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ABSTRACT

This article discusses the relationship between Engineering Systems (highways) and their relationship with the economic development/growth of three municipalities in the Ribeira Valley of Paraná: Adrianópolis, Cerro Azul and Doutor Ulysses. The aim of the research is to understand how highways, as fixed modifiers of geographical space, are capable of altering the development logic of a given spatial area. The research is based on a theoretical review of the subject and a comparison between the ICMS tax collection of the municipalities analyzed between 1997 and 2022. The results show that highways are an important element in the economic growth of municipalities, with higher tax collection rates being observed after their implementation. Engineering systems are not agents that produce economic or municipal/regional development, but they are a condition for it to happen.

Keywords: Regional Development. Infrastructure and Mobility. Territorial Sustainability. ICMS. Highways.

RESUMO

O presente artigo discute a relação entre os Sistemas de Engenharia (rodovias) e a sua relação com o desenvolvimento/crescimento econômico de três município do Vale do Ribeira Paranaense: Adrianópolis, Cerro Azul e Doutor Ulysses. O objetivo da pesquisa é compreender como as rodovias, enquanto fixos modificadores do espaço geográfico, são capazes de alterar a lógica de desenvolvimento de um determinado recorte espacial. A construção da pesquisa está baseada na revisão teórica sobre o tema e a comparação entre a arrecadação do ICMS dos municípios analisados entre os anos de 1997 e 2022. Os resultados encontrados apontam para as rodovias como elementos importantes para o crescimento econômico dos municípios, sendo observados maiores índices de arrecadação a partir de sua implantação. Os Sistemas de Engenharia não são agentes produtores do desenvolvimento econômico ou municipal/regional, mas são condição para que ele aconteça.

Palavras-chave: Desenvolvimento Regional. Infraestrutura e Mobilidade. Sustentabilidade Territorial. ICMS. Rodovias.

INTRODUCTION

The main goal of this article is to understand how engineering systems are capable to promote the economic development of the municipalities Cerro Azul, Doutor Ulysses and Adrianópolis, in the State of Paraná. The spatial cutout analyzed is the microregion of Cerro Azul- PR, according to the regionalization of the Brazilian Institute of Geography and Statistic of 1989 (IBGE, 2017). This microregion established by the IBGE was defined by its specialties as its structure of agricultural production, industrial, mineral extraction and fishing.

The analysis focus is the influence of the engineering systems. This article works just with one connection system, the highways. According to Santos e Silveira (2001), it is considered that the engineering systems are fixed implanted in space where they produce some kind of social and productive change in site. When considering fixed that promote change in certain geographic space cutout, we may suggest that, from the connections and from the capitalist system action, we are promoting a regional economic development, and it can be felt by impacting directly into the territorial development settings (Dallabrida, 2020), through a continue space change according to the fixation of ways capable of change the production model and the economy reproduction (Neto, 2023).

The justification for the research is based on two interdependent reasons. The municipalities of Doutor Ulysses and Cerro Azul (PR) occupy nowadays the last and penultimate positions of the Municipal Human Development Index (IDHM) from the state of Paraná, even though they are inserted into the influence area of Curitiba's metropolitan region (RMC). In turn, the spatial cutout is based in the regionalization promoted by IBGE in 1989, which puts Cerro Azul, Doutor Ulyssis and Adrianópolis in the same general economic and social development position. So, in a specific time space, the municipality of Adrianópolis just for being in a better IDHM position, separates from the pattern of the two other municipalities. But what is the reason (or at least one of them)? What happened during this period?

To analyze these questions, we need to understand the concepts of region, engineering systems, regional development, territorial sustainability and regional governance. From the theoretical discussion, it is analyzed the increase of the Operations Taxes related to the circulation of goods (ICMS) collected by the state before and after the implementation of the fixed highways. To

address the central question, the construction of ideas is based on the theoretical discussion of the context of the municipalities and the relevant concepts to understand the discussion, the methodology used, data analysis, and the considerations linked to this investigative journey.

HOW TO DEVELOP THE REGIONAL?

We must understand that there are different region concept perspectives, that, according to Corrêa (1986) are fundamentally connected to the differentiation of areas. The attempt of the Geography researchers for a long time was to consolidate a concept that could be out of the common sense (Cunha, 2000). According to Castro (1995), the region depends on the scale, in a cutout that allows to understand the phenomenon. In turn, this conjecture is not simply ~~posited~~ posted, it is constructed over time and space. We may affirm that the spatial conditions in a given temporal-spatial cut have a singular complexity, starting from the physical form of the territory, the culture, the sociabilities, the economic models, and many other characteristics that cannot be superficially or generally delineated. However, it is just because of their different combined complexities that they differ from another reality.

Lencioni (1999) agrees with Corrêa (1986) while mentioning on its analysis that the region is an intellectually constructed definition. In her discussion, the author presents the different perspectives and understandings according to various authors on the concept of region, identifying that the delineation is established based on the object of study: “when the issue changes, the scale changes. It means that the delineations must be developed based on a specific issue.” (Lacoste, 1979, p. 30 apud Lencioni, 1999, p. 165).

Corrêa (1986) affirms that all concepts of region can be used when considering their respective purposes. In this specific case, we are dealing with the phenomenon of regional development – more specifically, to understand why a region ‘did not develop,’ allowing the use of different regional delineations to comprehend the object. According to Corrêa (1986), there is the law of uneven and combined development, which presents through dialectics, in the interpenetration of opposites. This encompasses the relation of events over time and space that are opposed to each other but related. It can be understood through the advance of techniques and properties in one area and

another that cannot keep up with these same changes, causing differentiations based on capitalist logic. Following this dialectical line, Lencioni (1999) points that this geographical perspective is influenced by Marxism, which considers the region a part of the whole. It means that in a general system where society is subjected to materialist logic, with social inequalities and class differences, world limits arise for the different. This way, poorer regions and richer regions may emerge.

According to Santos (1988), the region is characterized as the result of the flow of actions that occur internally and externally. The region will always depend on internal and external conditions, being homogeneous within and heterogeneous in relation to the exterior. These different conditions are delineated over time in history, where the different actions of each group condition their state in the future. For Santos (2003), for a long time the region was seen as synonymous of identity, characterized by belonging to the space, delineated by specific characteristics of morphology and climate, and also of social organization. This way, the different forms of organization establish differences from one space to another, consolidating the regions.

In turn, despite some authors having their respective definitions of this portion of the geographic space – region, it is necessary to be careful when delineating or discussing a specific area. This condition derives from the fact that there are different ways of dividing the space when considering different criteria. In this particular case, we are dealing with a portion of the space of the state of Paraná, which has some specific characteristics based on different delineations for understanding the region.

The region of Vale do Ribeira for example, extrapolates the state boundaries and contemplates the states of Paraná and São Paulo. As his own name suggests, it is about a predominantly delimited region by a mountain valley which thalweg moves the Ribeira do Iguape River, regarding the delimitation of the river basin, with the same name (ANA, 2021).

Another regionalization that encompasses this same portion of geographic space is the Cerro Azul Microregion (as a specific area within the Mesoregion that includes it, composed by Cerro Azul, Doutor Ulysses and Adrianópolis), delimited by IBGE in 1989, which highlights how the dynamics of the capitalist development process affected the national territory in different ways. This IBGE delimitation shows how some areas have achieved significant socioeconomic progress,

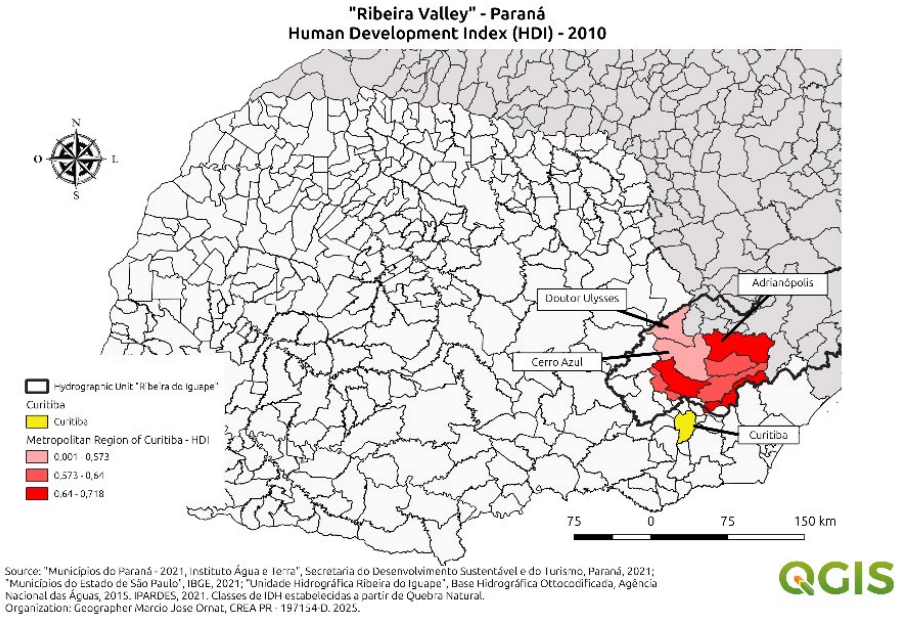
while others have experienced stagnation and more severe economic challenges. The update of this division is now represented by the Immediate and Intermediate Geographic Regions (2017), which were defined based on the last three decades, in 2017, and reflect a delineation built on concrete elements. In this division, "regions are structured based on nearby urban centers to meet the immediate needs of the population" (IBGE, 2017, p. 20), with the delimitation based on the purchase of durable and non-durable consumer goods, job seeking, access to health and education services, and the provision of public services such as branches of the National Institute of Social Security (INSS), the Ministry of Labor, judicial services, among others. The regionalization proposal was based on the identification of central cities and their respective associated municipalities.

This same portion of space is inserted in a cutout with characteristics of the physical domain called "Mares de Morros" by Aziz Ab'Saber (2003). Therefore, it elucidates the difficulties of studies and implementation, consequently demanding high investments for the execution of works that can be effectively safe and durable in these spaces. According to AMEP ("Metropolitan Affairs Agency of Paraná.), this same spatial section is overlapped by the Metropolitan Region of Curitiba – RMC (see Figure 1), which was established by Federal Complementary Law No. 14/73. The municipalities of the Cerro Azul microregion were only included more recently, in 1994 by Law No. 11.027, the municipalities of Cerro Azul and Doutor Ulysses, and in 1995 by Law No. 11.096, the municipality of Adrianópolis.[1]

This information ends up sounding contradictory, once the metropolitan region of Curitiba includes both the highest and the lowest Municipal Human Development Index (IDHM) in the state in the same spatial section (Figure 1), and the municipalities of the microregion do not have potential space for enterprises, besides they have an industrial zone and government support in logistics for connection with other centers (Doutor Ulysses and Cerro Azul).

1 Currently, the composition is given by the cites of Curitiba, Adrianópolis, Agudos do Sul, Almirante Tamandaré, Araucária, Balsa Nova, Bocaiúva do Sul, Campina Grande do Sul, Campo do Tenente, Campo Largo, Campo Magro, Cerro Azul, Colombo, Contenda, Doutor Ulysses, Fazenda Rio Grande, Itaperuçu, Lapa, Mandirituba, Piên, Pinhais, Piraquara, Quatro Barras, Rio Branco do Sul, Rio Negro, São José dos Pinhais, Quitandinha, Tijucas do Sul e Tunas do Paraná (AMEP, 2023).

Picture 1 | Vale do Ribeira Paranaense - delimitation of the Watershed.



The picture 1 shows the delimitation of the Ribeira do Iguape River Basin, considering the administrative boundaries of the states of São Paulo and Paraná, as well as the consideration of the IDHM of the municipalities that are entirely inside the basin.

Beyond that, Table 1 shows the IDHM of the municipalities of Adrianópolis, Cerro Azul, and Doutor Ulysses in relation to the state capital, according to the 2010 census. According to these numbers, it is possible to understand the significant difference between the state capital of Paraná and the other municipalities analyzed.

Table 1 | Municipal Human Development Index according to the municipalities of Paraná 2.

	1991		2000		2010	
Municipality	**IDHM**	**State Ranking**	**IDHM**	**State Ranking**	**IDHM**	**State Ranking**
Curitiba	0,640	1	0,750	1	0,823	1
Adrianópolis	0,400	283	0,542	328	0,667	331
Cerro Azul	0,297	383	0,450	392	0,573	398
Doutor Ulysses	0,227	397	0,377	399	0,546	399

Source: PNUD/IPEA/FJP - Atlas do Desenvolvimento Humano no Brasil 2013.

2 Although there is already a new census (2022) at the time of this article was written, the data is not yet available for analysis. Organization of the author.

The data shows us that even though there was an increase in the IDHM of the municipalities over the years, there was still a drop in the ranking position of all three municipalities in the state ranking (comparing with the others). It means that even though the life conditions have improved over the years in this municipality, when compared to the other municipalities in the state of Paraná, this progress was not significant.

According to the United Nations Development Programme (PNUD) – an organization focused on sustainable development, democratic governance, peacebuilding, and resilience to climate and disasters – the Municipal Human Development Index (IDHM) is measured based on the Global Human Development Index and includes indicators of longevity, education, and income (AtlasBR methodology, 2023). It is directly connected to the development of the municipality and, consequently, the region. From this perspective, it is considered that internal actions have the potential to produce positive (or negative) effects on neighbor municipalities or the region in which they are located – changing the scales of influence.

It is important to emphasize that these regional boundaries encompass different scales, whether in terms of physical scope or selection criteria. This way, it is necessary to justify that no intersections between these scales are being made or placed on the same level. The demonstration consists to present some of the possible delineations for this same region using different criteria, so that they can be analyzed as a group, as relevant factors in the local and regional development process of the Cerro Azul Microregion[3], which must be examined from multiscale and multidimensional perspectives.

THE ROLE OF ENGINEERING SYSTEMS IN REGIONAL DEVELOPMENT

Development in the Microregion of Cerro Azul is a rather complex discussion, as is the concept itself. Development has often been confused with and mostly linked to the idea of progress and economic growth, but it consists in other dimensions, such as human development and the social and environmental quality of life of people. According to Souza (1997), economic development - represented by GDP, GNP, and technological modernization - is not independent, but it is influenced

3 The municipalities of Doutor Ulysses and Cerro Azul, in the state of Paraná, are part of a project titled 'Advisory for the Development of Urban and Regional Development Projects for Municipalities with Medium and Low HDI in the State of Paraná, through the preparation/revision of their Participatory Master Plans,' established between the State University of Ponta Grossa, with support from the Secretariat of Science, Technology and Higher Education of Paraná, and the municipalities in question (Geocidades, 2024).

by the perspective of scale and also tied to other sectors of development. The local, regional, and national scales are materialized spaces of economic interests, composed of people who identify with certain life flows.

Given the related dynamics and the various factors closely tied to the functioning and development of a municipality, we can list health and education as basic rights, an ecologically balanced environment, sustainable consumption and biodiversity, economic growth, gender equality, among others. Chies and Mendes (2018) point out in their discussion that local development arises from the understanding that urban and rural areas complement each other, since in small municipalities a large part of the economy is essentially agricultural. In this context, it is possible to relate issues such as productive outflow, for example, to an agricultural society like those that make up the municipalities of Cerro Azul and Doutor Ulysses, in the state of Paraná.

As analyzed by IBGE (2023) in the publication 'Methodological Proposal for the Classification of Rural, Urban, and Natural Spaces in Brazil', the classification of areas referred to as rural, or more precisely, rural spaces, is based on the combination of 'integration / high integration' of 'croplands / pastures' and 'rural occupations'. The municipalities included in this classification, and in our case Cerro Azul and Doutor Ulysses, are characterized by a grouping of land cover and land use categories such as 'agricultural area', 'managed pasture', 'mosaic of occupation in forested areas', 'silviculture', and 'mosaic of occupation in grassland areas' (IBGE, 2023).

Another point made by Chies and Mendes (2018) is that the development of these municipalities is linked to the effective participation of the residents in municipal discussions and decisions. Development is also not exclusively tied to the participation of the inhabitants of a municipality in all decision-making processes, but to the collective establishment of the direction that this community chooses, a municipal/regional governance. According to Chhotray and Stoker (2009), governance refers to the practice of collective decision-making. More specifically, for these authors, governance is related to the set of rules for collective decision-making, in a set of environments where there is a plurality of actors and organizations. More importantly, governance is related to environments where no system controls or dictates the rules for this relationship to occur between these actors and organizations. These considerations are also connected to Souza's (1997)

argument, based on Cornelius Castoriadis, about the idea of a community's autonomy in being aware of the lived reality and having equal chances of participating in decision-making. For this research, the understanding is of territorial sustainability constituted by territories with universal access to basic services, oriented towards a viable, productive, and environmentally sustainable economic offer.

It has been discussed that it is through the accumulation of capital that municipalities or centers more developed than others are produced, and that serve as a reference for peripheral economies - as is the case with the Immediate Regions (IBGE, 2017). We must agree that the state of Paraná has a large territory in extension, and that human groups settled in these spaces at different times, as well as building their way of life. Similarly, technical actions and modernization also affect spaces in different ways. Therefore, when analyzing the value of ICMS collection in a certain portion of the geographic space, it is possible to verify how the behavior of economic flows can influence the collection of municipalities and, consequently, the alteration of the development logic - in the capital sense - of this region. Furthermore, how the existence of engineering systems generating economic flows can alter the living conditions and well-being of the population.

Etymologically, the concept of development is associated with growth or gradual expansion and the passage to a lower state to a more improved one. This is not about saying that economic growth is not important, but we emphasize the idea that a set of other factors must be aligned in order to realize the monetary perspective. In the same way, numerical data and indicators such as the HDIM are considered important analysis components, highlighting that quantitative depends on intrinsic and underlying qualitative actions throughout the process or time period being examined - historical, social, and cultural elements. Beyond that, according to Pimenta (2014), we can affirm that development is a phenomenon which contain long term dynamics, that is, being necessary an appropriate spatial cutout too e observed. In this way, justifying the temporal scope of this article - considering the current condition of the municipalities of Adrianópolis, Doutor Ulyssis and Cerro Azul/PR.

To Marcelo Lopes de Souza, 'Clain for development [...] it is Only acceptable, therefore, within a culture that seeks for change or that is consciously open to this possibility as a *social value*.' (Souza, 1996, p. 5.). Its definition of development concretizes in the *movement*, something that keeps changing and does not have and end. In light of this, we consider that to develop is to change, without going into

the merits of discussing to whom is development and to whom is regression in front of the changes. To the author subscribed above, it is clear that the development occurs in different ways in different spatial cutouts, involving the culture and the Society that is immersed in this cutout, considering that each Society is a whole indivisible and it possesses its own operation mode. What we must understand is that this movement owns a sense and that 'The dominant tendency, in the material world, is the progressive movement, the changes that lead to an inferior passage to a superior one, from the simple to the complex, this is development.' (Cheptulin, 1982, p. 167).

According to Cheptulin (1982), the movement is continuous, but can achieve a point of rest, which he characterizes as 'movement in equilibrium'. In other words, even if moments of movement or leaps are not noticeable, there is still an inherent movement in the phenomenon. In this sense, he affirms that space and time are directly connected to the development stage, and they are fundamental properties of matter, forms of its existence. For the author, space organization is related to matter, and depends on it, as well as it possesses time dependence in relation to its presentation ways, over time. These different space and matter settings over time are development analysis compositions, here, understood as regional, which possess the direction from the past to the present, and then to the future. As seen in Lima (2021), the regional development is a transformation process, a movement through a region becomes more advanced. Still, according to the author, we may talk about sustainable regional development that rises from the regional development. The Sustainability of this process suggests that this region modernization process must not harm the future generations, the proper exploration of natural resources related to the production factors, preservation, and solidarity.

In front of this contextualization, it is considered the space organization – from the municipalities of Cerro Azul, Doutor Ulyssed and Adrianópolis, Vale do Ribeira's region -, is matter - engineering systems, occupying space-, and the time, to understand the organization of this matter during time, understanding its development.

The 'engineering systems' concept was created by Santos and Silveira (2001) and comes from the perception of Milton Santos, that the space is a "unsolvable union of object systems and actions, and its hybrids forms, the techniques (Santos, 1996), that indicates us as territory is used: how, where, by who, why, for what." (Santos; Silveira, 2001, p. 11). This idea comes from another one, older, about

space consideration starting from fixed and streams. Santos (1996) considered that the technique is the way which humas, though their technical action (streams) built and fix objects in space, of how the space is made by objects - an organized set.

The author discusses and asserts that time and space are not disconnected and that technique is this confirmation, because it allows the qualification and identification of the materiality of space over time, as they are characterized differently throughout history. The techniques implemented in space are dated and therefore they can be a measure of time. This way, it can be said that techniques are historical phenomena. However, we must consider that the placement of an object as a technique in space is altering a pre-existing set, in this case, promoting a change - movement.

The objects fixed in space have a social value that permeates the logic of society's living conditions and their use. Objects can be individual or collective, but here we will consider the changes in space that have provided movement or change to reality and therefore acquire a certain value. When we consider a fixed object that allows significant changes in space, we are also dealing with actions that are planned, seeking modification. This way, we must consider that the actions materialized in the geographical space have a practical objective, an intentionality.

For such fixed elements of locomotion and communication, engineering systems are conceptualized (as engineering works that facilitate movement): constructions, irrigation, dams, ports and airports, railways, highways, waterways, electricity, refineries and pipelines, material bases of telecommunications, and others - each in its specific time and intentionality (in this article, only highways are considered). The implementation of these fixed techniques in space, inserted into the capitalist system, presupposes the movement of capital and (it is hoped) the circulation of capital and economic growth, which directly influences local and regional development (Santos; Silveira, 2001). The movement, circulation, and flow are fundamental in the survival process of capitalist organizations, spaces, and capitalist groups. According to Santos and Silveira, 'The production of fluidity is the result of conflicts and cooperations, agreements and negotiations, always provisional, between the State and companies, in the construction and operation of large technical systems.' (2001, p. 175), referring to the different engineering systems.

The implementation of these transportation systems depends on the circulation of capital to consider the profitability of the investment. According to Marcos Xavier (Santos; Silveira, 2001), the

construction of roads arises from a need to be supplied, so investments are made in locations that indicate demands for such. According to the author, in Brazil, the road system was chosen to articulate between different spaces, specially to connect areas of low population and production to constitute a unified market (as in the case of São Paulo), but which can be expanded to other locations.

The relation that is made between the history of the municipalities in the Cerro Azul Microregion and regional development occurs mainly because for more than a decade, Adrianópolis, Cerro Azul, and Doutor Ulysses were unprovided of highways connections capable of producing a commercial flow that could move the local economy. Starting from 2005, the implementation of asphalt led to changes in the dynamics of regional economic flows. Considering the installation of the highway and the actual revenue generated from it, we can directly look at the relation between regional development, infrastructure, public policies, and how all this can contribute to poverty reduction (Oliveira; Medeiros, 2020) and changes in the lives of the local population. Beyond that, the importance of this research is highlighted, as mentioned by authors like Oliveira and Medeiros (2020), there is a scarcity of discussions around this topic. Also, there is a lack of practical application of the concept of Engineering Systems by Santos and Silveira (2001) since the first year of its publication.

ABOUT LOCAL DEVELOPMENT

ICMS is the Tax on Operations related to the Circulation of Goods and on the provision of Interstate and Intermunicipal Transport and Communication Services, a state-level tax in Brazil. This tax is paid on sales and import operations of products, service provision, and transportation, and is already included in the invoice. The amount is calculated by multiplying the tax base by the rate, which is a percentage that varies depending on each Brazilian state and usually differs according to the area of incidence. The amount collected by the state is redistributed to municipalities according to the Municipal Participation Index, which also varies from state to state. What matters at the moment is to analyze the value generated by each sector of the municipalities in the Cerro Azul Microregion following the implementation of fixed elements in the territory. Initially, the existence and implementation of land connection systems, such as roads and highways, will be considered.

It should be considered that the Vale do Ribeira region was "put on the map"[4] with the establishment of the Assunguy Colony, and since then, there have been several historical, physical, and political developments that have allowed the municipalities of Cerro Azul, Doutor Ulysses, and Adrianópolis to form their current composition. An important piece of information to consider about this region is the locational rigidity of mining activity, given the geological conditions of the area. There are also certain preferences among companies operating in the region[5].

Paved roads provide greater safety and comfort for vehicle traffic, thus enabling a higher circulation of automobiles. Based on personal experiences along the PR-092 and PR-340 routes (DER, 2023), there is a noticeable lack of maintenance, dangerous areas, and damage caused by excessive loads, which makes frequent traffic in these locations unfeasible. The municipalities of Cerro Azul and Doutor Ulysses are connected by PR-092[6], from Rio Branco do Sul to Cerro Azul (paved in 2005), and from Cerro Azul to Doutor Ulysses up to Jaguariaíva (unpaved), meeting PR-151. There is also a connection from Cerro Azul to Tunas do Paraná via PR-340 (unpaved), meeting BR-476 (paved in 2005 between Bocaiúva do Sul and Adrianópolis), which connects Bocaiúva do Sul to Tunas do Paraná and Tunas do Paraná to Adrianópolis.

Some considerations can be made regarding the implementation of asphalt on the highways that connect these municipalities. First, it is necessary to consider the traffic demand — that is, whether there is a justification for the implementation, as argued by Santos and Silveira (2001). Second, one must think from the perspective of investment versus return, since being located in a morphologically mountainous area (Ab'Sáber, 2003), the region requires greater structural investment and more complex work than a flat area. Third, it is necessary to consider regional political and economic interests, and in this case, reflect on what advantages this brings to the political scenario or to the state's development. From this perspective, considering the concept of uneven and combined development (Corrêa, 1986), the choice to invest in certain areas automatically leads to the neglect of others.

4 It is not a matter of disregarding the presence of Indigenous peoples, but rather of analyzing the understanding of the development model linked to wealth/capital.

5 Some companies (fixed establishments) have passed through - or are still present in - the municipalities, promoting social, spatial, and monetary changes.

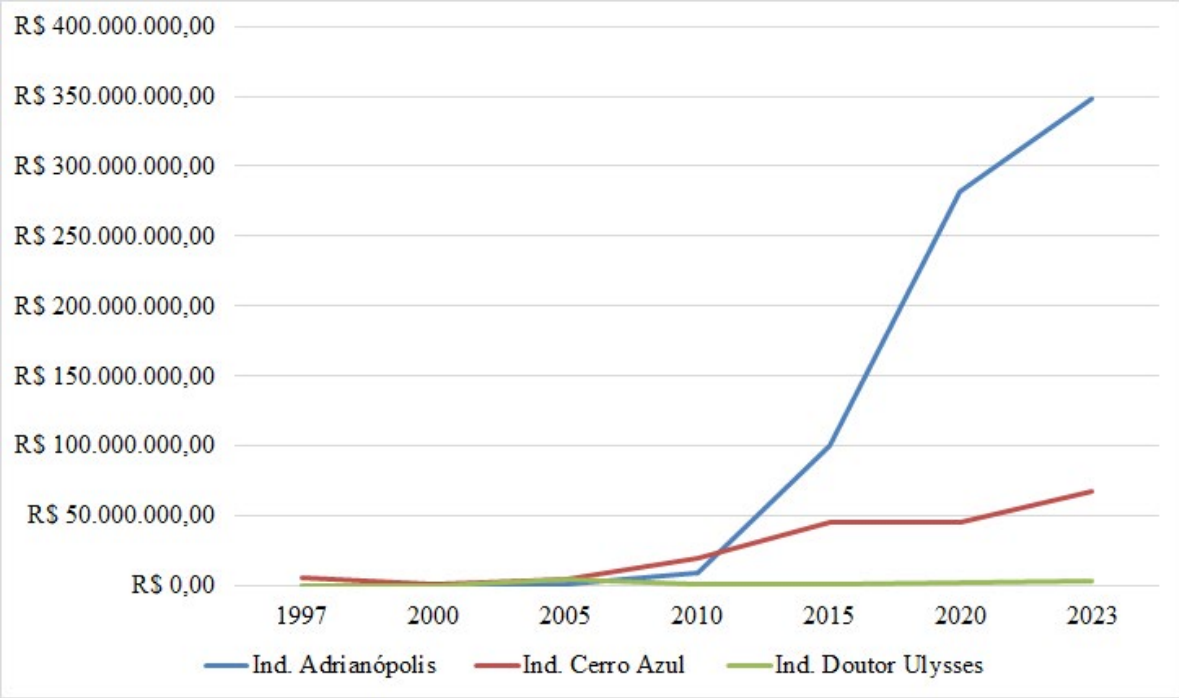
6 Information about highways found at Paraná Department of Highways (Departamento de Estradas de Rodagem do Paraná.).

Based on these considerations, we proceed to analyze the graphs relating the municipalities participation in the state ICMS, regarding the sectors of industry, commerce and primary production. The order of selected years is organized starting with the first year of record, also corresponding to post-regionalization by IBGE in 1989, to the last year of record with intervals of five years (to avoid visual clutter and allowing close intervals).

Up to the present moment, the municipality of Doutor Ulysses has no paved connections with neighboring municipalities and no officially established industries, only logging companies that extract raw materials from the municipality but do not process them locally. The highest revenue in this sector occurred in 2004, totaling R$ 4,936,212.00, surpassing Cerro Azul. Starting in 2005, with the implementation of the engineering system that connected Cerro Azul to Rio Branco do Sul, the metropolitan region, and the state capital, there was a slight increase in revenue, indicating a rise in traffic flow and economic activity.

The municipality of Cerro Azul developed economically in a steady manner following its connection with the city of Rio Branco do Sul and the activities of the mining company Nossa Senhora do Carmo, until stabilizing between 2015 and 2020, and then resuming growth in the last two years. It is conjectured that this recent growth is due to the installation of the juice industry “Suco Mitz” in 2020. On the other hand, experienced little economic activity after 2005, but saw a significant increase in monetary circulation and tax revenue in 2015, coinciding with the establishment of the company “Supremo Secil Cimentos S.A.”, which has a production capacity of 1.7 million tons of cement per year (SECIL, 2023). This explains the progressive growth of ICMS in the following years, as shown in Graph 1. This supports the statements of Marcos Xavier (Santos; Silveira, 2001), considering that the implementation of engineering systems, such as highways, alone does not bring significant economic benefits to the municipality — they need to be useful. In other words, there must be a demand for the circulation of goods and services so that capital turnover is promoted and the municipality benefits.

Graph 1 | Municipal ICMS Participation Index - Industry

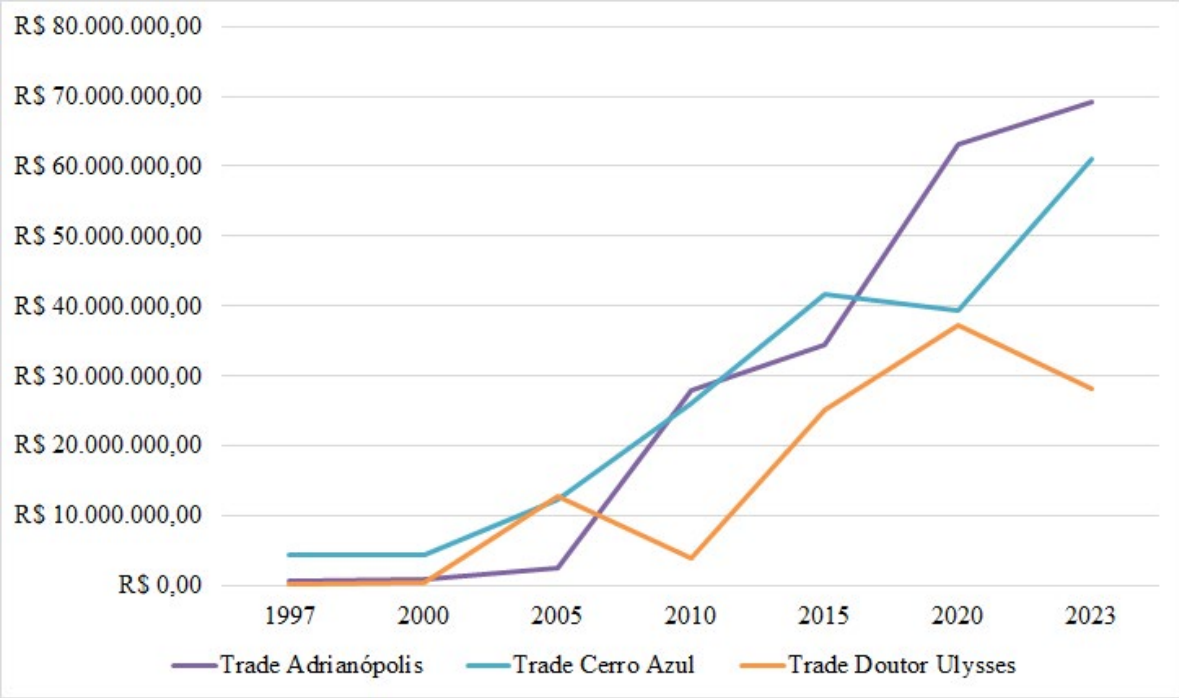


Source: Paraná State Department of Finance, 2023

On the other hand, the commercial sector of the three municipalities experienced immediate growth following the paving in 2005, with Cerro Azul standing out. It is believed that the growth in Doutor Ulysses, which was even greater than that of its neighbor in 2005, was a consequence of the asphalt paving, even if not fully completed, which influenced this growth, as there was a decline in 2010 followed by continuous growth. The municipality of Cerro Azul had been expanding its commercial activity since the 2000s, but it was from 2005 onwards that growth became more pronounced, reaching a slight decline in 2020, which may have been influenced by the COVID-19 pandemic (PAHO, 2023), although this is not considered conclusive since the same trend was not observed in the other municipalities.

The municipality of Adrianópolis had a peak after the year 2005 until 2010, with the growth of the circulation of goods and services available to the population. From the year 2015, with the implementation of Supremo Secil S.A., and consequently the increase in the circulation of people (in transportation) and the increase in the purchasing power of the company's workers, the growth in the commercial sector of the municipality is positively surprising, as shown in Graph 2.

Graph 2 | Index of Participation of Municipalities in ICMS- Commerce

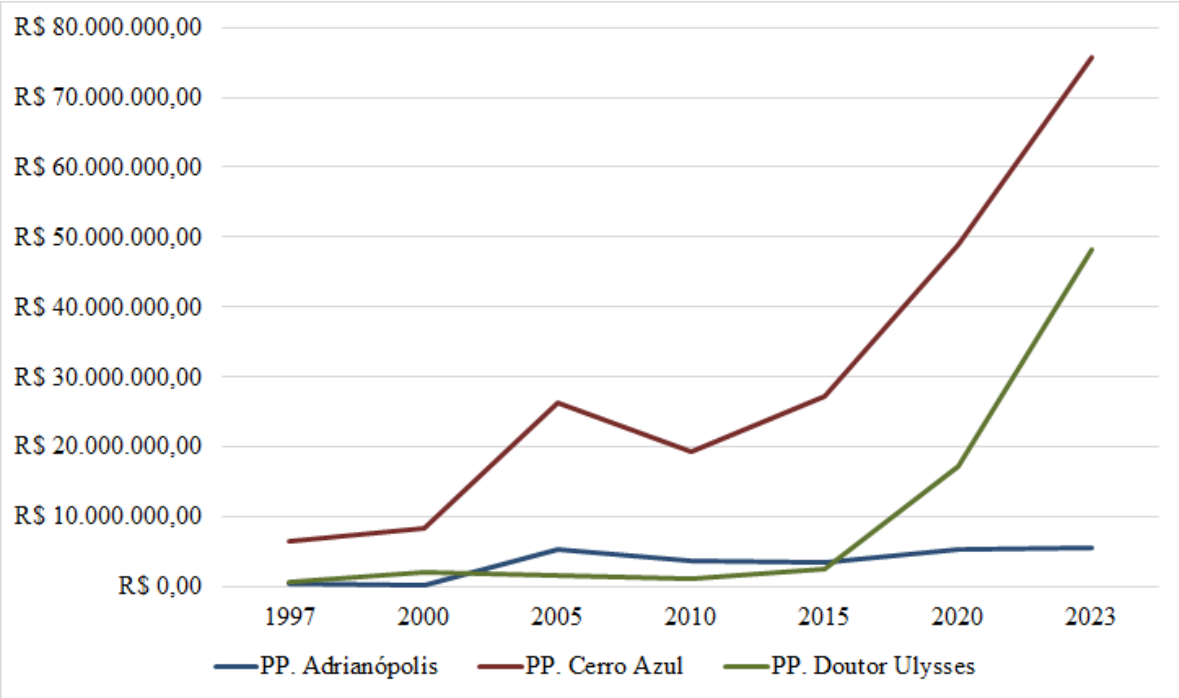


Source: Paraná's Secretary of Finance, 2023.

Regarding the primary production of the municipalities, the highlight of this sector's circulation is in the municipality of Cerro Azul with the production of tangerines, which is recognized by Law No. 14,608 of June 20, 2023, as the National Capital of Ponkan, although the fruit has been produced in the municipality since the 1960s (SEBRAE, 2023), maintaining leadership in ICMS participation during the analyzed period. Still, there was a peak of growth in 2005, a moment of decline until 2010, and since then, progressive growth, mainly due to the recognition of production at the regional level. Stands out that Cerro Azul is the main producer of tangerines in Brazil, accounting for 9.3% of national production and 9.2% of the Gross Production Value (VPB).

Doutor Ulysses has most of its territory dedicated to forestry, with the planting area in the municipality and processing in other locations. Due to the morphology of the terrain, which is the same in the three municipalities, the highlight of primary production develops from small properties, with emphasis on the growth of agriculture and livestock activities in the municipality of Doutor Ulysses in 2020, mainly due to the cultivation of Ponkan - the fifth largest producer in the country, with a participation of 3.1%. Let's look at the next graph:

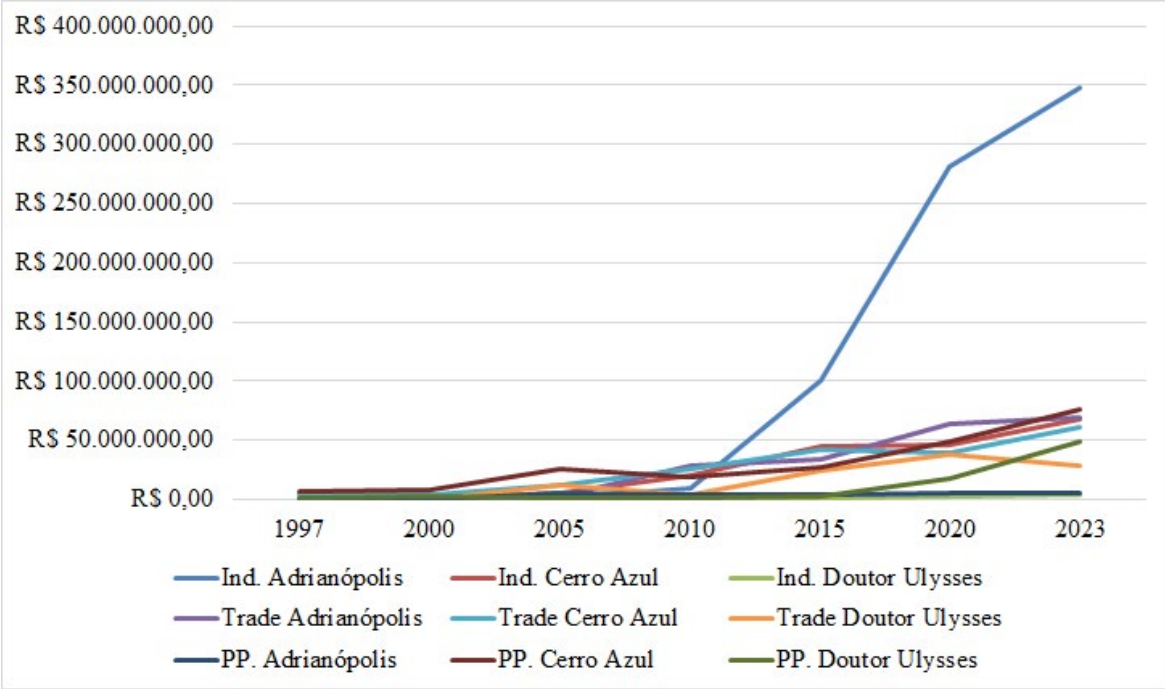
Graph 3 | Index of Participation of Municipalities in ICMS - Primary Production.



Source: Paraná's Secretary of Finance, 2023.

We can consider that economic growth develops in different ways in different municipalities according to their characteristics, public investments, connections, productive viability, economic and political interest, areas that attract interest, etc. The modernization of higways and the implementation of new ways of producing and organizing ensure different revenues over time. The following graph shows the significant prominence of the industrial sector in Adrianópolis during the analyzed period, compared to other sectors in this and other municipalities. As a result of the increased purchasing power through labor in the industry, the commercial logic of the municipality is consequently altered, which can be observed by the growth of the sector in the last two years.

Graph 4 | Index of Participation of Municipalities in ICMS - Industry, Commerce, and Primary Production.



Source: Paraná's Secretary of Finance, 2023.

The comparison between the three municipalities through history has been delineating the degree of importance of recognition in the participation of ICMS for each one, and demonstrates the condition of circulation of goods, services, and people over time. In this sense, considering that the action of communication with other spaces also enables and provides individual economic growth. Since 2015, the difference in the comparison between the municipality of Adrianópolis in relation to Cerro Azul and Doutor Ulysses is quite significant, with the base value being that of the industry. Hierarchically, economic development has been more significant in: Adrianópolis, Cerro Azul, and Doutor Ulysses. In turn, it is important to highlight that Adrianópolis has a fixed demand generator that does not exist (or at least not to the same extent) in the other municipalities.

It can be affirmed, according to the reflections made until now, that engineering systems (highways) impact on the socio-economic and territorial development of the Vale do Ribeira Paranaense, as they provide increased mobility, regional integration, and also reduce geographical inequalities, as evidenced by the graphs above. It can be argued that, between the second half of the 19th century and the beginning of the 21st century, the Vale do Ribeira region, on the scale of the Cerro Azul Microregion, experienced

a strengthening of its internal characteristics, a kind of regional consolidation, in terms of its external conditions, due to the significant spatial alteration experienced in its surroundings over the last 150 years.

Having as a reference the year 2005, when PR-092 was paved, in the section Rio Branco do Sul ↔ Cerro Azul, and PR-476, in the section Bocaiúva do Sul ↔ Adrianópolis, only after 19 years, the Vale do Ribeira received another investment for the completion of an engineering system, when Governor Carlos Massa Ratinho Junior signed the service order for the paving of PR-092, 11.95 kilometers at the exit of the municipality of Doutor Ulysses, towards the municipality of Cerro Azul, on April 23, 2024. The above argument highlights the predominant role of public investment policies in infrastructure in improving regional integration, which, when receiving investment, can potentially maximize socio-economic benefits and promote territorial equity.

FINAL CONSIDERATIONS

In view of the discussion held, and data analysis, it is possible to affirm that engineering systems are important fixtures for promoting the development and economic growth of municipalities, but they are not exclusively responsible for this. During the analysis of the numbers and the context of the municipalities, it was identified that a demand-generating point is of great importance for the fixture implemented in the space to be effectively used, fulfilling its role as a promoter of movements, regardless of the production sector, being able to contribute with the municipality (in tax collection, for example).

From this perspective, it can be understood that engineering systems are not *per si* producers of economic or municipal/regional development, but they are conditioning agents for such. They are structures that allow communities to perform their demands more dynamically and facilitate the flow of productive turnover, outflow, or technological adaptations.

Regarding the case of the municipalities of Cerro Azul, Doutor Ulysses, and Adrianópolis, it is possible to affirm that the detachment of the last municipality from the patterns identified by the IBGE regionalization of 1989 is significantly influenced by the implementation of the engineering system and its effective use. Highways, as means of promoting displacement, provide better transportation conditions, time savings, reduction of some costs such as lodging, vehicle repairs, and enable better living conditions for people. In this sense, directly affecting the way of life and altering the components of the municipality's IDHM.

What is learned is that the condition of locomotion and the means used for the production of capital turnover and the promotion of employment and income are directly related to communication. In this sense, considering engineering systems as important components for the development of a municipality and a region. Ahead, it is expected to produce and stimulate studies and public policies that may promote the recognition of equity and investment in the municipalities.

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