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I. Introduction

This scientific article proposes an in-depth investigation into the reality of Brazilian Higher Education, with a focus on the Civil Engineering course. The scope of this research is situated within the context of the assessment and regulation of higher education, aiming to present a comprehensive analysis of data related to the in-person Civil Engineering course. The evaluation parameters considered encompass territorial, demographic, and indicators from the National System of Higher Education Assessment (SINAES), the Higher Education Census, as well as demographic and territorial data from IBGE, and information from CONFEA.

The choice of the in-person Civil Engineering course at the national level as the object of study is justified by its relevance in the formation of professionals who play a crucial role in the social development of cities and regions. Furthermore, the predominant history of offering this course in the in-person modality facilitates the analysis, given the significant sample representativeness, eliminating the need to consider distance learning courses.

The Brazilian educational scenario is influenced by territorial factors that go beyond physical and environmental characteristics, incorporating cultural and infrastructural aspects. The methodology adopted for this research is quantitative in nature, with data collection and basic research established as methodological techniques. Data analysis is conducted through indicators, providing a comprehensive view of the current landscape of the in-person Civil Engineering course.

By exploring Brazilian intermediate regions with lower Human Development Index (HDI), specifically those with at least one active Civil Engineering course. This analysis is essential for guiding Higher Education Institutions (HEIs) managers in strategic decision-making regarding the expansion, maintenance, or reduction of course offerings.

In addition to data analysis, this article presents the development stages of the PanoramaEDU website, a technological tool designed to provide transparency and access to information about in-person Civil Engineering courses, contributing to informed decision-making and planning in the educational sphere.

In this context, this research aims to fill a gap by offering a detailed analysis of the reality of in-person Civil Engineering courses nationwide, considering various Brazilian intermediate regions. The objective is to provide support for managers, public bodies, and other stakeholders interested in improving Brazilian higher education, contributing to the development of effective and informed strategies.

II. Method

This study adopts a quantitative approach grounded in indicators and statistical data, as advocated by Diehl (2004). Quantitative research

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employs statistical techniques in both data collection and analysis, aiming for results that minimize potential distortions in analysis and interpretation, providing a more robust margin of safety.

Although the use of quantitative data in Brazilian educational research has historically faced challenges, as observed by Gatti (2004), this study chose to employ this methodology to construct a comprehensive overview of Higher Education in Brazil, specifically focusing on the on-site Civil Engineering course.

The research was designed to facilitate the construction of the overview through a website. In this context, the relevance of mobile technologies and mobile applications stands out, enabling access to information and knowledge quickly and flexibly, without time and space restrictions.

The employed method followed the planning of the thesis objectives, prioritizing their achievement. Initially, data collection was carried out, encompassing information from CC, CPC, ENADE reports based on SINAES, as well as data from the Higher Education Census. Additionally, demographic and territorial data from IBGE, including the Brazilian Statistical Yearbook and the Cities Portal, were considered, along with information on the number of registered civil engineers per municipality from CONFEA.

The data collection for the courses began with a search in the National Register of Courses and Institutions of Higher Education (e-MEC Register). Reports from the Higher Education Census, with a focus on disclosure tables, were used to collect data and build the overview. IBGE information, such as the new regional division of federative units into intermediate regions, was utilized.

CONFEA data, obtained through email requests, provided information on the number of active civil engineers per municipality, contributing to the construction of the overview. The treatment of EMEC data allowed verification of the existence of courses in extinction, extinct, and not initiated, which were excluded from the analysis.

Facing difficulties in obtaining data at the intermediate level of the region, usually available at the municipal or state level, the conversion of this data to intermediate regions was carried out. This conversion involved the summation of municipality numbers per intermediate region. The criteria adopted for data conversion and analysis enabled a reading of the national situation of the on-site Civil Engineering course, identifying peculiarities in the analyzed intermediate regions. Detailed results are presented in the next chapter, highlighting the national overview of the course and the analysis of five Brazilian intermediate regions with lower HDI, one in each major region of the country, along with the construction of the PanoramaEdu website.

III. Results

The results obtained through the collection, processing, and analysis of data, along with the interpretation of this information, enable the identification of differentiated readings. This involves observing Public Higher Education Institutions (Federal, State, and Municipal) and Private Institutions (Community, Confessional, Philanthropic, and for-profit), thereby allowing for the exploration of the perspective on the profile of courses nationwide and in their respective intermediary regions.

Subsequently, the Brazilian panorama of Higher Education in Civil Engineering in 2022 is presented. To introduce the results, the overview of the course is first provided in terms of national status. Following this, the results of the Intermediate Regions are presented, with consideration given to one Intermediate Region in each major Brazilian region (Central-South, Northeast, North, Southeast, and South), totaling five regions, following the criterion of lower Human Development Index (HDI).

a) Overview of the Civil Engineering Course in Brazil

Brazil is a country situated in South America, with an estimated population of 213,317,639 inhabitants as of 2021. Due to its vast dimensions, its territory spans 8,510,345.538 km² and is divided into five major regions: North, Northeast, South, Southeast, and Midwest. Brazil is a Federative Republic organized politically and administratively into states, municipalities, and districts. There are 26 Brazilian states, in addition to the Federal District, totaling 27 Federative Units that constitute the Federative Republic of Brazil (IBGE, 2022). The Brazilian population density is 25.07 inhabitants/km².

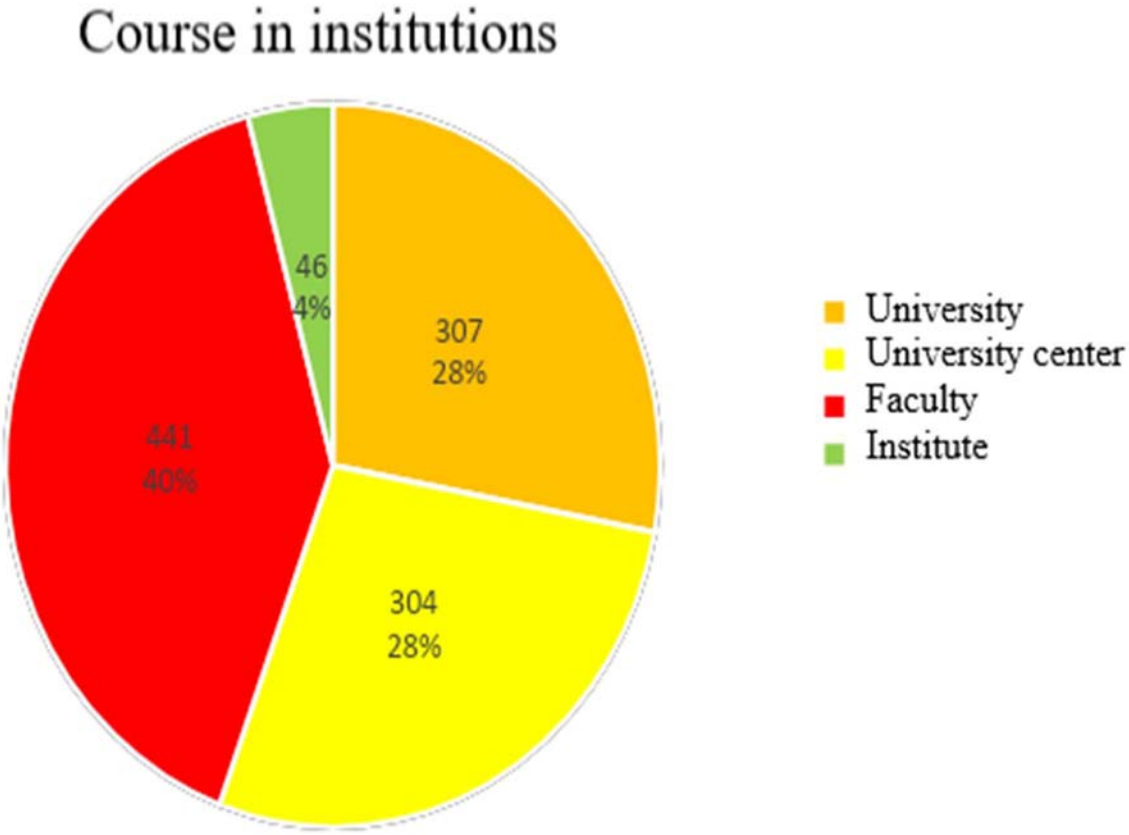
In 2017, the Brazilian states were subdivided into Intermediate Geographic Regions and Immediate Geographic Regions. Intermediate Geographic Regions represent an intermediate scale between the Federative Units and Immediate Geographic Regions. The delimitation of Intermediate Geographic Regions sought to include Metropolises or Regional Capitals, preferably. In some cases, especially where there were no Metropolises or Regional Capitals, smaller urban centers that were representative of the Immediate Geographic Regions that composed their respective Intermediate Geographic Regions were used. Intermediate Geographic Regions organize the territory, articulating Immediate Geographic Regions through a differentiated higher-hierarchy center based on private and public management flows and the existence of urban functions of greater complexity. Quantitatively, the country has 133 Intermediate Geographic Regions, 510 Immediate Geographic Regions, and 5,570 municipalities (IBGE, 2022).

The offering of on-site civil engineering courses in Brazil in 2022, in gross terms, is 1,366 courses,

collectively providing 220,769 vacancies according to data from the E-MEC system of INEP, spread throughout the national territory. However, only 1,098 courses are currently active and underway, reducing the number of vacancies to 179,515, a difference of 41,254 fewer vacancies.

The 1,098 courses currently in operation are distributed across the five major Brazilian regions, serving as the subject of quantitative analysis in this Panorama of Higher Education in On-Site Civil Engineering.

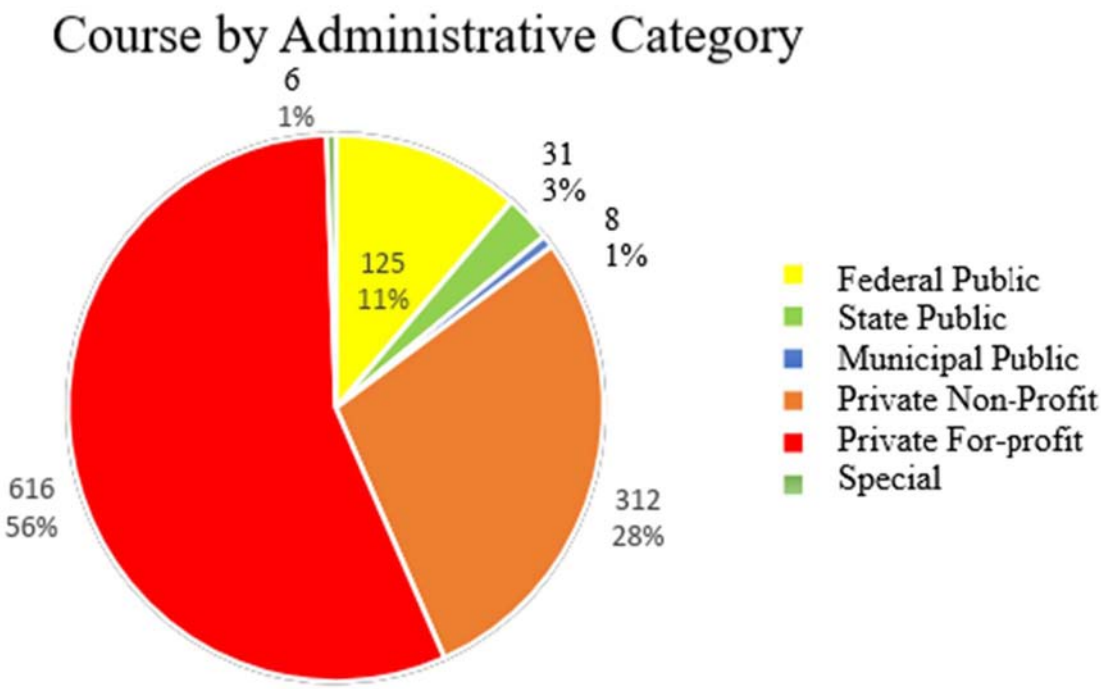
Subsequently, graphs presenting the results of the national panorama of On-Site Civil Engineering courses are provided, considering the various indicators of this thesis.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 1: Number of courses by academic organization

Given the above chart, it is evident that the courses are well distributed, with a notable increase in the number of on-site civil engineering courses offered by Federal Institutes. Despite their characteristic nature of providing technical courses, these institutes respond to the demand for higher education in civil engineering. However, the program is also prevalent in universities, constituting 40% of the total quantity of existing courses.

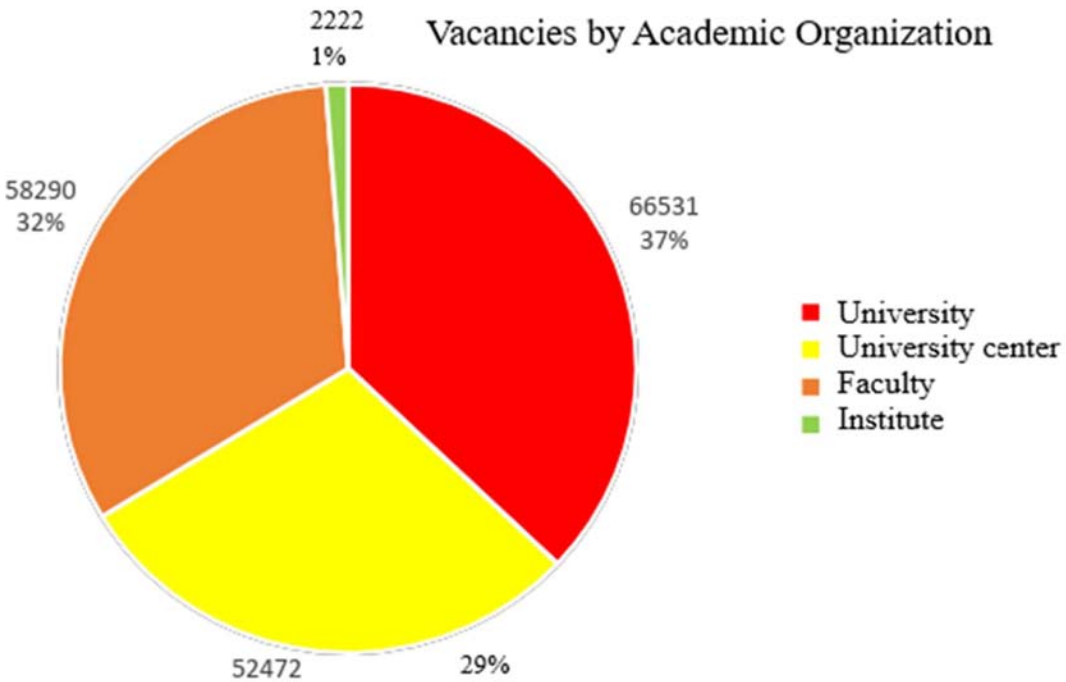


Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 2: Number of courses by administrative category

According to the chart, it is evident that the course is offered by For-Profit Private HEIs, totaling 56%. Following this, there is a 28% allocation in Non-Profit Private HEIs and an 11% allocation in Federal Public HEIs.

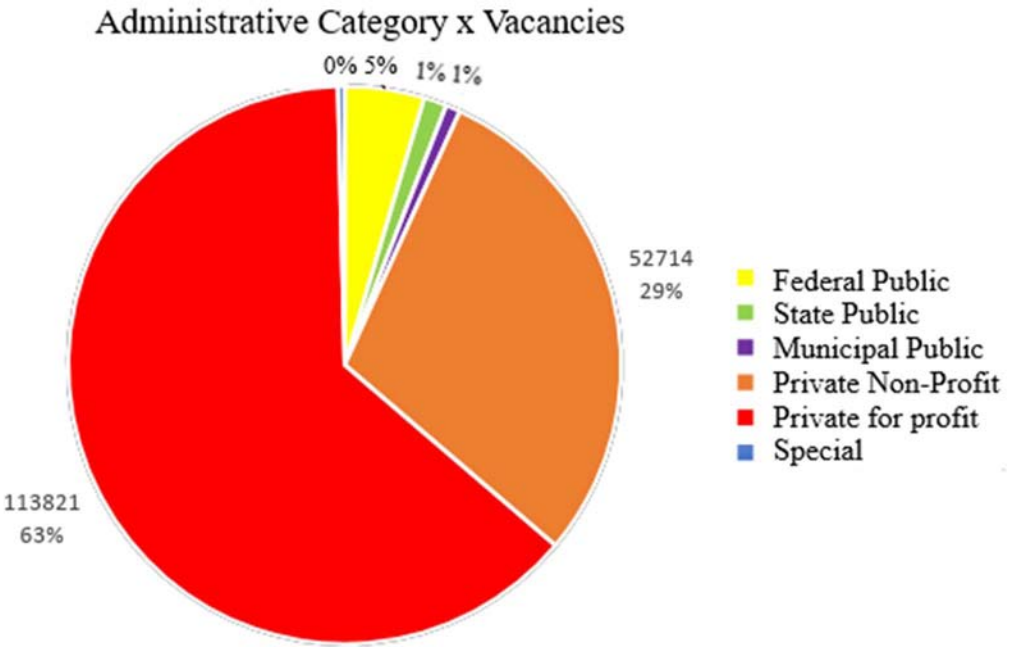
Considering the total number of civil engineering courses offered by private HEIs (both for-profit and non-profit), we observe a total of 84.5% of courses in Brazil. This highlights a noteworthy aspect to be considered in the analysis: the in-person Civil Engineering course tends to be pursued in private HEIs. To confirm this, it is necessary to examine the authorized positions at this point.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 3: Number of vacancies in courses by academic organization

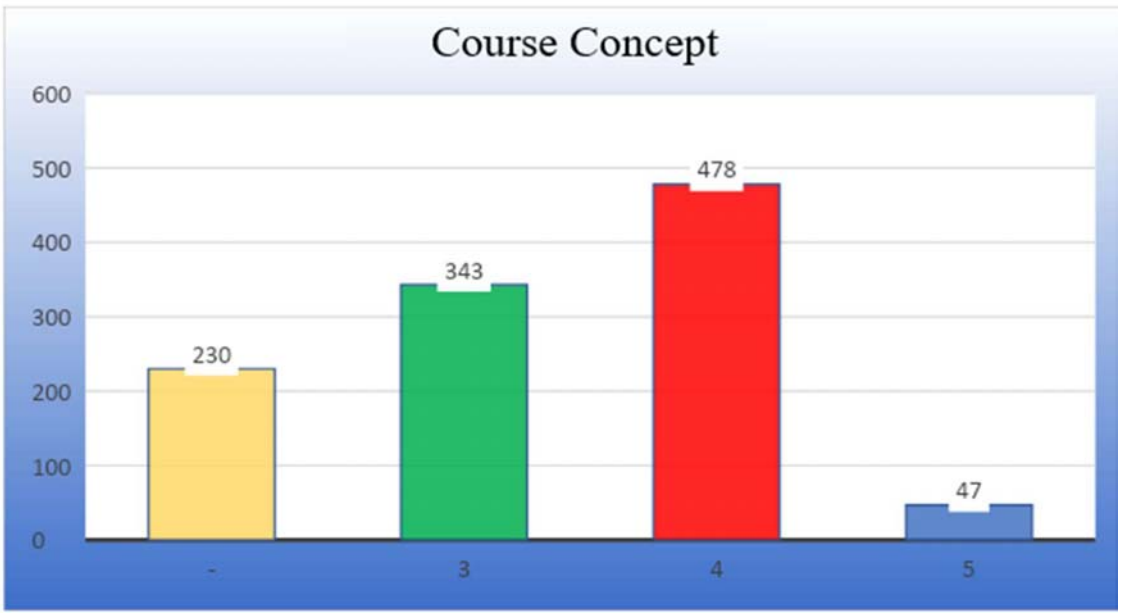
From the observations derived from the graph, a discernible trend toward equilibrium in the number of available positions among Universities, University Centers, and Colleges becomes apparent. Notably, the number of positions in Universities stands out, constituting 37.06% of the total. Despite Institutes featuring a lower count of positions, the figure of 2,222 vacancies still represents approximately 1.24% of the total, signifying a noteworthy outcome.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 4: Number of vacancies in courses by administrative category

Given what is presented in the previous graph, it is evident that the largest quantity of positions is in private higher education institutions (HEIs) with profit-making purposes, nearly 114,000 positions, representing 64% of the positions offered in this administrative category. This graph is crucial in responding to the fact that the On-site Civil Engineering course is predominantly offered in both for-profit and non-profit private HEIs, totaling 166,535 positions, corresponding to 93% of the positions offered in the country.

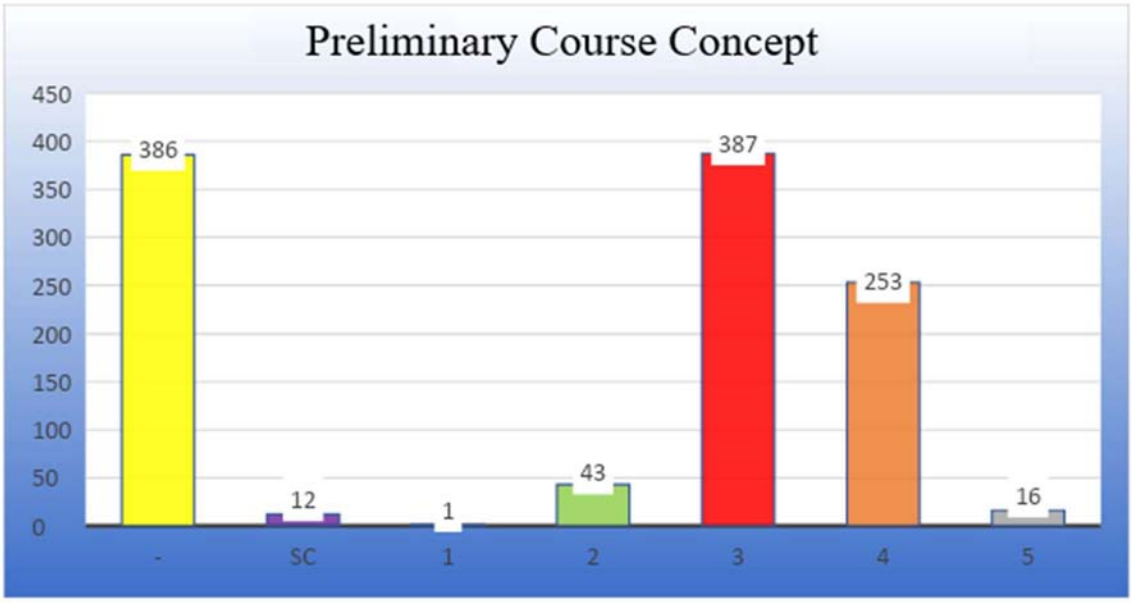


Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 5: Number of courses according to the course concept – CC

The concept of Course 4 represents the on-site civil engineering course, totaling 478 courses, constituting 44%. Within this total, only 47 courses have a Course Concept rating of 5, which is the maximum rating in the indicator. Even with this information, it is evident that there are not many civil engineering courses at the highest standard. However, this data alone is insufficient to assert a scarcity of civil engineering courses with the maximum rating, as other variables need to be considered. Nevertheless, it remains a relevant datum, given that only 4% of on-site courses have a rating of 5 in this concept. With a Course Concept of 3, there are 343 courses, representing 31%, and 230 courses, 21%, lack a rating in this indicator.

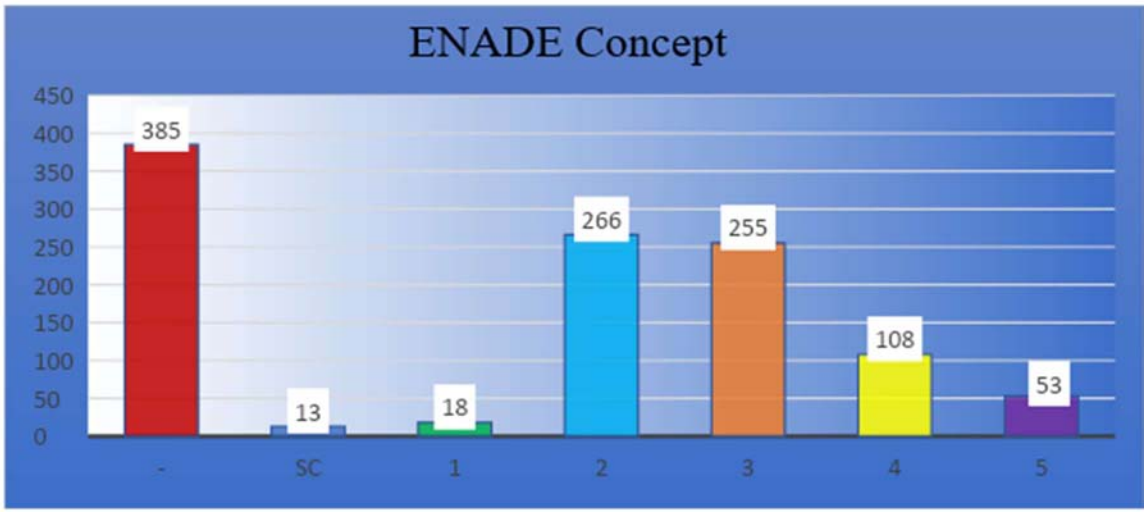
Despite this data raising concerns, it is observed that the majority of courses in this indicator have a Course Concept rating of 4, indicating that the courses in the country meet the indicator's criteria as being Very Good. Furthermore, 79% of courses demonstrate sufficiency in the Course Concept indicator.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 6: Number of courses according to the Preliminary Course Concept – CPC.

Regarding the Preliminary Course Concept, concept 3 had the highest frequency, accounting for 35%. It is crucial to note, upon observing the graph, that there are courses with a concept lower than the level of sufficiency, which is the concept grade 3. In other words, 4% of the courses have CPC scores of 1 or 2. It is noteworthy to emphasize the concept 4, constituting 23%. Additionally, when combining courses with concepts 3, 4, and 5, there is a total of 60% of courses demonstrating sufficiency in the CPC concept.



Source: National Register of Higher Education Courses and Institutions – e-MEC Register.

Graph 7: Number of courses according to the ENADE concept

Regarding the ENADE (National Student Performance Exam), the results indicate that the majority of courses do not have a rating, totaling 385 courses. Among those with a rating, the highest frequency is observed with ratings 2 and 3, suggesting a normal distribution trend in the indicator.

Upon analyzing regulatory data, it was found that only 6 courses in the country have both CC (Course Concept) 5 and ENADE 5. This finding raises concerns, as achieving the highest quality in higher education in Brazil is a goal that very few courses manage to attain, constituting only 0.54% of the total. These courses are as follows: Universidade Federal de Viçosa - UFV, Universidade Federal de Lavras - UFLA, Centro Federal de Educação Tecnológica de Minas Gerais – CEFET/MG, Universidade Federal de Itajubá – UNIFEI, Faculdade IBMEC, and Instituto Federal de Educação, Ciência e Tecnologia de São Paulo - IFSP.

These courses are located in Minas Gerais (5) and São Paulo (1). Consequently, it can be concluded that Minas Gerais is the state with the highest prominence in regulatory results, with four out of the thirteen intermediate regions being served by courses that received the highest rating (Course Concept 5).

However, it is crucial to note that courses are operating with low ratings in both Course Concept and ENADE. There are 18 courses with an ENADE rating of 1, with one course standing out negatively, as it not only has an ENADE rating of 1 but also a Preliminary Course Concept rating of 1. This is the Civil Engineering course at Faculdades Integradas Dom Pedro II in the municipality of São José do Rio Preto in the state of São Paulo.

The discovery that the state of São Paulo exhibits both extremes, featuring a Civil Engineering course with the highest ratings and another with the lowest ratings, is not surprising. This can be attributed to the demographic dimensions of the state of São Paulo, which has an estimated population of 46,649,132 inhabitants.

IDHM

To ascertain the feasibility of comparing the indicators of SINAES (CC, CPC, and ENADE) with the HDI, it is necessary to assess the normality of the sample, as substantiated by the calculations below:

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

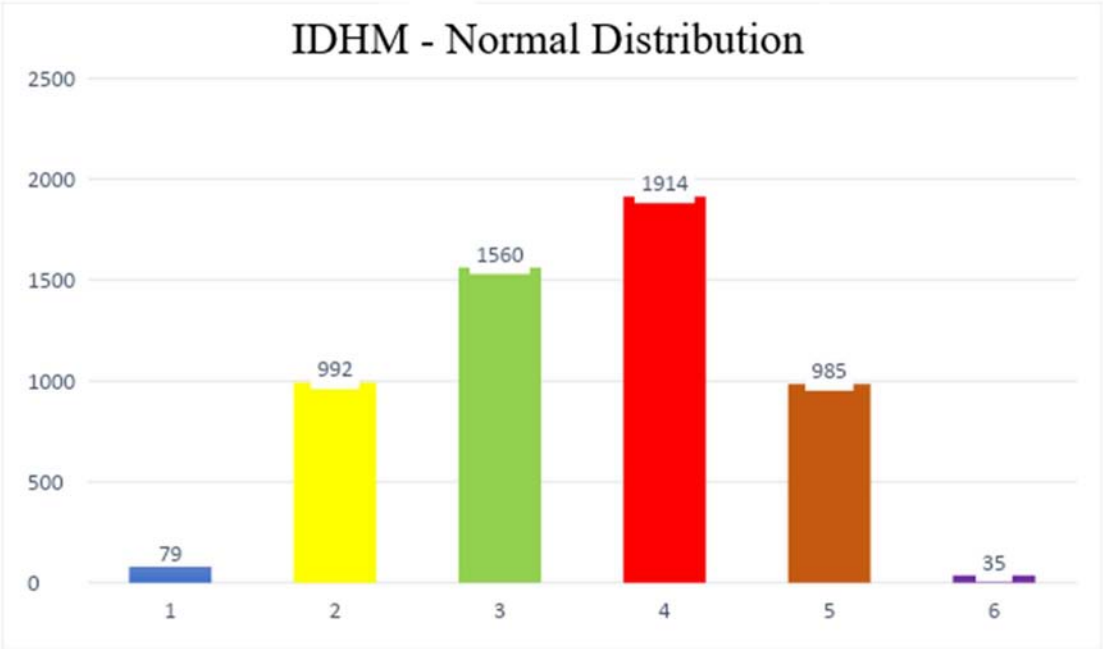
IDHM "Calculation of the Mean" = 3668,211 / 5565 = 0,659

The calculated sample standard deviation is 0.071991; rounding it to 0.072 is warranted, as the Human Development Index (HDI) employs three decimal places.

Table 1: Interval scale according to standard deviation of the HDI

Standard deviation	HDI range
σ -3	0,418 - 0,514
σ -2	0,515 - 0,586
σ -1	0,587 - 0,659
σ 1	0,659 - 0,730
σ 2	0,731 - 0,802
σ 3	0,803 - 0,875

Source: Prepared by the author



Source: Prepared by the author

Graph 8: Normal distribution of IDHM Brazil

The p-value of the Anderson-Darling normality test (A^2) was computed utilizing the following formula.:

$$A^2 = \left(-n - \frac{1}{n}\sum_{i=1}^{n}((2i-1)\ln\Phi(Z_i) + (2(n-i)+1)\ln(1-\Phi(Z_i)))\right)$$

Where Φ is the cumulative standard normal distribution, and Zi represents the corresponding normalized scores. The associated "p" value is $p = 0 \geq 0.05$, indicating that we lack sufficient evidence to claim a significant deviation from normality in the sample data; hence, we do not reject normality.

Consequently, it can be asserted that based on the Anderson-Darling normality test result, the distribution of the Human Development Index (IDH) in Brazilian municipalities tends towards a normal distribution.

Given this outcome, considering that the indicators of the National System of Higher Education Assessment (SINAES) - such as Institutional Concept (CC), Course Concept (CPC), and National Student Performance Exam (ENADE) - tend to follow a normal distribution, it becomes possible to establish a parameter for the Human Development Index according to the table below:

Table 2: Number of municipalities according to normal distribution

Standard deviation	IDHM Range	No. Counties
σ -3	0,000 - 0,514	79
σ -2	0,515 - 0,586	992
σ -1	0,587 - 0,659	1560
σ 1	0,659 - 0,730	1914
σ 2	0,731 - 0,802	985
σ 3	0,803 – 1,000	35

Source: PNUD, 2013.

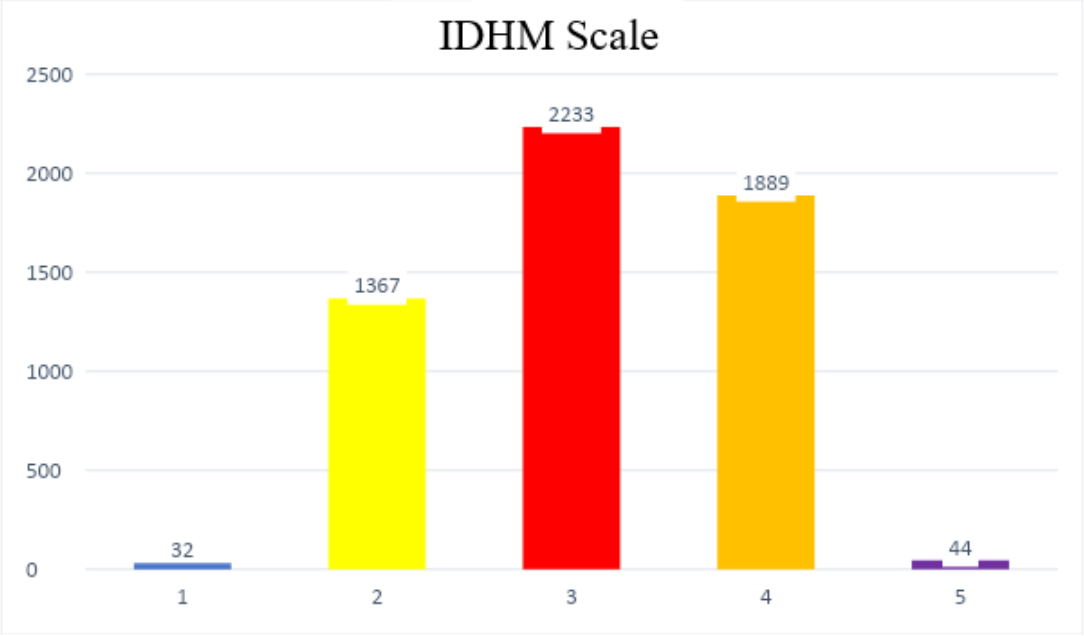
Under the classification of the Human Development Index (IDHM) based on parameter definitions, the analysis scale considers the following developmental ranges:

- 1. Very low human development (1): IDHM between 0.000 and 0.499;
- 2. Low human development (2): IDHM between 0.500 and 0.599;
- 3. Medium human development (3): IDHM between 0.600 and 0.699;
- 4. High human development (4): IDHM between 0.700 and 0.799;
- 5. Very high human development (5): IDHM between 0.800 and 1.000.

Table 3: Distribution of municipalities according to the **IDHM** scale

IDHM Scale	IDHM Range	No. Counties
Very low	0,000 - 0,499	32
Low	0,500 - 0,599	1367
Average	0,600 - 0,699	2233
High	0,700 - 0,799	1889
Very High	0,800 – 1,000	44

Source: PNUD, 2013.



Source: PNUD, 2013.

Graph 9: Number of municipalities according to the **IDHM** scale

The Human Development Index (HDI) of Brazil is 0.765, thus placing it in the category of high HDI. It ranks 84th in the global ranking, and from the graph, it is evident that the majority of Brazilian municipalities fall within the range of medium HDI.

Upon presenting the data, it is possible to perform several cross-analyses between the indicators, revealing interesting findings. The purpose of this analysis is to contribute to the decision-making process for the opening of on-site Civil Engineering courses by Higher Education Institution (HEI) administrators. The results presented here are not intended to exhaust the search for information, and it is recommended to conduct a local demand survey to complement the provided data.

The first cross-analysis was conducted to determine the ratio between the population and the number of civil engineers. The result obtained was 213,317,639 / 367,953 = 579.74, meaning there is approximately 1 civil engineer for every 580 people in the country. Consequently, there are 1.72 active civil engineers per 1000 inhabitants.

The second cross-analysis examined the ratio between the number of civil engineers and the number of companies in the construction industry. The result was 367,953 / 125,067 = 2.94, indicating that there are

almost 3 active civil engineers for each construction industry company in Brazil.

The third cross-analysis aimed to determine the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result was 1,903,715 / 367,953 = 5.17, meaning there are 5 employed individuals in construction industry companies for every active civil engineer in the country.

The fourth cross-analysis was conducted to assess the ratio between the number of engineers and the number of available slots in on-site civil engineering courses. The result was 367,953 / 179,515 = 2.05, demonstrating that the number of active civil engineers is almost double the number of available slots in active on-site civil engineering courses.

The fifth cross-analysis focused on the ratio between the number of engineers and the number of courses. The result was 367,953 / 1,098 = 335.11, indicating there are approximately 335 active civil engineers for each active on-site civil engineering course.

The sixth cross-analysis aimed to determine the ratio between the number of people employed in construction industry companies and the number of available slots in on-site civil engineering courses in Brazil. The result was 1,903,715 / 179,515 = 10.60, signifying that there are approximately 11 employed individuals in construction industry companies for each available slot in active on-site civil engineering courses.

The seventh cross-analysis focused on the ratio between the number of people employed in construction industry companies and the number of active on-site civil engineering courses. The result was 1,903,715 / 1,098 = 1733.8, indicating that there are approximately 1734 employed individuals in construction industry companies for each active on-site civil engineering course.

The eighth cross-analysis aimed to determine the ratio between the Brazilian population and the number of people employed in construction industry companies. The result obtained was 213,317,639 / 1,903,715 = 112.05, meaning there is approximately 1 employed individual in construction industry companies for every 112 people.

The ninth cross-analysis aimed to determine the average between the number of people employed in construction industry companies and the number of companies in the construction industry. The result was 1,903,715 / 125,067 = 15.22, indicating that there is an average of 15 employed individuals in each construction industry company.

The tenth cross-analysis aimed to determine the ratio between the Brazilian population and the number of companies in the construction industry. The result obtained was 213,317,639 / 125,067 = 1705.62, signifying that there is approximately 1 construction industry company to serve approximately 1706 people.

The eleventh cross-analysis focused on the ratio between the number of construction industry companies and the number of active on-site civil engineering courses. The result was 125,067 / 1,098 = 113.9, indicating that there are approximately 114 construction industry companies for each active on-site civil engineering course.

The twelfth cross-analysis aimed to determine the ratio between the national population and the number of available slots in active on-site civil engineering courses. The result was 213,317,639 / 179,515 = 1188.3, signifying that there is 1 slot for every 1188 people in Brazil.

The thirteenth cross-analysis aimed to determine the ratio between the number of available slots in active on-site civil engineering courses and the number of construction industry companies. The result was 179,515 / 125,067 = 1.43, demonstrating that there are approximately 1.5 construction industry companies for each available slot in active on-site civil engineering courses.

The fourteenth cross-analysis aimed to determine the ratio between the national population and the number of active on-site civil engineering courses. The result obtained was 213,317,639 / 1,098 = 194,278.35, indicating that there is 1 active on-site civil engineering course for every 194,278 inhabitants.

Table 4: Summary of crossings at national level

Crossings	Result
Population/active civil engineers	580 inhabitants for each engineer
Active civil engineers/construction industry companies	3 engineers for each company
People employed in construction industry companies/active civil engineers	5 people employed for each engineer
Active civil engineers / vacancies on courses	2 engineers for each place on the courses
Engenheiros civis ativos / número de cursos	335 engineers for each course
People employed in companies in the construction industry / vacancies on courses	11 people employed for each place on the courses
People employed in construction industry companies/civil engineering courses	1734 people employed for each course

Population/people employed in construction industry companies	112 inhabitants for each person employed
Persons employed in construction industry companies/construction industry companies	15 people employed in each company
Construction industry population/companies	1706 inhabitants for each company
Companies in the construction industry / civil engineering courses	114 companies for each course
Population / number of vacancies	1188 inhabitants for each place on the courses
Crossings	**Result**
Number of places on courses/companies in the construction industry	1.5 places on courses for each company
National population/civil engineering courses	194,278 inhabitants for each course

Source: Prepared by the author

From the presented results, the recurrence of the following national profile of the on-site civil engineering course was observed:

The on-site civil engineering course is offered in private for-profit colleges, with a course rating of 4, a preliminary course rating of 3, and an ENADE rating of 2. The ratio of active civil engineers to the number of courses is 335 civil engineers per course; the number of individuals employed in construction industry sector companies relative to the number of courses is 1734 employed individuals per course; currently, there are 114 companies in the construction industry sector for each course, and the population ratio is 194,278 inhabitants for each initiated on-site civil engineering course in activity.

All the results presented in this overview can serve as a foundation for managers operating in Brazilian public and private higher education institutions to undertake planning and make decisions regarding on-site civil engineering courses.

According to Franco and Longhi (2021, p. 244):

> The manager organizes the institution politically and administratively. Facilitates the development and systematization of programs, plans, processes, strategies, and procedures; clarifies and prioritizes budgets, evaluates, proceeds, enhances, or retracts. Initiates processes, ensures their replanning, organizes instances, delegates authority, and promotes responsible democratic management to mobilize the internal and external community, seeking support for the systemic operation to achieve the institutional mission and objectives.

These results, at the national level, already demonstrate the wealth of information upon which academic studies can be grounded from this panorama. However, despite the recurrence of courses aligning with the aforementioned national profile, not all courses and intermediate regions reflect this reality.

In light of this, the analysis of indicators yields divergent results when considering the criterion of intermediate regions with lower HDI, featuring at least one in-person Civil Engineering course in operation and initiated in the Central-West, Northeast, North, Southeast, and South Regions, totaling 5 regions. Similarly, the subsequent focus will be on intermediate regions where there are no in-person Civil Engineering courses in operation and initiated, as this outcome indicates potential scarcity of courses in these intermediate regions.

It is important to emphasize that, given the volume of information, a decision by the author, in agreement with the advisor, has been made to include in the appendix a brief analysis of the results for an intermediate region by Federal Unit, considering the criterion of intermediate regions with the lowest HDI, while also specifying the criterion that there must be at least one in-person Civil Engineering course in operation and initiated.

b) Overview of On-Site Civil Engineering Courses in the Five Intermediate Regions with the Lowest Human Development Index (HDI).

Midwest: Intermediate Region of Corumbá

The Intermediate Geographic Region of Corumbá is one of the three intermediate regions in the Brazilian state of Mato Grosso do Sul and one of the 134 intermediate regions in Brazil, established by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It comprises 13 municipalities, distributed across three immediate geographic regions. The total estimated population for the year 2021, as reported by the IBGE, is 367,327 inhabitants, spread over a total area of 131,050.917 km². Corumbá is the most populous municipality in the intermediate region, with 112,669 inhabitants, according to 2021 estimates from the Brazilian Institute of Geography and Statistics.

Source: HUNTER (2020).

Figure 1: Map of the intermediate region of Corumbá

The Intermediate Region of Corumbá is the area with the lowest Human Development Index (HDI) in the State of Mato Grosso do Sul and in the Central-West region.

Table 8: Data of municipalities in the intermediate region of Corumbá

Municipalities of the Intermediate Region CORUMBÁ	Active Civil Engineers	IDH	Position IDH	Estimated Population 2021	Population Density Estimated
Ladário	8	0,704	1776	24040	67,86
Corumbá	21	0,688	2224	112.669	1,75
Porto Murtinho	1	0,666	2759	17460	0,99
Nioaque	0	0,639	3312	13794	3,52
Jardim	19	0,712	1546	26375	12,41
Guia Lopes da Laguna	3	0,675	2545	9754	7,96
Caracol	1	0,647	3172	6247	2,12
Bonito	7	0,67	2663	22401	4,17
Bela Vista	9	0,698	1969	24842	5,07
Miranda	5	0,632	3448	28423	5,19
Municipalities of the Intermediate Region CORUMBÁ	**Active Civil Engineers**	**IDH**	**Position IDH**	**Estimated Population 2021**	**Population Density Estimated**
Bodoquena	2	0,666	2759	7802	3,01
Aquidauana	21	0,688	2224	48184	2,82
Anastácio	5	0,663	2828	25336	8,70
TOTAL	102	0,673	2598°	367.327	2,80

Source: IBGE, CONFEA, adapted by the author.

The intermediate region has only 1 Public On-Site Civil Engineering course, offered by IFMS, a Federal Public institution, with 40 authorized slots in the municipality of Aquidauana, and it has not yet received any SINAES rating. This indicates that the course is authorized but has not undergone the recognition process.

The intermediate region does not have any Private On-Site Civil Engineering courses offered by private initiatives.

In the State of Mato Grosso do Sul, there are 669 construction industry companies employing 17,504 people, according to data from the Brazilian Statistical Yearbook for the year 2019, in a region with 367,327 inhabitants and 102 active civil engineers registered with CONFEA. Based on this information, the following data cross-references were conducted:

The first cross-reference for the intermediate region aimed to determine the ratio between the population and the number of civil engineers. The result obtained was 367,327 / 102 = 3,601.24, indicating that there is 1 active civil engineer for every 3,601 people.

The second cross-reference for the intermediate region aimed to verify the ratio between the number of construction industry companies and the number of civil engineers. The result obtained was 620 / 102 = 6.07, indicating that there are 6 construction industry companies for every active civil engineer.

The third cross-reference aimed to verify the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 16,172 / 102 = 158.55, meaning that there are approximately 159 people employed in construction industry companies for every active civil engineer in the intermediate region.

The fourth cross-reference for the intermediate region aimed to verify the ratio between the number of engineers and the number of slots in on-site civil engineering courses. The result obtained was 102 / 40 = 2.55, demonstrating that the number of active civil engineers is nearly double the number of available slots in on-site civil engineering courses that are currently in operation.

The fifth cross-reference checks the ratio between the number of engineers and the number of courses; however, there is only 1 course in the intermediate region. The result obtained was 102 / 1 = 102, meaning there are 102 active civil engineers for the single on-site civil engineering course currently in operation.

The sixth cross-reference for the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies and the number of slots in the on-site civil engineering course in the intermediate region. The result obtained was 16,172 / 40 = 404.3, signifying that there are practically 404 people employed in construction industry companies in the state for each slot in the on-site civil engineering courses currently in operation in the intermediate region.

The seventh cross-reference for the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in operation. However, since the intermediate region has only one course, the result obtained was 16,172 / 1 = 16,172. This result indicates that there are 16,172 people employed in construction industry companies for the single on-site civil engineering course currently in operation in the intermediate region.

The eighth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 367,327 / 16,172 = 22.71, meaning there is approximately 1 person employed in construction industry companies for every 23 inhabitants.

The ninth cross-reference in the state aimed to verify the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 16,172 / 620 = 26.08, indicating that there is an average of 26 people employed in each construction industry company.

The tenth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 367,327 / 620 = 592.46, signifying that there is approximately 1 construction industry company in the state to serve 592 people in the intermediate region.

The eleventh cross-reference aimed to verify the ratio between the number of construction industry companies and on-site civil engineering courses currently in operation. The result obtained was 620 / 1 = 620, which is approximately 620 construction industry companies for each on-site civil engineering course currently in operation in the intermediate region.

The twelfth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of slots in on-site civil engineering courses currently in operation. The result obtained was 367,327 / 40 = 9,183.17, meaning there is 1 slot for approximately every 9,183 people in the intermediate region.

The thirteenth cross-reference aimed to verify the ratio between the number of slots in on-site civil engineering courses currently in operation and the number of construction industry companies. The result obtained was 620 / 40 = 15.5, indicating that there are approximately 16 construction industry companies for each slot in on-site civil engineering courses currently in operation.

The fourteenth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in operation. The result obtained was 367,327 / 1 = 367,327, meaning there is 1 on-site civil engineering course currently in operation for every 367,327 inhabitants. Despite this significant result, it is

important to consider the population density of the region, which is 2.80 inhabitants per square kilometer.

Table 9: Summary of crossings at the intermediate region level of Corumbá

Crossings	Result
Population / active civil engineers	3601 inhabitants per engineer
Construction industry companies / active civil engineers	6 companies per engineer
People employed in construction industry companies / active civil engineers	159 people employed per engineer
Active civil engineers / course vacancies	2 engineers per course vacancy
Active civil engineers / number of courses	102 engineers per course
People employed in construction industry companies / course vacancies	404 people employed per course vacancy
People employed in construction industry companies / civil engineering courses	16172 people employed per course
Population / people employed in construction industry companies	23 inhabitants per employed person
People employed in construction industry companies / construction industry companies	Average of 26 people employed in each company
Population / construction industry companies	592 inhabitants per company
Construction industry companies / civil engineering courses	620 companies per course
Population / number of vacancies	9183 inhabitants per course vacancy
Construction industry companies / number of course vacancies	16 companies per course vacancy

Source: Developed by the author

The intermediate region has only one Public On-site Civil Engineering course, offered at IFMS, therefore, a Federal Public institution, with 40 authorized slots in the municipality of Aquidauana, and it does not yet have any SINAES concept, indicating that the course is authorized but has not yet undergone the recognition process.

The intermediate region does not have an On-site Civil Engineering course offered by private initiative. The state of Mato Grosso do Sul has 669 construction industry companies employing 17,504 people, according to data from the Brazilian Statistical Yearbook for the year 2019, in a region with 367,327 inhabitants and 102 active civil engineers in CONFEA. Given this information, the following data cross-references were conducted:

The first cross-reference for the intermediate region was conducted to determine the ratio between the population and the number of civil engineers. The result obtained was 367,327 / 102 = 3,601.24, meaning there is 1 active civil engineer for every 3,601 people.

The second cross-reference for the intermediate region was conducted to check the ratio between the number of construction industry companies and the number of civil engineers. The result obtained was 620 / 102 = 6.07, indicating there are 6 construction industry companies for every active civil engineer.

The third cross-reference aimed to check the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 16,172 / 102 = 158.55, meaning there are approximately 159 people employed in construction industry companies per active civil engineer in the intermediate region.

The fourth cross-reference for the intermediate region aimed to check the ratio between the number of Engineers and the number of slots in on-site civil engineering courses. The result obtained was 102 / 40 = 2.55, demonstrating that the number of active civil engineers is almost twice the number of slots in on-site civil engineering courses currently in progress.

The fifth cross-reference checks the ratio between the number of engineers and the number of courses; however, there is only one course in the intermediate region. The result obtained was 102 / 1 = 102, meaning there are 102 active civil engineers for the single on-site civil engineering course currently in progress.

The sixth cross-reference for the intermediate region aimed to check the ratio between the number of people employed in construction industry companies and the number of slots in the on-site civil engineering course in the intermediate region. The result obtained was 16,172 / 40 = 404.3, indicating there are practically 404 people employed in construction industry companies per slot in on-site civil engineering courses currently in progress in the intermediate region.

The seventh cross-reference for the intermediate region aimed to check the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in progress. However, as the intermediate region has only one course, the result obtained was 16,172 / 1 = 16,172. The result shows 16,172 people employed in construction industry companies for the single on-site civil engineering course currently in progress.

The eighth cross-reference aimed to check the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 367,327 / 16,172 = 22.71, meaning there is approximately 1 person employed in construction industry companies for every 23 inhabitants.

The ninth cross-reference in the state aimed to check the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 16,172 / 620 = 26.08, indicating an average of 26 people employed in each construction industry company.

The tenth cross-reference aimed to check the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 367,327 / 620 = 592.46, meaning there is approximately 1 construction industry company in the state to serve 592 people in the intermediate region.

The eleventh cross-reference aimed to check the ratio between the number of construction industry companies and the on-site civil engineering courses currently in progress. The result obtained was 620 / 1 = 620, approximately 620 construction industry companies for each on-site civil engineering course currently in progress in the intermediate region.

The twelfth cross-reference aimed to check the ratio between the population of the intermediate region and the number of slots in on-site civil engineering courses currently in progress. The result obtained was 367,327 / 40 = 9,183.17, meaning there is 1 slot for approximately every 9,183 people in the intermediate region.

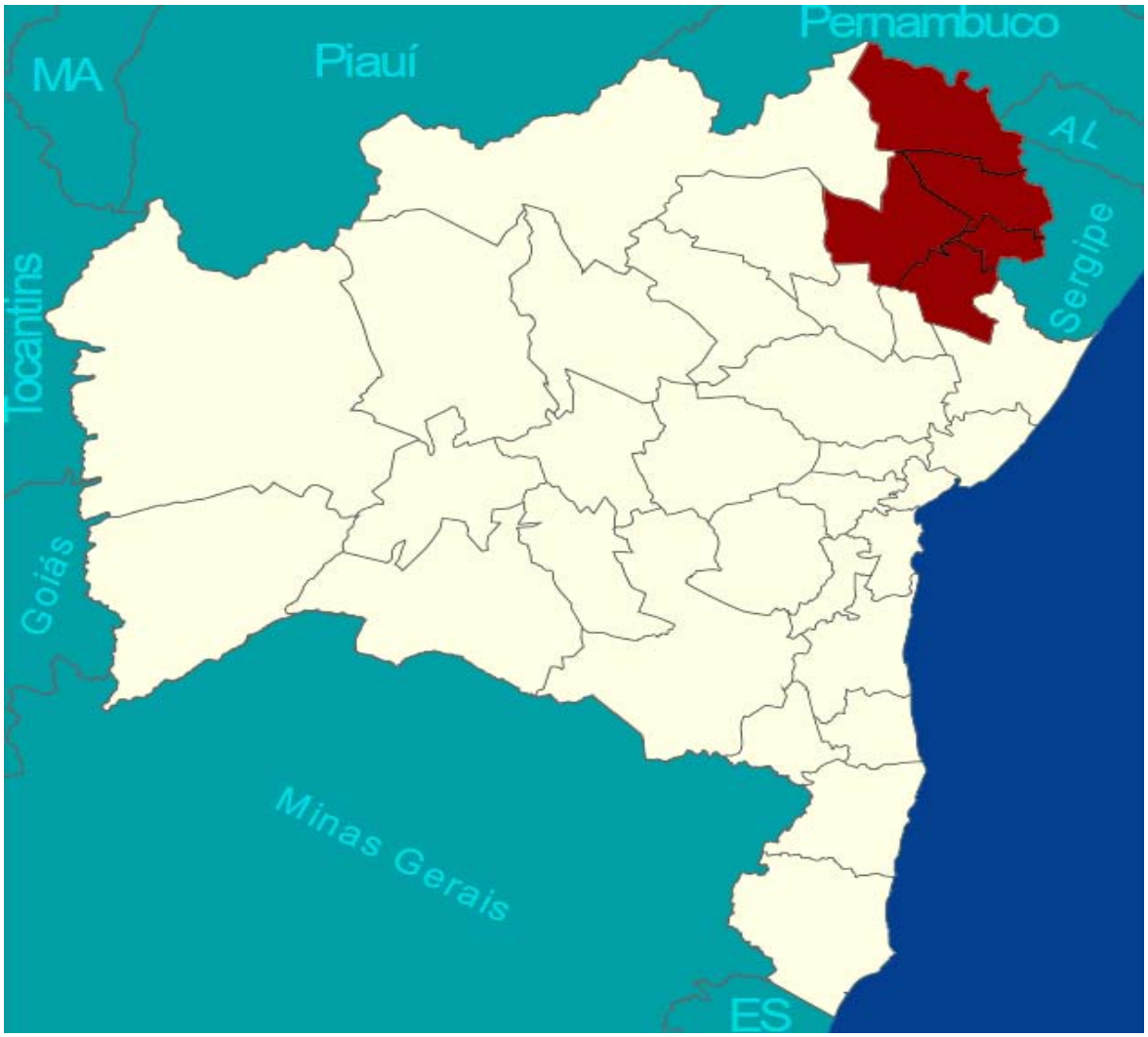
The thirteenth cross-reference aimed to check the ratio between the number of slots in on-site civil engineering courses currently in progress and the number of construction industry companies. The result obtained was 620 / 40 = 15.5, demonstrating that there are approximately 16 construction industry companies for each slot in on-site civil engineering courses currently in progress.

The fourteenth cross-reference aimed to check the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in progress. The result obtained was 367,327 / 1 = 367,327, meaning there is 1 on-site civil engineering course currently in progress for every 367,327 inhabitants. Despite the significant result, it is important to consider the region's population density, which is 2.80 inhabitants/km^2.

Northeast: Intermediate region of Paulo Afonso

The Geographical Intermediate Region of Paulo Afonso is one of the ten intermediate regions in the Brazilian state of Bahia and one of the 134 intermediate regions in Brazil, created by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It consists of 30 municipalities distributed across five immediate geographical regions.

Its total estimated population by the Brazilian Institute of Geography and Statistics (IBGE) for 2021 is 820,216 inhabitants, distributed over a total area of 40,788.175 km^2. Paulo Afonso is the most populous municipality in the intermediate region, with 119,213 inhabitants, according to 2021 estimates from the Brazilian Institute of Geography and Statistics (IBGE).



Source: HUNTER (2020).

Figure 2: Map of Paulo Afonso's intermediate region

The Intermediate Region of Paulo Afonso is the area with the lowest Human Development Index (HDI) in the State of Bahia and the Northeast region.

Table 10: Data of municipalities in the intermediate region of Paulo Afonso

Municipalities of the Intermediate Region Paulo Afonso	Active Civil Engineers	IDH	Position IDH	Estimate Populati on 2021	Population Density Estimated
Santa Brígida	3	0,546	5253	13917	14,89
Rodelas	3	0,632	3448	9548	4,32
Paulo Afonso	69	0,577	4695	119213	77,19
Macururé	2	0,604	4055	7752	3,04
Glória	2	0,593	4309	15247	9,73
Chorrochó	3	0,6	4144	11221	3,73
Abaré	2	0,575	4742	20594	12,83
Tucano	33	0,579	4654	50903	23,15
Ribeira do Pombal	49	0,601	4123	54097	43,20
Ribeira do Amparo	2	0,512	5494	14631	22,71
Olindina	2	0,559	5066	28373	44,51
Nova Soure	5	0,555	5128	27047	27,97

Cipó	8	0,601	4123	17402	103,38
Banzaê	6	0,579	4654	13251	32,35
Quijingue	2	0,544	5277	27672	20,04
Monte Santo	10	0,506	5510	49145	16,19
Euclides da Cunha	24	0,567	4903	61112	30,17
Canudos	2	0,562	5002	16832	4,72
Municipalities of the Intermediate Region Paulo Afonso	**Active Civil Engineers**	**IDH**	**Position IDH**	**Estimate Populati on 2021**	**Population Density Estimated**
Cansanção	8	0,557	5098	34929	25,83
Paripiranga	20	0,577	4695	29124	65,86
Heliópolis	5	0,563	4984	12946	41,30
Fátima	8	0,559	5066	17801	48,84
Cícero Dantas	21	0,585	4515	32636	39,80
Antas	6	0,592	4334	19659	61,48
Adustina	7	0,546	5253	17209	27,35
Sítio do Quinto	11	0,533	5370	9431	13,78
Pedro Alexandre	1	0,513	5490	16698	18,77
Novo Triunfo	2	0,554	5146	15445	55,46
Jeremoabo	21	0,547	5244	40832	9,56
Coronel João Sá	2	0,535	5361	15549	19,49
TOTAL	339	0,565	4941°	820.216	20,10

Source: IBGE, CONFEA, adapted by the author

The intermediate region hosts two ongoing academic programs, both of which are privately operated for profit. Both programs hold a course accreditation rating of 3, and they have received an ENADE (National Student Performance Exam) rating of 2.

Table 11: Number of courses in the intermediate region of Paulo Afonso

Intermediate Region	Courses	PF	PE	PM	PSFL	PCFL	UNI	CEU	FAC	INST
Paulo Afonso	2	0	0	0	0	2	0	1	1	0

Source: National Registry of Courses and Higher Education Institutions – e-MEC Registration.

The courses are offered in different municipalities: UniAGES has 100 authorized slots in the municipality of Paripiranga; FDL has 200 authorized slots in the municipality of Ribeira do Pombal. The intermediate region does not have a Public On-site Civil Engineering course.

The state of Bahia has 2,010 construction industry companies employing 79,518 people according to data from the Brazilian Statistical Yearbook for the year 2019, and the intermediate region has 820,216 inhabitants with 339 active civil engineers registered with CONFEA.

Given this information, the following data cross-references were conducted:

The first cross-reference in the intermediate region was conducted to determine the ratio between the population and the number of civil engineers. The result obtained was 820,216 / 339 = 2,419.52, indicating that there is 1 active civil engineer for every 2,419 people.

The second cross-reference in the intermediate region was conducted to verify the ratio between the number of construction industry companies and the number of civil engineers. The result obtained was 2,010 / 339 = 5.92, meaning there are approximately 6 active civil engineers for each construction industry company.

The third cross-reference was conducted to verify the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 79,518 / 339 = 234.57, signifying that there are approximately 235 people employed in the state's construction industry companies for every active civil engineer in the intermediate region.

The fourth cross-reference in the intermediate region was conducted to verify the ratio between the number of Engineers and the number of slots in on-site civil engineering courses. The result obtained was 339 / 300 = 1.13, demonstrating that the number of active civil engineers is approximately equal to the number of slots in on-site civil engineering courses currently in progress.

The proposed fifth cross-reference to verify the ratio between the number of engineers and the number of courses yielded the result: 339 / 2 = 169.5, meaning there are approximately 170 active civil engineers for each on-site civil engineering course currently in progress.

The sixth cross-reference in the intermediate region was conducted to verify the ratio between the number of people employed in construction industry companies and the number of slots in the on-site civil engineering course in the intermediate region. The result obtained was 79,518 / 300 = 265.06, indicating that there are 265 people employed in the state's construction industry companies for each slot in on-site civil engineering courses currently in progress in the intermediate region.

The seventh cross-reference in the intermediate region was conducted to verify the proportion between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in progress. However, as the intermediate region has only one course, the result obtained was 79,518 / 2 = 39,759. The result shows that 39,759 people are employed in construction industry companies for the single on-site civil engineering course currently in progress.

The eighth cross-reference was conducted to verify the proportion between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 820,216 / 79,518 = 10.31, meaning there is approximately 1 person employed in construction industry companies for every 10 inhabitants.

The ninth cross-reference in the state was conducted to verify the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 79,518 / 2,010 = 39.56, signifying that there is an average of 40 people employed in each construction industry company.

The tenth cross-reference was conducted to verify the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 820,216 / 2,010 = 408.07, indicating that there is approximately construction industry company in the state to serve 408 inhabitants of the intermediate region.

The eleventh cross-reference was conducted to verify the ratio between the number of construction industry companies and the on-site civil engineering courses currently in progress. The result obtained was 2010 / 2 = 1,005, which means there are 1,005 construction industry companies for each on-site civil engineering course currently in progress in the intermediate region.

The twelfth cross-reference was conducted to verify the ratio between the population of the intermediate region and the number of slots in on-site civil engineering courses currently in progress. The result obtained was 820,216 / 300 = 2734.05, meaning there is 1 slot for approximately every 2734 people in the intermediate region.

The thirteenth cross-reference was conducted to verify the ratio between the number of slots in on-site civil engineering courses currently in progress and the number of construction industry companies. The result obtained was 2010 / 300 = 6.7, demonstrating that there are approximately 7 construction industry companies for each slot in on-site civil engineering courses currently in progress.

The fourteenth cross-reference was conducted to verify the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in progress. The result obtained was 820,216 / 2 = 410,108, indicating that there is 1 on-site civil engineering course currently in progress for every 410,108 inhabitants.

Table 12: Summary of crossings at the intermediate region level of Paulo Afonso

Crossings	Result
Population / Active Civil Engineers	2419 inhabitants per engineer
Construction Industry Companies / Active Civil Engineers	6 companies per engineer
People employed in construction industry companies / Active Civil Engineers	235 people employed per engineer
Active Civil Engineers / Course vacancies	1 engineer per course vacancy
Active Civil Engineers / Number of courses	170 engineers per course
People employed in construction industry companies / Course vacancies	265 people employed per course vacancy

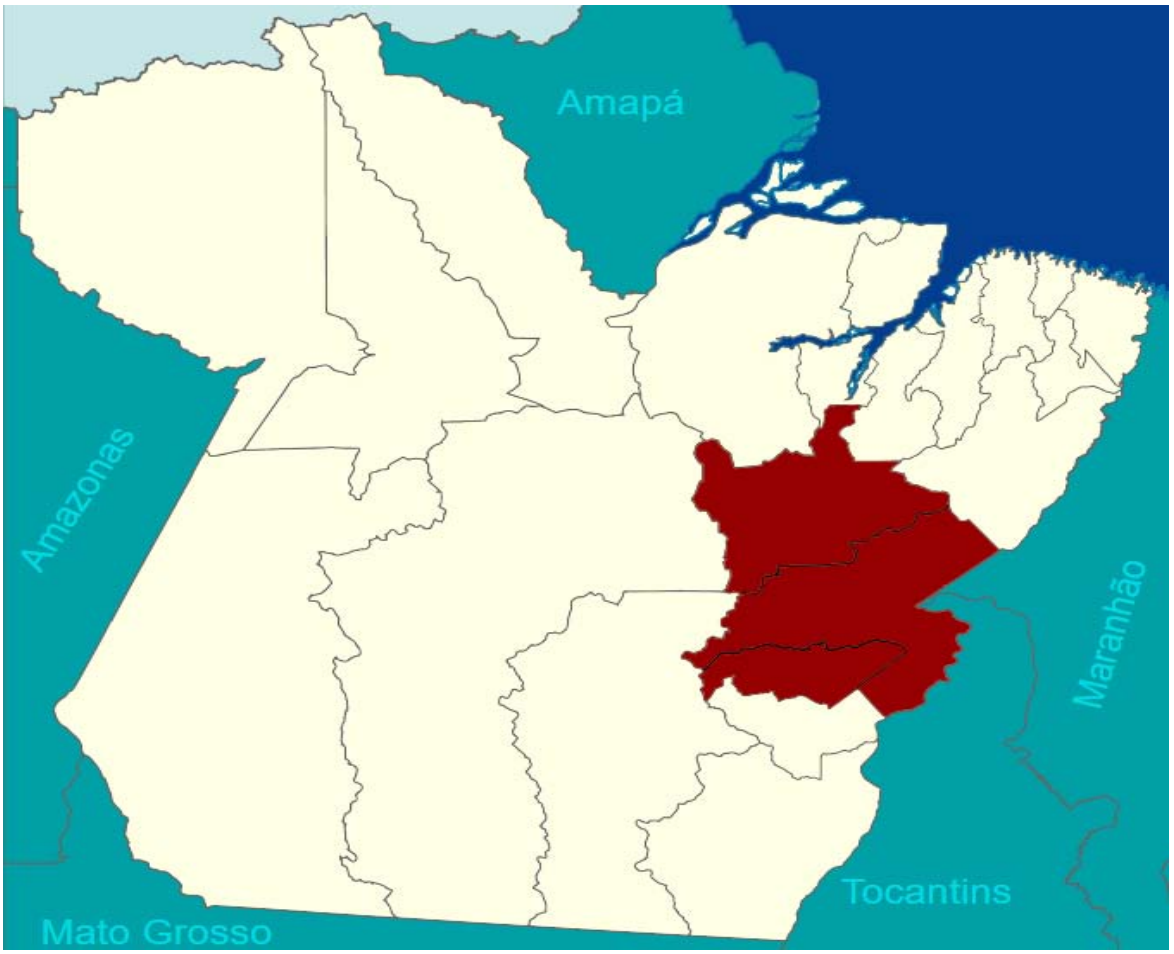
People employed in construction industry companies / Civil Engineering courses	39759 people employed per course
Population / People employed in construction industry companies	10 inhabitants per employed person
People employed in construction industry companies / Construction industry companies	Average of 40 people employed in each company
Population / Construction industry companies	408 inhabitants per company
Construction industry companies / Civil Engineering courses	1005 companies per course
Population / Number of course vacancies	2734 inhabitants per course vacancy
Construction industry companies / Number of course vacancies	7 companies per course vacancy
National population / Civil Engineering courses	410,108 inhabitants per course

Source: Developed by the author

Paulo Afonso is an intermediate region that hosts only two on-site civil engineering courses in private higher education institutions (IES). The region lacks the availability of on-site civil engineering courses in public IES, indicating a potential unmet demand. Therefore, it is incumbent upon the administrators of public IES to analyze to determine the feasibility of offering such a program to cater to the region. Additionally, it has been observed that the existing courses have ENADE scores of 2, suggesting a need for public IES administrators to assess the creation of a high-quality on-site civil engineering course that can, in the long run, stimulate the development of the intermediate region with a low Human Development Index (HDI). The ratio of engineers to course openings is the lowest among the five regions, indicating a limited number of active civil engineers despite a significant number of available slots in the two courses. It is noteworthy that the ratio of the intermediate region's population to the number of courses is the highest among the five regions, attributed to the limited number of courses in the intermediate region. This reinforces the necessity for public IES administrators to thoroughly evaluate the feasibility of offering at least one new high-quality on-site civil engineering course to meet the needs of the intermediate region of Paulo Afonso.

North: Intermediate Region of Marabá

The Geographical Intermediate Region of Marabá is one of the seven intermediate regions in the Brazilian state of Pará and one of the 134 intermediate regions in Brazil, established by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It encompasses 23 municipalities distributed across three immediate geographical regions. The total estimated population by the IBGE for 2021 is 1,302,858 inhabitants, spread over a total area of 109,083.881 km^2. Marabá is the most populous municipality in the intermediate region, with 287,664 inhabitants according to 2021 estimates from the IBGE.



Source: HUNTER (2020).

Figure 3: Map of the intermediate region of Marabá

The Intermediate Region of Marabá is the area that encompasses courses initiated in activities with the lowest Human Development Index (HDI) in the State of Pará and the Northern Region.

Table 13: Data from municipalities in the intermediate region of Marabá

Municipalities of the Marabá Intermediate Region	Active civil Engineers	IDH	Position IDH	Estimated Population 2021	Estimated Demographic Density
São João do Araguaia	2	0,55	5194	14105	11,02
São Geraldo do Araguaia	6	0,595	4255	24566	7,75
São Domingos do Araguaia	5	0,594	4284	25945	18,63
Rondon do Pará	9	0,604	4101	53242	6,45
Piçarra	1	0,563	4984	12976	3,91
Palestina do Pará	1	0,589	4416	7575	7,69
Nova Ipixuna	7	0,581	4614	17027	10,88
Marabá	411	0,668	2716	287.664	19,01
Jacundá	17	0,622	3653	60517	30,13
Itupiranga	11	0,528	5408	53439	6,78
Brejo Grande do Araguaia	1	0,591	4372	7357	5,70
Bom Jesus do Tocantins	4	0,589	4416	17254	6,12
Abel Figueiredo	2	0,622	3653	7536	12,27
Parauapebas	231	0,715	1454	218787	31,77
Eldorado do Carajás	11	0,56	5049	34069	11,52
Curionópolis	5	0,636	3378	17764	7,49
Canaã dos Carajás	37	0,673	2598	39103	12,42
Tucuruí	134	0,666	2759	116605	55,94

Pacajá	1	0,515	5481	49110	4,15
Novo Repartimento	9	0,537	5345	78488	5,09
Goianésia do Pará	7	0,56	5049	41678	5,93
Breu Branco	8	0,568	4884	68597	17,40
Baião	2	0,578	4670	49454	13,15
TOTAL	922	0,596	4238	1.302858	11,94

Source: IBGE, CONFEA, adapted by the author

The region hosts five active academic programs, with three being privately owned for-profit institutions and two being federally funded public universities. Notably, the federal public program offered by UNIFESSPA stands out, holding a course rating of 4 and an ENADE (National Student Performance Exam) rating of 5. Additionally, the for-profit private program at Pitágoras College, Parauapebas Campus (FPUP), deserves recognition for achieving a course rating of 4. The remaining programs all hold a course rating of 3 and include UFPA, Pitágoras College, Marabá Campus; Pitágoras University, Marabá Campus; and Pitágoras College, Marabá Campus.

Table 14: Number of courses in the intermediate region of Marabá

Intermediate Region	Courses	PF	PE	PM	PSFL	PCFL	UNI	CEU	FAC	INST
Marabá	5	2	0	0	0	3	3	1	2	0

Source: National Registry of Courses and Higher Education Institutions – e-MEC Registry.

The courses offered in the municipality of Marabá are as follows: UNIFESSPA with 60 authorized slots, Faculdade Pitágoras de Marabá with 80 authorized slots, and Centro Universitário Pitágoras de Marabá with 140 authorized slots. The UFPA course is offered in the municipality of Tucuruí with 48 authorized slots, and the FPUP course is offered in the municipality of Parauapebas with 50 authorized slots.

The state of Pará has 667 construction industry companies employing 31,249 people, according to data from the Brazilian Statistical Yearbook for the year 2019. The intermediate region has a population of 1,302,858 and comprises 922 active civil engineers registered with CONFEA.

In light of this information, the following data cross-referencing was conducted:

The first cross-reference for the intermediate region was conducted to determine the ratio between the population and the number of civil engineers. The result obtained was 1,302,858 / 922 = 1,413.07, indicating that there is one active civil engineer for every 1,413 people.

The second cross-reference for the intermediate region aimed to examine the ratio between the number of construction industry companies and the number of civil engineers. The result obtained was 667 / 378 = 2.13, signifying that there are 2 active civil engineers for each construction industry company.

The third cross-reference for the intermediate region sought to determine the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 31,249 / 992 = 31.5, indicating that there are approximately 32 people employed in construction industry companies per active civil engineer in the intermediate region.

The fourth cross-reference for the intermediate region aimed to examine the ratio between the number of civil engineers and the number of slots in on-site civil engineering courses. The result obtained was 992 / 378 = 2.62, demonstrating that the number of active civil engineers is approximately three times the number of slots in on-site civil engineering courses currently in progress.

The fifth cross-reference aimed to determine the ratio between the number of civil engineers and the number of courses. The result obtained was 992 / 5 = 198.4, meaning there are 198 active civil engineers for each on-site civil engineering course currently in progress.

The sixth cross-reference for the intermediate region aimed to determine the ratio between the number of people employed in construction industry companies and the number of slots in on-site civil engineering courses in the intermediate region. The result obtained was 31,249 / 378 = 82.67, indicating that there are approximately 83 people employed in construction industry companies for each slot in on-site civil engineering courses currently in progress in the intermediate region.

The seventh cross-reference for the intermediate region aimed to determine the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in progress. However, as the intermediate region has only one course, the result obtained was 31,249 / 5 = 6,249.8. This result indicates that there are approximately 6,250 people employed in construction industry companies for the single on-site civil engineering course currently in progress.

The eighth cross-reference aimed to determine the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 1,302,858 / 31,249 = 41.69, meaning there is approximately one person employed in construction industry companies for every 42 people in the intermediate region.

The ninth cross-reference for the state aimed to determine the average ratio between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 31,249 / 667 = 46.85, indicating an average of 47 people employed in each construction industry company.

The tenth cross-reference aimed to determine the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 1,302,858 / 667 = 1,953.31, signifying that there is approximately one construction industry company in the state to serve every 1,953 people in the intermediate region.

The eleventh cross-reference aimed to determine the ratio between the number of construction industry companies and the on-site civil engineering courses currently in progress. The result obtained was 667 / 5 = 133.4, indicating that there are 133 construction industry companies for each on-site civil engineering course currently in progress in the intermediate region.

The twelfth cross-reference aimed to determine the ratio between the population of the intermediate region and the number of slots in on-site civil engineering courses currently in progress. The result obtained was 1,302,858 / 378 = 3,446.71, meaning there is one slot for approximately every 3,446 people in the intermediate region.

The thirteenth cross-reference aimed to determine the ratio between the number of slots in on-site civil engineering courses currently in progress and the number of construction industry companies. The result obtained was 667 / 378 = 1.76, indicating that there are approximately 2 construction industry companies for each slot in on-site civil engineering courses currently in progress.

The fourteenth cross-reference aimed to determine the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in progress. The result obtained was 1,302,858 / 5 = 260,571.6, meaning there is one on-site civil engineering course currently in progress for every 260,571 inhabitants.

Table 15: Summary of crossings at the intermediate region level of Marabá

Crossings	Result
Population / active civil engineers	1413 inhabitants per engineer
Construction industry companies / active civil engineers	2 companies per engineer
People employed in construction industry companies / active civil engineers	32 people employed per engineer
Active civil engineers / course vacancies	3 engineers per course
Active civil engineers / number of courses	198 engineers per course
People employed in construction industry companies / course vacancies	83 people employed per course vacancy
People employed in construction industry companies / civil engineering courses	6250 people employed per course
Population / people employed in construction industry companies	42 inhabitants per employed person
People employed in construction industry companies / construction industry companies	Average of 47 people employed in each company
Population / construction industry companies	1953 inhabitants per company
Construction industry companies / civil engineering courses	133 companies per course
Population / number of vacancies	3446 inhabitants per course vacancy

Construction industry companies / number of vacancies in courses	2 companies per course vacancy
National population / civil engineering courses	260,571 inhabitants per course

Source: Developed by the author

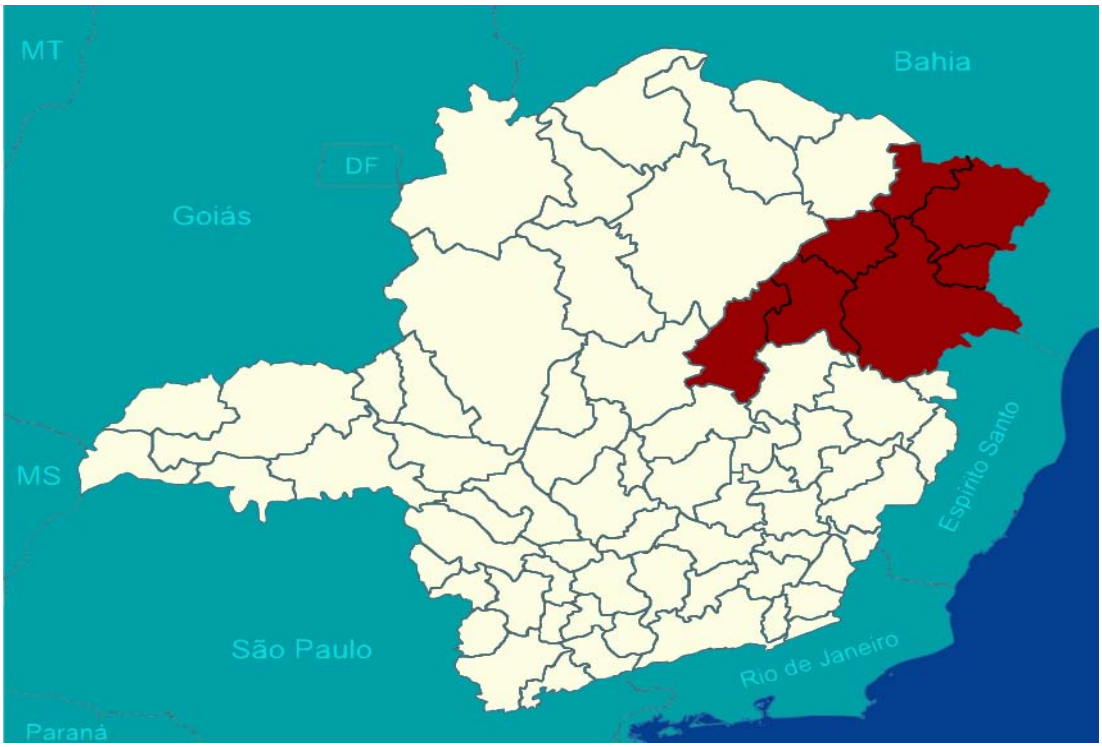
Marabá is an intermediate region with the provision of five on-site civil engineering courses by both private and public higher education institutions (HEIs). Consequently, it is evident that there is a higher demand for these courses in this region compared to others under analysis. Therefore, an examination by the HEI administrators in the region is warranted to assess the feasibility of maintaining these offerings to meet the local demand. The analysis reveals a competitive market for civil engineers, as evidenced by the intersection of construction industry companies with the number of active civil engineers, which is the lowest among the five regions. Similarly, the number of employed individuals in construction industry companies in relation to the number of active civil engineers is also the lowest, indicating a scarcity of companies and consequently, a limited workforce in the sector. This is further supported by the intersection of active civil engineers in relation to course vacancies, which is three times higher than the number of offered vacancies.

This intersection allows for the observation and reinforcement of the fact that despite having a higher number of trained civil engineers in the region compared to other analyzed regions, the average number of individuals working in companies is the highest among the five intermediate regions. This suggests that the local market is predominantly comprised of large and medium-sized companies in the sector.

This result is noteworthy, as the region with fewer construction sector companies yields the best ratio in terms of population and number of construction industry companies among the analyzed regions. For HEI administrators in the region, it is recommended to assess the continuation of these courses, as there is no evidence of a shortage of courses or engineers in the region, and there are few local construction sector companies.

Southeast: Intermediate region of Teófilo Otoni

The Geographical Intermediate Region of Teófilo Otoni is one of the thirteen intermediate regions in the Brazilian state of Minas Gerais and one of the 134 intermediate regions in Brazil, established by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It comprises 86 municipalities, distributed across seven immediate geographical regions. The total estimated population by the IBGE for 2021 is 1,225,731 inhabitants, spread over a total area of 77,935.048 km^2. Teófilo Otoni is the most populous municipality in the intermediate region, with 141,269 inhabitants, according to 2021 estimates from the IBGE.



Source: HUNTER (2020).

Figure 4: Map of the intermediate region of Teófilo Otoni

The Intermediate Region of Teófilo Otoni is the area characterized by educational programs initiated in activities within the lowest Human Development Index (HDI) in the State of Minas Gerais and the Southeast Region.

Table 16: Data of municipalities in the intermediate region of Teófilo Otoni

Municipal data from the Intermediate Region of Teófilo Otoni.	Active Civil engineers	IDH	Position IDH	Estimated population 2021	Population Density Estimated
Teófilo Otoni	471	0,701	1866	141269	43,57
Serra dos Aimorés	4	0,651	3090	8725	40,85
Setubinha	5	0,542	5293	12493	23,36
São José do Divino	6	0,658	2946	3851	11,71
Poté	13	0,624	3607	16675	26,67
Ponto dos Volantes	11	0,595	4255	12235	10,09
Pescador	7	0,656	2986	4261	13,42
Pavão	5	0,627	3534	8390	13,95
Padre Paraíso	34	0,596	4238	20346	37,37
Ouro Verde de Minas	6	0,595	4255	5895	33,59
Novo Oriente de Minas	15	0,555	5128	10800	14,30
Novo Cruzeiro	14	0,571	4827	31339	18,40
Nova Módica	4	0,63	3487	3548	9,43
Nanuque	53	0,701	1866	40583	26,73
Monte Formoso	4	0,541	5306	4939	12,81
Malacacheta	23	0,618	3735	18556	25,49
Frei Gaspar	5	0,59	4395	5858	9,34
Franciscópolis	3	0,603	4081	5287	7,37
Catuji	6	0,54	5325	6206	14,79
Carlos Chagas	25	0,648	3156	18516	5,78
Caraí	9	0,558	5081	23872	19,21
Campanário	4	0,616	3771	3739	8,45
Municipal data from the Intermediate Region of Teófilo Otoni.	**Active Civil engineers**	**IDH**	**Position IDH**	**Estimated population 2021**	**Population Density Estimated**
Ataléia	11	0,588	4444	12496	6,80
Ladainha	5	0,541	5306	18272	21,09
Itaobim	39	0,629	3501	20997	30,92
Itambacuri	28	0,634	3407	23207	16,35
Itaipé	20	0,552	5169	12910	26,84
Veredinha	4	0,632	3448	5733	9,07
Turmalina	10	0,736	876	20280	17,58
Minas Novas	26	0,633	3433	31509	17,38
Chapada do Norte	4	0,598	4198	15334	18,45
Capelinha	55	0,653	3055	38321	39,69
Aricanduva	1	0,582	4590	5305	21,80
Angelândia	1	0,597	4215	8594	46,40
Água Boa	20	0,576	4718	13319	10,08
Leme do Prado	8	0,67	2663	4923	17,57
Itamarandiba	21	0,646	3186	35130	12,84
Santo Antônio do Jacinto	5	0,574	4764	11570	22,96
Santa Maria do Salto	1	0,613	3847	5203	11,80
Salto da Divisa	4	0,608	3957	7014	7,47
Rubim	10	0,609	3927	10269	10,63
Rio do Prado	0	0,605	4029	5117	10,66
Palmópolis	3	0,565	4941	5196	11,99
Mata Verde	6	0,581	4614	8700	38,23
Felisburgo	2	0,583	4562	7548	12,65
Bandeira	4	0,599	4167	4738	9,79

Almenara	89	0,642	3254	42380	18,47
Jordânia	9	0,628	3519	10872	19,88
Joaíma	5	0,587	4467	15476	9,29
Jequitinhonha	24	0,615	3796	25555	7,27
Jacinto	6	0,62	3702	12320	8,84
Serro	13	0,656	2986	20915	17,17
Serra Azul de Minas	1	0,557	5098	4292	19,63
Senador Modestino Gonçalves	3	0,62	3702	4056	4,26
Santo Antônio do Itambé	2	0,558	5081	3763	12,30
Presidente Kubitschek	0	0,595	4255	3000	15,85
Gouveia	9	0,681	2412	11811	13,62
São Gonçalo do Rio Preto	0	0,64	3291	3178	10,10
Felício dos Santos	3	0,606	3999	4656	13,01
Diamantina	57	0,716	1427	47924	12,31
Datas	1	0,616	3771	5431	17,51
Couto de Magalhães de Minas	4	0,659	2924	4436	9,13
Carbonita	6	0,638	3333	9432	6,47
Alvorada de Minas	1	0,572	4802	3605	9,63
Virgem da Lapa	18	0,61	3902	13729	15,80
Francisco Badaró	2	0,622	3653	10311	22,34
Coronel Murta	6	0,627	3534	9209	11,29
Berilo	8	0,628	3519	11813	20,12
Araçuaí	63	0,663	2828	36715	16,41
José Gonçalves de Minas	2	0,632	3448	4474	11,73
Jenipapo de Minas	7	0,624	3607	7781	27,35
Itinga	14	0,6	4144	15053	9,12
Pedra Azul	16	0,627	3534	24333	15,25
Medina	20	0,624	3607	20701	14,41
Divisópolis	3	0,609	3927	11396	19,89
Municipal data from the Intermediate Region of Teófilo Otoni.	**Active Civil engineers**	**IDH**	**Position IDH**	**Estimated population 2021**	**Population Density Estimated**
Divisa Alegre	0	0,608	3957	6946	58,96
Comercinho	2	0,593	4309	6624	10,11
Cachoeira de Pajeú	5	0,578	4670	9470	13,61
Águas Vermelhas	9	0,601	4123	13656	10,86
Umburatiba	1	0,638	3333	2582	6,36
Santa Helena de Minas	5	0,567	4903	6406	23,17
Fronteira dos Vales	2	0,592	4331	4542	14,16
Crisólita	4	0,585	4515	6814	7,05
Bertópolis	1	0,594	4284	4609	10,77
Águas Formosas	21	0,645	3201	19285	23,51
Machacalis	9	0,64	3291	7112	21,39
TOTAL	1466	0,613	3847	1.225.731	15,72

Source: IBGE, CONFEA, adapted by the author.

The region has five active courses, comprising one federal public course, two private non-profit courses, and two private for-profit courses. The UFVJM course holds a course concept rating of 3 and an ENADE (National Student Performance Exam) rating of 4. The course at Faculdade Presidente Antônio Carlos de Teófilo Antoni has a course concept rating of 5 and an ENADE rating of 2. The courses at UNEC, UNIDOCTUM, and Faculdade ALFAUNIPAC in Almenara all have a course concept rating of 3.

Table 17: Number of courses in the intermediate region of Teófilo Otoni

Intermediate Region	Courses	PF	PE	PM	PSFL	PCFL	UNI	CEU	FAC	INST
Teófilo Otoni	5	1	0	0	2	2	1	2	2	0

Source: National Registry of Courses and Higher Education Institutions - e-MEC Registry.

The courses are offered in the municipalities of Diamantina, Teófilo Otoni, Nanuque, Teófilo Otoni, and Almenara, respectively: UFVJM has 80 authorized vacancies; President Antônio Carlos College of Teófilo Otoni has 120 authorized vacancies; UNEC has 120 authorized vacancies; UNIDOCTUM has 80 authorized vacancies, and ALFAUNIPAC College of Almenara has 100 authorized vacancies.

The State of Minas Gerais has 6,835 construction industry companies employing 262,482 people, according to data from the Brazilian Statistical Yearbook for the year 2019. The intermediate region has a population of 1,225,731 and 1,466 active civil engineers registered with CONFEA.

In Light of this Information, the Following Data Cross-Referencing was Conducted:

The first cross-referencing in the intermediate region aimed to determine the ratio between the population and the number of civil engineers. The result obtained was 1,225,731 / 1,466 = 836.1, meaning there is 1 active civil engineer for every 836 people.

The second cross-referencing aimed to verify the ratio between the number of construction industry companies in the state and the number of civil engineers. The result obtained was 6,835 / 1,466 = 4.66, meaning there are approximately 5 active civil engineers in the intermediate region for each construction industry company in the state.

The third cross-referencing aimed to verify the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 262,482 / 1,466 = 179.05, meaning there are approximately 179 people employed in construction industry companies in the state for each active civil engineer in the intermediate region.

The fourth cross-referencing in the intermediate region aimed to verify the ratio between the number of engineers and the number of vacancies in on-site civil engineering courses. The result obtained was 1,466 / 500 = 2.93, indicating that the number of active civil engineers is approximately three times the number of vacancies in on-site civil engineering courses currently underway.

The fifth cross-referencing aimed to verify the ratio between the number of engineers and the number of courses. The result obtained was 1,466 / 5 = 293.2, meaning there are 293 active civil engineers for each on-site civil engineering course currently underway.

The sixth cross-referencing in the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies and the number of vacancies in on-site civil engineering courses in the intermediate region. The result obtained was 262,482 / 500 = 524.96, indicating that there are approximately 525 people employed in construction industry companies in the state for each vacancy in on-site civil engineering courses currently underway in the intermediate region.

The seventh cross-referencing in the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently underway. The result obtained was 262,482 / 5 = 52,496.4. This result indicates that there are 52,496 people employed in construction industry companies for the only on-site civil engineering course currently underway in the intermediate region.

The eighth cross-referencing aimed to verify the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 1,225,731 / 262,482 = 4.67, meaning there is approximately 1 person employed in construction industry companies for every 5 people.

The ninth cross-referencing in the state aimed to verify the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 262,482 / 6,835 = 38.4, meaning there are, on average, 38 people employed in each construction industry company.

The tenth cross-referencing aimed to verify the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 1,225,731 / 6,835 = 179.33, meaning there is approximately 1 construction industry company in the state to serve 179 people in the intermediate region.

The eleventh cross-referencing aimed to verify the ratio between the number of construction industry companies and the on-site civil engineering courses currently underway. The result obtained was 6,835 / 5 = 1,367, indicating that there are 1,367 construction industry companies for each on-site civil engineering course currently underway in the intermediate region.

The twelfth cross-referencing aimed to verify the ratio between the population of the intermediate region and the number of vacancies in on-site civil engineering courses currently underway. The result obtained was 1,225,731 / 500 = 2,451.46, meaning there is 1 vacancy for approximately every 2,451 people in the intermediate region.

The thirteenth cross-referencing aimed to verify the ratio between the number of vacancies in on-site civil engineering courses currently underway and the number of construction industry companies. The result obtained was 6,835 / 500 = 13.67, indicating that there are approximately 14 construction industry companies for each vacancy in on-site civil engineering courses currently underway.

The fourteenth cross-referencing aimed to verify the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently underway. The result obtained was 1,225,731 / 5 = 245,146.2, meaning there is 1 on-site civil engineering course currently underway for every 245,146 inhabitants in the intermediate region.

Table 18: Summary of crossings at the intermediate region level of Teófilo Otoni

Crossings	Result
Population / active civil engineers	836 inhabitants per engineer
Construction industry companies / active civil engineers /	5 companies per engineer
People employed in construction industry companies / active civil engineers	179 individuals employed per engineer
Active civil engineers / course vacancies	3 engineers per course
Active civil engineers / number of courses	293 engineers per course
People employed in construction industry companies / course vacancies	525 individuals employed per course
People employed in construction industry companies / civil engineering courses	52496 individuals employed per course
Population / people employed in construction industry companies	5 inhabitants per employed individual
People employed in construction industry companies / construction industry companies	Average of 38 individuals employed in each company
Population / construction industry companies	179 inhabitants per company
Construction industry companies / civil engineering courses	1367 companies per course
Population / number of vacancies	2451 inhabitants per course vacancy
Construction industry companies / number of course vacancies	14 companies per course vacancy
National population / civil engineering courses	245,146 inhabitants per course

Source: Developed by the author

Teófilo Otoni is an intermediate region with the provision of five on-site civil engineering courses by private and public higher education institutions (IES). Thus, it is evident that there are five courses available to meet local demand. However, an analysis by IES administrators is necessary to assess the feasibility of new offerings and the viability of maintaining or expanding the current number of available slots. This analysis should consider the competitive market for civil engineers, as reflected in the ratio of the population to the number of active civil engineers, which proved to be the lowest among the five regions.

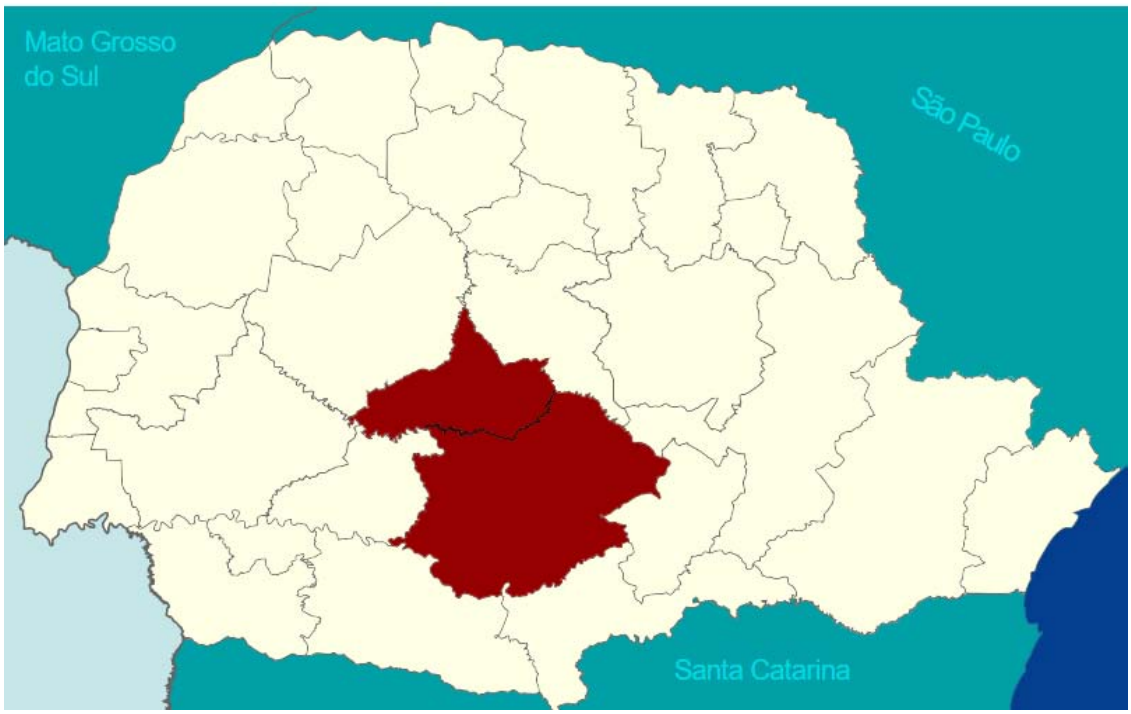
On the other hand, the region has shown itself to be a highly attractive market for new on-site civil engineering courses, boasting the best result in the ratio between employed individuals in construction industry companies and the number of civil engineering courses. This is also evident in the ratio between employed individuals in construction industry companies and the number of available slots in these courses. The results indicate the need for a thorough study by IES administrators to evaluate the feasibility of new offerings and the maintenance or expansion of current offerings to cater to the intermediate region.

South: Intermediate region of Guarapuava

The Intermediate Geographic Region of Guarapuava is one of the six intermediate regions in the Brazilian state of Paraná and one of the 134 intermediate regions in Brazil, established by the Brazilian Institute of Geography and Statistics (IBGE) in 2017. It comprises 19 municipalities, distributed across two immediate geographic regions.

The total estimated population of this region, according to the Brazilian Institute of Geography and Statistics (IBGE) for 2021, is 427,222 inhabitants, spread over a total area of 19,291.794 km^2. Guarapuava is the

most populous municipality in the intermediate region, with 183,755 inhabitants, according to 2021 estimates from the Brazilian Institute of Geography and Statistics (IBGE).



Source: HUNTER (2020).

Figure 5: Map of the intermediate region of Guarapuava

The Intermediate Region of Guarapuava is the area that hosts educational programs initiated in regions with the lowest Human Development Index (HDI) in the State of Paraná and the Southern Region.

Table 19: Data from municipalities in the intermediate region of Guarapuava.

Municipalities of the Guarapuava Intermediate Region	Active Civil Engineers	IDH	Position IDH	Estimated Population 2021	Population Density Estimated
Turvo	6	0,672	2621	12977	13,82
Reserva do Iguaçu	5	0,648	3156	8127	9,74
Prudentópolis	46	0,676	2524	52776	23,48
Pinhão	21	0,654	3030	32722	16,34
Inácio Martins	4	0,6	4144	11117	11,87
Guarapuava	280	0,731	993	183755	58,00
Guamiranga	3	0,669	2691	8881	36,27
Goioxim	1	0,641	3275	6997	9,96
Foz do Jordão	6	0,645	3201	4466	18,97
Cantagalo	11	0,635	3393	13340	22,86
Candói	11	0,635	3393	16126	10,65
Campina do Simão	0	0,63	3487	3831	8,54
Nova Tebas	2	0,651	3090	5252	9,62
Mato Rico	0	0,632	3448	3142	7,96
Santa Maria do Oeste	3	0,609	3927	9210	11,00
Pitanga	33	0,702	1842	29686	17,84
Palmital	27	0,639	3312	12755	15,59
Laranjal	2	0,585	4515	5719	10,22
Boa Ventura de São Roque	6	0,655	3008	6343	10,22
TOTAL	467	0,648	3156	427.222	2,21

Source: IBGE, CONFEA, adapted by the author.

The region hosts three active academic programs, comprising one federal public course and two private for-profit courses. The academic program at UTFPR holds a course rating of 4 and an ENADE (National Student Performance Exam) rating of 5. The academic program at Centro Universitário Campo Real holds a course rating of 4, while the program at FG has a course rating of 3.

Table 20: Number of courses in the Intermediate region of Guarapuava

Intermediate Region	Courses	PF	PE	PM	PSFL	PCFL	UNI	CEU	FAC	INST
Guarapuava	3	1	0	0	0	2	1	1	1	0

Source: National Registry of Courses and Higher Education Institutions - e-MEC Registry.

The courses are offered in the municipality of Guarapuava: UTFPR has 88 authorized vacancies; Centro Universitário Campo Real has 80 authorized vacancies; FG has 120 authorized vacancies.

The State of Paraná has 4,890 construction industry companies employing 111,282 people, according to data from the Brazilian Statistical Yearbook for the year 2019. The intermediate region has 427,222 inhabitants and 467 active civil engineers according to CONFEA.

In light of this information, the following data cross-references were conducted:

The first cross-reference in the intermediate region was performed to determine the ratio between the population and the number of civil engineers. The result obtained was 427,222 / 467 = 914.82, meaning there is 1 active civil engineer for approximately every 915 people.

The second cross-reference was conducted to verify the ratio between the number of construction industry companies in the state and the number of civil engineers. The result obtained was 4,890 / 467 = 10.47, indicating there are 10 active civil engineers in the intermediate region for each construction industry company in the state.

The third cross-reference was conducted to verify the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The result obtained was 111,282 / 467 = 238.29, meaning there are approximately 238 people employed in construction industry companies for each active civil engineer in the intermediate region.

The fourth cross-reference in the intermediate region was conducted to verify the ratio between the number of engineers and the number of vacancies in on-site civil engineering courses. The result obtained was 467 / 288 = 1.62, demonstrating that the number of active civil engineers is approximately twice the number of vacancies in on-site civil engineering courses currently in progress.

The fifth cross-reference aimed to verify the ratio between the number of engineers and the number of courses. The result obtained was 467 / 3 = 155.66, meaning there are approximately 156 active civil engineers for each on-site civil engineering course currently in progress.

The sixth cross-reference in the intermediate region was conducted to verify the ratio between the number of people employed in construction industry companies and the number of vacancies in on-site civil engineering courses in the intermediate region. The result obtained was 111,282 / 288 = 386.39, indicating that there are 386 people employed in construction industry companies in the state for each vacancy in on-site civil engineering courses currently in progress in the intermediate region.

The seventh cross-reference in the intermediate region aimed to verify the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses currently in progress. The result obtained was 111,282 / 3 = 37,094, demonstrating that there are 37,094 people employed in construction industry companies for the single on-site civil engineering course currently in progress.

The eighth cross-reference was conducted to verify the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. The result obtained was 427,222 / 111,282 = 3.84, meaning there is approximately 1 person employed in construction industry companies for every 4 people in the intermediate region.

The ninth cross-reference in the state aimed to verify the average between the number of people employed in construction industry companies and the number of construction industry companies. The result obtained was 111,282 / 4,890 = 22.75, indicating an average of 23 people employed in each construction industry company.

The tenth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of construction industry companies. The result obtained was 427,222 / 4,890 = 87.37, meaning there is approximately 1 construction industry company in the state to serve 87 people in the intermediate region.

The eleventh cross-reference aimed to verify the ratio between the number of construction industry companies and the on-site civil engineering courses currently in progress. The result obtained was 4,890 / 3 = 1630, indicating approximately 1630 construction

industry companies for each on-site civil engineering course currently in progress in the intermediate region.

The twelfth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of vacancies in on-site civil engineering courses currently in progress. The result obtained was 427,222 / 288 = 1483.41, meaning there is 1 vacancy for approximately every 1483 people in the intermediate region.

The thirteenth cross-reference aimed to verify the ratio between the number of vacancies in on-site civil engineering courses currently in progress and the number of construction industry companies. The result obtained was 4,890 / 288 = 16.97, indicating 17 construction industry companies for each vacancy in on-site civil engineering courses currently in progress.

The fourteenth cross-reference aimed to verify the ratio between the population of the intermediate region and the number of on-site civil engineering courses currently in progress. The result obtained was 427,222 / 3 = 142,407.33, meaning there is 1 on-site civil engineering course currently in progress for every 142,407 inhabitants.

Table 21: Summary of crossings at the intermediate region of Guarapuava

Crossings	Result
Population / active civil engineers	915 inhabitants per engineer
Construction industry companies / active civil engineers	10 companies per engineer
People employed in construction industry companies / active civil engineers	238 people employed per engineer
Active civil engineers / course vacancies	2 engineers per course vacancy
Active civil engineers / number of courses	156 engineers per course
People employed in construction industry companies / course vacancies	386 people employed per course vacancy
People employed in construction industry companies / civil engineering courses	37,094 people employed per course
Population / people employed in construction industry companies	4 inhabitants per employed person
People employed in construction industry companies / construction industry companies	Average of 23 people employed per company
Population / construction industry companies	87 inhabitants per company
Construction industry companies / civil engineering courses	1,630 companies per course
Population / number of vacancies	1,483 inhabitants per course vacancy
Construction industry companies / number of course vacancies	17 companies per course vacancy
Population / civil engineering courses	142,407 inhabitants per course

Source: Developed by the author

Guarapuava is an intermediate region that offers a face-to-face civil engineering course by both private and public Higher Education Institutions (HEIs). In other words, it can be observed that there is a supply of civil engineering course to meet the demand in the region. However, it is incumbent upon the HEI administrators to analyze to determine the feasibility of maintaining these offerings to serve the region. This is particularly important given the competitive market for civil engineers due to the smaller population of the region. Despite this, the ratio of construction industry companies to the number of active civil engineers is the most favorable among the five regions analyzed. Similarly, the number of individuals employed in construction industry companies compared to the number of active civil engineers is also optimal, indicating that the region provides diverse opportunities compared to the other regions.

Nevertheless, the proportion of the population in the intermediate region relative to the number of people employed in construction industry companies is the lowest among the five regions, as previously mentioned. Additionally, the average number of people employed in construction industry companies relative to the number of construction industry companies is the lowest among the five regions analyzed. This can be explained by the high number of companies, which is reflected in the population-to-construction-industry-companies ratio, the lowest among the five intermediate regions.

Due to the region having the smallest population in relation to the number of courses, it may seem that there is no room for new civil engineering courses in the area. However, upon examining the proportions between the number of construction industry companies and face-to-face civil engineering courses, the region's population compared to the number of available slots, and the number of construction industry companies relative to the number of slots in the courses, it is evident that the intermediate region of Guarapuava exhibits the best results among the five intermediate regions analyzed. This indeed allows HEI administrators to conduct a demand study and assess the feasibility of offering new courses or increasing the slots for existing face-to-face civil engineering courses in the intermediate region.

To facilitate a visual understanding of the proportions among the five regions analyzed in this thesis, the summary table of the five intermediate regions is presented below.

Table 22: Summary of crossings of the 5 intermediate regions

Crossings	Corumbá	Paulo Afonso	Marabá	Teófilo Otoni	Guarapuava
Population / Active Civil Engineers	3601	2419	1413	836	915
Construction Industry Companies / Active Civil Engineers	6	6	2	5	10
People Employed in Construction Industry Companies / Active Civil Engineers	159	235	32	179	238
Active Civil Engineers / Course Vacancies	2	1	3	3	2
Active Civil Engineers / Number of Courses	102	170	198	293	156
People Employed in Construction Industry Companies / Course Vacancies	404	265	83	525	386
People Employed in Construction Industry Companies / Civil Engineering Courses	16172	39759	6250	52496	37094
Population / People Employed in Construction Industry Companies	23	10	42	5	4
People Employed in Construction Industry Companies / Construction Industry Companies	26	40	47	38	23
Population / Construction Industry Companies	592	408	1953	179	87

Crossings	Corumbá	Paulo Afonso	Marabá	Teófilo Otoni	Guarapuava
Construction Industry Companies / Civil Engineering Courses	620	1005	133	1367	1630
Population / Number of Vacancies	9183	2734	3446	2451	1483
Construction Industry Companies / Course Vacancies	16	7	2	14	17
Population / Civil Engineering Courses	367,327	410,108	260,571	245,146	142,407

Source: Compiled by the author

In light of this information, it is evident that intermediate regions exhibit distinct characteristics, and some particularities were observed, highlighted in each of the following data intersections:

The first data intersection conducted aims to determine the ratio between the population and the number of active civil engineers. The results are as follows: Corumbá has the highest population compared to the number of active civil engineers, while Teófilo Otoni has the lowest ratio.

The second intersection is conducted to assess the ratio between the number of construction industry companies in the state and the number of civil engineers. The findings indicate that Guarapuava has the highest number of construction industry companies compared to the number of active civil engineers, whereas Marabá exhibits the lowest ratio.

The third intersection examines the ratio between the number of people employed in construction industry companies and the number of active civil engineers. The results show that Guarapuava has the highest number of people employed in construction industry companies compared to the number of active civil engineers, while Marabá presents the lowest ratio.

The fourth intersection of the intermediate region evaluates the ratio between the number of engineers and the number of vacancies in on-site civil engineering courses. The outcomes reveal that Marabá and Teófilo Otoni are the regions with the highest number of active civil engineers compared to the number of vacancies in on-site civil engineering courses, with Paulo Afonso having the lowest ratio.

The fifth proposed intersection assesses the ratio between the number of engineers and the number of courses. Teófilo Otoni is identified as the region with the highest number of active civil engineers compared to the number of on-site civil engineering courses, while Corumbá exhibits the lowest ratio.

The sixth intersection of the intermediate region aims to determine the ratio between the number of people employed in construction industry companies and the number of vacancies in the on-site civil engineering course of the intermediate region. Teófilo Otoni is found to be the region with the highest number of people employed in construction industry companies compared to the number of vacancies in on-site civil engineering courses, and Marabá presents the lowest ratio.

The seventh intersection of the intermediate region assesses the ratio between the number of people employed in construction industry companies in the state and the number of on-site civil engineering courses initiated in activity. The results indicate that Teófilo Otoni has the highest number of people employed in construction industry companies compared to the number of on-site civil engineering courses, while Marabá presents the lowest ratio.

The eighth intersection evaluates the ratio between the population of the intermediate region and the number of people employed in construction industry companies in the state. Marabá is identified as the region with the highest population in the intermediate region compared to the number of people employed in construction industry companies, while Guarapuava has the lowest ratio.

The ninth intersection assesses the average between the number of people employed in construction industry companies and the number of construction industry companies. Marabá is recognized as the region with the highest average between the number of people employed in construction industry companies and the number of construction industry companies, with Guarapuava presenting the lowest average.

The tenth intersection is conducted to evaluate the ratio between the population of the intermediate region and the number of construction industry companies. The results indicate that Marabá has the highest population compared to the number of construction industry companies, while Guarapuava has the lowest ratio.

The eleventh intersection assesses the ratio between the number of construction industry companies and the on-site civil engineering courses initiated in activity. Guarapuava is identified as the region with the highest number of construction industry companies compared to the on-site civil engineering courses initiated in activity, while Marabá presents the lowest ratio.

The twelfth intersection examines the ratio between the population of the intermediate region and the number of vacancies in on-site civil engineering courses initiated in activity. The findings reveal that Corumbá has the highest population compared to the number of vacancies in on-site civil engineering courses initiated in activity, with Guarapuava having the lowest ratio.

The thirteenth cross-examination was conducted to examine the ratio between the number of openings in active civil engineering courses and the number of companies in the construction industry. The following result was obtained: Guarapuava is the region with the highest number of openings in active civil engineering courses compared to the number of construction industry companies, and Marabá exhibited the lowest ratio.

The fourteenth cross-examination aimed to verify the ratio between the population of the intermediate region and the number of active civil engineering courses. The following result was obtained: Paulo Afonso is the region with the highest population compared to the number of active civil engineering courses, while Guarapuava presented the lowest ratio.

As clarified by Boswell, Stiller, and Straubhaar (2004), the lack of specific workers may occur due to "incompatibility" or mismatch in the labor market, leading to shortages in a particular region, occupation, or field of activity. There are four types of mismatch: qualitative, regional, preference-related, and information-related.

In the case of qualitative mismatch, even if there are enough workers, they may lack the required level of qualification or skills demanded by the market, either due to a lack of experience or inadequate training. Regional considerations are relevant, as shortages may occur in aggregate terms if there is a balance between supply and demand, and workers are unwilling to relocate to distant cities or regions where job opportunities exist. Preferences can also lead to mismatches, as not all job seekers may fit the characteristics required for a particular occupation, even if there are job openings. Finally, there are deficits related to information, which tend to be resolved when job openings and workers "meet" through traditional market mechanisms (Boswell, Stiller, Straubhaar, 2004).

Based on the results presented in this study, according to Boswell, Stiller, and Straubhaar (2004), it is crucial to recognize that a shortage of workers may coexist with unemployment. In other words, job openings may go unfilled due to a lack of specific skills, or unemployed workers may be unwilling to take up certain activities or relocate to other regions. Similarly, when there is demand for job openings, employers may not be willing or able to offer higher salaries or create conditions that encourage changes in occupation or location. All these factors need to be considered in the analysis to support decision-making by higher education institution managers.

According to Franco and Longhi (2021), management must act as a driving force and protagonist in the conservation, construction, and use of knowledge for the development of Higher Education from the perspectives of socio-environmental sustainability, creative and responsible innovation, and social justice. This requires unfolding into three systematizing axes: 1) institutional conceptions and guidelines in Higher Education management; 2) organization and institutional decision-making processes in Higher Education management; and 3) academic associative movements and Higher Education management.

In light of the above, we now proceed to present the intermediate regions that do not have in-person civil engineering courses currently in operation.

Brazilian intermediate regions without in-person civil engineering courses initiated in activity. The Northeast and North regions of Brazil are the ones facing signs of scarcity in on-site civil engineering courses that have commenced activities.

In the Northeast, five intermediary regions do not have the course available:

- In Maranhão, the intermediate region of Presidente Dutra lacks an initiated in-person civil engineering course. This intermediate region comprises 28 municipalities and three immediate regions: Presidente Dutra, São João dos Patos, and Colinas.
- In the state of Piauí, the intermediate regions of Picos, São Raimundo Nonato, and Corrente – Bom Jesus currently lack any onsite Civil Engineering courses that have been initiated and are in operation. The intermediate region of Picos comprises 58 municipalities and 04 immediate regions: Picos, Paulistana, Oeiras, and Simplício Mendes. The intermediate region of São Raimundo Nonato encompasses 21 municipalities and 02 immediate regions: São Raimundo Nonato and São João do Piauí. Similarly, the intermediate region of Corrente – Bom Jesus includes 22 municipalities and 02 immediate regions: Corrente and Bom Jesus.
- In the state of Rio Grande do Norte, the intermediate region of Caicó lacks the provision of a face-to-face Civil Engineering course that has commenced activities. The intermediate region of Caicó encompasses 24 municipalities and 02 immediate

regions: Caicó and Currais Novos. "In total, there are 13 immediate regions and 153 municipalities in the northeastern region of Brazil that do not have the provision of in-person Civil Engineering courses in progress.

In the northern region, 6 intermediate regions do not offer the course:

- In the Acre state, the intermediate region of Cruzeiro do Sul lacks a face-to-face civil engineering course that has commenced activities. The intermediate region of Cruzeiro do Sul comprises 8 municipalities and 2 immediate regions: Cruzeiro do Sul and Tarauacá.
- In Amapá, the intermediate Oiapoque-Porto Grande region lacks a locally initiated in-person civil engineering course. The intermediate Oiapoque-Porto Grande region comprises 10 municipalities and 02 immediate regions: Oiapoque and Porto Grande.
- In the state of Amazonas, the intermediate regions of Tefé, Lábrea, and Parintins lack on-site civil engineering courses that have been initiated and are currently active. The intermediate region of Tefé encompasses 21 municipalities, distributed across 3 immediate regions: Tefé, Tabatinga, and Eirunepé. The intermediate region of Lábrea consists of 9 municipalities and 2 immediate regions: Lábrea and Manicoré. Similarly, the intermediate region of Parintins includes 11 municipalities and 2 immediate regions: Parintins and Itacoatiara.
- In Roraima, the intermediate region of Rorainópolis-Caracaraí lacks a locally initiated in-person civil engineering course. The intermediate region of Rorainópolis-Caracaraí comprises 6 municipalities and 2 immediate regions: Rorainópolis and Caracaraí.

In total, there are 13 immediate regions and 65 municipalities in the Brazilian northern region that lack the provision of on-site Civil Engineering courses currently in progress. In contrast to the situations in the Northeast and North regions, such a phenomenon does not occur in the Central-West, Southeast, and South regions, as all intermediate regions within these areas have at least one on-site Civil Engineering course currently in progress.

This overview of the Civil Engineering course highlights regional disparities. In light of this context, it falls upon higher education administrators to guide decision-making processes, taking into consideration the region under analysis. They must weigh the hierarchical structure of course offerings, as well as instruments and devices within the various academic architectures of the respective Higher Education Institutions (HEIs). Deliberation on programs, teaching, research, extension, and management is necessary for planning, organizing, directing, making decisions, and evaluating, all while serving the academic community in the surrounding area (FRANCO; LONGHI, 2021).

Following this presentation of quantitative results regarding the panorama of Higher Education in on-site Civil Engineering courses, the focus now shifts to the development of the PanoramaEdu application. With this website, the expectation is to enhance transparency and facilitate access to information, enabling users to construct scenarios for higher education.

For Higher Education, the production of a website with organized information and mapping that illustrates the survey of various indicators related to the spaces and individuals in an intermediate region can underpin significant actions in constructing a project involving educational opportunities in the territory.

Thus, the mapping carried out in this thesis can serve as a technological tool demonstrating the Panorama of Higher Education regarding the course and can be utilized by HEI administrators, schools, public authorities, or social movements to record opportunities in a specific intermediate region or municipality. In addition to its positive aspects, this mapping has revealed local problems by presenting data from the intermediate region. In light of these considerations, the development of PanoramaEdu is presented.

c) Development of PanoramaEdu

For the development of PanoramaEdu, an academic partnership was established among Ana Beatriz Sales Ramos, Gabriel Sebastiano de Maria, and Dr. Adriana Soares Pereira, who are respectively a student, a student, and a professor in the Bachelor's degree program in Information Systems at the Department of Information Technology (DTecInf) of the Federal University of Santa Maria (UFSM) – Frederico Westphalen Campus, in collaboration with the author of this Thesis.

The following sections outline the phases of PanoramaEdu's development, describing the planning of the Panorama App prototype. Subsequently, the evolution of the PanoramaEdu website is presented, along with the envisioned changes and implementations made from the initial prototype version, which started as an app and transitioned into a responsive website.

d) PanoramaEdu App Prototype

The PanoramaEdu App prototype was developed by student Ana Beatriz Sales Ramos under the guidance of Dr. Adriana Soares Pereira as part of her Bachelor's thesis project in Information Systems at DTecInf, UFSM's Frederico Westphalen Campus. The planned prototype is detailed below.

To substantiate decisions regarding the prototype's design, a search was conducted to identify suitable technologies for app development. Following the acquisition of project requirements at the outset of

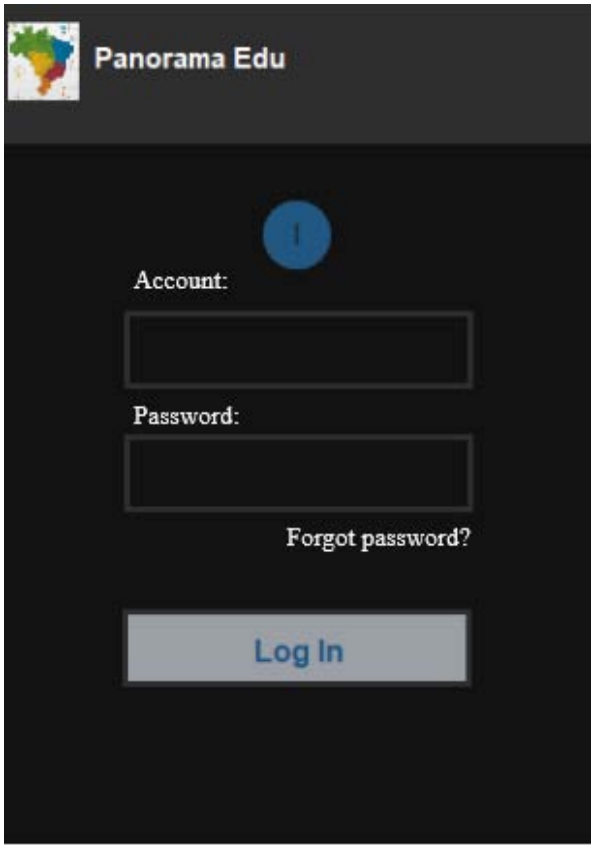
development, the developer conducted a study to determine the technology that best aligns with the project (COSTA, 2017).

Express is a rapid, flexible, and minimalist web framework for Node.js, a browserless environment for executing JavaScript. It provides a robust set of features for web and mobile applications, along with utility methods for HTTP and middleware. JSON, or JavaScript Object Notation, is a subset of the JavaScript programming language. Given that all data in this format aims to fulfill a pre-ordered set of commands resulting in a program, JSON is defined as a textual representation of structured data in a collection of key/value pairs (FREITAS; BIRNFELD; SARAIVA, 2021).

jQuery, an open-source JavaScript toolkit, is employed for creating dynamic web applications. It is cross-browser, functioning uniformly across platforms and browsers, supports asynchronous server communication (AJAX) more straightforwardly than JavaScript, employs CSS-based element selectors, supports animations and effects, and offers various widgets and themes (MATOS; ZABOT, 2020).

React Native allows the creation of "HTML5 apps" or "hybrid apps" for Android and iOS development. The framework combines Objective-C, Java, or Swift, and an example of its application is Discord. React Native exposes JavaScript interfaces to platform APIs, enabling applications to access resources such as the user's camera and location (ESCUDELARIO; PINHO, 2021).

Decisions regarding the PanoramaEdu app prototype initially embraced the Model-View-Controller (MVC) architecture. This pattern defines the software division into three interconnected layers, each serving a specific purpose. In this model, data is passed between layers through predefined interfaces, ensuring information isolation and security, given that in applications, most information resides on the device itself. Figure 6 presents the proposed initial screen of the application.



Source: Prepared by the PanoramaEdu team

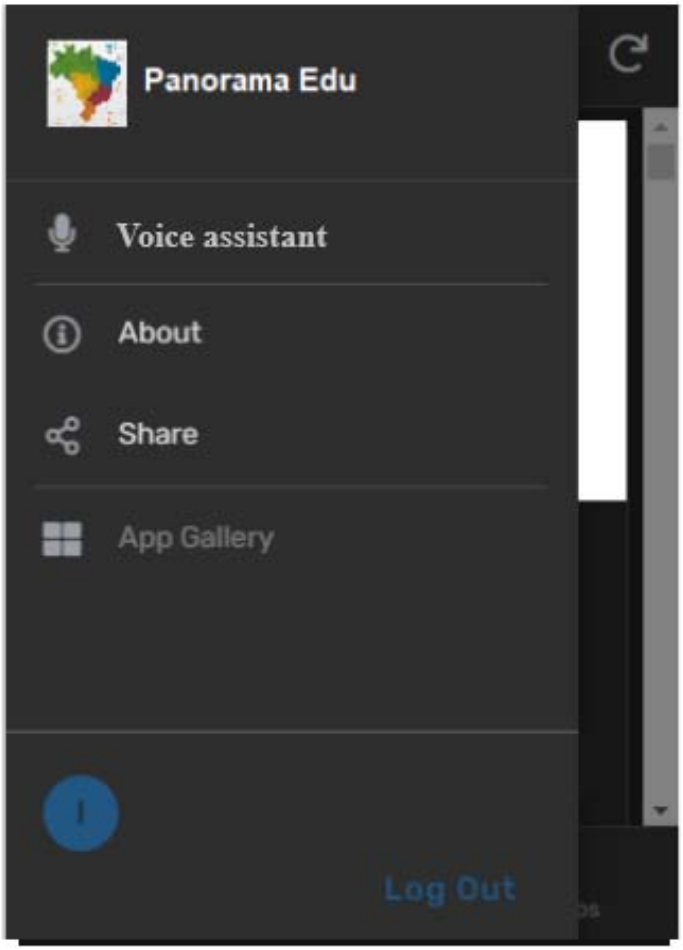
Figure 6: Prototype - Panorama Edu Login Screen

Following the proposed model, here is the prototype of each screen and its functionalities in the PanoramaEdu application:

- PanoramaEdu Menu Screen: This screen holds paramount significance within the application, as it serves as the primary navigation hub for the majority of the application's features.
- PanoramaEdu Registered Courses Screen: On this screen, a list of registered courses will be displayed, presenting information and images of the respective educational institutions.
- PanoramaEdu Course Map Screen: This screen features a map of Brazil, divided into intermediate regions, with the displayed

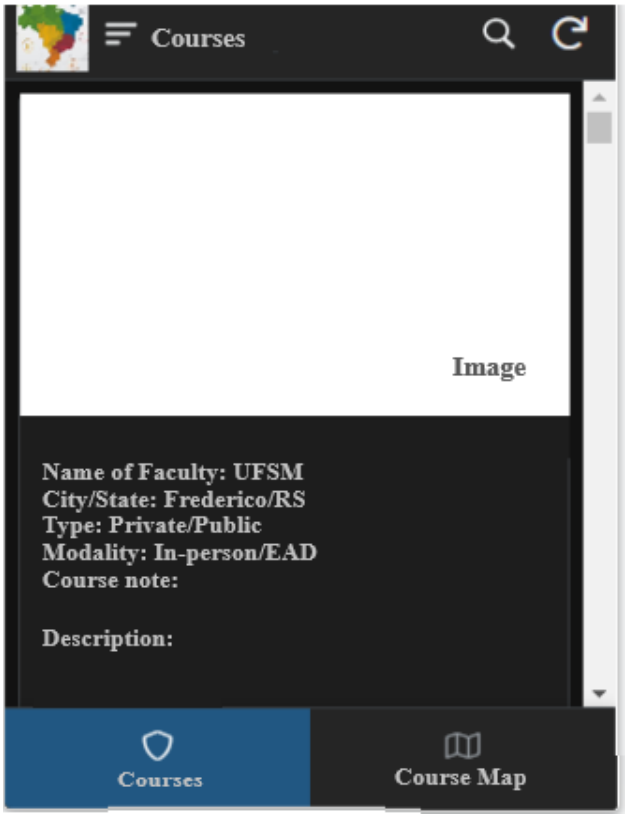
courses indicated on the map as illustrated in Figure 7.

- PanoramaEdu Logout Screen: When the user wishes to close the application, a prompt will inquire whether they indeed want to exit and log out of the application.



Source: Prepared by the PanoramaEdu team

Figure 7: Prototype - PanoramaEdu Menu Screen



Source: Prepared by the PanoramaEdu team

Figure 8: Prototype - PanoramaEdu Registered Courses Screen

Source: Prepared by the PanoramaEdu team

Figure 9: Prototype - PanoramaEdu Course Map Screen

After the approval of the prototype project for the PanoramaEdu App, there were few advances in its development. Due to personal reasons, the academic Ana Beatriz Sales Ramos chose not to participate in the team, leading to the need to find another person to develop the virtual environment. In this context, the academic Gabriel Sebastiano de Maria joined the team and took on the responsibility of developing the website. The process of how the development occurred is described below.

e) Development of the PanoramaEdu Website

The definitions of the PanoramaEdu application prototype were modified during the website development process. The main change was in the interface, which followed the architecture of responsive web design to allow web pages to respond to any device without loss of information for the user.

The content of a responsive website adapts to the space allocated to it, adjusting the visualization and navigability without losing information, regardless of the device, screen resolution, size, touch or mouse interface, whether it is mobile or not.

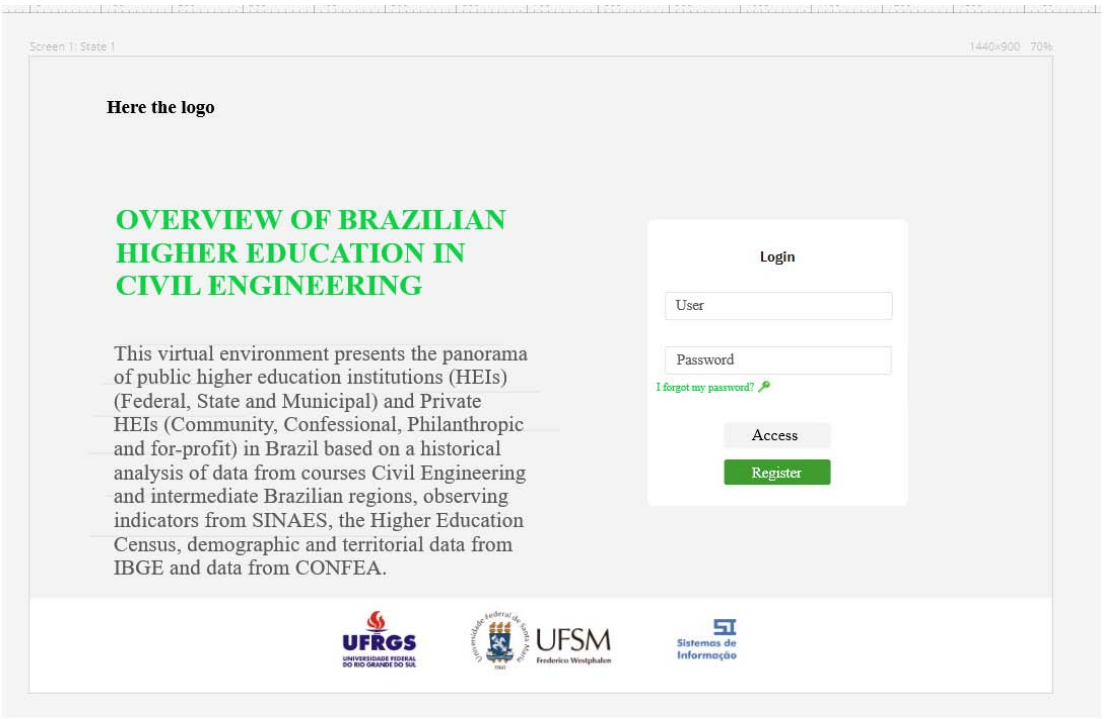
It is not the physical size of the screen or device that matters in responsive design, but its resolution. Responsive web design involves a series of techniques and technologies combined to make a single application work on a variety of devices as practically as possible. It is not only web professionals who have recognized this need. Small and large companies are looking for ways to make their web projects accessible regardless of where the user may access them (FISHER; SHARKIE, 2013, p. 2).

A web page with responsive content can be accessed on conventional computers, laptops, smartphones, tablets, TVs, and any other device with internet access, presenting itself well.

For the development of the website, PHP 7 was chosen, being a server-side scripting language embedded in HTML, which can be understood as a collection of HTML supertags that allow adding server functions to web pages. PHP has little to do with layout, events, or anything related to the appearance of a web page. In fact, most of what PHP does is invisible to the end user.

Bootstrap, a style framework, is used in development, providing a range of features, styles, and templates to make web development easy and fast. This framework offers resources that facilitate the creation of responsive interfaces, i.e., interfaces that adjust automatically for a good display on different devices.

The website hosting will be performed at the address: www.ufrgs.br/panoramaedu. Below are some screens from the PanoramaEdu website during its development, which is not yet finalized.



Source: Prepared by the PanoramaEdu team

Figure 10: Development - home screen of the PanoramaEdu website

For the initial screen of the proposed virtual environment, an explanatory summary of the theme and a registration proposal for new users, as well as a login and password for accessing the environment, are presented.

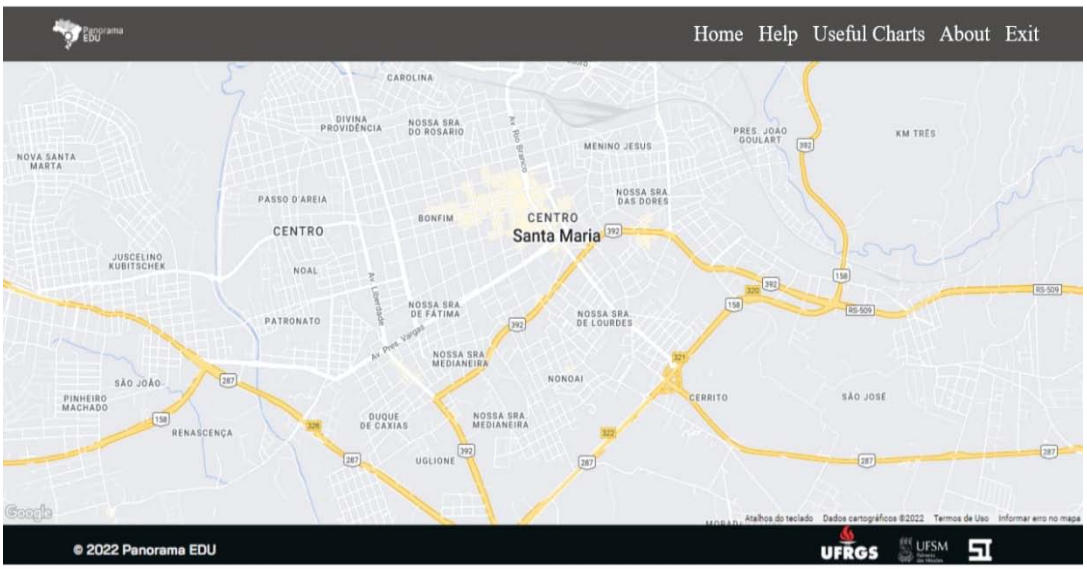
With the explanatory summary of the theme, the user has the opportunity to comprehend the content available in the virtual environment and choose to register in order to gain access.

The registration process serves as a means for the virtual environment to establish a user database. In addition to collecting basic information such as name, email, city, state, country, and contact number, the intention is to ascertain the user's access profile, which includes options such as student, teacher, or higher education administrator. Users will be prompted to provide information about their current educational institution (IES) or school, as the virtual environment aims to become interactive in the future and respond to user demands.

Source: Prepared by the PanoramaEdu team

Figure 11: Development - PanoramaEdu Maps website screen

The screen above depicts the current status of the territorial map under construction. In the information bubble option, course-related information is suggested for the user to gain awareness and access to data that has been collected and processed for presentation within this virtual environment.



Source: Prepared by the PanoramaEdu team

Figure 12: Developed screen - PanoramaEdu website map loaded

This is the proposal for the main navigation screen in the virtual environment. The menu consists of "Home," to which the user can always return during navigation to the start of the navigation screen. The "Help" menu aims to include all help information on navigating the environment, shortcuts, and FAQs. It also intends to provide the user with a contact record, in the form of opening a ticket, detailing their request.

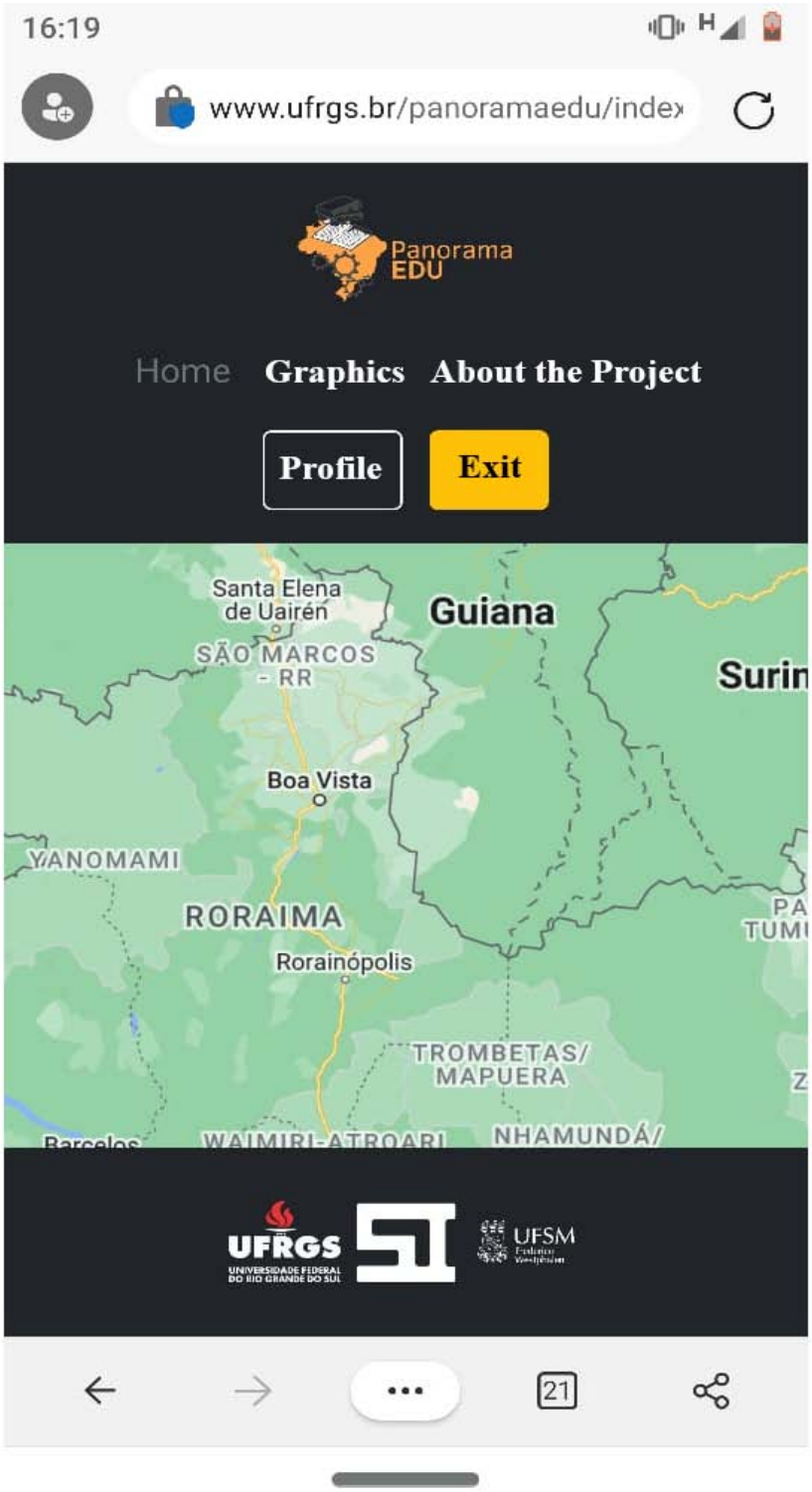
In the "Useful Graphics" menu, some thesis graphics will be initially presented. However, the intention is that, through interaction with users, new analysis graphics of the landscape will be proposed. The "About" menu will present a detailed study with the introduction of the team of authors and developers, an explanation of the virtual environment, and a link to access the final version of this thesis.

For the continued development of the virtual environment, the goal is to include information that allows users to cross-reference indicators and compare courses, thereby generating reports for use, for example, in decisions by higher education institution managers, in future teacher research, and to meet the information needs regarding students' courses. It is intended to include an artificial intelligence software related to conversation interfaces and chatbots, as well as customer support and data generation.

The development of the virtual environment had the main objective of serving as a reference for the development of studies and virtual environments, to extend the environment to other higher education courses in different knowledge areas, and to assess the possibility of developing the virtual environment for Brazilian Higher Education, respecting the specificities of each knowledge area in all higher education courses.

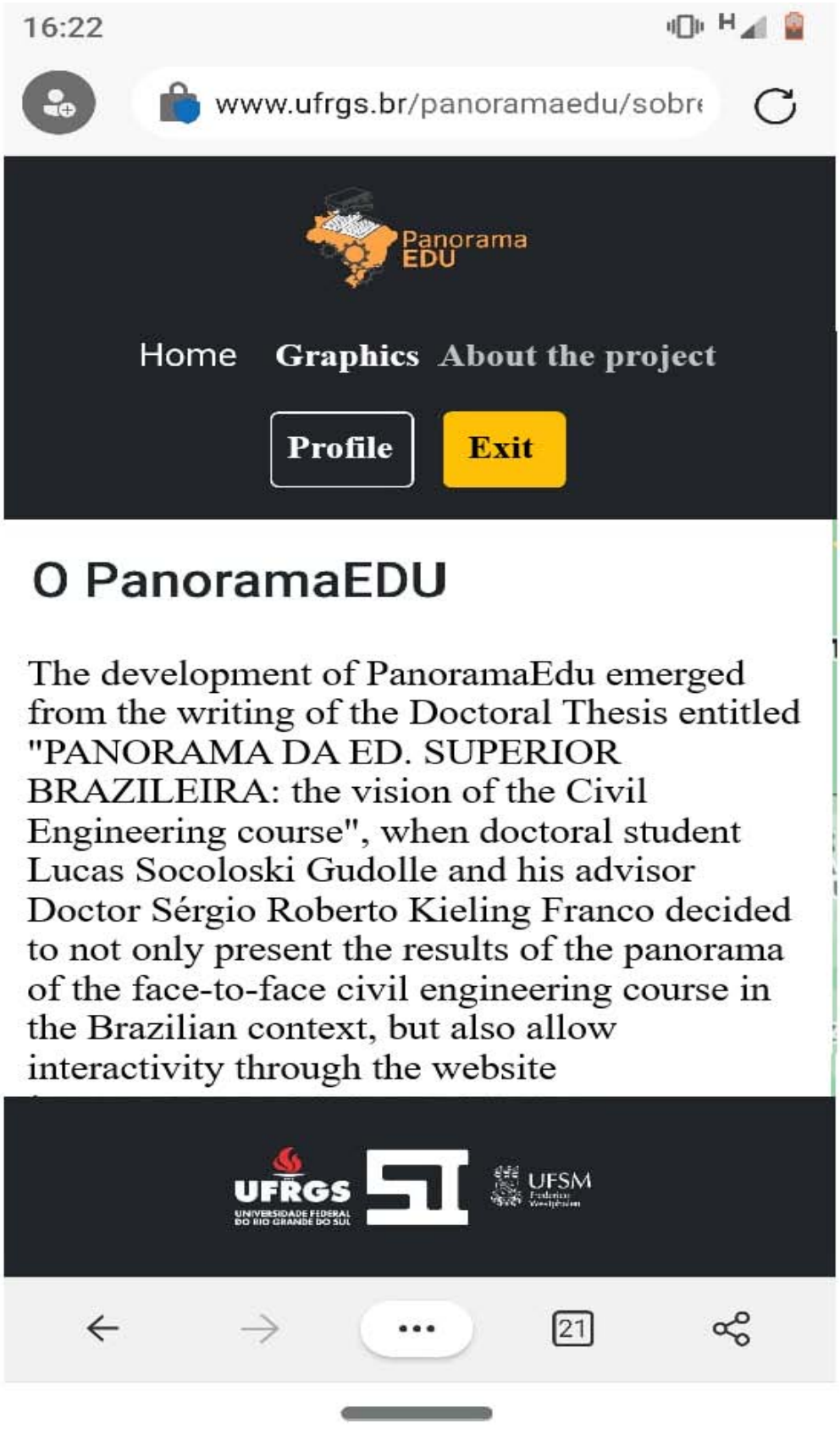
f) Final Version of the PanoramaEDU Website

Below are images from the online version of the PHP website in October 2022.



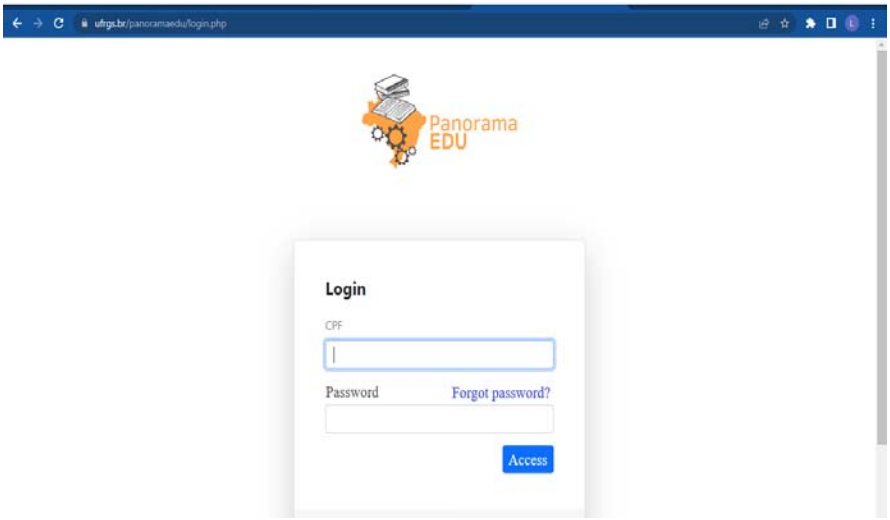
Source: Prepared by the PanoramaEdu team

Figure 13: Home screen - PanoramaEdu Map website on mobile device



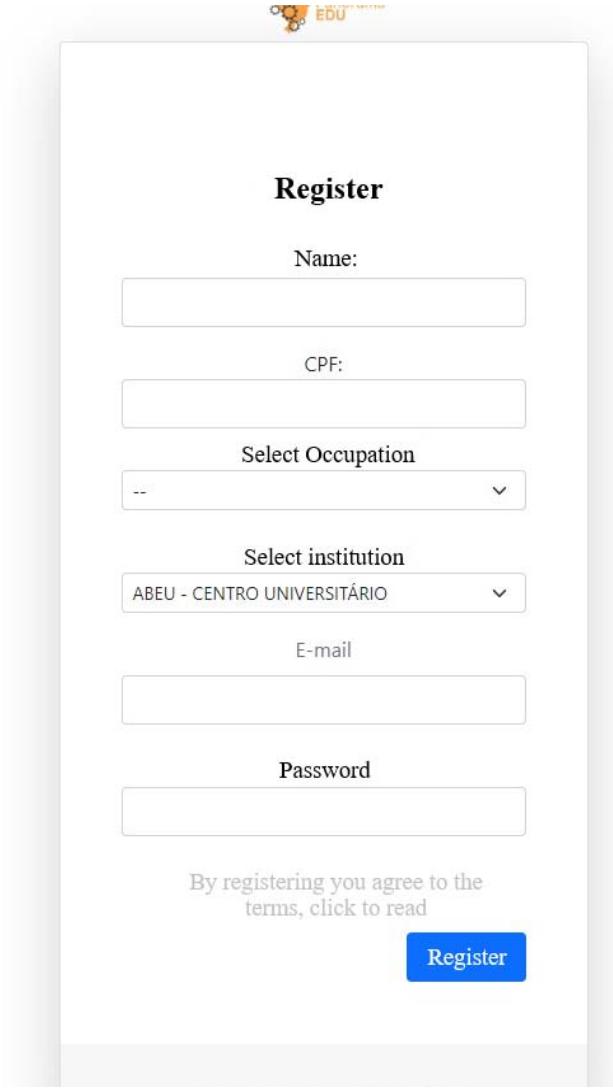
Source: Prepared by the PanoramaEdu team

Figure 14: Project screen - PanoramaEdu website on mobile device



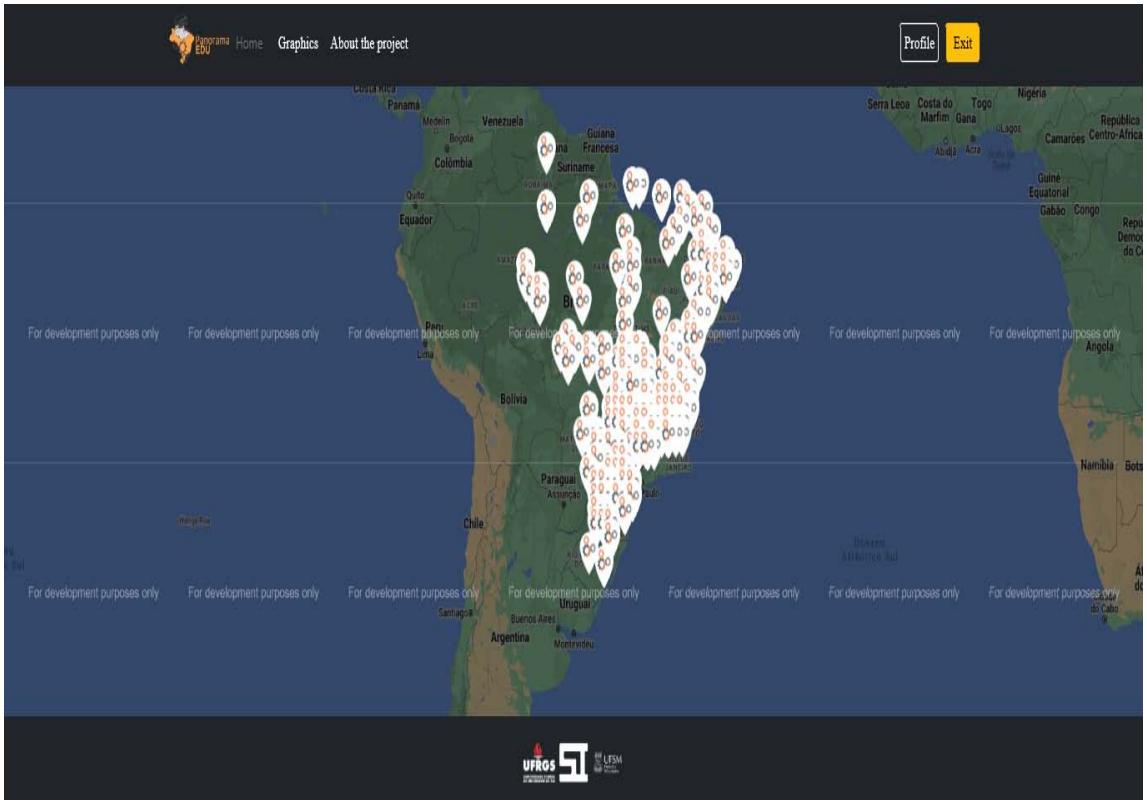
Source: Prepared by the PanoramaEdu team

Figure 15: Login screen - PanoramaEdu website on the computer



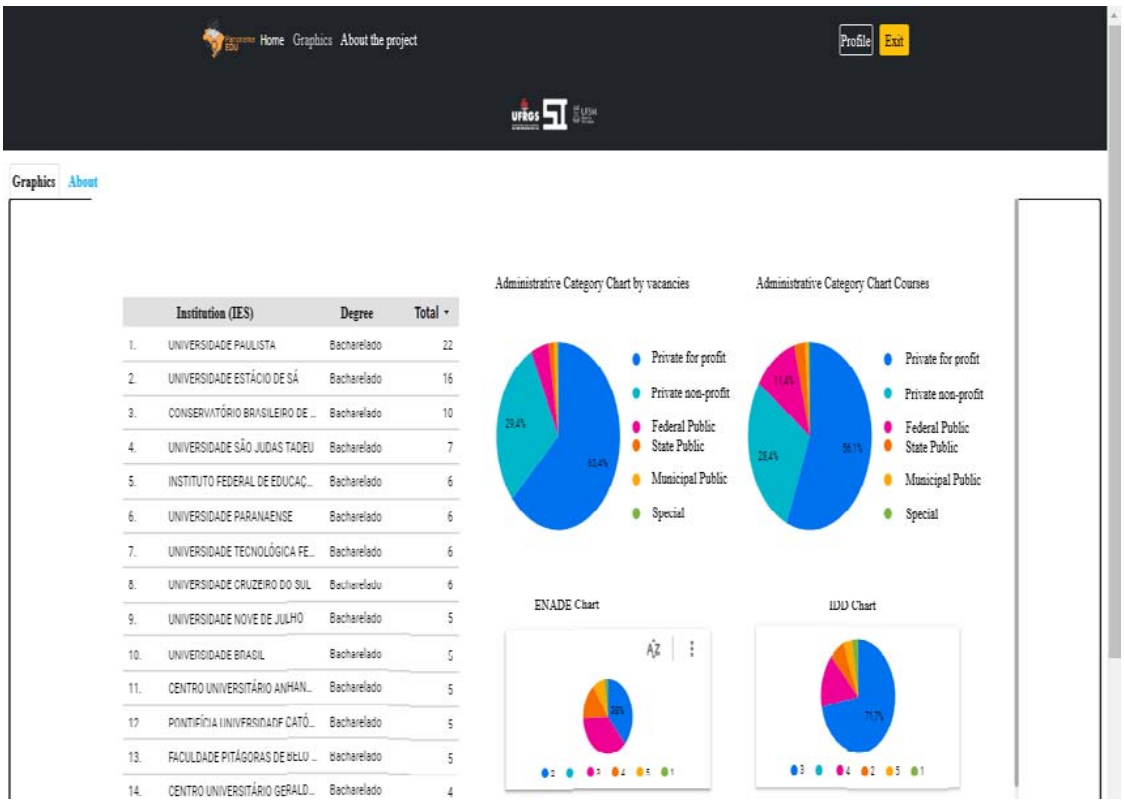
Source: Prepared by the PanoramaEdu team

Figure 16: Registration screen - PanoramaEdu website on the mobile device



Source: Prepared by the PanoramaEdu team

Figure 17: Main screen of the PanoramaEdu website on the computer



Source: Prepared by the PanoramaEdu team

Figure 18: Graphics screen from the PanoramaEdu website on the computer

IV. Final Considerations

The current research fulfilled its scope by conducting the collection, processing, analysis, and presentation of data, indicators, and results, culminating in a comprehensive overview of the on-site Civil Engineering course in Public (Federal, State, and Municipal) and Private (Community, Confessional, Philanthropic, and For-Profit) Higher Education Institutions (HEIs) in Brazil, as well as in the intermediate regions of the country.

The overall objective was fully achieved, as evidenced by the presentation of the national panorama of the course and the analysis of intermediate regions with lower Human Development Index (HDI), covering one intermediate region in each of the five major national regions.

The specific objectives were also entirely met. The first focused on presenting the national panorama of indicators for the on-site Civil Engineering course in HEIs, requiring data collection from various sources, with an emphasis on indicators from the National System of Higher Education Assessment (SINAES), Brazilian Institute of Geography and Statistics (IBGE), HDI, and Federal Council of Engineering and Agronomy (CONFEA).

The second specific objective, involving the analysis of indicators for five Brazilian intermediate regions with the lowest HDI, was achieved after formulating the methodology for data processing and analysis. This process allowed for the identification of regions showing signs of a shortage of the course, as well as those without the course in operation in the North and Northeast regions of Brazil.

The third objective, related to the construction of the PanoramaEdu Website to present data on on-site Civil Engineering courses in Brazilian HEIs, was achieved through academic collaboration. The partnership established with Prof. Dr. Adriana Soares Pereira, academic Ana Beatriz Sales Ramos, and academic Gabriel Sebastiano de Maria, all from the Information Systems course at UFSM, enabled the development of the prototype, Beta version, and final version of the website.

The challenges faced during the doctoral program primarily centered on the development of the PanoramaEdu Website, requiring efforts to overcome setbacks and establish partnerships for project execution. Nevertheless, the prototype was developed, providing an accessible online version.

The analysis of the five intermediate regions revealed traces of a shortage of civil engineering training, related to obstacles such as access and transportation difficulties, combined with adverse geographical conditions, such as significant distances from capitals and medium-sized municipalities.

Regarding the research problem on the current panorama of on-site Civil Engineering courses, the results highlighted that the general characteristics of the courses presented in the results section do not reflect the reality of some institutions. It was observed that, despite the prevalence of courses in profitable private colleges, with course ratings of 4, preliminary course ratings of 3, and ENADE ratings of 2, there are courses that do not follow this evaluative pattern. The analysis also revealed the absence of on-site Civil Engineering courses in 153 municipalities in the Northeast region and 64 municipalities in the North region, indicating signs of scarcity in territories with significant geographical and demographic challenges.

Limitations encountered during the research, such as difficulties in developing the PanoramaEdu Website and the scarcity of specific data from intermediate regions, were overcome with strategies such as adopting data conversion methods and establishing academic partnerships. Access to the website is expected to influence decisions by higher education managers, enabling informed investments in regions with a lack or few courses, contributing to long-term local development.

In summary, this research not only addressed the proposed problem but also made a significant contribution to understanding the distribution and situation of on-site Civil Engineering courses in the national and regional context, providing a solid foundation for decision-making in the field of higher education.

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