A didactic teaching methodology to assist in the analysis of the economic impact on fuel prices commercialized in the Carajás region.

Daniel dos Anjos Nazaré Vilhena Junior
Universidade Federal Rural da Amazônia (UFRA)

Heylon de Oliveira Sales
Universidade Federal Rural da Amazônia (UFRA)

Vanessa Saraiva Pinto
Universidade Federal Rural da Amazônia (UFRA)

Katiane Pereira da Silva
Universidade Federal Rural da Amazônia (UFRA)

Fábio Israel Martins Carvalho
Universidade Federal Rural da Amazônia (UFRA)

Priscilla Andrade Silva
Universidade Federal Rural da Amazônia (UFRA)

Antonio Thiago Madeira Beirão
Universidade Federal Rural da Amazônia (UFRA)

Abstract

This research aims to analyze the economic impacts caused by the addition of the third digit after the comma in the prices of fuels commercialized in the Carajás region (Parauapebas, Canaã dos Carajás, Curionópolis e Serra dos Carajás) located in the southeast of Pará State, Brazil, and the professional categories chosen were UBER application drivers, who use gasoline with additives in their vehicles, sales representatives who use motorcycles and regular gasoline for their work and lastly, intercity van cooperative drivers who use regular diesel fuel. The results of the investigation highlighted that there was a total loss of 2,10 BRL, for the three categories of professionals for every 100 liters of fuel consumed, representing an economic impact of approximately 43% for S-10 diesel, 38% for regular gasoline and 19% for gasoline with additives. Furthermore, in the professional categories analyzed, it was observed that the greatest economic impact occurred for the group of inter-municipal van drivers, with an annual cost of 191,52 BRL. Subsequently, App drivers obtained 14,72 BRL of economic implication per year, and finally, with less annual impact, sales representatives with a cost of 2,72 BRL.

Keywords: Economic impact, third digit after the comma, fuel prices, Scientific literacy in Financial Mathematics teaching.

1. INTRODUCTION

The town Parauapebas-PA is located in southeastern Pará, more precisely in the Carajás region. According to the Intersindical Department of Statistics and Socioeconomic Studies recognized the city of Parauapebas as having the highest fuel prices in the state of Pará (DIEESE-PA, 2019). The research included the cities of Parauapebas, Canaã dos Carajás, Curionópolis and Serra dos Carajás, which is a district of the city of Parauapebas, located about 30 km from its headquarters. Analyzing the fuel prices in these cities so that it could be known the average price of fuel in the region of Carajás.

In contrast to the high prices already paid, fuel consumers, whether fleet owners, freelance drivers, or private drivers, are affected by the abusive pricing of fuel at the gas stations with the insertion of the third decimal place after the comma. The practice has been in place since the creation of the real plan, expressed in Art. 1, item 5, that *"Law no. 9,069, of June 29, 1995, has always allowed the practice of more than two decimal places, as an exception to the general rule"*. Moreover, the regulation for the third digit after the comma is present in Art. 20 of Administrative Rule 41/2013 of the National Agency of Petroleum, Natural Gas and Biofuels (ANP), which is stated *"The prices per liter of all automotive fuels sold shall be expressed to three decimal numbers on the price display and at the measuring pumps".*

Thus, if the liter of fuel costs 5,055 BRL and in the purchase of two liters of fuel a consumer will pay 10,11 BRL instead of 10,10 BRL and consequently the consumer will pay one cent (BRL) more for every two liters purchased according to the example, evidencing that the third digit after the comma in fuel prices aims to increase the product costs for each consumer.

This research analyzed the economic impacts resulting from the insertion of the third digit after the comma in the fuel prices evidenced in gas stations in the Carajás region. This investigation was based on the consideration of three different professionals who use motor vehicles: An application driver (UBER), who uses gasoline with additives; a sales representative who uses regular gasoline; and a van cooperative driver who uses S-10 diesel fuel.

In fact, this research is the result of the application of the content of the subject Financial Mathematics taught in the sixth semester of the Production Engineering course at the Universidade Federal Rural da Amazônia (UFRA), Parauapebas campus in 2020. The purpose of this research is to provide the development of scientific literacy according to the National Curricular Common Core (BNCC) to the students of the sixth period of the Production Engineering undergraduate course and to the entire community of students of UFRA at the Parauapebas Campus, analyzing the financial context of how much in reais (BRL – Brazilian Real) each of the professionals engaged in the research spends more in a one-year period by comparing the values with and without the third digit after the comma.

2. THE TEACHING OF FINANCIAL MATHEMATICS APPLIED IN THE CONTEXT OF FUEL PRICING AT GAS STATIONS.

According to the Ministry of Education (MEC, 2017), "mathematical knowledge cannot be limited to knowledge of terminology, data and procedures. However, students must be able to combine these elements

to meet the needs of everyday life". Hence, investigations of everyday life are becoming increasingly relevant in educational research in Brazil, since there is a need to improve school learning and relate it to the practical life of individuals because "everyday life is first of all the organization, day by day, of men's individual lives" (KOSIK, 2002, p. 80).

In the teaching of mathematics there should be no differences between the formal study and the application of this knowledge in everyday life. It is necessary to relate the content taught in the classroom to the students' everyday experiences, that is, when there is a relationship between the content covered in the classroom and the experiences that are part of the student's everyday life, learning becomes meaningful and motivating. According to Schliemann et al (2006, p. 12) "Mathematical learning in the classroom is a moment of interaction between mathematics organized by the scientific community, that is, formal mathematics, and mathematics as a human activity."

Mathematics teaching through the National Curricular Common Core (BNCC) has math literacy as a teaching commitment to guarantee students' learning rights, enabling them to recognize the role math plays in the world and become critical, engaged, reflective, and competent citizens to make decisions.

The BNCC (2017) strengthens the conception, in its introductory text, that mathematical literacy is responsible for guaranteeing students the cognition that mathematical knowledge is essential for subjects' action in the world, so that:

(...) we can explain our understanding for "mathematical literacy" as a category expression that we are interpreting, as: a process of the subject that comes to the study of mathematics, aiming at the knowledge and abilities about the notational systems of his natural language and of mathematics, at the conceptual knowledge and of the operations, at the adaptation to abstract and deductive logical reasoning, with the help and by means of notational practices, as of noticing mathematics in the conventional writing with notability to be studied, understood and constructed with the developed aptitude for its reading for its writing. (MACHADO, 2003, p. 135).

In accordance with the thought of Fiorentini and Lorenzato (2007, p. 12), "Mathematics Education is both an area of theoretical research and an area of practical action, as well as being, at the same time, a science, an art, and a social practice. Consequently, it is necessary to associate school life with everyday life, understanding reality to unite theory and practice. In addition, the *Programme for International Student Assessment* (PISA) report establishes math literacy as:

[...] an individual's ability to formulate, apply and interpret mathematics in a variety of contexts, which includes mathematical reasoning and the application of mathematical concepts, procedures, tools and facts to describe, explain and predict phenomena. In addition, mathematical literacy helps individuals to recognize the importance of mathematics in the world, and to act consciously in considering and making decisions that are necessary for all constructive, engaged, and reflective citizens. (INEP, 2012, p. 18).

In face of this, mathematical literacy should provide the individual with the ability to assimilate and critically observe the different numerical, symbolic, and graphic data, among other mathematical representations that are presented in everyday life, so that:

This literacy should enable them to make rational choices, based on understanding, modeling, predicting and controlling their effects, in the face of situations that are unprecedented and often full of doubts. Therefore, it is essential, first of all, that all individuals are, in the course of their mathematics education,

progressively brought into contact with the complexity of today's numerical (digital) world, that they learn to refer to this world and to act upon it by becoming familiar with the diversity of the modes of representation that are used in it. It is also important that individuals be progressively familiarized with the modes of probabilistic and statistical thinking, which are necessary to put mathematics at the service of understanding numerous phenomena that, in the sciences and in social life, bring uncertainty and risk. (UNESCO, 2016, p. 14).

From the analysis of the importance of scientific literacy in teaching mathematics based on the BNCC, it is necessary to relate in this instant, the knowledge of financial mathematics proposed in the classroom for the students of Production Engineering at UFRA, with the knowledge of everyday life, in order to provide the subject, a solid academic training that observes and understands mathematics in the world in a critical way.

The high taxes applied on several products in Brazil affect the Brazilian economy, some of these products are used by nationals in their occupations, however, such products suffer from excessive taxations that severely compromise their income, as is the case of fuels. According to the National Fuel and Lubricants Trade Federation, the national average tax rate imposed on fuels in the month of September 2019, as shown in Table 1.

Table 1: List of fuel taxes in Brazil.

Taxes and fuel list	**GASOLINE**	**DIESEL**	**ETHANOL**
	44%	**23%**	**26%**
ICMS (state tax varies by state)	25% to 34% of the listed value	12% a 25% of the listed value	12% a 32% of the listed value
PIS/COFINS (federal tax)	0,7925 BRL/liter	0,3515 BRL/liter	0,1309 BRL/liter for the producer and 0.11 BRL for the distributor
CIDE (federal tax)	0,1000 BRL/liter	0,000 BRL/liter	No effect on ethanol

Source: National Federation of the Trade of Fuels and Lubricants (Fecombustíveis, 2019).

According to the National Petroleum Agency (ANP, 2013) the composition of fuel prices is basically based on the acquisition cost of the retailer plus the resale margin. The cost is composed of the freight value plus taxes, among them PIS/CONFINS, ICMS and CIDE. In Brazil, the structure of the formation of the final sales price of fuel at the retailer is described in the following equation:

$$U = S + T, \quad (1)$$

with,

S: Dealer acquisition cost;

T: Resale margin;

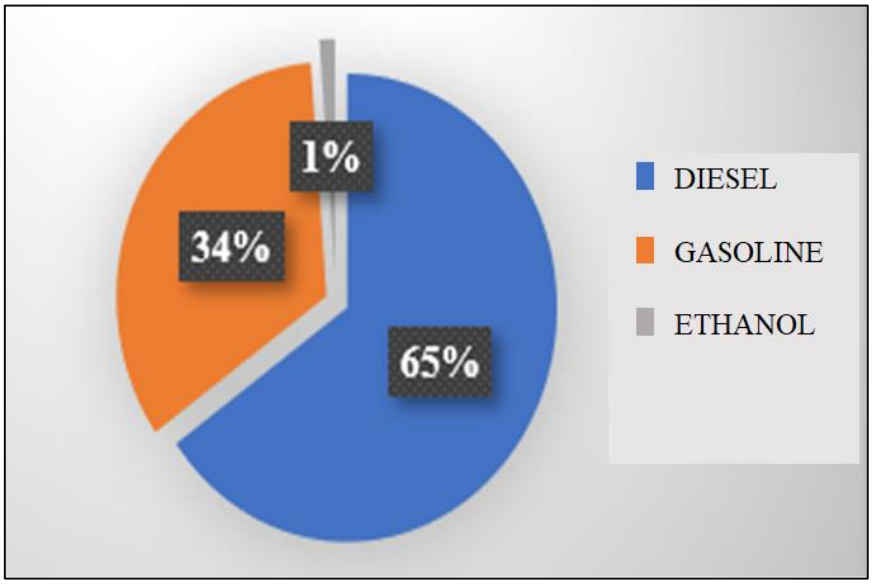
U: Fuel pump price.

According to the Secretariat of Finance of the State of Pará (SEFA-PA), the ICMS is the "Tax on Transactions relating to the Circulation of Goods and on Interstate, Intermunicipal and Communication Transport Services" and Law nº 10.336 of December 2019, institutes the Contribution of Intervention in

the Economic Domain levied on the import and sale of oil and its derivatives, natural gas and its derivatives, and ethyl alcohol fuel (Cide).

Thus, besides the high tax burden on fuel in general in Brazil, another major problem for the consumer is the third digit after the comma that makes up the way gasoline pumps are charged nationwide. This idea is in line with Proposed law 6548/16, by Congressman Heitor Schuch (PSB-RS), which requires gas stations to sell their products with only two places after the comma, with the intention of avoiding abusive charges to consumers. Figure 1 shows the fuel consumption data in the state of Pará in the first half of 2018.

Figure 1: Fuel consumption data in the state of Pará in the first half of 2018.



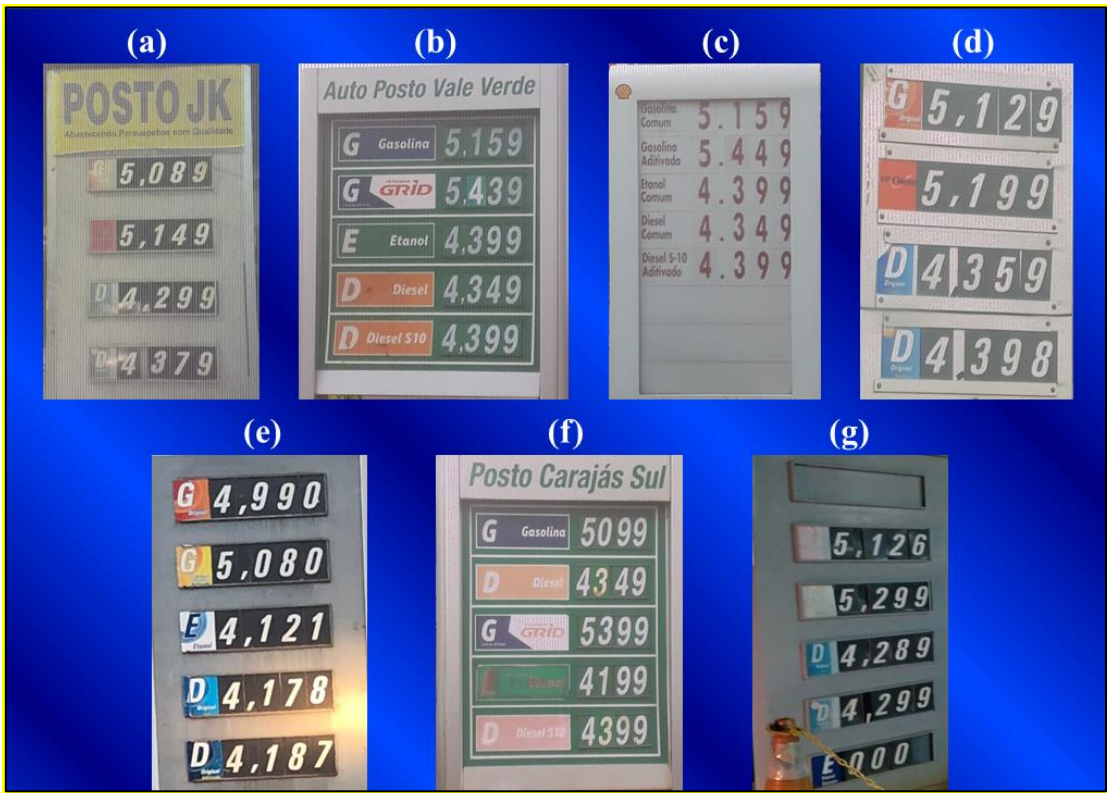
Source: National Federation of the Trade of Fuels and Lubricants (Fecombustíveis, 2019).

The state of Pará has a great demand for fuels, the Carajás region located in the southeast of Pará is an area dominated by the mining industry, which includes the largest open iron ore mine in the world, the Vale do Rio Doce mining company. (VALE, 2018) and, this industry requires a large amount of machines that use petroleum derivatives and ethanol as fuel.

3. METHODOLOGY

The method used for the research is qualitative, applying as a data collection tool a questionnaire (Appendix 1) containing five questions to measure the average fuel consumption for each category of professionals chosen during one year, corroborating the conceptions of Lüdke and André (2007) who highlight qualitative research to provide for the description and interpretation of data in a scientific context. Therefore, we aim to understand from the answers in Appendix 1, the economic impact on fuel consumption of the professionals involved in the research due to the insertion of the third digit after the comma in fuel prices in the Carajás region. In addition, data was collected by taking pictures of fuel prices, available on the advertising boards of some gas stations in the region of Carajás-PA, more precisely in the cities of Parauapebas, Canaã dos Carajás and Curionópolis, as shown in Figure 2.

Figure 2: Fuel prices in the Carajás region: (a) Gas station 1 in Parauapebas; (b) Gas station 2 in Serra dos Carajás; (c) Gas station 3 in Canaã dos Carajás; (d) Gas station 4 in Canaã dos Carajás; (e) Gas station 5 in Curionópolis; (f) Gas station 6 in Serra dos Carajás; (g) Gas station 7 in Parauapebas.



Source: Authors (2020).

In this research we interviewed five UBER drivers from the city of Parauapebas, five sales representatives from the city of Parauapebas and five intercity van drivers who make trips between the cities of Parauapebas and Marabá, both located in the southeast of Pará. The survey in attachment (I) had the purpose of identifying the professionals' work routine and investigating from equation (3), the amount of liters of fuel consumed by them at the end of twelve months of work. As a result, Table 2 below was calculated, which expresses the amount of liters of fuel consumed by each professional group mentioned above throughout a year. To establish an average price (M) of the value of the fuels in the region, an arithmetic average of each fuel price found in the region was used. For this, we used equation (2) given by:

$$M = \frac{x_1 + x_2 + x_3 + \cdots + x_n}{n} \qquad (2)$$

where $x_1, x_2, x_3, \ldots, x_n$ the price of each type of fuel for each such gas station.

The fuel prices of seven gas stations in the Carajás region were analyzed, being one in the city of Curionópolis, two in the city of Canaã dos Carajás, three in the city of Parauapebas and one in Serra dos Carajás, which is located 30km from Parauapebas. After collecting the price data, the arithmetic mean was taken and then the average price per fuel in the region was calculated. The values are shown in table 2.

Table 2: Average prices per fuel in the Carajás region

	Gas Station 1	Gas Station 2	Gas Station 3	Gas Station 4	Gas Station 5	Gas Station 6	Gas Station 7	AVERAGE PRICE
COMM. GAS	5,089 BRL	5,159 BRL	5,159 BRL	4,990 BRL	5,129 BRL	5,099 BRL	5,129 BRL	5,108 BRL
ADD. GAS	R$ 5,149	R$ 5,479	R$ 5,449	R$ 5,080	R$ 5,199	R$ 5,399	R$ 5,299	5,224 BRL
S-10 D.	4,379 BRL	4,399 BRL	4,399 BRL	4,187 BRL	4,398 BRL	4,399 BRL	4,299 BRL	4,339 BRL

Source: Authors, based on Figure 2 and the equation (2).

3.1 AVERAGE FUEL CONSUMPTION PER YEAR IN LITERS (l) FOR EACH PROFESSIONAL.

To determine the average fuel consumption during the year in liters for the professionals chosen in the investigation, equation (3) was used. The multiplication between kilometers driven per day (k), days worked during the week (d), weeks worked during the month (s), and months worked during the year (m). After multiplying all the variables described, it is necessary to divide the quantity found by the autonomy of the vehicle (c) and, this results in the quantity of liters consumed during one year.

$$Q = \frac{d.s.m.k}{c} \tag{3}$$

For each group of professionals chosen, it was organized in Table 3 how much fuel in liters each group spent by the end of twelve months. In this case, to determine this quantity the data collected from the Attachment (I) was used together with equation (3), so that:

Table 3: Amount of fuel (Q) in liters (l) spent by professional group in one year.

	UBER drivers	Sales representatives	Intermunicipal van drivers
Amount of fuel in liters (l).	3.681,40	339,43	21.280

Source: Authors, based on equation (3).

From the data calculated for the average consumption in liters of fuel for each group of professionals involved in the investigation, the next section will provide the results obtained based on the methodology used in this research.

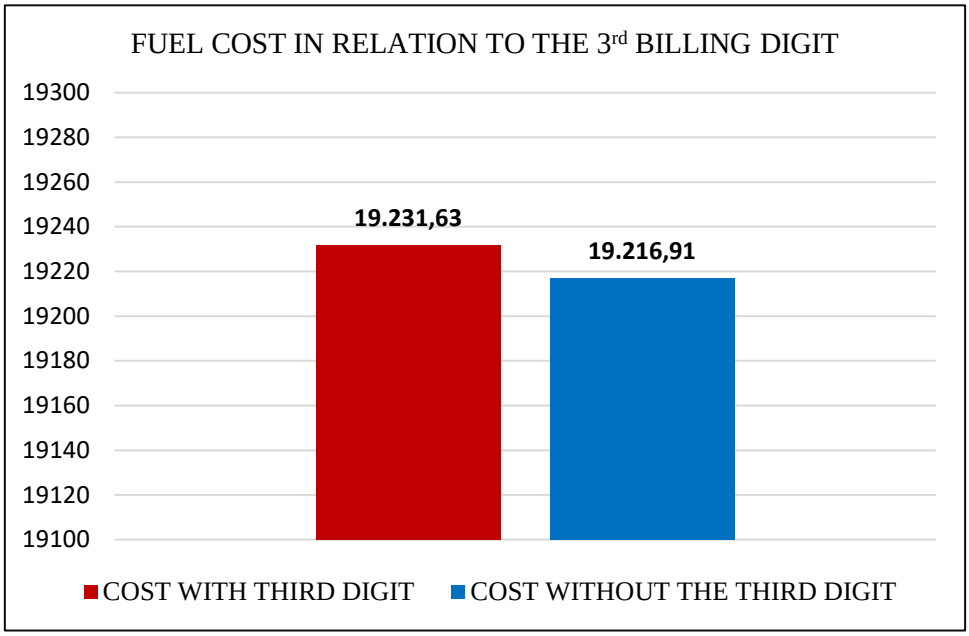
4. RESULTS

Considering the data collected from the survey in attachment I and the construction of Table 3, this section will analyze the information obtained in order to examine the average consumption per year for each professional group involved and establish the economic impact of the third decimal after the comma in the fuel charge.

The Uber application professional had an average annual consumption of 3.681,40 liters of fuel, using gasoline with additives, and this fuel, according to research, has an average price in the region of Carajás-PA of 5,224 BRL.

To determine the cost of fuel consumption it was necessary to multiply the average annual fuel consumption of this professional with the average price of fuel in the region, analyzing the cost with the third digit and without the third digit after the comma present in the fuel pricing.

Figure 3: Price difference with respect to the third decimal place of fuel charges for UBER app drivers.

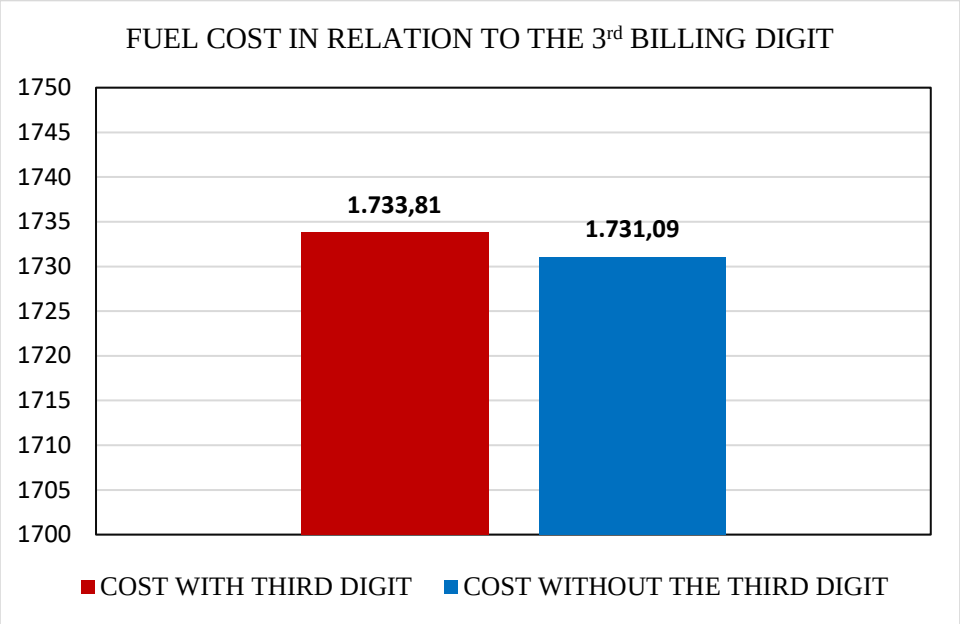


Source: Authors (2020).

From the analysis of Figure 3 it can be seen that there was an economic impact due to the existence of the third digit after the comma in the price of fuel. In this case, for the group of Uber app drivers who use gasoline with additives, the annual fuel cost taking into account the third digit after the comma was 19.231,23 BRL and without taking into account the third digit, the cost was 19.216,91 BRL, making, in quantitative terms, the economic impact 14,72 BRL.

For the group of sales representatives the average annual consumption of regular gasoline fuel was 339,43 liters. This fuel has an average price in the region of Carajás - PA of 5,108 BRL. Furthermore, according to the data collected and calculated it was possible to determine the following Figure 4:

Figure 4: Price difference to the third decimal place of fuel charge for sales representatives.

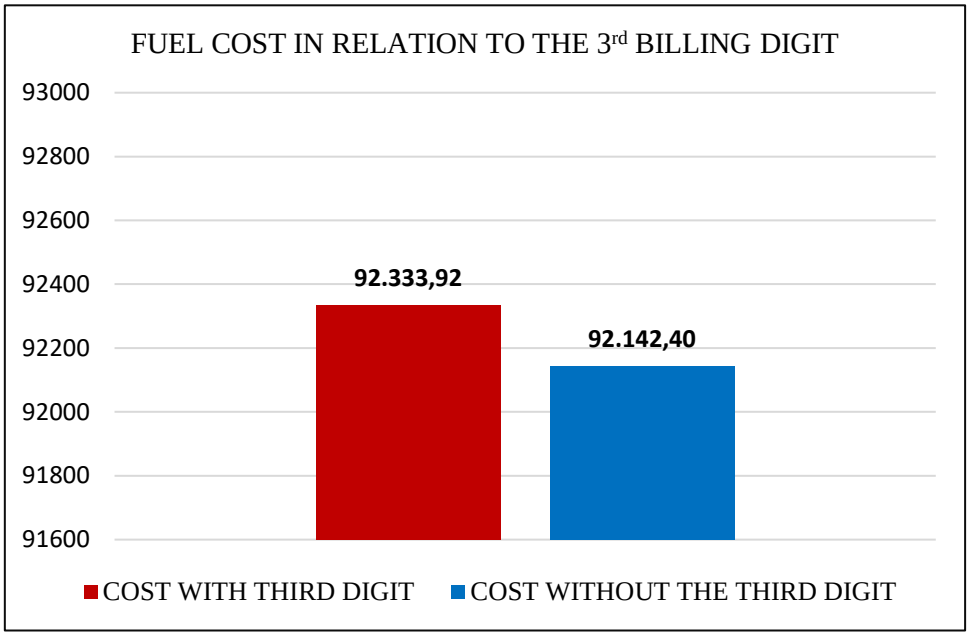


Source: Authors (2020).

It is possible to verify once again, but to a lesser extent, that there is an economic impact for the group of sales representatives as a result of the insertion of the third digit after the comma present in the pricing of fuel. In this situation, the annual cost of fuel taking into account the third digit was 1.733,81 BRL and without taking into account the third digit, the cost was 1.731,09 BRL, obtaining an annual economic impact of 2,72 BRL for this group of professionals.

For the group of inter-municipal van drivers, who use S-10 diesel fuel, with an average price in the Carajás - PA region of 4,339 BRL, an average annual consumption of 21.280 liters was observed. Analogously to the previous graphs, the multiplication between the average annual consumption and the average price of fuel in the region was performed, taking into consideration the insertion of the third digit and without it in the fuel pricing.

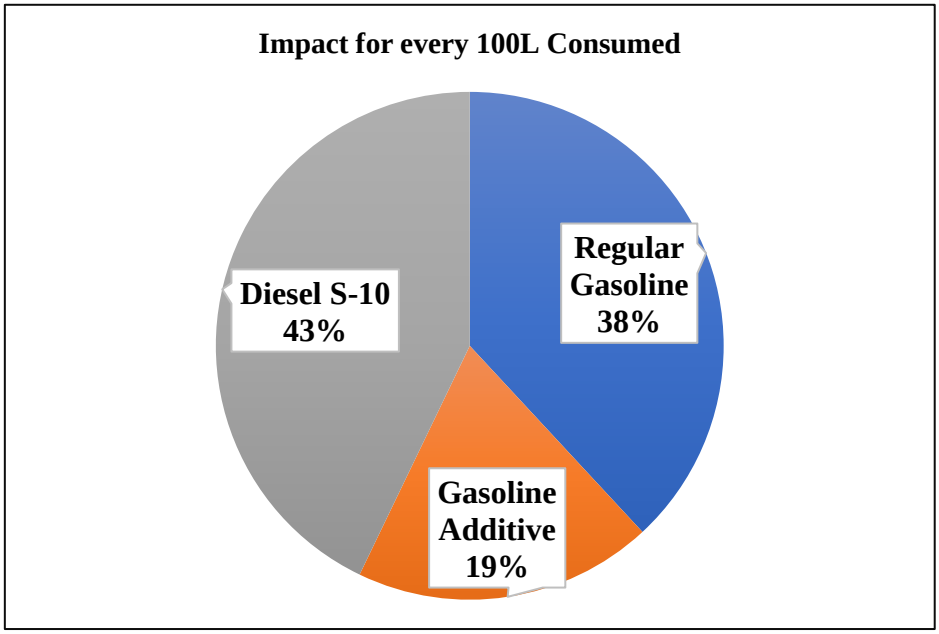
Figure 5: Price difference with respect to the third decimal place of fuel charge for inter-municipal van drivers.



Source: Authors (2020).

So that in Figure 5 is evidenced the annual economic impact of 192,52 BRL on the professional inter-municipal van drivers. The average annual cost due to the presence of the third digit in the price of S-10 diesel was R$ 92.333,92 and without the third digit was R$ 92.142,40, confirming the economic impact cited above.

Figure 6: Economic impact in relation to the third decimal place after the comma for each 100L of fuel consumed.



Source: Authors (2020).

Figure 6 shows the economic impact that occurred in the analyzed professional groups with their respective fuels used. Furthermore, this implication was investigated for every 100 liters of fuel consumed and,

consequently, it was possible to identify that the drivers of intercity vans carried the greatest annual loss with a cost of 0,90 BRL, followed by sales representatives, with a cost of 0,80 BRL and, subsequently, the drivers of the Uber application with a cost of 0,40 BRL, totaling 2,10 BRL of losses for the three modalities of professionals.

5. CONCLUSION

By means of the form (Attachment I) it was possible to obtain the average consumption data of the vehicles of the investigated professional groups, which are: 6 km/l for the intercity van driver, 11,5 km/l for the application driver and 35 km/l for the sales representatives and, thus, justify the difference in fuel consumption in the year per professional category in relation to the performance of their respective vehicles.
The current way fuel is charged to the consumer was established by an ordinance of the National Agency of Petroleum, Natural Gas and Biofuels (ANP). This practice has been carried out since the creation of the Real Plan "Law nº 9.069, of June 29, 1995 (the Real Law). However, it appears that this practice is considered an abusive way of charging and after more than two decades this has gone unnoticed in the eyes of consumers. Although it remains until today, it has already been opposed by the Project of Law 6548/16.
To evidence this abusive practice caused by the insertion of the third digit after the comma in the pricing of fuels, Figures 3, 4 and 5 show that the S-10 diesel is the fuel that most impacts economically the group of intercity van drivers with an annual cost of 191,52 BRL, followed by the group of professional drivers of Uber applications with an annual cost of 14,72 BRL and, finally, the group of sales representatives using regular gasoline with an annual cost of 2,71 BRL.
Additionally, it is verified that regular gasoline, gasoline with additives and S-10 diesel have respectively in their third charging digits the monetary values, in Reais, of 0,008 BRL, 0,004 BRL and 0,009 BRL. When analyzing the economic impact due to this third digit for the professionals chosen for each 100 liters of fuel consumed, there is a total loss of 2,10 BRL for the three categories analyzed and, according to Figure 6, this impact represents approximately 43% for S-10 diesel; 38% for regular gasoline and 19% for gasoline with additives as a function of the total cost.

6. ACKNOWLEDGEMENT

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APPENDIX 1

Federal Rural University of the Amazon
Campus of Parauapebas
Production Engineering Course

Qualitative research on the opinion of fuel consumers in the Carajás region.

Subject: Economic impact due to the insertion of the third digit after the comma in fuel prices, based on professionals who use motor vehicles in the Carajás region.

1ª) How many kilometers does your car travel per day?

2ª) How many months do you work a the year using your motor vehicle?

3ª) What type of fuel do you put in your vehicle?

4ª) Do you have control over your fuel expenses?

5ª) What's the average consumption of your vehicle per day?