https://dx.doi.org/10.22161/ijaers.6.5.1 *ISSN: 2349-6495(P) | 2456-1908(O)*

Sustainability Analysis of Porto Velho City Through a Basket of Indicators

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***Abstract*— *Sustainability is a theme that is on the agenda of cities when discussing municipal development. This research adopts the methodology developed by Cândido, Vasconcelos e Souza (2010) that builds the Participatory Municipal Sustainable Development Index (IDSMP) and in this research the IDSMP is calculated for the city of Porto Velho, state of Rondônia. It is an instrument already used in several places, citing as examples the municipalities of Cabaceiras and Guarabira, in the state of Paraíba. This index is important so that public and private managers can make decisions about the directions of local sustainability. This is a qualitative and explanatory study. In the data collection phase, the results of 38 sustainability indicators were extracted, 7 of which were cultural, 12 were social, 05 were demographic, 04 were institutional policies, 04 were environmental, and 06 of the economic dimension. As a result, it can be shown that the municipality obtained the result of 1 on the cultural dimension, 0.6860 for the social dimension, 0.5159 for the demographic dimension, 0.7392 for the institutional political dimension, 0.4237 for the environmental dimension and 0.7713 for the economic dimension, which eventually generated an IDSMP of 0.6893 for the municipality and, according to the method, the locality is in an acceptable level of sustainability. It is worth mentioning that the parameter of interpretation of the result of this index is comprised between the numbers 0 and 1, the lowest level of sustainability being in result 0 and the largest is in 1.*

Keywords*— *Sustainable Development. Sustainability Indicators. IDSMP.

I. INTRODUCTION

Sustainable development is a topic widely discussed by science and society in general. This is due to the importance that sustainability indicators present when we want to obtain a logical and rational picture of the impact of economic results. These indicators help pinpoint the paths to be pursued for sustainable development. And this is the way that this text inserts 38 indicators of sustainability and proposes a Participatory Sustainable Development Index of the Municipality (IDSMP) for the city of Porto Velho, state of Rondônia.

The main reference of the IDSMP comes from Martins and Cândido (2008), being a very used instrument, mentioning, as examples, the municipalities of Cabaceiras and Guarabira, in the state of Paraíba, but with little modification, since the authors used 48 indicators and in the case of Porto Velho, it was only possible to construct 38, but it should be noted that there were no negative impacts on the index.

The guiding question of the text is: What is the level of sustainable development of the city of Porto Velho when analyzed in the light of multiple indicators (basket of 38 indicators)?

The importance of the methodology focuses on the fact that in a basket of indicators, instead of analyzing them individually, the main benefit is the possibility of a relationship between the data, thus producing aggregate information for decision making in a more realistic way and compatible with local complexity.

II. THEORETICAL REFERENCE

2.1 Sustainable Development

Saeta (2012) informs us that the term sustainability is derived from Latin sustenance: "the word sustain comes from Latin to support, protect, maintain, care for, conserve. Therefore, sustainability is the characteristic or condition of maintaining and conserving a set of elements necessary for the maintenance of life. "The term"

https://dx.doi.org/10.22161/ijaers.6.5.1 *ISSN: 2349-6495(P) | 2456-1908(O)*

sustainable development "began to be generated and debated on the international scene with the United Nations Conference on the Human Environment, which took place in 1972 and is known worldwide as the Stockholm Conference, which was organized by the United Nations - UN (LAGO, 2007). Rosa and Staffen (2012) mention that the main concern at the Stockholm Conference was the need to combine development with the preservation of natural resources. It is true, the authors claim, that, in the first principle of that convention, it was stated that man has the fundamental right to freedom, equality, enjoyment of adequate living conditions in such a dignity and enjoyment of the well-being, and it has a solemn obligation to protect and improve the environment for present and future generations.

In this perspective, the study or research on the sustainable development of a specific region or locality requires a set of actions that must be observed by local government in partnership with organized civil society, since "there is no way to think of sustainability without the contribution (RANAURO, 2004), "the effectiveness of sustainability is to involve all actors involved in the same process" (RANAURO, 2004). As well as Cruz and Bodnar (2011), who define sustainability as an integrating and unifying concept capable of establishing the relationship between man and the environment at the same level, without any hierarchy, they reinforce that sustainability, as well as implying social transformation is also an integrating and unifying concept that suggests the celebration of the man / nature unity, in the origin and in the common destiny, which presupposes a new paradigm, therefore. While the content of the principle of sustainability is historically directed to the basis of production in liberal capitalist models, this notion must be broadened so that the beneficiaries of development are all those biotic and abiotic components that will ensure life to the fullest, even for future generations.

Buarque (2008, p.15), discussing the best planning for the promotion of sustainable regional development, based on the following strategies:

> (...) organization of society, contributing to the formation of local social capital (understood as capacity for organization and cooperation of local society) combined with the formation of institutional spaces for negotiation and management, value added in the productive chain, with the articulation and increase of the competitiveness of the economic activities with local advantages, and restructuring and modernization of the local public sector, as a form of decentralization of the decisions and elevation of efficiency and effectiveness of the local public management.

Quiroga (2001) argues that "technically, an indicator can be defined as the function of one or more variables, which together measure a characteristic or attribute of individuals in a study." In turn, Bellen (2005) states that the main functions of indicators are "to assess the conditions and trends of a phenomenon observed in relation to the goals and objectives intended to be able to warn in advance and anticipate future conditions."

Emery (2016) understands that the viable development of human societies is only one that does not ignore the notion of sustainability in its multiple dimensions. For him, sustainability is a profound, complex, multivectoral concept that reaches a myriad of multidisciplinary interests that encompass countless areas of knowledge that bequeath to it a connotation of balance, maintenance of a situation, perpetuity. It involves actions that reflect on various fields of human activity that have to be coherent with each other, and although different activities imply a greater emphasis on one or another aspect, there is a common substrate that allows the formulation of a single concept to support the sustainable development.

III. RESEARCH PROCEDURES

3.1 Methodological Framework

The following are the processes implemented for the production of the indicator divided into phases: in phase 1 the importance of each indicator, weighted by means of weights, are determined in surveys with experts from the postgraduate programs of the Federal University of Rondônia Foundation with adherence to the theme.

The tools used were: questionnaires with closed answers and transformed into value from the Likert scale.

In this case, we multiply each value by its "weight", that is, by its relative importance. Thus, the p-weighted arithmetic mean of a set of numbers x 1, x 2, x 3, ..., xn where its weight is respectively p 1, p 2, p 3, ..., pn is calculated by through Equation 1, as follows:

Equation 1:

https://dx.doi.org/10.22161/ijaers.6.5.1 ISSN: 2349-6495(P) | 2456-1908(O)

$$x_p = \frac{\sum_{m=1}^{n} p_m * x_m}{\sum_{m=1}^{n} p_m}$$

In Phase 2, according to the positive and negative relation of the indicators, this previously defined in the method, so that equations 2 and 3 can be applied, depending on the case.

Equation 2 (Positive Relationship)

$$I_+ = \frac{x - m}{M - m}$$

Equation 3 (Negative Relationship)

$$I_- = \frac{M - x}{M - m}$$

At where:

I - calculated index for the municipality analyzed;

x - value of each variable for the municipality;

m - minimum value of the variable identified in the State;

M - maximum value of the variable identified in the State.

The calculations for each dimension are defined according to equations 2 or 3, depending on whether the relationship is positive or negative in each Sustainability Indicator, and then equation 1 is used for the result in each dimension.

Eq. 04

$$IDSMP = \frac{IDC + IDS + IDD + IDP + IDA + IDE}{n}$$

It is worth noting that each of these dimensions are calculated by means of Equations 1 and 2.

At where:

IDSMP-Participatory Municipal Sustainable Development Index

IDC-index of the cultural dimension

IDS-index of the social dimension

IDD-index of the demographic dimension

IDP-index of the political-institutional dimension

IDA-index of the environmental dimension

IDE-index of the economic dimension

n-number of dimensions

The development index has four levels represented by table 01 below, the closer and the better the level of sustainability.

Table.1: Classification of sustainability levels.

INDEX (0 - 1)	LEVEL OF SUSTAINABILITY
0.0000 - 0.2500	Critical
0.2501 - 0.5000	Alert
0,5001 - 0,7500	Acceptable
0.7501 - 1.0000	Ideal

Source: Martins and Cândido (2008).

Considering the difficulty of obtaining some data for the construction of some indicators, 2 different calculations were made: in the first one, all the indicators were considered absent with the result 0, thus having a minimum value to be reached by the dimension; in the second moment, calculations were made considering the value of 1 for the missing data, thus simulating a maximum value to be achieved as a result.

3.2 Characterization of the Municipality

The present study was the municipality of Porto Velho, state of Rondônia, which was created by virtue of the Petropolis treaty in 1903, but it was made by pioneers around 1907, during the period when the Madeira Mamoré Railroad, in view of the need to surpass the stretch of the Rio Madeira, in order to enable the transportation of rubber production in Bolivia and the Guajará Mirim region.

On the other hand, in economic terms, the municipality has the fourth largest GDP of the North region, which in 2010 was estimated around R $ 7.5 billion.

The municipality also had a Municipal Human Development Index (HDI) in 2010 of 0.736, according to SEBRAE (2010).

3.3 Secondary Data Collection

It is worth noting, however, that in view of the extreme difficulty of accessing data, especially about the municipalities of the interior, due to the fact that they were not available by the IBGE during the study period, and also due to the lack of information filed at each location, used in the method adopted in this research, only 38 information were found, which is why in the calculation of the dimensions the obligation to calculate the minimum and maximum probable results was calculated to calculate the influence of this absence of indicators on the final result of the IDSMP . The table

https://dx.doi.org/10.22161/ijaers.6.5.1 *ISSN: 2349-6495(P) | 2456-1908(O)*

below describes the data collected in official bodies, used to calculate the Participatory Sustainable Development Indices of each Dimension, and, afterwards, the general IDSMP of the Municipality.

IV. DATA PRESENTATION AND ANALYSIS

From this part of the research, the results of each constructed indicator and thecalculation of the IDSMP in their respective dimensions will be presented, and, finally, the level of sustainability of the municipality.

4.1 Construction of the Participative Municipal Sustainable Development Index

For the effective Construction of the Participative Municipal Sustainable Development Index for the city of Porto Velho, it is necessary to calculate the Indices in each dimension. In Table 02, the results are presented with the minimum and maximum values, comparing them with the results achieved when considering the data collected:

It should be noted that for the minimum result the number 0 was considered and for the maximum the number 1 was considered.

Table.2: Dimensional Results

Dimensions	Indicators	Minimum Results	Maximum Results	Results obtained
Cultural	Bibliotecas	_	_	**1**
	Museus	_	_	**1**
	Centro Cultural	_	_	**1**
	Unidade de Ensino Superior	_	_	**1**
	Ginásio de Esportes e Estádios	_	_	**1**
	Cinema	_	_	**1**
	Teatros ou Sala de Espetáculos	_	_	**1**
	IDC	_	_	**1**
Social	Índice de Gini da dist. do rendimento	0,4167	0,4167	0,4167
	Rend. familiar per capita (% até 1/2 SM)	0,8165	0,8165	0,8165
	Famílias Atendidas por transf. Benef. Socais	0,8061	0,8061	_
	Razão de rendapopulação masculina e feminina	0,8562	0,8562	0,8562
	Esperança de vida ao nascer	0,9111	0,9111	0,9111
	Oferta de Serviços de Saúde****	0	1	-
	Taxa de mortalidade infantil	0,8957	0,8957	0,8957
	Prevalência de Desnutrição Total****	0	1	_
	Imunização contras doenças infec. Infantis****	0	1	_
	Taxa de escolarização	0,6959	0,6959	0,6959
	Taxa de alfabetização	1	1	1,0000
	Analfabetismo funcional	0,4625	0,4625	0,4625
	Morte por acidente de transporte	0,682	0,682	0,6820
	Morte por homicídios	0,586	0,586	0,586
	Adequação de moradias	0,2205	0,2205	0,2205
	IDS	0,5566	0,7566	0,6820

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Demográfico	Densidade demográfica hab/km2	_	_	0,6472
	Razão entre a população masculina e feminina	_	_	0,7905
	Distribuição da população por faixa etária	_	_	1
	Taxa de crescimento da população	_	_	0,6904
	Razão entre população Urbana/Rural	_	_	0,0482
	IDD	_	_	0,5159
Político - Institucional	Acesso Público a Internet****	0	1	
	Acesso a serviços de telefonia	0,4974	0,4974	0,4974
	Acesso a Justiça****	0	1	
	Comparecimento nas eleições	0,3654	0,3654	0,3654
	Despesa por função	1	1	1
	Transferências intergovernamentais da união	0,9637	0,9637	0,9637
	Número de Conselhos Municipais****	0	1	
	IDPI	0,4158	0,8533	0,7392
Ambiental	Acesso a esgotamento sanitário	0,2514	0,2514	0,2514
	Acesso a serviço de coleta de lixo doméstico	0,8292	0,8292	0,8292
	Acesso a sistema de abastecimento de água	0,3529	0,3529	0,3529
	Consumo médio per capita de água	0,18	0,18	0,18
	Volume da Água Tratada (%)****	0	1	
	Qualidade das Águas (rios e igarapés)****	0	1	
	Pastagens e Lavouras (Percentual)****	0	1	
	Matas e Florestas (Percentual)****	0	1	
	IDA	0,2118	0,7118	0,4237
Econômico	PIB	_	_	1
	Participação da Agropecuária no PIB	_	_	0
	Participação da Administração Pública no PIB	_	_	1
	Participação de Comércio/Serviços no PIB	_	_	
	PIB per capita (R$ 1,0)	_	_	0,7537
	%Renda proveniente do trabalho	_	_	1
	IDE	_	_	0,7713

https://dx.doi.org/10.22161/ijaers.6.5.1 *ISSN: 2349-6495(P) | 2456-1908(O)*

Source: Elaborated by the author from data collected in the research (2018)
Subtitle:
* Result when the number 0 is assigned to the missing indicators.
** Result when the number 1 is assigned to the missing indicators.
*** Result when calculated with the data collected.
Color scheme: Critical Acceptable Alert Ideal

After calculating the Development Index of each dimension, by means of equations 1 and 2, we calculate the IDSMP of the municipality, simulating also their respective minimum and maximum values, according to Table 04:

Table.4: Dimensional Results

Dimensões	Resultados Mínimos*	Resultados Máximos**	Resultados Obtidos***
IDC	_	_	
IDS	0,5566	0,7566	1
IDD	_	_	0,5159
IDPI	0,4158	0,8533	0,7392
IDA	0,2118	0,7118	0,4237
IDE	_	_	0,7713
IDSMP	0,5658	0,7606	0,6893

Source: Elaborated by the author from data collected in the research (2018)
Subtitle:
* Result when the number 0 is assigned to the missing indicators.
** Result when the number 1 is assigned to the missing indicators.
*** Result when calculated with the data collected.
Color scheme: Critical Acceptable Alert Ideal

It is observed, therefore, that the maximum and minimum values of the IDSMP ranged from 0.7606 to 0.5658, respectively.

Therefore, when compared to the result calculated with the existing indicators that was 0.6893, the IDSMP Maximum, at the level of 0.7606, is very close to the result found for the municipality, presenting only 0.07 of difference, demonstrating, therefore, that the results of the sustainability of the municipality of Porto Velho are very close to the calculated maximum.

V. CONCLUSION

The sustainability of the municipality of Porto Velho was at an acceptable level, considering that the Participatory Municipal Sustainable Development Index - IDSMP reached the result of 0.6893, once again remembering that the reference value variesbetween the number 0, as minor and 1, as higher level.

The method adopted proved to be effective for the search of the results of the research, enabling the numerical analysis, in this way, a rational level of sustainability of the municipality, which, through a mathematical equation, added several indicators in their respective dimension, corresponding, in last analysis, to the arithmetic mean of the six areas studied, which is described below:

Regarding the Cultural Dimension, all of its indicators had a maximum level of sustainability, perhaps due to the fact that it is a capital and, as a result, it has increased investments by the State, which has considerably increased the final result of the municipality's IDSMP.

Concerning the Social Dimension, six indicators were presented in an Ideal state, among them, the literacy rate with maximum result (1), while three were constructed in an Acceptable state, in addition to the Gini Index (0.4167), Functional Illiteracy (0.4625) and Household Adequacy (0.2205), with the first two being on the alert and the last in the Critical state, respectively, which resulted in a result for the Social Development Index of 0 , 6860.

The Demographic Dimension, in turn, presented two indicators in the Ideal state. The distribution of the population by age group, with a result (1), and two were still at Acceptable level and the ratio between urban / rural population, which was 0.0482, and therefore a critical level, which represents a great concern in the result of the present research, the great concentration of inhabitants in urban area of the municipality, and that ended up contributing to the Demographic Development Index reaching the level of 0.5159, therefore, in Acceptable State.

https://dx.doi.org/10.22161/ijaers.6.5.1 *ISSN: 2349-6495(P) | 2456-1908(O)*

The Political-Institutional Dimension presented two indicators in an Alert state and two in an Ideal state, which resulted in the result of the Political-Institutional Development Index of 0.7392, thus, in an Acceptable State of Sustainability.

Regarding the Environmental Dimension, three indicators were highlighted: Access to sanitary sewage, Access to water supply system and Average per capita consumption of water, with 0.2514, 0.3529 and 0.1800 respectively, while o Access to domestic waste collection showed a result of 0.8292, resulting in an Environmental Development Index of 0.4237, therefore, in a degree of sustainability alert.

Finally, the Economic Development Index was determined at the level of 0.7713, thus, in an Ideal degree of Sustainability, caused by three excellent results, according to the adopted methodology: GDP, Public Administration Participation in the GDP and GDP per capita, with a result of 1, therefore, in maximum state.

Regarding the general and specific objectives, as well as the research problem, all are considered and answered, considering that the Participative Municipal Sustainable Development Index was determined for the municipality of Porto Velho, with a result of 0.6893, in this way, in an Acceptable State of Sustainability.

Based on this information, it is possible to clearly, mathematically, and therefore rationally, not only the Sustainability Index of the municipality, but also the possibility of verifying in which indicators the public power and society in general should devote themselves to to seek the necessary improvements to the well-being of the citizens.

Within this context, chapter 5 was dedicated to simulating the results needed to make all the indicators that were in a critical and alert state in an acceptable level of sustainability.

In this way, it intends to foster the reflection of the need, in practice, through integrated public-private actions to improve the results, to meet some of the municipality's wishes, thus promoting the sustainable development of the municipality, understood as the improvement in six dimensions analyzed by the adopted method, taking into account the last specific objective adopted in the present research.

Confirmed the hypothesis adopted in the survey that indicated the sustainability of the municipality of Porto Velho as an acceptable level, according to the method adopted, due to the fact that some results of indicators are better than the rest of the municipalities of the State, decade important ventures, however, encountering the other variables with their not so good results.

As a limitation of the research, it can be presented that there are no important data for the construction of 10 indicators, which generated the need to exclude these variables from the general calculation of the Index. Therefore, of the 48 variables adoptedin the method, a basket with 38 was used, a limitation that was solved through the creation of maximum and minimum parameters for each indicator.

This limitation, in turn, eventually contributed to future research, considering that the criterion was adopted to simulate the maximum and minimum possible values for the results, thus creating a parameter of evaluation of possibilities, which will allow other authors to solve any problems of lack of data in their research.

The non-existent variables were thus simulated with maximum value (1) and minimum value (0), to obtain the result better or worse than each indicator, each dimension and, consequently, the municipality index could reach if the data existed.

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