materials always moist and covered, covering trucks used for material and waste transportation with plastic tarps, installing wheel washers at truck exits, and properly storing material that may disseminate dust.	Yes
Sacramento	Residencial Riviera / GOR Con.	Yes	Yes	During dry days, atmospheric dispersion of soils from excavations may occur.	Partially
Neves	Viva Mais São Gonçalo / Habitarq	-	-	-	No
Galo Branco	Residencial Flores de Maricá / RJ Eng.	Yes	Yes	Performing periodic water spraying within the construction site, keeping trucks covered with tarps, and conducting regular maintenance of trucks and diesel-powered machinery.	Yes

Source: Prepared by the authors based on data from the EIVs of the developments (2024).

Once again, the results indicated that the developments by the construction company M&P obtained different mitigation measures. While in the Mutondo neighborhood the company showed greater concern regarding the IBAMA's Ordinance 85/96 and other pollution-related regulations, in the condominium present in the Patronato neighborhood only the IBAMA's Ordinance 85/96 recommendations were followed. The development in the Tribobó neighborhood, by Rio Largo, and the development in the Maria Paula neighborhood, by CAC

ISSN 2318-8472, v. 13, n. 88, 2025

Engenharia, followed only one regulation. For this reason, they were considered partially adequate.

The results related to the temperature variable are presented in Table 3. These were the most contradictory ones, since in many cases the EIVs' text only generically signalized possible impacts on the local microclimate, even indicating actions capable of minimizing such effects, without, however, committing to such actions in their EIVs.

It should be highlighted that the perception that urban areas have distinct climates from the adjacent areas began to be noticed in the 19th century (Monteiro, 1976). Therefore, it is necessary to understand the impact a building will have on local temperature. The Brazilian instruction NBR 15220 provides fundamental parameters for the performance of buildings, in which each Brazilian territory will have technical and construction recommendations that aim to optimize the thermal performance of buildings through better climatic adequacy (ABNT, 2004).

Planning a building having bioclimatic architecture as reference consists in considering the climatic and environmental characteristics of the location during the design process, prioritizing the environmental comfort of the buildings (Lanham; Gama; and Braz, 2004).

Table 3 - Increase in temperature due to heat masses - Minha Casa, Minha Vida Program in São Gonçalo.

Predictability of Mitigation Measures and Their Adequacy – Temperature					
Neighborhood	**Development / Construction Company**	**Impacts?**	**Mitigation Measures?**	**Which ones?**	**Adequate?**
Mutondo	Residencial Jardim Central 2 / M&P	No	-	-	No
Patronato	Residencial (sem nome) / M&P	Not identified	-	-	No
Tribobó	Rio largo empreendimentos imobiliários ltda/ Rio Lago	Not identified	-	-	No
Maria Paula	Residencial Alfredo Volpi / CAC	Not identified	-	-	No
Lagoinha	Reserva dos Manacás / MRV Residencial Mauá / MRV	No	No	It is recommended that, in addition to the maintenance of permeable areas on the site, the planting of trees in common areas be planned to soften the local microclimate.	Yes
Trindade	Flores de Aracajú / RJ Eng.	-	-	-	-
Sacramento	Residencial Riviera / GOR Con.	-	-	-	-
Neves	Viva Mais / Habitarq	-	-	-	-
Galo Branco	Residencial Flores de Maricá / RJ Eng.	Yes	No	-	No

Source: Prepared by the authors based on data from the EIVs of the developments (2024).

ISSN 2318-8472, v. 13, n. 88, 2025

It can be observed that of the 10 projects analyzed, only the company RJ Engenharia, responsible for the development Residencial Flores de Maricá, in the Galo Branco neighborhood, comprehends the impact its construction will have on the urban microclimate, without, however, presenting adequacy measures. In contrast, MRV, despite not identifying its impacts, recommends planting tree vegetation in permeable areas, in order to mitigate the local climate. The developments Flores de Aracaju by RJ Engenharia, Residencial Riviera by GOR Construções, and Viva Mais São Gonçalo by Habitarq do not even mention temperature in their EIVs.

5 CONCLUSION

Although the analyses conducted in this study are, so far, focused almost exclusively on the impacts generated during the construction phase and on specific variables (selected according to the scope of the research), they provide a good notion on the environmental concerns present or absent in the modus operandi of the main companies involved in the implementation of Social Housing in the municipality of São Gonçalo/RJ.

Overall, the analyses showed that the more explicitly the impact mitigation measures are defined by legal and regulatory frameworks, the more compliant the developments/companies tend to be, since, this way, non-conformities can be more easily identified. Nevertheless, some of them either ignore the possibility of impact caused by the development or recognize it but do not present actions to mitigate it, or present such actions just partially.

When there is no clear specification in legal and regulatory frameworks concerning the actions that must be taken, the companies/developments present a lack of proactivity in recognizing impacts and, especially, in prescribing and committing to the implementation of mitigation actions. This is what was revealed, as an example, by the analysis of the temperature variable in this study.

In both cases, given the scientific demonstrations regarding the environmental impacts and the occurrence of extreme climate events resulting from them, it is unacceptable for businesses to turn a blind eye to potential urban microclimate and environmental damage. Furthermore, there is need to widen the analyses conducted in this study through additional research on other developments in the municipality, as well as widening its analytical scope, including additional criteria capable of deepening the assessment of the developments' impacts on bioclimatic, hygrothermal, and energy efficiency terms, using other variables, such as carbon footprint, water consumption in the materials production and the used construction systems, the adoption of passive strategies for environmental comfort in the projects, and so on.

Finally, it is necessary to highlight that the adoption of environmental impact mitigation measures during construction not only helps preserve the environment, but also brings economic and social benefits, contributing to a more sustainable and responsible form of development.

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