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GREEN GDP INDICATOR: APPLICATION IN A BRAZILIAN FOUNDRY INDUSTRY (2008-2016)

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ABSTRACT

The objective is to calculate the value of the green industrial PIB of a foundry in the territory of Santa Catarina and to contextualize its importance as a new methodological tool. To legitimize the objective of this study, the green GDP equation is equal to the Gross Sales Revenue (Industrial GDP) - (Depletion of Water Resources + Cost of Environmental Degradation). In this context, the depletion of natural resources corresponds to the total value of the extraction of water resources, and the cost of sectoral environmental degradation is given through the proxies of the methodology of the Industrial Pollution Projection System (IPPS) applied directly to the industrial product sector. estimate of the cost of the industrial sector studied here. Methodologically, it is an exploratory, descriptive, explanatory, bibliographic, documentary and ex post facto study. As a result, the green GDP of the foundry was lower than the industrial GDP in all the surveyed years. It is noticed that the industrial economic activity of the foundry, within these parameters of analysis, signals a loss of future sustainability, taking into account the years investigated. Therefore, in order for this particular industry to reverse this scenario, investments in technologies are necessary, in order to minimize the consumption of natural resources and consequently maximize its green GDP.

Keywords: Green GDP methodology, Regional development, Corporate sustainability, Foundry, Territory Catarinense.

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INDICADOR DE PIB VERDE: APLICAÇÃO EM UMA INDÚSTRIA DE FUNDIÇÃO BRASILEIRA (2008-2016)

RESUMO
O objetivo é calcular o valor do PIB verde industrial de uma fundição no território catarinense e contextualizar sua importância como uma nova ferramenta metodológica. Para legitimar o objetivo deste estudo, a equação PIB verde é igual à Receita Bruta de Vendas (PIB industrial) - (Depleção dos Recursos Hídricos + Custo de Degradação Ambiental Setorial). Neste contexto a depleção dos recursos naturais corresponde ao valor total da extração de bens hídricos, já o custo de degradação ambiental setorial é dado através das proxies da metodologia do Industrial Pollution Projection System – IPPS, aplicado diretamente sobre o produto industrial setorial, gerando assim uma estimativa de custo do setor industrial aqui estudado. Metodológicamente é um estudo exploratório, descritivo, explicativo, bibliográfico, documental e ex post facto. Como resultados, o PIB verde da fundição foi inferior ao PIB industrial em todos os anos pesquisados. Percebe-se que a atividade econômica industrial da fundição, dentro destes parâmetros de análise, sinaliza uma perda de sustentabilidade futura,

levando em consideração os anos investigados. Portanto, para que esta determinada indústria consiga reverter esse cenário, é preciso principalmente de investimentos em tecnologias, para que assim se alcance a minimização do consumo de recurso natural e consequentemente consiga maximizar o seu PIB verde.

Palavras-chave: Metodologia do PIB Verde, Desenvolvimento Regional, Sustentabilidade Empresarial, Fundição, Território Catarinense.

1. INTRODUCTION

Economic development implies promoting "increase in the capacity of a society to produce more goods and in a better way, […] so as to satisfy human needs" (SOUZA, 2012, p.18, our translation). However, reconciling the interests and needs of society with the environment has become a real challenge today, for "development is, rather than a qualitative change in social relations, above all a quantitative expansion in the essential and unquestioned social capitalist model" (SOUZA, 2012, p.19, our translation). This way, it is evident that the great challenge is to develop public policies that include the existing productive processes and that, together with these processes, may find local alternatives that contribute to sustainable development.

Thus, in order to understand how development takes place in the territory, it is necessary to observe two conflicting elements: the social and the natural, which constantly change. In this sense, the ideal sustainable development is the one that meets the needs of the present without compromising the ability to meet the needs of future generations. Within this approach, organizational practices, which in one way or another, have been adapting to the new legislations, especially environmental laws, whose purposes involve achieving sustainability in all dimensions. This way, sustainable actions to minimize the consumption of natural resources only have organizational legitimacy if they are consolidated in strategic plans. In this perspective, it is worth mentioning that nowadays any productive sector, if it causes any kind of exhaustion of natural resources, tends to cause harm to society as a whole.

Starting from this assumption, then, the green gross domestic product (GDP) methodology is an indicator for measuring corporate sustainability. With this methodology, it is possible to evaluate corporate sustainability, identifying if industries are producing environmental liabilities to be faced by future generations. Thus, in order to use the methodology of the green GDP as an approach, an industry of the metal mechanics sector (foundry industry), located in the city of Joinville, state of Santa Catarina, Brazil, was used as

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a case study. The objective, therefore, is to identify the value and contribution of the foundry's industrial green GDP as an indicator of corporate sustainability, from 2008 to 2016.

To legitimize the objective of this study, the fundamental equation of the green GDP is used through an adaptation for its measurement in the foundry, therefore allowing for its use as an indicator of sustainability of the industrial activity at stake. Thus, the green GDP equation is equal to the Gross Sales Revenue (industrial GDP) minus the (Depletion of Water Resources + Cost of Sectorial Environmental Degradation). In this context, the depletion of natural resources corresponds to the total value of the extraction of water resources, and the cost of sectoral environmental degradation is given through the proxies of the methodology of the Industrial Pollution Projection System (IPPS), applied directly to the sectorial industrial product in the industrial GDP.

This way, it generates an estimate of the cost of the industrial sector studied here. In this perspective, the gap between the green GDP and the industrial product will be analyzed based on the fact that if the green GDP equals the industrial GDP, there is no loss of sustainability, otherwise, if the green GDP is less than industrial GDP, it implies that industrial activity is losing sustainability, reducing future possibilities for growth.

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2. DEVELOPMENT SUSTAINABLE

Given the numerous development concepts, sustainable development approaches meet the green GDP discussions, understanding that this discussion aims to preserve and maintain the environment from the point of view of business activities. The term sustainable, in its origin, comes from the Latin Sustentare, in which it is associated with the idea of sustaining, defending, conserving and caring. From this perspective, it is noteworthy that approaches to sustainable development emerged and intensified in the last decades of the twentieth and early twenty-first centuries. Thus, sustainable development leads us to the idea that action should not be oriented in isolation, either in the accumulation of wealth or in the protection of natural resources. MALETHERS; COUTINHO; PHILIPPI JR. (2012) point out that the worldwide process of building a common concept for this idea of reconciling economic development and protecting social and natural heritage emerged most strongly from the 1960.

The growing awareness of the human population with environmental and social issues began to require companies to pay greater attention to the conflicts that their activities cause in the environment and civil society in which they operate (DESWANTO & SIREGAR, 2018). In this context, the fact that the population is more attentive to environmental and social issues has led companies to implement sustainable solutions, seeking the satisfaction of all stakeholders, and not only the maximization of shareholders' interests, as emphasized by the classical economy (LOPEZ; GARCIA & RODRIGUEZ, 2007). Thus sustainability starts from the idea that more than generating financial results, companies in general should generate social and environmental actions.

Organizations legitimately concerned with sustainability can be considered as those that pursue in their activities the balance between economic, social and environmental dimensions (BARBIERI, VASCONCELOS & ANDREASSI, 2010). Hallstedt, Thompson & Lindahl (2013) point out that in order to incorporate and practice sustainability in an efficient, effective and strategic way, it is necessary to define what sustainability in its three dimensions represents for the company. In this context, sustainability signals a well-defined strategic situation, which can be a set of values, actions and procedures that companies address in order to minimize any damage resulting from their activities and thus create economic, social and environmental value (SHERMAN, 2012; ESTEVES, 2014).

Thus comes the green GDP, which, by analyzing the impact of economic growth on our natural resources, allows companies to map out more accurate strategies for sustainable development.

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3. METHODOLOGICAL PATH

In order to delineate the research, we used the taxonomy presented by Vergara (2016) since it classifies the scientific study as to its ends and means.

As for the purposes, the present study is of an exploratory, descriptive, explanatory, and evaluative nature. It is exploratory, because no study related to the subject in question has been identified, that is, related to the use of the methodology of the green GDP as an indicator of industrial sustainability, having as a case study an industry of the mechanical metal sector of Joinville, state of Santa Catarina, Brazil, more precisely a foundry. This way, Gil (2017, p.27, our translation) highlightsthat “exploratory research is intended to provide greater familiarity with the problem, with a view to making it more explicit or constructing a hypothesis.”

It is descriptive since it approached concepts and theories related to the research theme. It has also as contribution in the description, the analysis of the results on the foundry from the application of the methodology of the green GDP. According to Gil (2017), this type of research has the purpose of describing the characteristics of a given population, with the purpose of identifying possible relationships between variables.

It is explanatory, because it aims to point out the real numbers of the industrial green GDP of the foundry, seeking to link with the theoretical discussions addressed in the course of this work. Gil (2017) explains that explanatory studies aim to deepen knowledge with the reality, having a purpose to explain the reason, the reason for things.

It is evaluative, because it aims to evaluate the degree of sustainability of the foundry, from the comparison between industrial GDP and green GDP, thus demonstrating their relationships. For Aguilar and Ander-Egg (1994), an evaluation study only has meaning to occur if it is socially relevant and especially if it is a significant problem, and of interest of the researcher and the researched subjects.

As for the means of investigation, the present study is classified as bibliographical, documentary, case study and *ex post fact*. It is bibliographic, because to support the study was necessary to refer books, specialized articles in the topic in question, materials made available on the internet, search databases (CAPES), among other research instruments. Vergara (2016, p.43, our translation) describes that bibliographic research is a systematic study developed on the basis of published material, in books, magazines, newspapers, electronic networks, and with accessible material to the general public."

The study is documentary, since accessible documents were referred to on the foundry and BM&FBOVESPA websites (annual financial reports, integrated sustainability report, among others) that are totally available in the public domain. Gil (2017, p.30, our translation) stresses that documentary research is used in practically all social sciences and is one of the most important designs in the field of history and economics."

It is a case study, since it studies an industry (foundry) that has its legal structure nominated as a joint-stock company. This way, Martins (2008) points out that case studies involve the study of a social unit that is analyzed in a deep and intense way, through empirical research that investigates phenomena in a real context, but without the researcher's control over their effects and variables.

Last but not the least, this study can be considered *ex post facto*, because data and information that are already elaborated will be analyzed. Vergara (2016, p.44, our translation) classifies this type of investigation as referring to an already occurred fact, that is, manifestations that have already occurred, and the variables are not controllable."

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The universe or body of analysis of the study was a foundry in the municipality of Joinville, and data sampling is focused on the verification of the value of the green industrial GDP in the period from 2008 to 2016, as well as a description of the main actions performed by the company with the purpose of promoting corporate sustainability. Data collection was done through documents of the organization that were obtained through electronic means (company website and BM & FBOVESPA). The main documents analyzed by the company from the BM & FBOVESPA website were the annual reports of the consolidated standard financial statements/income statement for the years 2008 to 2016.

Data were collected from 2008, as they are available to the public as of this year (2008) both on the industry site and on the BM & FBOVESPA website. The referred reports compose the gross revenue from sales of goods and services. With such information, it was possible know the value of the industrial GDP of the foundry, given that this is very important for the calculation of the industrial green GDP. In addition, environmental and social sustainability reports were consulted from 2008 to 2016, in order to know the actions carried out by the company in the economic and social sphere. The data were processed in a qualitative and quantitative manner, through content analysis and the use of the proposed methodology to calculate the green GDP, so that the objectives could be legitimized.

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3.1 The Green GDP Methodology

The quantitative treatment was based on the adaptation of the methodology provided by the World Bank in the document *Handbook of National Accounting – Integrated Economic and Environmental Accounting – Final Draft Circulated for Information prior to Official Editing*, published in 2003 by the United Nations with the objective of measuring the degree of sustainability of the economy.

The methodology for calculating conventional GDP does not include variations in natural capital, nor the costs associated with pollution, nor does it include the environmental dimension of the indicator. For Young (2003, p.103-4, our translation), the calculation of GDP only considers the gains obtained in the exploitation of natural capital, without taking into account that the consumption of this in rates higher than its replacement can lead to exhaustion in the long term, impairing the ability of the economy to maintain the same rhythm of activities based on the use of natural resources. Within this context emerges the Green

GDP, in which it differs from conventional GDP through two variables: mineral or water depletion, and the cost of environmental degradation.

The cost of environmental degradation is calculated based only on the industrial sector, due to the unavailability of information about other coefficients of environmental degradation of other sectors (YOUNG et al., 2000). Therefore, the cost of Sector Environmental Degradation is calculated through the application of proxies from the International Pollution Projection System (IPPS) methodology of the World Bank. To do so, the following calculation formula is used to calculate the Green GDP:

Green GDP of the Foundry = Gross Value of Production - (Depletion of Water Resources + Cost of Environmental Degradation Sector)

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In order to obtain the necessary values for the calculation, the data of the average consumption of water used in the production were raised from the site of a foundry, in which the production process is similar to that of the foundry studied, considering the years from 2008 to 2016. In addition to these data, reports of standardized financial statements (gross value of production) were also collected from BM & FBOVESPA website. Data were also obtained from the water company, *Águas de Joinville*, such as the water tariff. Thus, in order to calculate the green GDP of the foundry, the following data were necessary: Value of the tariff paid by m³ of water used in the foundry; Volume of consumed water in m³ - by the total production of the industry, thus with the value of the tariff per m³, multiplied by the volume spent in m³ one the value in reais related to water consumption, that isconsidered, in this study, the variable “Depletion of Water Resources in R$.

The depletion of water resources is nothing more than the monetary valuation of the water resources used in production, considering that the depletion reflects the depletion of the water resources of that sector. Lana (2009) states that new development possibilities need to be demonstrated in order to improve the efficiency of the use of natural resources, thus avoiding their complete depletion. In order to know the “Cost of Environmental Degradation in R$”, it is necessary to know the gross value of the production year, in which the emission coefficient and industrial toxicity (%) will be applied. The applied coefficients were the “manufacture of other metallurgical products correspond to (0.08%)” and “manufacture of other vehicles, parts and accessories correspond to (0.09%)” which are the types of activities that the foundry performs.

The sum of these percentages (0.08 + 0.09) totaled 0.17%, then divided by two, and so the average proxies (0.09%) were used to calculate the cost of environmental degradation impact of the foundry. Given these data, with the gross value of production (VBP / R$) less the depletion of water resources in R$ and the cost of degradation in R$, it reaches the objective, which is the real value of the green GDP. In relation to the average of the coefficients applied to annual industrial production, Young (2003) points out that this methodology associates the emission of pollutants with the production value of each activity. Such a system consists of a database that provides the industrial emission and toxicity coefficients calculated for the American industry, but the author combined them with Brazilian Institute of Geography and Statistics (IBGE) data on industrial production in Brazil. The methodology provides control cost coefficients for organic load, sulfur dioxide, nitrogen dioxide, volatile organic compounds, and particulate matter for air emissions.

4. RESULTS AND DISCUSSIONS

4.1 Practical Calculation of the Green GDP Methodology for the Studied Foundry

With the green industrial GDP, it is possible to evaluate the sustainability of each industrial sector. What is worth mentioning is that the greater an economic activity is linked to the depletion of natural resources (such as minerals and water) and high environmental degradation costs, the worst the results will be at future levels of growth. Thus, there are three possibilities for sustainability:

1 - Green GDP = Industrial GDP - Indicates a high degree of sustainability, since this equality emphasizes that the depletion of natural resources and the costs of environmental degradation are equal to zero.

2 - Green GDP> Industrial GDP - Indicates a high degree of sustainability, given that the composition of industrial GDP is not based on the depletion of natural resources, besides acting with low costs of environmental degradation.

3 - Green GDP <Industrial GDP - Indicates loss of sustainability of the economic activity, and both the depletion of natural resources and the cost of environmental degradation are

reducing the green GDP, and depending on participation, the loss of sustainability can be high.

Thus, in view of these circumstances, what needs to exist in the face of this reality is a parameter for evaluation, so it is possible to evaluate sustainability from an acceptable level between the green GDP and the industrial GDP. The relationship between industrial GDP and green GDP may reveal a paradox, that is, known as a growth paradox. What this means is that the industrial GDP can indicate growth and the green GDP can indicate retraction. This relationship is due to the fact of a high degree of loss of sustainability, where the predominance of the variable depletion of water resources is in combination with the high cost of environmental degradation.

Previously to the calculation of the Green GDP of the foundry in question, it is necessary to detail the variables that compose the calculation methodology, among them, the depletion of water resources and the environmental degradation of the mechanical metal sector. Thus, depletion of water resources was calculated based on the water consumption of an industry, whose production process has particular characteristics similar to that of the foundry used as a case study. Within this context, in order to reach the average water consumption of the company studied, a rule of three was applied, based on another industry of the metal sector in Santa Catarina. Àvila (1986) considers that the rule of three from the same idea of proportion proposes an algebraic resolution for these problems, since it consists of multiplying the two opposite numbers and dividing this product by the other number. In this sense, the practice of applying the rule of three in this study was due to the fact that the company studied does not make available in its annual corporate sustainability reports of the total water consumption in m³ for the production process.

Thus, the adoption of the rule of three is legitimized by the insufficiency of data present in the sustainability reports of the foundry studied. The company, taken as the basis for the calculation of the average, provides the total consumption of water (m³) in its production processes, in addition to the gross sales revenue (Industrial GDP). Even with the lack of data, we chose the foundry, because it is a company of great representation in the territory of Santa Catarina, besides having granted a day of visitation so that we would know the industrial plant of the foundry. Therefore, if the average was not calculated in order to reach the average water consumption in the production processes of the foundry between 2008 and 2016, the study would be unfeasible. For that, the difficulties of finding the data were many, because the variables of the methodology of the green PIB are not calculated and published by the industries at the moment. This is due to the fact that it is a new discussion both in the scientific community and in the business environment, thus, a better consolidation of the variables through the application of the green GDP methodology law throughout the national territory is needed.

In order to achieve the average water consumption, the "Integrated Annual Report" of the reference industry for the year 2016 was used as the basis. The financial data were obtained from BM & FBOVESPA (2017) based on the business reports of both the foundry and the company taken as a reference. Therefore, in order to reach the values, the gross revenue from sales (PIB PIB) of the foundry in 2016, which corresponds to R$ 3,255,310,000.00 (BM & FBOVESPA, 2016), was used and multiplied by the total consumption of water in 2015 (664,928 m³) of the reference industry, and finally, was divided by the total sales revenue (Industrial GDP) of 2015, that totals R$ 9,760,323,000.00 of the reference industry (BM&FBOVESPA, 2015).

The average consumption was 221,770 m³ for the year 2016. Under these conditions, that is the average volume of water needed to supply a metalworking industry with this contribution of gross sales revenue, and consequently, annual production. The following table shows the volume spent in m³ for all the years surveyed (2008 - 2016):

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Table 1. Calculation of the average volume of water resources consumed by the foundry in m³ per year.

Year	Green GDP (R$) *	Water Flow (m^3) **
2016	3.255.310.000.00	221.770
2015	3.426.996.000.00	233.466
2014	3.114.661.000.00	212.188
2013	3.122.984.000.00	212.755
2012	2.671.120.000.00	181.972
2011	2.185.548.000.00	148.892
2010	1.871.527.000.00	127.499
2009	1.223.841.000.00	83.375
2008	1.767.753.000.00	120.429

Source: * (BM & FBOVESPA, 2016) ** (Calculated Value, 2017).

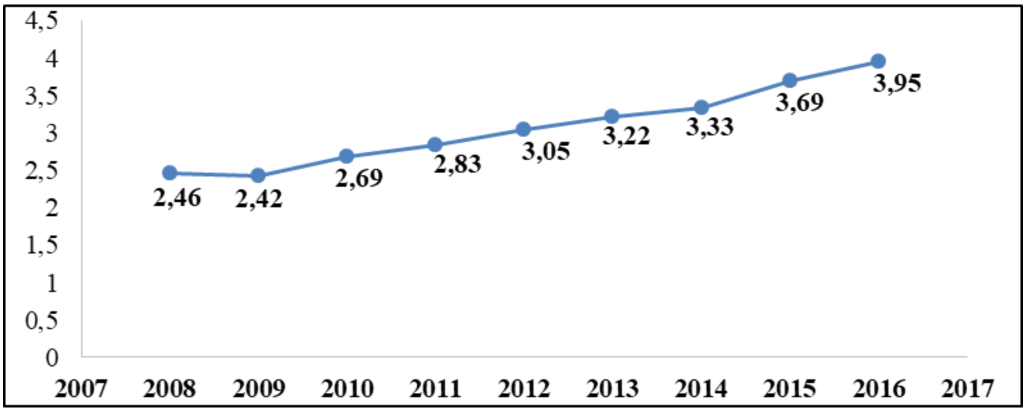
Faced with the consumption of water (m³) in the production process, one starts to calculate the depletion of water resources. As for the value of the tariff the foundry is charged, the water company of Joinville is the company that supplies the foundry with water resources.

It discriminates the values charged for each sector (residential, commercial, industrial, public, and special industry), so that in this study the special industry tariff (above 120,000m³) was used, thus, costing R$ 3.95 per m³ of water consumed in 2016. In order to reach the values from 2008 to 2015, the amount charged in 2016 was deflated.

In view of this situation, it is worth highlighting and clarifying that for the attribution of value by m³ of water used by the industry in its production process, it was necessary to have knowledge of the total value of water consumption m³ in reais (Brazilian currency). It is known that the foundry uses not only the water treated by the water company of Joinville, because the company also uses groundwater, surface water and reuse water. The assigned tariff is applied to the total amount m³ spent on production, according to what was found from the average, regardless of the origin of the resource, because for the calculation of the green GDP, more specifically the calculation of the depletion of water resources, what one needs to know is the m³ spent and the annual rate, thus generating the total monetary value of the depletion.

The tariff value attributed to the calculation of the depletion of water resources was deflated by the IGP-M (General Market Price Index), in which the deflator was applied from the amount charged in 2016, which was R$ 3.95. (tariff) of the industry in the previous years (2008 to 2015). The procedures used to reach the tariff values were from DrCalc.net software. In this software, the value is to be updated or deflated, assigning the time (starting date and end date), and finally selecting the index that will be deflated, in this case the IGP-M (FGV). Thus, after applying the deflator for all the years investigated, one has the following tariff values, in which the evolution since 2008 can be observed in Graph 1.

Graph 1. Tariff values charged per m³ used in the production process of the foundry per year.



Source: Research Data (2017).

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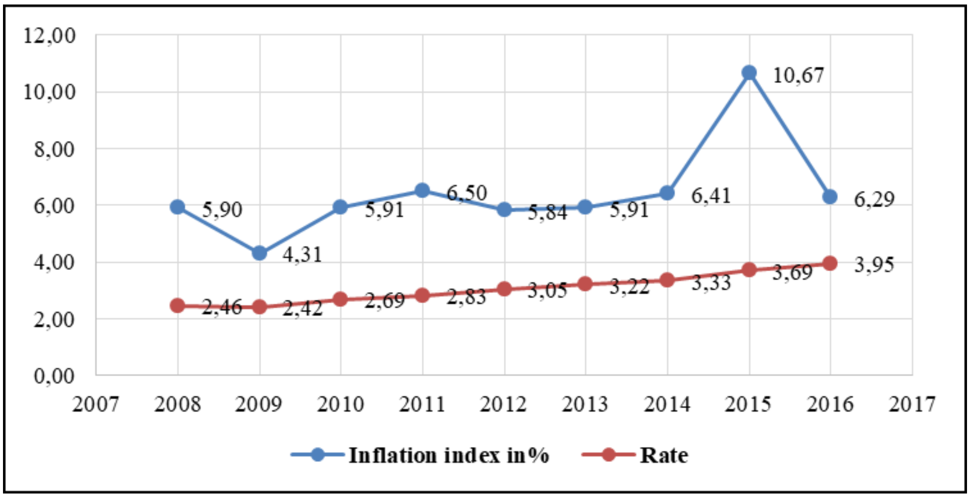
To better understand the variation in tariff values between 2008 and 2016, or graph 2 illustrates how the bar in red represents the real value of the tariff, and the blue bar represents the year. As can be seen, there was a variation in the value of the tariff between 2008 and 2009, with a decrease of R$ 2.46 (2008) to R$ 2.42 (2009). The reason for such difference is inflation since the tariff value of 2009 suffered a fall.

Graph 2. Water tariffs and annual inflation rates from 2008 to 2016.



Source: Research Data (2017).

Thus, considering the average volume of water (m³) consumed by the foundry and the annual values of the tariff (R$), one starts to calculate the depletion of water resources, as shown in table 2.

Table 2. Depletion of the water resources of the foundry from 2008 to 2016.

Year	**Industrial Foundry GDP (R$)**	**Water Volume (m³)**	**Rate (R$)**	**Total value of water consumption (R$)**
2016	3.255.310.000.00	221.770	3.95	875.991.500.00
2015	3.426.996.000.00	233.466	3.69	861.490.332.00
2014	3.114.661.000.00	212.188	3.33	706.586.707.00
2013	3.122.984.000.00	212.755	3.22	685.071.775.00
2012	2.671.120.000.00	181.972	3.05	555.013.673.00
2011	2.185.548,000,00	148.892	2.83	421.363.807.00
2010	1.871.527.000.00	127.499	2.69	342.972.123.00
2009	1.223.841.000.00	83.375	2.42	201.767.312.00

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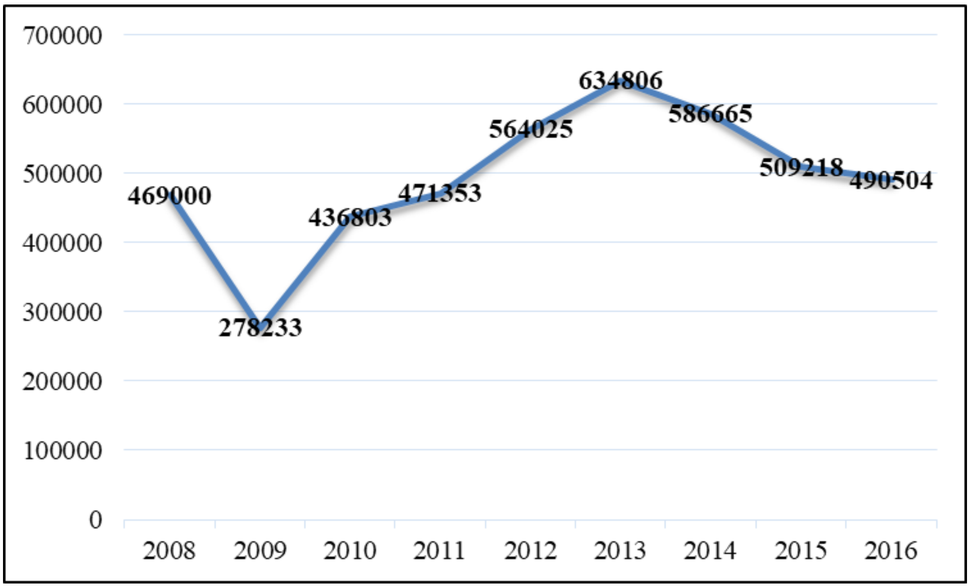
2008	1.767.753.000.00	120.429	2.46	296.255.986.00

Source: Research Data (2017).

According to table 2, the results presented show that, based on the calculated years (2008-2016), real numbers have increased since 2009 in relation to the total value in water consumption by the foundry in the production process. In the same analysis, it can be observed that, in 2009, there was a significant drop in water consumption compared to 2008. The justification for this is given by the fact that, in 2008, industries throughout the world witnessed an economic crisis, that reflected in exports, plaguing several sectors of the economy, causing a decrease in the production volume of this period, and consequently, a decrease in water consumption. In the year 2010, there was a resumption in the increase of production, with growth until 2013, at exponential levels, and with that, water consumption, which consequently was influenced by the volume of production, also increased. As for the value of industrial GDP, it fell in 2008, and, in the coming years, growth was constant, with only a slight decrease in 2016 in relation to 2015.

In Brazil from 2013, economic performance was weak. There was a rapid deterioration of the tax situation, inflation and weakening of the exchange rate, resulting in a strong recession, with the GDP falling close to 4%, according to Brazilian Central Bank data. The production of capital goods accumulated a consecutive decrease for more than 20 months between 2014 and 2015 and ended the year with a 25.5% decrease (IBGE, 2014). Graph 3 shows the total annual volume production in the years 2008 to 2016 of the foundry.

Graph 3. Production volume in tons of the foundry



Source: Research Data (2017).

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Within the context of the Green GDP, the cost of environmental degradation in 2009 (R$ 110,145,690.00) decreased in relation to the cost of degradation if compared to 2008 (R$ 159,097,770.00). In 2010, the cost of environmental degradation started to increase according to the industrial GDP until 2015, and in 2016 there was again a decrease compared to the previous year. During this period, the cost of environmental degradation fell from 2015 (R$ 308,429,640.00) to 2016 (R$ 292,977,900.00). Within this context, the cost of environmental degradation reflects the negative impacts of production on the environment. This way, the industrial activity of the foundry in the investigated years has been increasing the cost of environmental degradation due to the model of the production process of the industry. Table 3 outlines the results regarding the environmental degradation cost of the foundry in all the years studied.

Table 3. Environmental degradation cost of the foundry from 2008 to 2016

Year	Industrial GDP	Emission Coefficient and Industrial Toxicity (%)	Cost of environmental degradation (R$)
2016	3.255.310.000.00	0.09	292.977.900.00
2015	3.426.996.000.00	0.09	308.429.640.00
2014	3.114.661.000.00	0.09	280.319.490.00
2013	3.122.984.000.00	0.09	281.068.560.00
2012	2.671.120.000.00	0.09	240.400.800.00
2011	2.185.548.000.00	0.09	196.699.320.00
2010	1.871.527.000.00	0.09	168.437.430.00
2009	1.223.841.000.00	0.09	110.145.690.00
2008	1.767.753.000.00	0.09	159.097.770.00

Source: Research Data (2017).

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In order to corroborate this assertion, we start with the calculation of the Green GDP, the primary objective of this study. Table 4 presents the Industrial Green GDP of the Foundry inthe years analyzed (2008-2016). The base year for the calculation of this study is 2008, we can see a drop in the 2009 green GDP, which is related to the fall in gross sales revenue (industrial GDP), and consequently the cost of environmental degradation. It is also observed, that from 2015 to 2016, the values of these variables also reduced, in which the most probable justification is the retraction in the industrial activity itself, occasioned by moments of economic crisis in the national territory

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Table 4. Calculation of the Green GDP of the smelter in the period 2008-2016.

Year	Industrial GDP	Depletion (R$)	Cost of degradation (R$)	Green GDP (R$)	Variation % Green GDP / Industrial GDP
2016	3.255.310.000.00	875.991,500.00	292.977.900.00	2.086.340.600.00	64%
2015	3.426.996.000.00	861.490.332.00	308.429.640.00	2.257.076.028.00	66%
2014	3.114.661.000.00	706.586.707.00	280.319.490.00	2.127.754.803.00	68%
2013	3.122.984.000.00	685.071.775.00	281.068.560.00	2.156.843.665.00	69%
2012	2.671.120.000.00	555.013.673.00	240.400.800.00	1.875.705.527.00	70%
2011	2.185.548.000.00	421.363.807.00	196.699.320.00	1.567.484.873.00	72%
2010	1.871.527.000.00	342.972.123.00	168.437.430.00	1.360.117.447.00	73%
2009	1.223.841.000.00	201.767.312.00	110.145.690.00	911.927.998.00	75%
2008	1.767.753.000.00	296.255.986.00	159.097.770.00	1.312.399.244.00	74%

The foundry's industrial GDP diverges on average 70% of its industrial Green GDP. Since there is no parameter to evaluate which percentage can be considered acceptable, what is established here is that, the closer the industrial green GDP is to he tindustrial GDP, the better it is, since it shows that the company has been making investments to maximize its green industrial GDP. Due to the fact that the industry is a foundry, its Green GDP result can be improved through the adaptation of the productive processes or through investments, mainly in cutting-edge technology, thus, minimizing the consumption of natural resources, in this case, water consumption. If this scenario does not change, investments are not made, and the industrial production continues to increase, in the medium and long term, the results can be aggravated by showing greater unsustainability of its industrial activity. The reflection is the fall of sustainability, in this case, and almost exclusively refers to the depletion of water resources, since the depletion has a greater weight in the composition of the Green GDP, due to the exhaustive use of natural resources.

The fall in the value of the Green GDP results in a distancing of the industrial GDP, placing the activity studied in a degree of alert, as to its sustainability in the medium and long term. The gap between industrial GDP and green GDP, by itself, is a parameter of sustainability. Thus, the formula that generates the green GDP, when discounting the depletion variables of water resources and the cost of environmental degradation, also makes an inter-face of the economic question with the environmental question. However, the inference given by the green GDP, with the generating matrix as the industrial GDP, also serves as an indicator of evaluation, referring to the future of industrial activity.

Due to the results presented so far, it is observed that environmental degradation processes tend to move along with the growth of industrial economic activity. In view of these approaches, it should be emphasized that the environmental requirements imposed by the consumer market involve preservation measures, as well as claims for green stamps on products. As mentioned in the course of this paper, these requirements from the market are consistent with the imposition of the Kyoto Protocol, which aims at reducing water depletion and environmental degradation. In order to change this reality, investments in technologies are necessary to reach an ideal stage of sustainability, especially regarding the use of water. With the introduction of technologies to minimize water consumption, favorable results can also be achieved against waste and misuse of water in industrial plants. In view of the data analyzed, the following topic aims to address suggestion scenarios, both at the methodological level and at the general level of the stakeholders involved. Therefore, the contribution of the methodology of industrial green GDP as an indicator of medium and long-term sustainability of industrial production processes is under consideration.

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5 CONCLUSIONS

Achieving and developing sustainable socio-economic development plans have become a major challenge today due to the diversity of actors and territorial contexts. The green growth placed here, in a sustainable way, has to do with how to make productive processes more efficient from the point of view of natural resources. From the point of view of regional development, environmental conservation is important and necessary for long-term development and economic growth, since both are interconnected, thus having a dependency relationship in the current productive context. However, in recent decades, several green growth strategies have emerged, in which proposals are made by various companies from various market segments, aiming at increasing natural capital and minimizing environmental degradation. It is known, however, that the pursuit of this type of development is not something new, but rather, its process of planning and change in this sphere is significantly innovative and complex.

Therefore, as seen in the course of this paper, among the three basic sectors of the economy, the industrial sector has the greatest impact on the environment. In this sense, an economy that cares about the environment needs to worry about all the negative impacts generated by its economic activities, especially those caused by the industry. In order to provide readers with a brief summary of this work, it is worth highlighting that, in the context of the concern for sustainable development, we sought to bring the state of Santa Catarina as a macro study territory, and Joinville municipality as a regional/local space. Through this space, we searched for an industry of the metal mechanics sector, so that the degree of sustainability of the industry could be measured using the methodology of the green GDP.

The degree of sustainability of the foundry, based on the methodology of the green GDP, was lower than the value of the industrial GDP in all the years investigated (2008 - 2016). What stands out is that in the first years analyzed, the green GDP was lower than the industrial GDP, but the distance between the percentages was smaller, leading to conclude that, in this period, the impact of the industrial activity on the environment was smaller if compared to the last years analyzed. The data showed that in recent years the discrepancy was greater, the industrial GDP grew at exponential scales and the green GDP did not follow this growth in the same proportion. The data reveal possible difficulties that the industry may suffer due to the fact that exploitation of water resources is accompanied by an increase in production.

Therefore, it is important for the industry to invest more and more in technologies in the production processes, thus minimizing the consumption of natural resources, especially water. Actions should be immediate, because even though water is a renewable resource, water is not free from scarcity, thus, causing serious problems for industries in the medium and long term. In this plan comes the thinking about resilience, influenced by ecology and natural resources management. Business strategies need new multidisciplinary tactics, so that acceptable solutions to environmental problems can be achieved. Understanding the fundamentals of resilience is an important process in the development of environmental conservation strategies. Given all that has been mentioned in this work, it is worth emphasizing that discussing sustainable development requires discussing the issues associated with new methodologies, which are alternative ways to achieve the expected sustainable development. This work is legitimized since it aims to identify the value and contribution of the green industrial GDP for the foundry, considering the methodology of the green GDP as an indicator of corporate sustainability.

The green GDP, although with all its limitations in its methodology, is an indicator of efficient sustainability when it comes to the valuation of natural resources. However, as this methodology underused by companies and governments, it has to be disseminated in

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civil society, having as main users of this indicator both state and private companies. Therefore, in the scope of sustainable development, the construction and operationalization of good indicators require the establishment of principles and good practices that guide the whole process, starting from the definition of needs and focus (MALHEIROS; COUTINHO; PHILIPPI JR, 2012). The advantages of the green GDP indicator are relevant when compared to other indicators, which measure the degree of corporate sustainability, and these instruments are used for organizational decision making.

As a suggestion for future studies, research on the use of technology as a tool to maximize the green industrial GDP, seeking to analyze this variable called technology in industries of the metal-mechanical sector, having as research territory other regions of Brazil. Finally, it should be highlighted that few studies have been carried out about the green GDP, little is known about industrial sustainability through this method. However, it is known that there is much to be done, so that it is possible to approach a correct estimate of the degree of sustainability of the studied industrial system. To this end, it is necessary to consider not only these indicators, which are part of the methodology of the green GDP, but to include more variables in the analysis, as the use of technology, thus working for a multi-criteria methodology.

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