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# INTRAURBAN MULTIDIMENSIONAL POVERTY: AN ANALYSIS FOR ILHÉUS AND ITABUNA, BAHIA

# POBREZA MULTIDIMENSIONAL INTRAURBANA: UMA ANÁLISE PARA ILHÉUS E ITABUNA, BAHIA

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## Abstract

This study analyzes multidimensional poverty in the urban areas of the municipalities of Ilhéus and Itabuna, south of the state of Bahia, northeast Brazil. It is based on the theoretical contribution of Armatya Sen regarding the concept of multidimensional poverty. Moreover, an Urban Multidimensional Poverty Index (UMPI) is estimated from multivariate data analysis. The data refer to the 2010 IBGE Demographic Census and were listed according to census tracts, namely 188 for Ilhéus and 246 for Itabuna, totaling 434 urban census tracts. The product of factor analysis results in four sub-indices, namely basic services, socioeconomic, infrastructure, and environmental. The results show that poverty is spread throughout the urban region of the municipalities and is especially high in the peripheral areas of both municipalities and the industrial zone of Itabuna. The socioeconomic subindex predominates in terms of poverty spots in urban areas, with the highest levels of deprivation for access to income and education. Internal disparities are observed regarding the center-periphery relationship and reveal the need for a public agenda to correct these disparities and promote the basic instrumental capabilities advocated by Sen.

**Keywords:** Deprivation. Factor Analysis. Center-periphery. Multivariate Data Analysis.

## Resumo

Este estudo analisa a pobreza multidimensional nas áreas urbanas dos municípios de Ilhéus e Itabuna, sul da Bahia. Parte-se do aporte teórico de Armatya Sen no que tange o entendimento do conceito de pobreza multidimensional e estima-se um Índice Urbano de Pobreza Multidimensional (IUPM) a partir da análise multivariada de dados. Os dados utilizados referem-se ao Censo

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Demográfico do IBGE de 2010 e estão dispostos em nível de setores censitários, sendo 188 para Ilhéus e 246 para Itabuna, totalizando 434 setores censitários urbanos. O produto da Análise Fatorial resulta em quatro subíndices, quais sejam: serviços básicos, socioeconômico, infraestrutura e ambiental. Os resultados demonstram que a pobreza está espraiada por toda extensão urbana dos municípios, se apresentando de forma mais elevada nas áreas periféricas de ambos os municípios e zona industrial de Itabuna. O subíndice socioeconômico prepondera na determinação das manchas de pobreza nas áreas urbanas, com maiores níveis de privação no acesso à renda e a educação. Evidenciam-se disparidades internas quanto à relação centro-periferia e a necessidade de uma agenda pública que busque corrigi-las no sentido de promover as capacidades básicas instrumentais preconizadas por Sen.

**Palavras-chave:** Privação. Análise Fatorial. Centro-periferia. Análise Multivariada de Dados.

## Introduction

In the last decades of the twentieth century, greater inequality and unequal distribution of income in Brazil was a persisting trend, despite a development model that prioritizes public policies for access to employment, income, education, housing, and healthcare (BARROS et al., 2001). According to the World Inequality Database[5], which evaluated data for inequality and income concentration in several countries between 2000 and 2015, 55% of Brazil's income belongs to 10% of its inhabitants. In 2010, the *Plano Brasil sem Miséria* (Brazil without Extreme Poverty Plan) established a one-dimensional approach to identify that more than 16 million people were extremely poor and 9.6 million of this total (59%) live in the Northeast region (BRASIL, 2011).

Despite the lack of consensus in the economic and social science literature regarding a single concept of poverty, the definition adopted over the years perceives the phenomenon as a state of need based on an established objective criterion, such as income, which is a widely used method. Notably, income is not disregarded from multidimensional analyses, as Sen (2010) stresses in the capability approach to poverty. This approach interpreted poverty as consisting of several dimensions, including aspects related to basic needs, but also considering people's capabilities as a result of substantive and instrumental freedoms, which includes their choices regarding well-being criteria and the ways of achieving them.

Thus, the approach developed by Sen highlights a shift in the global vision of the concept of poverty supported by universal public policies, with emphasis on the basic needs of people, their role in society, and their freedom of choice. These elements become essential to guarantee well-being.

Therefore, this study seeks to understand multidimensional poverty in the urban areas of Ilhéus and Itabuna, southern Bahia, northeast Brazil, by measuring an Urban Multidimensional Poverty Index. These two selected municipalities drive regional economic development since they are commercial hubs and provide health, education, and tourism services. In contrast, they are also seen as regions that attract poverty, with low-income spread throughout the territories. Itabuna, in particular, has notably high income inequality (PRATES, 2016; BARBOSA, 2016; MARTINS, 2019; SANTOS NETO et al., 2020). Thus, the aim is to contribute with data that can support assertive public policies and alleviate poverty in the studied region.

## Multidimensional Poverty

Poverty has long been studied according to reductionist analyses, validated by the neoclassical economic theory and grounded in utilitarian thinking, which means that a single factor can determine whether an individual is poor or not. This results in a one-dimensional vision of

[5] The World Inequality DataBase is an open access platform that contains data from hundreds of researchers regarding worldwide income and wealth both within countries and between countries. Of the national income pertaining to 10% of individuals, 37% is in Europe, 41% in China, 46% in Russia, 47% in the United States and Canada, approximately 55% in Brazil, Indian and Sub-Saharan Africa, and the Middle East is the most unequal region in the world with 61% (WORLD INEQUALITY LAB, 2018).

poverty, in which an individual is deemed to be poor by their *per capita* income bracket, and if they are under the limit, they are declared poor (MARINHO; SOARES; ROCHA, 2003). Over time, more precisely from the 1980s, other concepts have been constructed regarding the study of poverty from a multidimensional perspective. Authors such as Amartya Sen highlight the factors that generate the existence of poverty, notably the instruments capable of measuring it and outlining the characteristics of individuals deemed to be poor (SEN, 2010).

For Sen (2010), poverty is a complex phenomenon related to development, which is the result of so-called freedom, conditioned by social, political, and economic opportunities. In this context, numerous contributions emerge from the multifaceted perspective. Alkire (2002) contributes by establishing reasons to closely consider these dimensions, emphasizing multidimensionality in human development and poverty, and introducing methodologies that capture the entire scope.

According to Rocha (2006), the multidimensional vision has several facets and differs from the one-dimensional vision in the three following points: income is no longer the key indicator to measure poverty and adopted parameters must reflect quality of life; it is related to objectives and measurement of results that encompass all society, thus instruments must compare countries and assess the fulfillment of basic needs over time; and the notion of poverty becomes broader as it encompasses factors such as nutrition, education, sanitation, and housing.

Consequently, the genesis of the debate on poverty arises from analyses of income, although this should be the sole factor (SEN, 2010). The classic approach to poverty tends to simplify the causes and effects of a latent worldwide problem. The multidimensional approach represents progress precisely by expanding discussions on the topic, with relevant consequences for the planning, construction, execution, and correction of public policies.

In the debates about the multidimensional vision, some approaches can be highlighted. The approach to basic needs assumes that "basic goods" are an essential element for a minimally decent life. Conditions such as housing, access to food, health, and education can provide people with better living conditions (STEWART, 1995). Thus, this approach is concerned with "qualifying poverty" rather than "quantifying poverty" (LACERDA, 2010).

The approach to relative deprivations goes beyond the basic needs of human beings, to the idea of interdependence between the concept of poverty and the social and institutional structures in force in society (CODES, 2008). This means that the relationship between different types of deprivations and income can change over time.

Finally, Sen's approach of capability deprivation adds elements related to social justice, equality, and inequality, in addition to a concept that does not underestimate the role of economic factors, but adds their political and social implications. Therefore, overcoming poverty is related to development. For Sen (2010), development should chiefly expand individual freedoms, classified as substantive and instrumental freedoms.

Instrumental freedoms allow individuals to increase their total substantive freedom, and they are divided into the following five freedoms: *political freedoms,* considered as people's political choices; *economic facilities,* which is the individual's power to use economic resources, goods, and services, and to access income and credit; *social opportunities,* considers the social arrangements needed to provide education, health, and other enabling services; *transparency*, considers the guarantees of transparency and the right to information at all levels, especially in public spheres; and *social protection*, which includes social arrangements designed to protect vulnerable portions of the population, such as assistance, social security, unemployment insurance, etc. In contrast, substantive freedoms are the means to achieve these ends.

## Methodology

### Study area

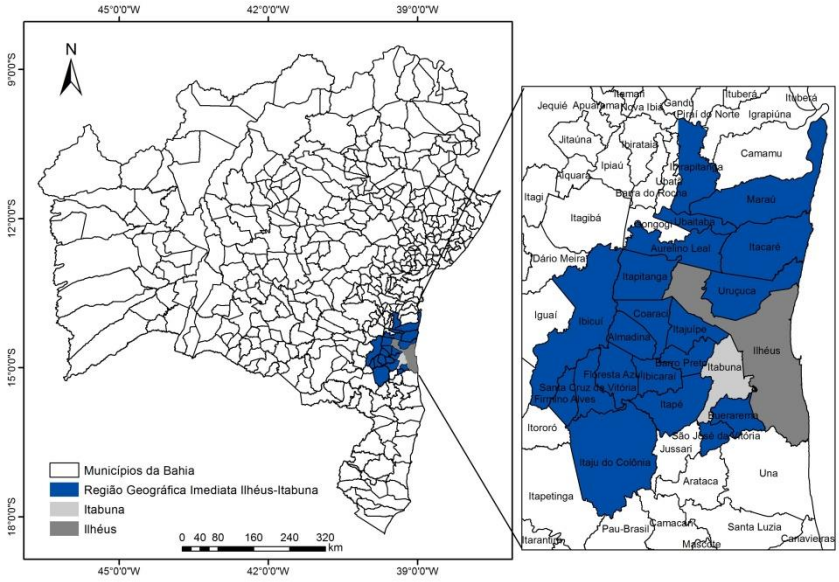
Ilhéus and Itabuna are considered medium-sized cities[6], located in southern Bahia, northeast Brazil (Figure 1). In the new Regional Division of Brazil, these municipalities are part of the region of immediate influence[7] composed of twenty municipalities with a predominantly urban population

[6] Population size is the most widely applied criterion to identify medium-sized cities, which are those cities with between 100,000 and 500,000 inhabitants (IPEA, 2009).

[7] The IBGE (Brazilian Institute of Geography and Statistics) defines Immediate Geographical Regions, with the urban network as the main reference element. They are structured from nearby urban centers that satisfy the population's immediate needs, such employment, health, education, commerce, and several public services. The Intermediate and

(82.1%). The municipalities that make up the region had around 661,000 inhabitants in 2010, and the populations of Ilhéus and Itabuna account for 52.4% of the region's total urban population. The urban populations of Ilhéus and Itabuna represent an urbanization rate of 85% and 98%, respectively (IBGE, 2010; 2019).

**Figure 1:** Geographical location of the municipalities of Ilhéus and Itabuna in relation to the Region of Immediate Influence, Bahia, 2020




Prepared by the authors.

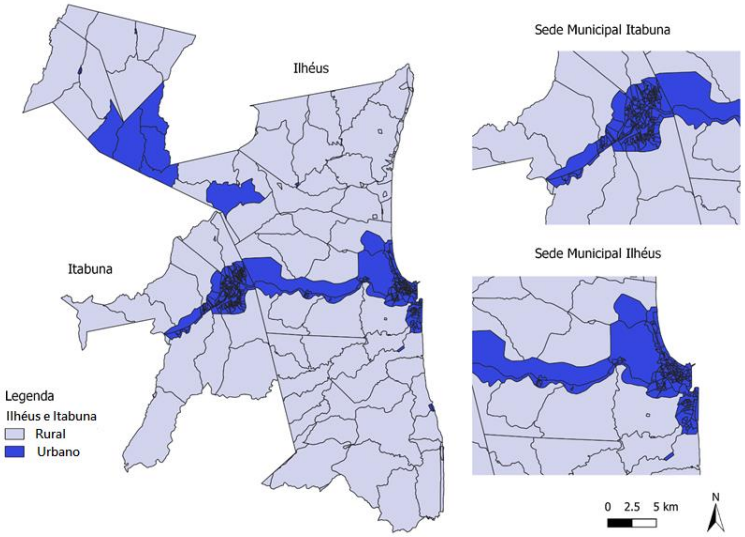
Itabuna and Ilhéus are two of the major municipalities of Bahia, ranking 9th and 12th in the state's GDP, respectively (IBGE, 2017). Of the two regional development hubs, Itabuna has a larger population (an estimated 213,223 inhabitants in 2019) and covers an area of 401.03 km² with a population density of 473.50 inhabitants/km². This municipality, which is connected by two federal highways (BR-415 and BR-101), had a current price GDP of BRL 3,565 million in 2017 and a predominance of the service sector - excluding administration, defense, education, public health, and social security (64%) (IBGE, 2020). Ilheús, in turn, had an estimated population of 162,327 inhabitants in 2019 and covers an area of 1,584.69 km², with a population density of 104.67 inhabitants/km². It is an extensive rural territory with industries, tourism, and services, and a current price GDP of BRL 3,309 million for 2017, with particular emphasis on service - excluding administration, defense, education, public health, and social security (51%), and industry (27%) (IBGE, 2020).

Given these characteristics, the present study analyzes multidimensional poverty in the urban census tracts[8] of Ilhéus and Itabuna. Ilhéus and Itabuna have 438 urban census tracts, of which 247 are in Itabuna and 191 in Ilhéus (Figure 2).

Immediate Geographic Regions comprise territories with a hub of higher hierarchy based on public and private management and urban functions of greater complexity (IBGE, 2017).

[8] According to IBGE, the census tract is the smallest statistical selection of a given population. In Brazil, there are 331,000 census tracts. According to the IBGE, a census tract can be any size and is not defined by its geographical area, but by the number of households, which helps census takers apply the Demographic Census more effectively.

**Figure 2:** Rural and urban census tracts of Ilhéus and Itabuna, Bahia

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## Selection of variables

Initially, 53 variables were selected for the study, from the theoretical discussions of the concept of multidimensional poverty, based on a calculation of the Multidimensional Poverty Index (MPI) by Alkire and Foster (2010) and Sen (2010) and the availability of census tract data. These authors establish 10 variables related to three dimensions, namely nutrition and infant mortality (health dimension); years of schooling and enrolled children (education dimension); and access to gas for cooking, sanitation, water, electricity, paving, and household goods (standard of living dimension). Due to the limitations of the variables available at the level of aggregation of census tracts, and considering the requirements needed to apply the factorial model, the model that is most suitable for the database applies to a set of 16 variables.

In this regard, Table 1 shows the set of variables selected according to the availability of existing data from the IBGE Demographic Census for the urban census tracts of the study area (IBGE, 2010). This database was selected due to data availability (latest information for census tracts) and the possibility of disaggregating urban and rural areas, despite possible differences regarding the characteristics observed currently and changes in the number of sectors or perimeter limits of the municipalities.

**Table 1:** Variables used to calculate the Urban Multidimensional Poverty Index (UMPI)

| Variables | Description | Reference |
|---|---|---|
| Average Residents | average n of residents per household (VDOM1) | Ávila (2013), Corrêa et al. (2015) |
| Water supply | % households with water supply via well or spring on the property, rainwater stored in cistern or other condition (VSB1). | Sen (2010), Ávila (2013), Corrêa et al. (2015), Araújo (2018) |
| Bathroom | % of households without a toilet (VSB2). | Sen (2010), Ávila (2013), Alkire e Foster (2010), Corrêa et al. (2015) |
| Sewage system | % of households with irregular sanitation, such as rudimentary pit, ditch, river, lake or sea, and other conditions (VSB3). | Krishnakumar (2005), Sen (2010), Ávila (2013), Alkire e Foster (2010), Corrêa et al. (2015), Araújo (2018) |
| Waste disposal | % of households where garbage is burned on the property, buried on the property, thrown onto wasteland or roads, thrown into river, lake, or sea, and other conditions (VSB4). | Ávila (2013), Alkire e Foster (2010), Sen (2010), Corrêa et al. (2015), Araújo (2018) |
| Electricity | % of households without electricity (VSB5). | Ávila (2013), Sen (2010), Alkire e Foster (2010), Corrêa et al. (2015), Araújo (2018) |
| Education | % of illiterate persons aged 9 years and over (VED1). | DataSUS (2010), Samman (2007), Ávila (2013), Krishnakumar (2005), Alkire e Foster (2010), Araújo (2018) |
| Color and race | % of self-declared white (VET1) or black (VET2) persons. | Sen (2010) |
| Income | Per capita income of persons aged 10 years and over at current prices (VR1). | Ávila (2013), Stiglitz, Sen, Fitoussi (2009), Hoffman (2000), Rocha (2003) |
| Neighborhood or infrastructure | % of households without street address (VINF1); without paving (VINF2); without sidewalks (VINF3); without storm drains (VINF4); with open sewers (VA1); with accumulated garbage (VA2). | Krishnakumar (2005) Sen (2010), Alkire e Foster (2010) |

Prepared by the authors.

According to census tract data from the Demographic Census (IBGE, 2010), a household "is the structurally separate and independent place intended to serve as housing for one or more people, or that is being used as such" (IBGE, 2010, p.18). It is divided into two forms of analysis: condition (house, apartment, condominium, village), type (owned, owned and paid off, rented, being acquired, transferred, transferred to employee), and situation according to the area of location (urban or rural). Since the household is the basis of information for the variables, it is the **unit of measurement used** in this study. To operationalize the model from factor analysis, the variables are presented as **percentage of occurrence or not** of a certain phenomenon in the households of each census tract. These variables are water supply; toilet; sewage system; waste disposal; electricity; and neighborhood or infrastructure. Average number of residents per household, education, and color and race are based on the **resident as unit of measurement**; therefore, it is presented as a proportion of residents. The variable *per capita* income of persons 10 years and over is attributed to a **monetary unit of measurement (BRL).**

Considering that this study aims to build an index that indicates the deprivations related to multidimensional poverty in census tracts, the variables are presented as a percentage of the occurrence of a certain phenomenon, i.e., regarding the precariousness of the survival conditions of these localities.

## Procedures for applying the factorial model

Factor analysis (FA) of the principal components of a series of variables (Table 1) is used to estimate the UMPI. FA is a multivariate statistical method used to synthetically present a set of data, either by reduction or summarizing of data and identification of underlying structures. The objective, therefore, is to summarize the original information with minimal loss (HAIR et al., 2009). This sheds light on the phenomenon of poverty without resorting to an exhaustive amount of information, and also permits the grouping of information through association.

When a statistical process is applied, normality of the variables and homoscedasticity must be observed. To verify whether the selected variables have a normal distribution, the literature suggests the Kolmogorov-Smirnov (or K-S) test, the histogram with normal curve overlay, the stem-and-leaf plot, and the normal Q-Q plot, and the parameters of asymmetry and kurtosis. When non-normality was observed, the variables were transformed as highlighted by Hair et al. (2009).

The next step is to verify the correlations between the variables. According to Hair et al. (2009), Pallant (2007), and Friel (2009), the correlation matrix can be observed by the anti-image correlation, measure of sampling adequacy (MSA), and by the Bartlett and Kaiser-Meyer-Olkin (KMO) tests.

The MSA varies from 0 to 1 and verifies the degree of intercorrelation between the variables. Variables with MSA[9] equal to or greater than 0.50 are usually considered good variables. In contrast, variables that oscillate below 0.50 can be considered for elimination.

Bartlett's test considers the complete correlation matrix and allows the identification of correlations that are significant between some variables, at the level of significance of below 0.05.

The KMO[10] ranges from 0 to 1, with the factorial model being more suitable the closer it is to the unit. The KMO identified that the FA model used is appropriate for the data, testing the overall consistency of the data.

The commonalities are evaluated during this stage, after extracting the factors from the model. The value for commonalities should be equal to or greater than 0.60 for most of the variables included in the analysis. Individually, Hair et al. (2009) recommend that values equal to or greater than 0.50 should be taken into account as a minimum acceptable value. Among the various models estimated in this research, the best KMO is 0.805 (good) and the commonalities of the variables are above 0.60 for 70% of the variables that form the model.

The factors are determined by extraction. Of the available methods, principal component analysis is the most widely used in the sciences. The total variance explained is based on the cumulative percentage of the total variance extracted, which must explain at least 60% of the variance, or sometimes less for studies in social sciences, which requires expertise on the part of the researchers. Thus, among the different estimated models, the best result for the study in question demonstrates total explained variance of 64%. Due to the methodological objective of the research, i.e., to explain the phenomenon of poverty from a reduced number of variables, this type of factor rotation is used.

## Estimating the Urban Multidimensional Poverty Index (UMPI)

The set of variables is submitted to principal component analysis (Table 1). The main factors or components $(CP)_i$ are orthogonal, determined by transforming the initial variables (*Varimax*) according to the following linear mathematical model:

$$X_i = a_{i1}CP_1 + a_{i2}CP_2 + a_{i3}CP_3 + \cdots + a_{ik}CP_k + e_i \quad (1)$$

Where "$X_i$" are the factors; "$a_{ik}$" are the weights or factorial loads that make up the model combination; and "$e_i$" is the error. The factor loadings "$a_{ik}$" express the correlation coefficients between each variable and its respective factors. In each factor, the most representative variables are those with factor loadings greater than 0.50 ($a_{ik} > 0.50$). However, due to difficulties in obtaining variables for applied social science studies, factor loadings of 0.30 are adopted as representative for inclusion of the analysis (HAIR et al., 2009). A factor loading with a negative sign means this variable has a negative influence on the factor.

9 Values of MSA ≥ 0.80 (adequate); 0.70 ≤ MSA < 0.80 (average); 0.60 ≤ MSA < 0.70 (mediocre); 0.50 ≤ MSA < 0.60 (poor); MSA < 0.50 (unacceptable).

10 Values of KMO ≥ 0.90 (excellent); ≤ 0.89 and ≤ 0.80 (good); ≤ 0.79 and ≤ 0.60 (average); ≤ 0.69 and ≤ 0.60 (mediocre); ≤ 0.59 and ≤ 0.50 (poor); ≤ 0.40 and ≤ 0.00 (inadequate).

To standardize the factors, as recommended in Passos (2019, P. 81), equation 2 is applied to factors that have a positive (direct) relationship with multidimensional poverty, and equation 3 is applied when the relationship is negative (inverse), as follows:

$$SI_{ki} = \frac{e_{ki} - e_{kmín}}{e_{kmáx} - e_{kmín}} \quad (2)$$

$$SI_{ki} = \frac{e_{kmáx} - e_{ki}}{e_{kmáx} - e_{kmín}} \quad (3)$$

Where "$SI_{ki}$" is the value of $k$-nth subindex of $k$-nth census tract; "$e_{ki}$" is the factor score of the $k$-nth census tract; "$e_{kmín}$" is the minimum value of the $k$-nth factor; and the "$e_{kmáx}$" is the maximum value of the $k$-nth factor.

After calculating the subindex of each census tract, the "UMPI" for each sector is calculated based on an adaptation of Passos (2019), as follows:

$$IUPM_i = \sum_{k=1}^{n} \frac{\sigma_k^2}{s^2} SI_{ki} \quad (4)$$

Where $\text{UMPI}_\text{i}$ is the value of the Urban Multidimensional Poverty Index of the $i$-nth census tract; n is the total number of factors in the model; $\sigma_k^2$ is the total variance explained by the $k$-nth factor; $s^2$ is the total variance explained by the factorial model; and $SI_{ki}$ is the value of $k$- nth subindex of the i-nth census tract.

To meet the specific objective of establishing comparative analyses between cities regarding poverty, the weighted average by number of households "$d_\propto$" of the UMPI is estimated for the set of census tracts that form the urban area of the cities of Ilhéus and Itabuna (equation 6). Weighting by household ($d_\propto$) is given by the total number of households in the tract as a proportion of the total number of households in the city, according to equation 5:

$$d_\propto = \sum \frac{households\ of\ tract\ x_i}{households\ of\ city\ x_i} \quad (5)$$

Therefore:

$$IUPM_i = \sum_{k=1}^{n} SI_k\ d_\propto \quad (6)$$

The values of the sub-indices and the UMPI vary between 0 and 1. Values close to the lower limit (zero) indicate the non-existence of Multidimensional Urban Poverty, while the closer values get to the upper limit (one), the more Multidimensional Urban Poverty there is. For the classification[11] of the subindex and UMPI values, the criterion of division into quartiles was used.

## Results and discussion

### Multivariate analysis

The methodological process that precedes FA provided an empirical and theoretically adequate result, excluding variables with unsatisfactory performance for applying this type of analysis, as well as observing their theoretical importance for the theme of multidimensional poverty. The Bartlett and KMO test values (0.805) demonstrate good adequacy of the database for application of the factorial model, as stated by Hair et al. (2009).

The data show that 35% of the correlations between the variables are greater than 0.30, although the specific literature indicates that a percentage below 50% is not recommended. This is considered the best result among the estimated models due to the complexity of the topic, with broad variables, several theoretical discussions, and scarcity of data that can be aggregated to the proposed methodological model.

[11] The values of UMPI sub-indices are classified as ≤ 0.25 (low), > 0.25 and ≤ 0.50 (moderate), > 0.50 and ≤ 0.75 (high), > 0.75 and ≤ 1 (very high).

**Table 2:** Database adequacy statistics for application of the model

| Variables | Correlations ≥ ± 0,30 | | Commonalities | MSA |
|---|---|---|---|---|
| | Amount | % | | |
| VDOM1 - MEDMORADOR | 5 | 31,25% | 0,554 | ,871a |
| VSB1 - ABASTAGUA | 5 | 31,25% | 0,655 | ,790a |
| VSB2 - SBANHEIRO | 5 | 31,25% | 0,665 | ,610a |
| VSB3 - ESGOTSANIT | 6 | 37,50% | 0,348 | ,870a |
| VSB4 - COLETALIXO | 6 | 37,50% | 0,625 | ,868a |
| VSB5 - SENERGELETR | 3 | 18,75% | 0,523 | ,815a |
| VED1 - PA9ANOSMAIS | 11 | 68,75% | 0,817 | ,897a |
| VET1 - BRANCO | 6 | 37,50% | 0,779 | ,744a |
| VET2 - PRETO | 4 | 25,00% | 0,546 | ,896a |
| VR1 - RENDA | 9 | 56,25% | 0,753 | ,721a |
| VINF1 - NLOGRAD | 3 | 18,75% | 0,505 | ,831a |
| VINF2 - NPAVIM | 8 | 50,00% | 0,654 | ,857a |
| VINF3 - NCALCADA | 9 | 56,25% | 0,750 | ,864a |
| VINF4 - NBUEIRO | 3 | 18,75% | 0,672 | ,819a |
| VA1 - ESGCEUABERTO | 6 | 37,50% | 0,710 | ,825a |
| VA2 - ELIXOACUM | 1 | 6,25% | 0,718 | ,639a |

Note: “VDOM1 – average n residents per household”; “VSB1 – inadequate water supply”; “VSB2 – lack of toilet”; “VSB3 – inadequate sewage system”; “VSB4 – inadequate waste disposal”; “VSB5 – lack of electricity”; “VED1 – illiterate persons aged 9 years and over”; “VET1 – self–declared white persons”; “VET2 – self–declared black persons”; “VR1 – per capita income of persons aged 10 years and over”; “VINF1 – no street address”; “VINF2 – no paving”; “VINF3 – no sidewalk”; “VINF4 – no storm drain”; “VA1 - open sewers”; “VA2 - accumulated garbage”.
Source: prepared by authors from the research data.

The highest number of significant correlations for the estimated model relate to the variable proportion of illiterate persons aged 9 years and over (VED1), *per capita* income of persons aged 10 years and over (VR1), and the non-existence of sidewalks (VINF3) on the face or counterface of the surveyed household. The high influence of income on deprivation situations in the analyzed municipalities was already expected. As shown in Santos Neto et al. (2020) and Espirito Santo (2020), there is marked income inequality in Ilhéus and Itabuna, as well as the influence of the “asset acquisition” dimension when composing the Multidimensional Poverty Index. Moreover, very significant correlations were observed for the variable non-existence of paving (VINF2) at the front or back of the surveyed households. These data may explain how scarce investments in urban infrastructure worsen the poverty situation in Ilhéus and Itabuna.

The variables of provision of basic services to society, people’s socioeconomic conditions, and environmental variables correlate significantly, accounting for 30% to 37% of the total correlations of the model. These variables are the average number of residents per household (VDOM1), inadequate water supply (VSB1), lack of toilet (VSB2), inadequate sewage system (VSB3), inadequate waste disposal (VSB4), self-declared white persons (VET1), and open sewers (VA1). Although the commonality of the variable inadequate waste disposal (VSB4) is classified as below 0.5, it was maintained in the factorial model since it includes correlations that can help explain the phenomenon of multidimensional poverty. Furthermore, statistically, the variable presents a 37.5% significant correlation and an excellent MSA of 0.870.

The variables with the lowest results varied between 6% and 18% of the significant correlations and consisted of households without electricity (VSB5), no street address at the front or back of the household (VINF1), no storm drains or drain grates at the front or back of the household (VINF4), and accumulated garbage (VA2). Regardless, the methodological option is to maintain the variables in the model since they are theoretically relevant and may explain the factors that substantiate poverty in the municipalities.

As for the commonalities of the set of variables of the factorial model, 70% were above 0.60. The measures of sampling adequacy (MSA) statistically presented adequate values, with 70% of the variables with MSA values above 0.80 and the remaining variables with MSA above 0.50 (acceptable limit). These results confirm the adequacy of the sample for the estimated factorial model, thus enabling the stages of factor estimation and index calculation.

**Table 3:** Eigenvalues and covariances of factors in the estimated model

| Component | Initial eigenvalues | | | Squared load rotation sums | | |
|---|---|---|---|---|---|---|
| | Total | % variance | % cumulative | Total | % variance | % cumulative |
| 1 | 5,116 | 31,978 | 31,978 | 3,006 | 18,789 | 18,789 |
| 2 | 2,557 | 15,984 | 47,962 | 2,995 | 18,717 | 37,506 |
| 3 | 1,475 | 9,221 | 57,183 | 2,734 | 17,088 | 54,594 |
| 4 | 1,126 | 7,036 | 64,219 | 1,540 | 9,625 | 64,219 |
| 5 | 0,966 | 6,039 | 70,258 | | | |
| 6 | 0,857 | 5,356 | 75,614 | | | |
| 7 | 0,666 | 4,161 | 79,774 | | | |
| 8 | 0,597 | 3,732 | 83,506 | | | |
| 9 | 0,507 | 3,171 | 86,678 | | | |
| 10 | 0,449 | 2,809 | 89,487 | | | |
| 11 | 0,429 | 2,682 | 92,169 | | | |
| 12 | 0,368 | 2,301 | 94,470 | | | |
| 13 | 0,348 | 2,175 | 96,645 | | | |
| 14 | 0,256 | 1,602 | 98,246 | | | |
| 15 | 0,196 | 1,223 | 99,469 | | | |
| 16 | 0,085 | 0,531 | 100,000 | | | |

Extraction method: principal component analysis.
Source: prepared by authors from the research data.

The factors were extracted using the principal component method, considering total initial eigenvalues greater than 1 (Table 11). Therefore, four components or factors were obtained with a total explained variance of 64.2%. This value is considered adequate for explaining the models in applied social science studies.

Table 4 shows the factorial loading obtained for each extracted component after rotation of the principal component matrix. Factor loadings greater than or equal to 0.3 and -0.3 are significant for explaining the factorial model (HAIR et al., 2009). The positive loading values demonstrate a direct relationship with the component or factor, which suggests a situation of deprivation, i.e., the variable in question has a positive relationship with multidimensional poverty. The negative loading values demonstrate an inverse relationship with the component or factor, which suggests an opposite situation. Even after matrix rotation, cross-loadings for the variable illiteracy (VED1) were observed, which reveals its relationship with factors 1 and 2 and their respective variables.

**Table 4:** Main Components Matrix (factors) rotated

| | Components | | | |
|---|---|---|---|---|
| Variables | 1 | 2 | 3 | 4 |
| VDOM1 - MEDMORADOR | | 0,730 | | |
| VSB1 - ABASTAGUA | 0,783 | | | |
| VSB2 - SBANHEIRO | 0,786 | | | |
| VSB3 - ESGOTSANIT | 0,401 | | | |
| VSB4 - COLETALIXO | 0,737 | | | |
| VSB5 - SENERGELETR | 0,718 | | | |
| VED1 - PA9ANOSMAIS | 0,510 | 0,651 | | |
| VET1 – BRANCO | | -0,836 | | |
| VET2 – PRETO | | 0,725 | | |
| VR1 – RENDA | | -0,690 | | |
| VINF1 - NLOGRAD | | | 0,673 | |
| VINF2 – NPAVIM | | | 0,738 | |
| VINF3 - NCALCADA | | | 0,749 | |
| VINF4 – NBUEIRO | | | 0,815 | |
| VA1 - ESGCEUABERTO | | | | 0,748 |
| VA2 - ELIXOACUM | | | | 0,841 |

Note: “VDOM1 – average n residents per household”; “VSB1 – inadequate water supply”; “VSB2 – lack of toilet”; “VSB3 – inadequate sewage system”; “VSB4 – inadequate waste disposal”; “VSB5 – lack of electricity”; “VED1 – illiterate

persons aged 9 years and over"; "VET1 – self–declared white persons"; "VET2 – self–declared black persons"; "VR1 – per capita income of persons aged 10 years and over"; "VINF1 – no street address"; "VINF2 – no paving"; "VINF3 – no sidewalk"; "VINF4 – no storm drain"; "VA1 - open sewers"; "VA2 - accumulated garbage".
Source: prepared by authors from the research data.

In terms of factor variances, factor 1 presents six variables with an explained variance of 18.78%, factor 2 presents five variables with an explained variance of 18.71%, and factor 3 presents four variables with an explained variance of 17.08%, totaling 54% of the explained variance. Finally, factor 4, which lists variables classified as environmental, represents 9% of the explained variance of the factorial model, totaling 64.2% of the total explained variance of the model. Furthermore, significant factor loadings (± 0.6) are observed (HAIR et al., 2009) for most variables.

Based on the theoretical framework of Sen (2010), factors can be named according to the observance of the group of variables that are grouped into a certain factor and the way their concept relates to the concept of the capabilities theory.

Factor 1 adds variables that denote deprivation in terms of access to water supply, lack of a toilet in the household, sewage system, garbage disposal, electricity, and illiteracy. This set of variables comprises basic and essential services to society and is related to the notion Sen (2010) calls social capabilities.

The set of variables aggregated in factor 2 denotes economic deprivation and social inequality and groups the number of residents per household, white persons, black persons, illiteracy, and income. An inverse relationship was observed for the variables income and white persons, i.e., the lower the income, the greater the deprivation in relation to the number of residents per household; this population can be predominantly black and without access to basic education. Therefore, a relationship with variables for socioeconomic characteristics is presented and established, which Sen (2010) describes as economic capabilities and social capabilities.

Similarly, a direct relationship is also established between the variables that make up factor 3, and access to public or private infrastructure. It is listed among the positive factor loadings, creating a direct relationship between the deprivation of households and identification of a street address, paving, sidewalk, and storm drains. Therefore, these aspects are presented in one of the dimensions foreseen in the groundbreaking study of Alkire and Foster (2007), referred to as "infrastructure".

Finally, the variables that are grouped in factor 4 represent deprivation in terms of health and environment as a proxy, in that they emphasize access to domestic open sewers and accumulated garbage at the front and back of the households. This group of variables is related to what Sen (2010) calls social opportunities, which discriminates people's access to education, health, and other enabling social services. In contrast, the specific literature demonstrates a direct relationship between poverty and the environment; however, due to the methodological difficulty of applying empirical analyses in Brazil, basic sanitation data have been used as a proxy, as identified by Hollander (2003) in "The Real Environmental Crisis". In this regard, factor 4 was named "environmental".

## Basic services subindex

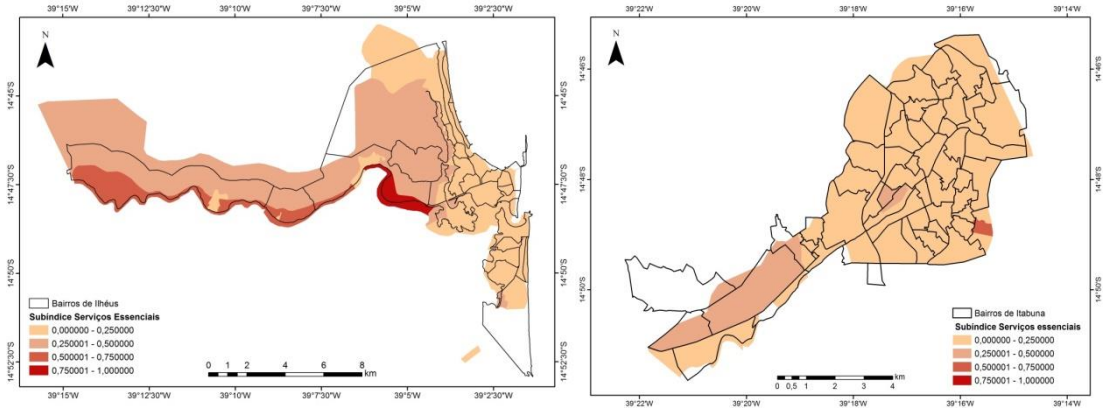
The basic services subindex aggregates the set of variables that assess deprivation in relation to basic and essential public or private services provided to the population, such as irregular water supply, lack of a toilet in the household, irregular sewage system, and irregular garbage collection. Regarding this factor, the model results in good indicators for the census tracts of Ilhéus and Itabuna, classifying more than 90% of the households studied as low deprivation (0.25). Isolated tracts that jointly account for approximately 5% of moderate ($> 0.25\% \leq 0.50$), high ($> 0.50\% \leq 0.75$), and very high ($> 0.75\% \leq 1$) deprivation for the urban areas of Ilhéus and for Itabuna total a little more than 1%.

Regarding this factor, it should be noted that the set of variables presented in this study has limitations, since the IBGE data does not determine whether the water supply is treated, for example, or whether the existence of a toilet requires a minimum hygiene condition, or whether sanitary sewage is treated, or even if garbage disposal is appropriate. This variable has the methodological limitation of classifying whether a certain set of households has or does not have access to the service, but does not consider the quality of this service.

For most localities in Ilhéus and Itabuna, the basic services subindex resulted in values below 0.5, which is considered low and moderate deprivation. Notably, the set of variables that make up this subindex does not evaluate the quality of the public or private service offered to the population and only informs whether the set of surveyed households has access to a certain basic service.

The municipalities (Figure 3)[12] show low rates for the entire central region of the city, the peripheral areas to the south and north (Itabuna), and the entire northern and southern coastal areas (Ilhéus). Moderate, high, and very high levels of deprivation are observed in Ilhéus along the entire BR-415 highway, where the neighborhoods of Salobrinho and Banco da Vitoria are located. These neighborhoods are bordered by rural regions and districts, which reveals the high precariousness of basic services in these areas compared to others closer to the city center. This is especially notable in the region approaching Teotonio Vilela, with a high subindex of poverty in this dimension. Itabuna, in turn, has a more homogeneous territory than Ilhéus, with a low subindex for the entire central region of the city and its peripheral areas. A subindex with moderate deprivation is observed for the southwest region of the municipality, where the industrial area and neighborhoods such as Urbis IV, Ferradas, Nova Ferradas, and Jorge Amado are located. In general, regarding the basic services subindex, Ilheus shows greater deprivation than Itabuna.

**Figure 3:** Spatialization of the basic services subindex for Ilhéus and Itabuna, Bahia




Source: IBGE, 2010. Prepared by the authors.

## Socioeconomic subindex

The socioeconomic subindex reveals a situation of moderate, high, and very high deprivation for both municipalities. A small portion of the census tracts are classified as low deprivation (≤ 0.25) in Ilhéus (6.91%) and Itabuna (9.35%). The subindex shows moderate deprivation (< 0.25% ≤ 0.50) for 23.4% of the urban census tracts of Ilhéus and 36.59% for Itabuna. The data demonstrate a high level (> 0.50% ≤ 0.75) of socioeconomic deprivation in Ilhéus, with 53.72% of tracts in these conditions, and 48.78% in Itabuna. Finally, 15.96% of the tracts revealed very high socioeconomic deprivation (> 0.75% ≤ 1) in Ilhéus, and 5.28% in Itabuna. Thus, the sum of the high and very high deprivation ranges reveals socioeconomic deprivation in both municipalities, namely 69.68% and 54.06% of the urban census tracts for Ilhéus and Itabuna, respectively.

The socioeconomic subindex lists the set of variables that assess the deprivation situation through interrelationships between color and race, income, and illiteracy of persons aged 9 years and over. The factor scores correlate, suggesting a direct relationship between self-declared black people and illiteracy, i.e., the data demonstrate that self-declared black people tend to be among the illiterate. In contrast, the other variables have an inverse correlation, i.e., self-declared white people have better incomes and tend to be literate. Given the inverse relationship of the two previous variables, it can be inferred that self-declared black and illiterate people are in the lowest income ranges.

[12] In the spatialization of the urban area of Ilhéus, some small territories further from the city center are not shown in maps. These areas comprise the districts of rural areas, which are classified as urban by the IBGE since they have minimal urban infrastructure. Because they are distant from the urban conglomerate of the municipality, they could not be included or viewed in the presented maps. The districts and their respective UMPI are, respectively, Coutos (0.45); Inema (0.40); Japu (0.36); Aritaguá (0.47); Banco Central (0.40); Castelo Novo (0.44); Pimenteira (0.41), and Rio do Braço (no data available).

The socioeconomic subindex presents the worst values among the four estimated subindices for both municipalities, demonstrating a direct influence on the worsening of poverty in Ilhéus and Itabuna for the analyzed period. Both municipalities have high deprivation in this regard, with Ilhéus concentrating a higher level of deprivation with 0.594, and Itabuna with 0.504. Among the variables that make up this subindex, the scores of the factorial model demonstrate that *per capita* income, together with illiteracy, contributes most significantly to the worsening of poverty in the municipalities.

According to the *Altas do Desenvolvimento Humano do Brasil* or Human Development Atlas of Brazil (UNDP, 2013), in 2010, Itabuna and Ilhéus were ranked as average for the Human Development Index - Education (HDI Education)[13], with 0.59 and 0.64, respectively. Moreover, the proportion of persons aged 15 to 24 who do not study, do not work, and are vulnerable to poverty is 35.28% for Ilhéus and 35.76% for Itabuna. These data confirm that socioeconomic conditions contribute significantly to estimated poverty in the study area.

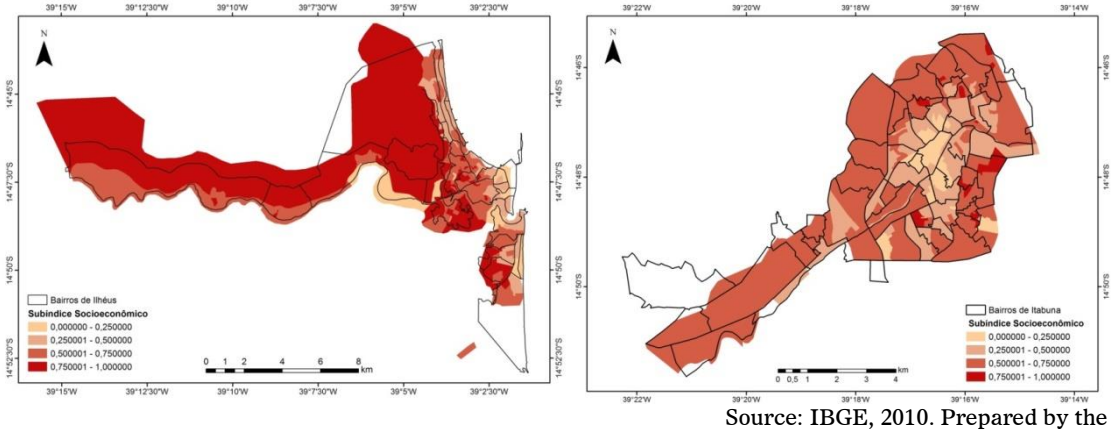
An isolated analysis of this result does not reveal intraurban differences in the two municipalities. However, Figure 5 shows how the state of socioeconomic deprivation is more intense and outspread across the entire territory of Ilhéus when compared to the Itabuna territory.

Moreover, this result reveals the intensity of the center-periphery relationship, with the highest subindices in localities outside the central region of the municipalities. In Ilheus, a state of very high socioeconomic deprivation can be observed across almost all the land area, from north to south, and from east to west. It is noteworthy that the largest strip in red from east to west of the city is a border region with rural areas and districts. The strip close to the eastern limit of the map (coast and central region) has better results in the subindex.

In the central region of the municipality, urban dynamics are more intense in terms of flows of services and people, and this is where banks, shops, clinics, and public institutions, are located, alongside other establishments. Therefore, due to the centralization of activities, higher wages and land prices are to be expected in this region, which improves socioeconomic results in relation to the other localities.

Furthermore, the northern coastal areas on the map, with lighter colors, house the city's industrial zone with electronics factories and cocoa bean processing companies. Although this zone can be considered peripheral, it benefits from the economic dynamics of the industries due to employment and income for local communities. Moreover, the coastal location is ideal for tourism-related activities and services, which is another source of income. The southern coastal region also benefits from tourism activities and its proximity to the center. The verticalization of housing in recent decades, with beachfront residential buildings, has led to increased urban land prices and residents with greater purchasing power. Notably, these so-called upmarket neighborhoods are surrounded by other neighborhoods with high deprivation, resulting in high and low-income people living in the same space, which reveals social pressure and an internal disparity in the city of Ilhéus.

**Figure 4:** Spatialization of the socioeconomic subindex in Ilhéus and Itabuna, Bahia




Source: IBGE, 2010. Prepared by the authors.

Itabuna also has the worst socioeconomic subindices, although, when compared with Ilhéus, a proportionally much smaller area is occupied by very high socioeconomic deprivation (strips in

[13] HDI ranges from zero (no human development) to 1 (total human development). An index of up to 0.499 means low human development. From 0.5 to 0.799 represents average development, while 0.8 or more is considered high development.

red). Itabuna displays high deprivation across almost all of its land area, especially in the peripheral regions throughout the municipality and the industrial area. Some sectors present a very high subindex of deprivation, while most of the municipality's services and commerce, as well as the households with higher *per capita* income, are concentrated in the central region, once again highlighting the center-periphery relationship.

In addition, Santos et al. (2010) applied the Williamson, Theil-L, and MPI coefficient, and stressed that the lack of monetary resources of the population of Ilheus and Itabuna regarding asset acquisition, revealed by the MPI calculation, reflects the inequality and concentration of income, and consequently, the absence of public policies to promote employment and offer adequate basic services. Underlying these issues, indicators related to basic infrastructure and education are also observed.

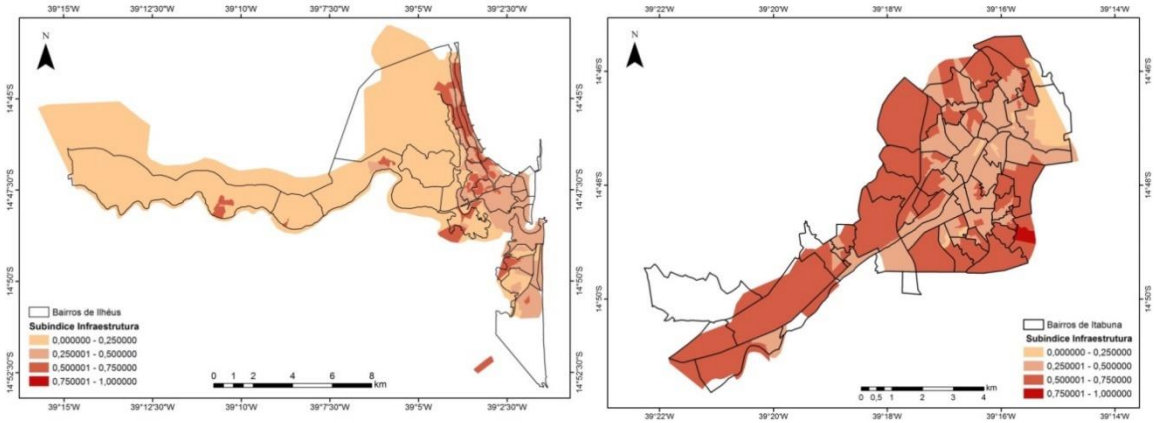
## Infrastructure subindex

Similar behavior can be observed regarding the infrastructure subindex. This subindex aggregates the set of variables that relate to those households without an identifiable street address, paving, sidewalk, and storm drains. The variables correlate positively to the factor, which determines interrelationships of existing deprivation regarding these observations. Ilhéus and Itabuna have moderate and high deprivations regarding urban infrastructure. With regard to moderate deprivation ($> 0.25\% \leq 0.50$), 60.65% of the urban sectors of Ilhéus are in this condition, against 56.50% of urban sectors in Itabuna. In terms of very high deprivation ($> 0.50\% \leq 0.75$), 23.40% of the sectors in Ilhéus were in this condition and 39.43% in Itabuna,

This subindex reveals greater deprivation in the territory of Itabuna, where the center-periphery dynamics are highlighted once again, with the central region showing moderate deprivation and the peripheral regions and industrial area displaying high levels of deprivation. In Itabuna, one census tract is classified as having a very high level of deprivation, which calls for a more detailed investigation of the factors that most influence this situation.

Concomitantly, the urban infrastructure in Ilhéus is better than in Itabuna based on the analyzed variables. Moderate deprivation levels are observed throughout the central region, periphery, and southern coastal areas. The coastal area north of the industrial zone, in turn, has a high level of deprivation regarding urban infrastructure. The large area represented by the strip to the west, shown as having low deprivation in Ilhéus, consists of agricultural production units.

**Figure 5:** Spatialization of the infrastructure subindex in Ilheus and Itabuna, Bahia




Source: IBGE, 2010. Prepared by the authors.

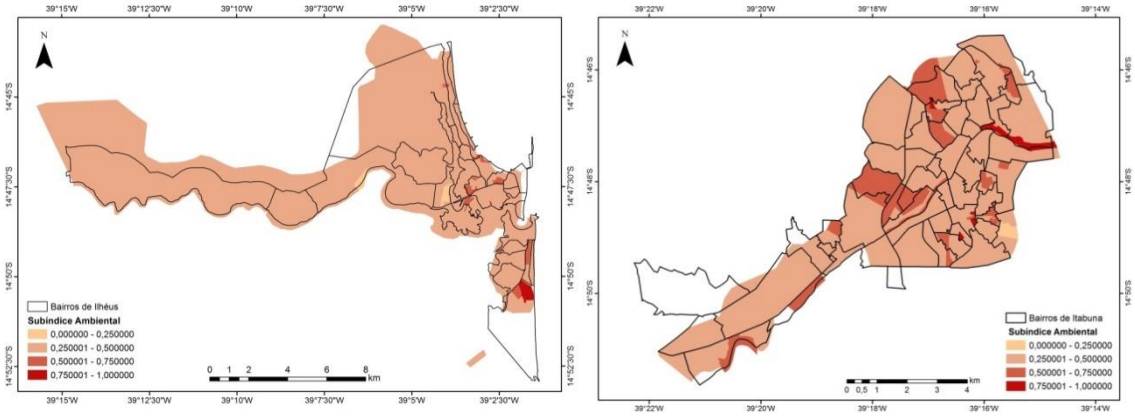
## Environmental subindex

Regarding the environmental subindex, the variables that demonstrate deprivation regarding urban basic sanitation are listed as a proxy for the environment, based on Hollander (2004). The variables relate to the existence of open sewers in the area around the households and the existence of accumulated garbage. This set of variables can aggravate the situation of poverty, expose people to health risks due to the unhealthy environment, and degrade the environment due to exposed domestic waste in the ecosystem.

The environmental subindex displayed a moderate level of deprivation for both municipalities. This dimension of deprivation was similar for both municipalities, although,

statistically Itabuna showed greater deprivation than Ilhéus, with values of 0.399 and 0.384, respectively.

**Figure 6:** Spatialization of the environmental subindex in Ilheus and Itabuna, Bahia




Source: IBGE, 2010. Prepared by the authors.

In Itabuna, high deprivation is observed in specific peripheral points and in the industrial zone, as well as very high deprivation (strip in red) in the peripheral area to the north. This observation reveals the absence of regular provision of basic services to the population, in addition to the lack of urban infrastructure. In Ilhéus, in general, moderate levels of deprivation regarding the environment are observed throughout the urban area, with specific census tracts in a situation of high and very high deprivation. This highlights the need for investments in basic urban infrastructure, a sewerage system, and treatment of household waste, as well as paving, sidewalks, and storm drains. Investment in basic sanitation can improve the quality of life of the population and reduce the risk of diseases caused by lack of sanitation, such as cholera, leptospirosis, and hepatitis. In addition, it also evokes the need for investment in primary and preventive healthcare.

## Urban Multidimensional Poverty Index (UMPI)

The results of the subindices of deprivation in relation to urban multidimensional poverty revealed that the socioeconomic dimension contributes the most to the worsening of poverty in the municipalities, especially in terms of income inequality and social differences between people, and showed the significant contribution of education in the composition of the subindex. Subsequently, the results of the infrastructure and environmental subindices demonstrated moderate deprivation for both municipalities.

The dynamics of the center-periphery relationship can be observed in the spatialization of all the presented subindices. The best subindices for the four studied dimensions displayed lower values, i.e., lower multidimensional poverty, for the central areas of the municipalities, while the highest subindices were observed for the peripheral regions in which all the industrial activity is concentrated.

For this study, the estimated UMPI ranged from 0.251 to 0.50 in most of the urban census tracts of Itabuna and Ilhéus, which is considered moderate deprivation.

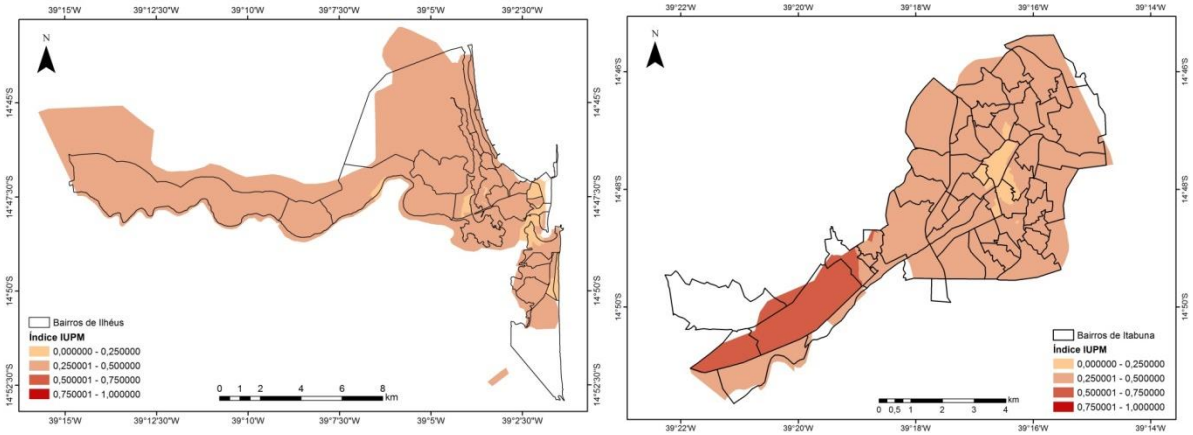
Analyzing the municipalities as a whole, the study reveals moderate UMPI for the urban areas of Ilhéus and Itabuna, with 0.357 and 0.353, respectively. In Ilheus, poverty is spread throughout the periphery of the urban area, in the coastal strip to the north, and in the peripheral areas of the neighborhoods behind the southern coastal strip. In Itabuna, the central region has low UMPI and a moderate level of poverty is observed in the peripheral regions in all directions of the map and more intensely, with a high level of deprivation, in the industrial region of the city, represented by the darkest strip on the map (Figure 7).

Thus, the factors that most contribute to these results are socioeconomic, revealing the dynamics of intraurban income disparities and the social inequality of access to basic education. As they are presented, they reveal a vicious circle of maintained inequalities since quality education provides more and better opportunities to obtain income. Moreover, lack of infrastructure directly aggravates multidimensional poverty, while the environmental factor that uses basic sanitation variables as a proxy as well as other factors, reveals the internal dynamics of cities in which the

greater the distance from the central services and commerce localities, the greater the level of deprivation.

Martins et al. (2019) estimated the MPI for the urban and rural areas of Itabuna and Ilhéus based on the methodology of Alkire and Foster (2010). The authors found MPI values ranging from 0.10 to 0.30 (medium-low) for most urban census tracts of households. For the areas further from the urban center, peripheral and industrial areas, the MPI is estimated to range from 0.31 to 0.50 (medium-high). The authors identified heterogeneity in the dimensions that group the variable water supply, sewers, electricity, garbage disposal, and asset acquisition. As revealed in the UMPI estimation, the smallest deprivations are mostly concentrated in the census tracts in the central areas of the cities (Itabuna and Ilhéus) and in the coastal region (Ilhéus).

**Figure 7:** Spatialization of the UMPI in Ilhéus and Itabuna, Bahia




Source: IBGE, 2010. Prepared by the authors.

An advanced urbanization process is observed in Ilheus and Itabuna that seemingly resulted from the disorderly occupation of urban areas, suggesting levels of deprivation in basic infrastructure and essential services.

For Itabuna, similar dynamics are identified by Barreto et al. (2018), who applied the Moran Index and observed poverty spots forming in the southwest region of the city, where the industrial area is located, in the Jorge Amado, Ferradas, Nova Ferradas, Fernando Gomes, and Urbis IV neighborhoods. Conversely, some areas were classified in the study as “low poverty” in the central regions of the city.

Similarly, according to the MPI estimated by Martins et al. (2019), the census tracts located in the urban center of Itabuna and in the coastal area of Ilheus, respectively, had the lowest incidence of poverty. In contrast, a higher incidence of poverty is observed in the peripheral areas of the municipalities, and in the rural areas of Ilhéus.

## Final considerations

Some limitations were identified in this study regarding the availability of data needed to apply the estimated model. Since aggregate census tract data were used, data were not available to profoundly assess environmental issues or access to basic consumer goods such as refrigerators, stoves, computers, and telephones. Moreover, all data that refers to basic services address the existence or non-existence of supply, without information on the quality, applicability, benefits, or proficiency of these services.

The estimated model shows that the variables classified as socioeconomic are the main factors that determine deprivation in both municipalities, and can be observed throughout the peripheral area of Ilhéus and Itabuna, and especially in the industrial area of Itabuna. Similarly, as shown in Santos Neto et al. (2020), Martins (2019), and Espirito Santo (2020), the high levels of deprivation in relation to socioeconomic issues and sanitation reveal the need for policies to promote employment for the economically active population and improve income distribution, thus putting Sen’s (2010) basic instrumental capabilities into effect.

Educational deprivation demonstrates the need for investments, school retention, and the professional qualification of illiterate persons aged 9 years and over. In contrast, the moderate deprivations in the infrastructure and environment subindices suggest the need to maintain the

creation of new urban infrastructures in the municipalities. Basic sanitation can increase the quality of life of the population, reduce the risk of diseases resulting from the lack of sanitation, and support investments in basic healthcare.

Data spatialization revealed that the further people move from the urban center, the more their living conditions worsen and even become precarious in the peripheral areas of both municipalities, which demonstrates the center-periphery relations and the way urban centers are on the margin of deprivation.

This condition further reveals the need for a public agenda that corrects the serious internal regional disparities. Partnering with the private sector to provide basic services such as education, water supply, sanitation, and regular garbage collection may also prove feasible.

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