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EDITOR'S LETTER

Today we publish number 28 of the Espacio I+D magazine, the last number of 2021 corresponding to Volume X. This year, the editorial team faced some changes, just as the entire world did, we finally had to face the "New Normality" and we returned to the facilities of our beloved University and, every time we receive collaboration proposals from other countries and states of Mexico, we confirmed that this editorial space is a window for the whole world.

In this issue, we publish the following articles from various educational institutions: Analysis of the sustainability of urban mobility alternatives in Tuxtla Gutiérrez, Chiapas; Guide to elaborate the operationalization of variables; Rosario Castellanos' short stories: characters and the significant moment; Trends in Patenting and Entrepreneurship among researchers of the Universidad Autónoma del Estado de Morelos; Traits to evaluate in teaching performance. The students' voice. Development of a free app to learn the design of reinforced concrete walls subject to in-plane bending and axial load; Acute Hepatopancreatic Necrosis affecting penaeid shrimp culture in Mexico; Knowledge, Use, and Command of teaching-learning technologies for ELT.

In the Academic Documents section, you will find a couple of valuable contributions: Mechanics Problems for Olympiad, The UNiTE campaign, "Orange the World in 2020": activities to eradicate violence against women and girls.

In this issue, we present the new section A space for science in which there will be a place for all the dissemination elements that are carried out in various multimedia formats, such as capsules, podcasts, and reports with which we hope to disseminate the academic and scientific activities carried out in the Universidad Autónoma de Chiapas and in the large scientific and academic universe that exists in Chiapas and the collaborations that we receive in the magazine, with the idea of expanding its dissemination on social networks and that they are suitable for all audiences.

As a team, we hope that the learning in prevention and self-care to which we have been forced to join will lead us to reestablish our social life. We are grateful that you are part of our magazine, and with this, you allow us to consolidate this space that is about to celebrate its first ten years of having seen the light.

Enjoy this Space of Innovation!

"*Por la conciencia de la necesidad de servir*"
Universidad Autonoma de Chiapas

The editors

ARTICLES

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Analysis of the sustainability of urban mobility alternatives in Tuxtla Gutiérrez, Chiapas

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— Abstract—

In recent years the demand of the urban mobility sector has become of particular interest. The high dependency on mobility and the excessive use of cars in urban areas are matters of concern because the transportation systems are lead to unsustainable scenarios. This circumstance makes long-term planning highly relevant in trying to reverse this trend. There should be an integrating project that is based on the development of strategies according to indicators that show whether urban mobility is intended to be sustainable, and at the same time its positive effects are maximized and the negative ones are mitigated.

This paper proposes a new method for calculating such indicators and sustainability relationships for long-term decision-making, to analyze urban mobility in Tuxtla Gutiérrez and achieve sustainable urban mobility environments.

A methodical analysis is made of the flows that intervene in the dynamic functioning of urban mobility and its different alternatives, by evaluating all the energy used in this process (all this energy is called eMergy), of the different components to quantify them in identical units. With this evaluation, we attempt to know the emergetic flows and deposits of the different mobility alternatives. The sustainability indexes and other correlations that indicate the degree of dependence on urban mobility were also calculated, the results are shown graphically.

Finally, an analysis of the environmental burden is presented, showing how environmentally friendly the current urban mobility system can be. It was found that the bicycle is the mobility alternative that consumes less eMergy and that the one that consumes the most eMergy is the Conejobús. Regarding the eMergy index per kilometer per person per type of unit, it is shown that the Conejobús is the most efficient modality above bus and bicycles. Concerning the total eMergy index of mobility by type of alternatives, the most efficient was the Conejobús followed by bus and bicycles.

Keywords:

eMergy; sustainability; urban mobility; environmental burden; ecological system.

Starting in the 1970s, the metropolitan area of Tuxtla Gutiérrez, which constitutes the most important population, economic and political center of the capital of Chiapas, had a significant population increase, due to the construction of the Manuel Moreno Torres Hydroelectric Plant (Chicoasén, Chiapas). Many of the foreign workers who participated in the construction of the dam settled in the city permanently. For this reason, in recent decades there has been rapid population growth in the municipality of Tuxtla Gutiérrez and, although to a lesser extent, also in the surrounding municipalities (Silva *et al*., 2015).

According to the SHGEC (2014), the municipality of Tuxtla Gutiérrez, Chiapas, has a total area of 335 km² and, with data from 2014 projected to 2018, it is inhabited by around 600 thousand people. Because it is the capital and the main political, commercial, and service center of the state, many inhabitants of nearby municipalities come by to this place every day (to carry out multiple activities: to work, study, buy, get medical assistance, etc.), some of whom have even moved or have their second place of residence in Tuxtla Gutiérrez.

Similar to other medium-sized cities in Latin America (Henríquez, 2007; Avalos *et al*, 2016), Tuxtla Gutiérrez shows rapid horizontal growth. A constantly growing population demands the expansion of living spaces, communication routes, and other infrastructures. In particular, the city's growth has created the need to travel to carry out all daily activities. In most cases, motorized vehicles are used, which has generated a notorious collapse in urban circulation as a result of the saturation of roads and the inefficiency of public transport services. However, the growing number of motorized vehicles and their greater use, as well as the reduction in their occupancy rate, causes pollutant emissions to increase, which translates into increasing pollution of the atmosphere. This pollution affects climate change, due to greenhouse gases and carbon dioxide (CO_2).

In recent years, strategies to achieve sustainable mobility and transportation have met with limited success. This raises the question of how the sustainability of transport systems and policies can be assessed, and how these measurements can be used to plan transportation (Gudmundsson, 2003; Polea, 2019).

Consequently, in this work, it is proposed to resort to a recent strategy called *Sustainable Mobility*, which has shown its benefits and possibilities in the treatment of urban mobility alternatives. The purpose of such a tool is to reconcile the mobility needs of citizens, with the quality of life and the environment, without limiting the potential development that these activities generate, or restricting the right of people to quality transportation (Ferreyra, 2008; ITDP, 2013). The main objective is to show, through measurements and evaluations, the analysis of the sustainability of urban

mobility alternatives in Tuxtla Gutiérrez and to show whether it is really sustainable. This environmental assessment will be based on eMergy, which is a methodology capable of integrating environmental, economic, and social indicators. EMergy is the sum of all energy inputs, directly or indirectly, necessary for a process to provide a specific product or service, these inputs are expressed in the same form or type of energy, usually solar energy. The eMergy analysis is designed to evaluate the energy and material flow of the systems in common units (solar joule, seJ) that allow the analyst to compare the environmental and financial aspects of the systems (Guillén Trujillo, 1998).

EMergy is defined as the amount of solar energy to make a product, its unit is the solar joule (seJ). Although energy is conserved according to the first law of thermodynamics, according to the second law, the ability of energy to do work is exhausted and cannot be reused (Odum, 1996), it is only conserved in a chain of transformations. This series of transformations makes it necessary to resort to the concept of Transformity, which is the amount of direct or indirect energy required to produce one type of energy in another type, but more useful -10,000 seJ/J wood, for example-. In other words, it is the measure of the energy required to transform one type of energy into another. Establishes the ecological hierarchy in energy analysis. Three different energy inputs are recognized: renewable premises, non-renewable premises, and purchased or imported flows. By dividing the community's energy inputs into these terms, it is possible to perform several very illuminating calculations: the population's environmental burden rate, its energy yield rate, and, most importantly, its sustainability index. In the emergetic analysis, environmental, social, and economic variables are included, and indexes are calculated as comparison tools for different systems. (Odum, 1996).

In the last 30 years, this technique has shown a great capacity to evaluate the sustainability of different processes in which different forms of energy are consumed. That is, it measures the quality of the different forms of energy that have been used, directly or indirectly, in the transformations necessary to generate a product or service. In this way, by integrating the environmental and financial aspects of the systems considered, eMergy can be used to evaluate urban mobility alternatives in Tuxtla Gutiérrez.

BACKGROUND

The efficient provision of social infrastructure and municipal services is essential to achieve a greater degree of productive specialization in the local economy and, as a result, in the well-being of the population in general. Therefore, investment in the three government levels is important to establish the conditions that allow aspiring to a better quality of life.

Urban development problems and their impact on the environment and quality of life constitute a challenge for those in charge of municipal infrastructure policies. Urban mobility is one of these concerns. This is the capacity and/or possibility of moving within the city. (Velásquez, 2010)

Consequently, urban mobility is a basic need of people that must be respected and satisfied in such a way that the effort and cost of travel necessary to access goods and services are sustainable and do not negatively affect people's quality of life or the possibilities of economic, cultural, and educational development.

Similarly, urban mobility is a fundamental right that must be guaranteed, under equal conditions, to the entire population, without differences derived from purchasing power, physical or mental condition, gender, age, or any other cause. (Velásquez, 2010)

Tuxtla Gutiérrez has experienced disorderly growth in recent decades. Due to this, in 2012 the Instituto Ciudadano de Planeación Municipal para el Desarrollo Sustentable (ICIPLAM) of Tuxtla Gutiérrez was created. The main function of ICIPLAM is to advise the governors for the design, planning, execution, and evaluation of the plans and programs applicable to the city. Thus, ensuring the quality of these and promoting citizen participation, through an approach based on sustainability.

The most important contribution of ICIPLAM, regarding urban mobility, dates from 2012, the year in which the proposal was made to replace the two main bus routes in Tuxtla Gutiérrez -routes 1 and 2-, and that circulated from East to West and from South to North. Such substitution occurred using ecological buses called "*Conejobús*". (Tuxtla 2030, the strategic agenda of our city, 2016).

With this exception, the city does not have a comprehensive mobility study that reports on urban areas that need transportation, how the population moves and what type of mobility is truly sustainable. Nor is there the infrastructure necessary for pedestrian mobility, mainly sidewalks and signs.

A deficiency has been detected in the promotion of mass-use mobility alternatives, at the same time, infrastructure to support the use of non-motorized means of transport is scarce. This aspect is very important since the use of quality mass public transport is directly related to improving the competitiveness and productivity of the city.

METHODS

The environmental accounting method called *eMergy* is used which is a tool to evaluate the sustainability of urban mobility in the City of Tuxtla Gutiérrez. This biophysical method was developed by Odum (1996) and is based on the analysis of energy with memory, to correctly account for

the services provided by ecosystems for free. This tool is used to compare nature's work with that of humans on a fair and equitable basis. It can represent, at the same time, the contributions of nature and the economy in a single unit and criterion, providing a diagnosis of comparative evaluation, between the different results of environmental performance over time. (Guarnetti *et al*, 2006; Álvarez, 2020)

The eMergy analysis is designed to evaluate the energy and material flow of the systems in common units, the solar joule (sej), which allows the analyst to compare the environmental and financial aspects of the systems (Guillén, 1998). Three different energy inputs are recognized: renewable premises, non-renewable premises, and purchased or imported flows. By dividing the community's energy inputs into these terms, it is possible to perform several very illuminating calculations: the population's environmental burden rate, its energy yield rate, and, most importantly, its sustainability index. In the emergetical analysis, environmental, social, and economic variables are included, and indexes are calculated as comparison tools for different systems. In this work, emergetic and financial indexes are calculated to determine the sustainability of urban mobility in Tuxtla Gutiérrez. The following characteristic activities of an energy study were carried out (Guillén, 1998):

1. Definition of the space-time limits of the investigated system.
2. Gathering of data in the field, for means of transportation - owned vehicle, taxi, bus, motorcycle, and bike-, to determine the physical quantities of renewable and non-renewable resources, materials, and services that are part of the system studied.
3. Modeling of the system, through matter and energy flow charts, using energy symbology (Odum, 1994; Bravo, *et al*, 2018), of the interaction between the external and internal sources of the system, and the natural productive systems and anthropic, as well as the outflows of the system and its feedback. Figure 1 shows the energy flows that interact with each other in the city of Tuxtla Gutiérrez. This figure is very useful for a better understanding of the laws of thermodynamics since the main flows of energy inputs and outputs in the system can be represented, in this case, the flow for the socio-ecosystem of Tuxtla Gutiérrez, Chiapas. Likewise, all the flows that intervene within the municipality are shown. The rectangle represents the municipality of Tuxtla Gutiérrez, and the elements outside it are flows that are external to the municipality. As they are, renewable resources (sun, rain, nutrients), fuels and minerals (necessary for motorized vehicles), goods (such as vehicles), services, and other goods (federal investment for conservation of roads,

bridges, etc.). Figure 2 summarizes the main energy flows in the municipality of Tuxtla Gutierrez.

4. Simplification of the models to capture the main inputs and outputs to the system, as well as other flows that explain its internal functioning. For Tuxtla Gutiérrez, the flows of the system that appear in table 1 were considered:
5. Construction of a chart with the main eMergy flows.
6. Calculation of emergetics indexes (table 2).

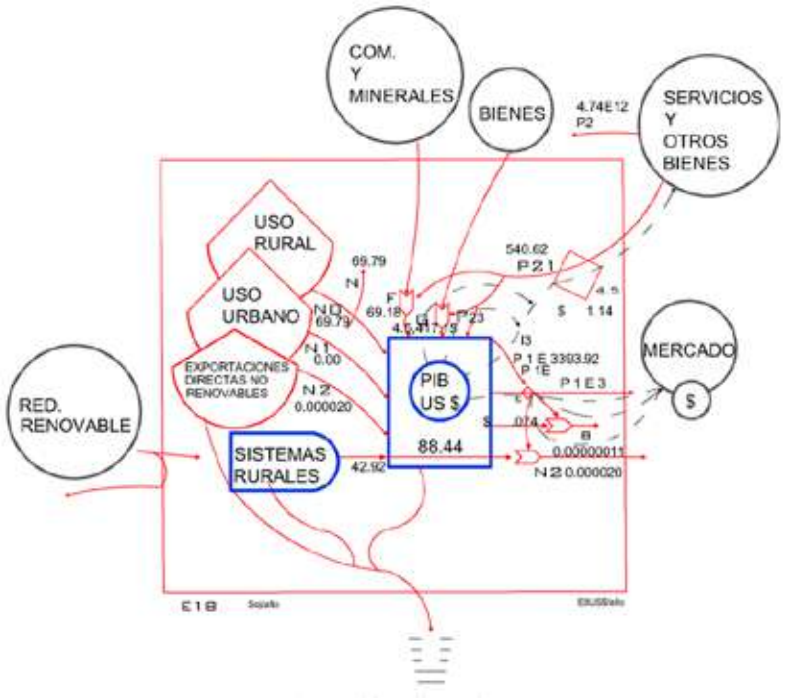


Figure 1. Tuxtla Gutiérrez' energy flows chart. Source: Own elaboration

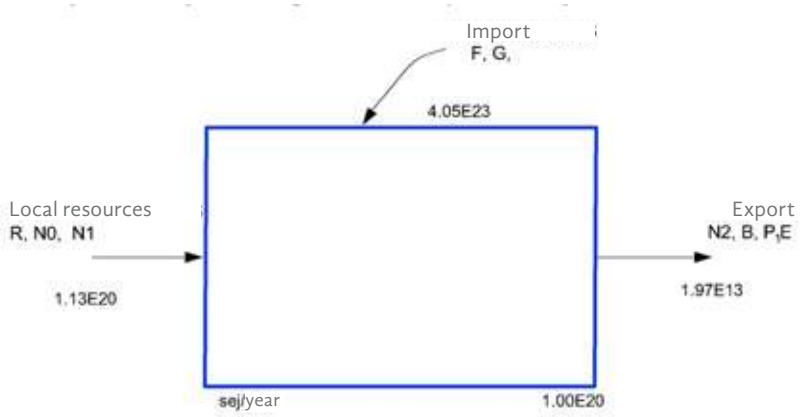


Figure 2. Tuxtla Gutiérrez' energy flows simplified chart. Source: Own elaboration

Table 1
Tuxtla Gutiérrez eMergy flows summary

Symbol	Item	Solar EMergía 1.00E+18 (sej/year)	Dollars 1.00E+18 (US$/year)
R	Renewable resources used (sun, rain, wind, etc.)	42.92	
N	Non-renewable resource flow within Tuxtla Gutiérrez	69.79	
	N0 Dispersed rural resource	69.79	
	N1 Internal consumption	0.00	
	N2 Exported without use	0.000020	
F	Imported fuel and minerals (includes services)	69.18	
G	Imported goods	405417.15	
I	Dollars paid for imports		1.14
P_2I	EMergy value of imported goods and services	540.62	
E	Dollars received from exports		0.74
P_1E	Emergy value of exported goods and services	3393.92	
B	Exported products processed in Tuxtla Gutiérrez	0.0000011	
X	Gross domestic product (GDP) of Tuxtla Gutiérrez		88.44
P_2	Chiapas' eMergy / Chiapas' GDP (used in imports)	4.74E+12	sej/US$
P_1	Tuxtla Gutiérrez' eMergy / Tuxtla Gutiérrez' GDP	4.59E+13	sej/US$

Source: Own elaboration

In table 1, it is observed that, according to its renewable resources, Tuxtla Gutiérrez contributes 42.92E + 18 sej/year, which is the sum of the energy of the sun, rain, wind, and the earth cycle. In the non-renewable resources heading, 69.79E + 18 sej/year were obtained, mostly contributed by the dispersed rural resource. These results indicate that Tuxtla Gutiérrez is a high importer of raw materials, that is, it does not take advantage of its non-renewable resources at all. The transformation (P2) of Tuxtla Gutiérrez (4.74E + 12 sej/US $) also appears in this table, this data was obtained from the total eMergy ratio of Chiapas, between the domestic product of Chiapas and the eMergy P1 (4.59E + 13 sej/US $), which was obtained by dividing the sum of dispersed natural resources (No), plus domestic consumption of non-renewable resources, plus renewable resources used, plus imported goods, fuels and minerals between the gross domestic product of Tuxtla Gutiérrez, Chiapas. The general methodology of how to obtain these emergetical analyzes is described in detail by Odum in his book Environmental

Accounting (1996), being subsequently reviewed by Brown and Ulgiati (2004). Table 2 shows the emergetical indexes calculated for the municipal system. The heading of renewable eMergy flows contributes 4.29E + 19 sej/year and that the heading of non-renewable resources contributes 6.98E + 19 sej/year, which is much lower than the national contribution (2.21E + 25 sej/year) and the state (2.70E + 25 sej/year) (Ramos, 2016). This is explained because most of the territory is an urban area.

Table 2
Tuxtla Gutierrez emergetic indexes

Index	Expression	Quantity	Units
Renewable eMergy flow	R	4.29E+19	sej/year
The flow of local non-renewable reserves	N	6.98E+19	sej/year
Imported eMergy flow	F + G	4.05E+23	sej/year
Total eMergy entries	R + N + F + G	4.06E+23	sej/year
Total eMergy used (U)	N0 + N1 + R + F + G	4.06E+23	sej/year
Total eMergy exported	N2 + B	1.97E+13	sej/year
Fraction of eMergy used derived from local resources	(N0 + N1 + R) / U	0.000278	
Imports minus exports	(F + G) - (N2 + B)	4.05E+23	sej/year
Export to import rate	(N2 + B) / (F + G)	0.00000000005	
The ratio of local eMergy to total eMergy	R / U	0.00011	
EMergy acquired to total eMergy rate	(F + G) / U	0.9997	
Free eMergy to total eMergy rate	(R + N0) / U	0.00028	
Processed eMergy to free eMergy rate	(F + G + N1) / (R + N0)	3597.64	
EMergy per unit area (4.12E+08 m²)	U / area	9.84E+14	sej/m²
EMergy per capita	U / population	6.61E+17	sej/person
Total eMergy to GDP rate	P1 = U / PIB	4.59E+13	sej/$
Electricity to total eMergy rate (includes hydroelectric and thermoelectric)	Electricity / U	0.999	sej/year
Fuel use per capita (domestic consumption of natural gas and oil)	Fuel / population	5.98E+13	sej/year

Source: Own elaboration

The total exported eMergy is 1.97E + 13 sej/year, which is lower than the index at the state level, 2.57E + 25 sej/year (Ramos, 2016), which is explained because Tuxtla Gutiérrez exports very few goods and resources. This is confirmed by the index of imports minus exports, 4.05E + 23 sej/year, and the index of exports to imports 0.00000000005 units, close to zero, which indicate that the number of exports is much lower than that of imports. The relationship between local eMergy and total eMergy is an

indicator of the use of natural resources, that is, how sustainable society is. In the case of Tuxtla Gutiérrez, this relationship is 0.00011 (0.011%), a very small index, so it is inferred that the city is not very sustainable. The amount of real wealth that circulates through the money reserve is indicated by the total eMergy rate index to GDP (P1), in this case, it was 4.59E + 13 sej/year, which shows the economic strength of Tuxtla Gutierrez. Finally, emergy spending per person was high, 6.61E + 17 sej/year.

CURRENT URBAN MOBILITY IN TUXTLA GUTIÉRREZ

The excessive use of owned cars has had a negative impact on the city since a chaotic circulation is generated, which directly influences the environment, the economy, and society itself, causing health problems due to pollution and environmental noise. This situation is exacerbated due to the poor quality of public transport and the disorderly growth of the urban area.

In 2011, the percentage of the modal distribution of transport was distributed 28% in private cars, 48% in public transport, and 24% in non-motorized active means, while government spending on urban transport was distributed 75% to cars, 11% to public transport and 3% to non-motorized transport (Municipal Government of Tuxtla Gutiérrez, 2014). This shows a clear tendency for governments to privilege the car over mass public transport, which inhibits the use of non-motorized means of transport and raises social and environmental costs in cities. Figure 3 shows the chart for general mobility energy flows of Tuxtla Gutiérrez.

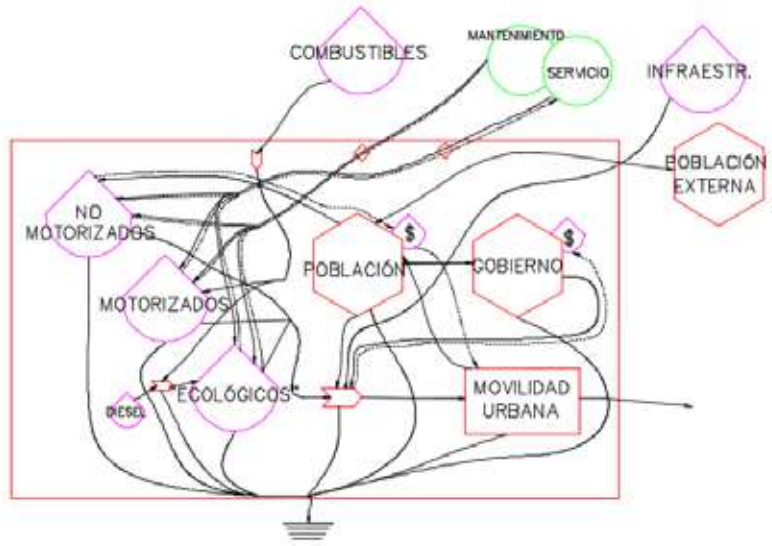


Figure 3. Simplified chart of Tuxtla Gutiérrez' mobility energy flows. Source: Own elaboration

Owned vehicles mobility eMergy analysis

Based on the flowchart in figure 3, we made a flowchart for the case of mobility by owned vehicles, in which the interaction of the flows in it is observed in more detail, from production to delivery operation and maintenance (see figure 4).

It can be seen that the chart in figure 4 emerges from the tank for Motorized Vehicles contained in figure 3, here all the flows that enter the system are shown: fuels -gasoline and oil in the case of owned vehicles-, machinery -which includes the production processes of the vehicle-, labor and services, infrastructure and maintenance -which considers roads, concrete and asphalt, payments, and contributions, which correspond to payments for vehicle ownership and insurance, to the state and federal governments -. All this results in the product of mobility to users. In the chart in Figure 4 there is no external renewable source flow -sun, wind, and rain-, this is because these flows are not required for mobility, since their main source of supply is fossil fuels.

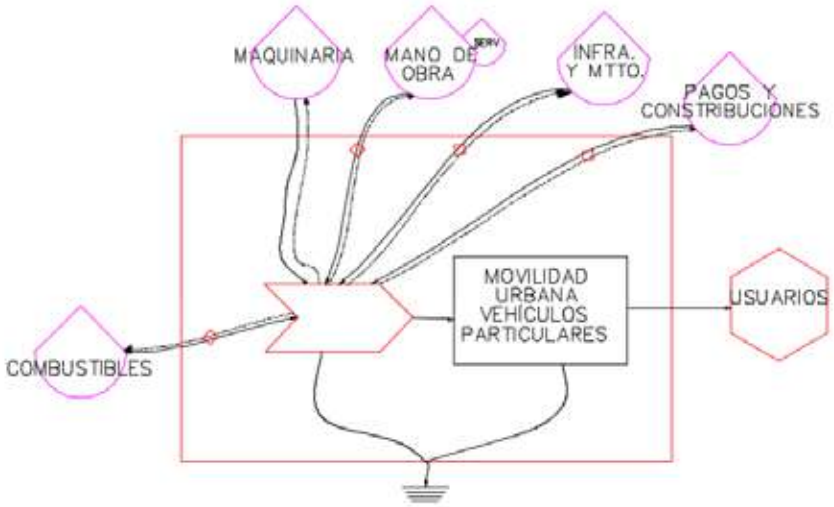


Figure 4. Simplified chart of mobility energy flows of Tuxtla Gutiérrez using owned vehicles. Source: Own elaboration

Taxi emergetic mobility analysis

Urban mobility through taxis involves the consumption of different material and intangible goods. The first consumption is that of space. Mobility demands space when the circulation infrastructure is built and when people use that infrastructure. The second consumption is energy, which in some societies is a scarce good. All motorized vehicles consume energy, from the vehicle production process to operation and maintenance, in addition to

other factors that influence mobility such as unit depreciation and annual miles driven estimated by auto dealers. The third consumption is financial resources. This cost affects the government with the costs of road maintenance, signaling, operation, and inspection of traffic.

Figure 5 shows the flowchart in which the inputs of tangible and intangible goods appear, which are correlated with mobility. This diagram shows the interaction of flows, from production to operation and maintenance, and the salaries that the vehicle operator includes. It can be seen that the chart in figure 5 emerges from the tank of Motorized Vehicles contained in figure 3, here all the flows that enter the system are shown: fuels –gasoline and oil in the case of taxi-, machinery –which includes the production processes of the vehicle-, labor and services, infrastructure and maintenance -which considers roads, concrete and asphalt-, payments and contributions, which correspond to payments for vehicle ownership and insurance, to the state and federal governments.

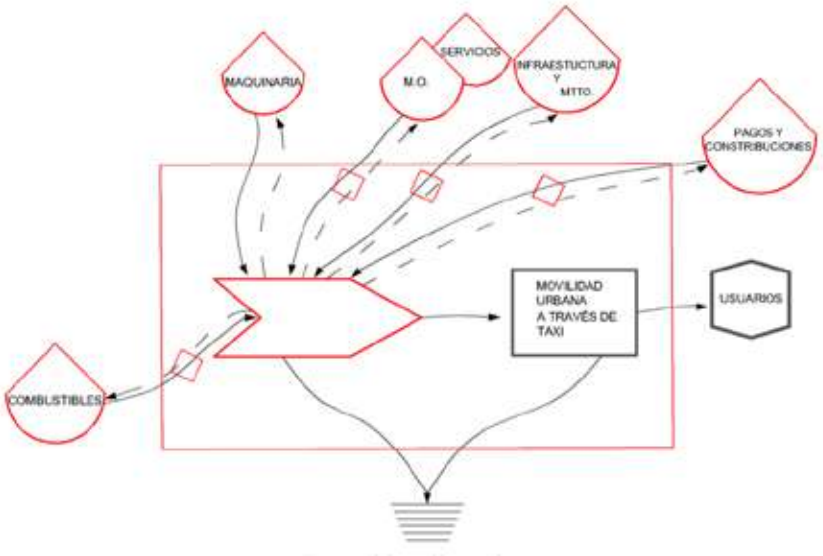


Figure 5. Simplified chart of mobility energy flows of Tuxtla Gutiérrez using taxis. Source: Own elaboration

In the case of taxis, service payments are considered, which include the salary of the unit's driver(s). All this results in the product of mobility to users. It is observed that in the diagram in figure 5 there is no flow from a renewable external source - sun, wind, and rain - since its main source of supply is fossil fuels. This chart is identical to that of figure 4 because private vehicles are acquired for taxi use, and they are adapted for public transport services as a taxi.

Bus mobility emergetic analysis

For this modality the same observations can be made as in the taxi modality, that is, space, energy, and financial resources are consumed. Therefore, the same methodology that was used in the analysis of owned vehicle mobility and taxi mobility was used. Thus, in figure 6 the flowchart for mobility through the bus is presented. This chart shows more precisely the interaction of the flows in it: production, operation, maintenance, and the salary of the unit operator.

For the chart in figure 6, the same observations can be made as for the chart in figure 4, that is, all the flows that enter the system are shown: fuels -gasoline and oil in the case of public transport-, machinery - that includes the production processes of the vehicle-, labor and services, infrastructure, and maintenance -which considers roads, concrete, and asphalt, payments, and contributions, which correspond to payments for vehicle ownership and insurance, to the state and federal governments. In the case of public transportation, payments for services that include the salary of the unit's driver(s) are considered. All this results in the product of mobility to users. It is observed that in the chart in figure 6 there is no flow from a renewable external source -sun, water, and rain-, this is since these flows are not required for mobility, since their main source of supply is fossil fuels.

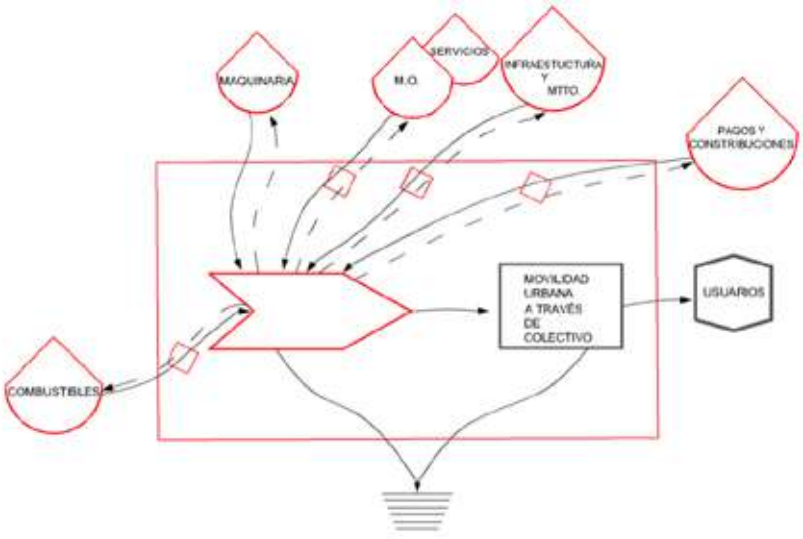


Figure 6. Simplified chart of mobility energy flows of Tuxtla Gutiérrez using public transport.
Source: Own elaboration

Conejobús mobility emergetic analysis

This is one of the most used means of transport in Tuxtla Gutiérrez, it is called *Conejobús* because the inhabitants of this city are known as rabbits (*conejos*). This means of transportation arose when the Chiapas government developed a program to replace 144 *combi*-type units on the main routes of Tuxtla Gutiérrez - routes 1 and 2-. With the *Conejobús*, an attempt was made to establish a more environmentally friendly transport system that would pollute less, stimulate the industry, promote the creation of new jobs and constitute a vision of the future to make cities with sustainable transport.

Urban mobility through the *Conejobús* involves the consumption of different material and intangible goods. The first consumption is that of space. Mobility demands space when there is a construction of circulation infrastructure and when people use said infrastructure. The second consumption is that of energy, which in many cases is a scarce good. Energy is consumed by all motorized vehicles, from the vehicle manufacturing process to operation and maintenance. The third consumption is that of financial resources. On the one hand, this cost affects the government, with road maintenance costs, signaling, operation, and traffic control. Figure 7 shows the flowchart for the *Conejobús* mobility.

This figure shows the interaction of flows, from operation and maintenance to the unit operator's salary. These flows are fuels -diesel and motor oil-, machinery -which includes the unit's production processes, contained in the import item-, labor and services, infrastructure, and maintenance. -this item considers roads, concrete, and asphalt-, and finally, payments and contributions, which correspond to payments for vehicle ownership and insurance, to the State Government and the Federal Government, respectively.

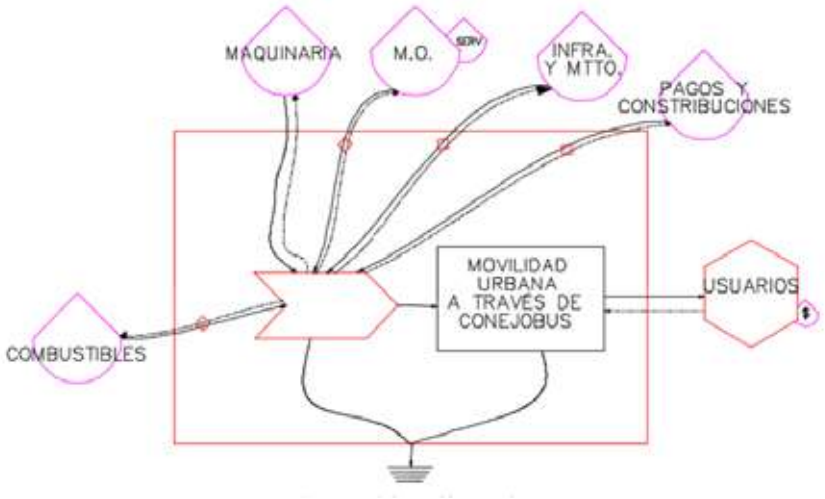


Figure 7. Simplified chart of mobility energy flows of Tuxtla Gutiérrez using *Conejobús*. Source: Own elaboration

It is observed that in this diagram there is no external renewable source flow - sun, wind, rain, etc.-, which is because these flows are not required for mobility, that is, the functionality does not depend on these resources but on fossil fuels.

Bike mobility emergetic analysis

Based on the Tuxtla Gutiérrez mobility flow chart (figure 3), the bike mobility chart is developed (figure 8). This last diagram shows the interaction of the flow, from production to operation and maintenance, as well as the roads used for circulation. In figure 3 the bike mobility alternative is contained within the heading "non-motorized" since the use of the bicycle does not require the use of a motor but rather the rider's strength and physical condition.

For this reason, a fuel item is not included, since the bike does not require it since it is more ecological mobility. The following flows are involved in mobility by bicycle: machinery supply -which includes the unit's production processes, contained in the import item-, labor and services, infrastructure and maintenance that considers concrete and asphalt roads, it is appreciated that there is no monetary section since anyone can use this mobility without having to pay for it - which makes it more attractive - as in the case of the previous modalities.

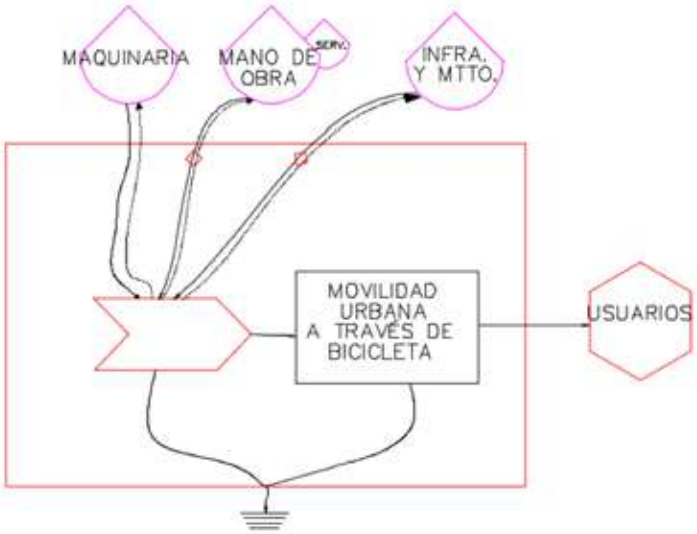


Figure 8. Simplified chart of mobility energy flows of Tuxtla Gutiérrez using bikes. Source: Own elaboration

It is observed that there is no external renewable source flow –sun, wind, rain, etc. -, since this type of ecological mobility does not use any of these resources because its operation is based on the rider's physical condition.

Motorcycle mobility emergetic analysis

Urban mobility by motorcycle involves the consumption of different material and intangible goods. The first consumption that this modality demands is space, this occurs in two situations: when there is a construction of circulation infrastructure and when people use said infrastructure. The second consumption is that of energy consumed by all motorized vehicles, from the vehicle's production process to operation and maintenance, in addition to other aspects such as the depreciation of the unit and the annual kilometers traveled. The third consumption is that of financial resources, which affects the government with the costs of road maintenance, signaling, operation, and traffic control.

The chart in Figure 9 shows the interaction of flows of this modality, from production to operation and maintenance. All the flows in the system are observed: fuels –gas and motor oil-, machinery - which includes the unit's production processes contained in the import item-, labor and services, infrastructure and maintenance –which considers roads, concrete and asphalt-, and payments and contributions –which correspond to payments for vehicle ownership and insurance, to the State and Federal Governments-.

It is appreciated that there is no monetary deposit because anyone can use this mobility without having to give a monetary reward. Neither is there a flow from a renewable external source - sun, wind, rain, etc. -, given that this mobility does not require these flows because it uses fossil fuels for its operation.

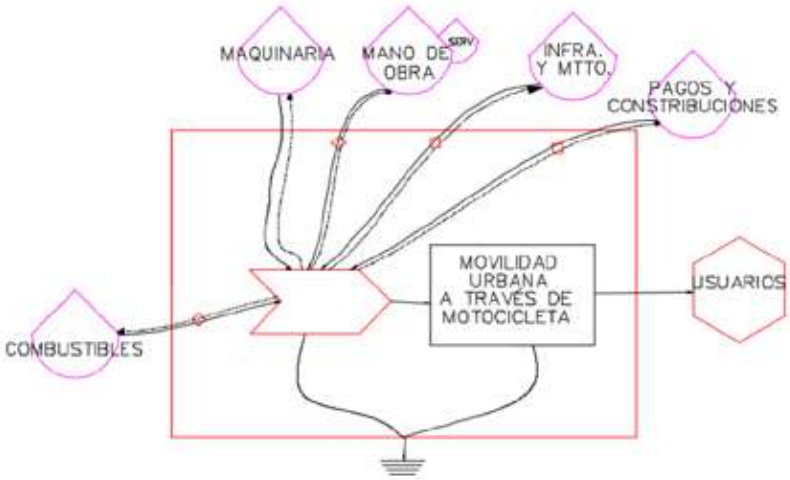


Figure 9. Simplified chart of mobility energy flows of Tuxtla Gutiérrez using motorcycles.
Source: Own elaboration

RESULTS ANALYSIS

Tuxtla Gutiérrez' urban mobility eMergency indexes

Table 3 summarizes the urban mobility indexes, obtained for the urban mobility modalities presented in the previous sections. This methodology, based on eMergy, has a technical and quantitative nature since all the flows involved in mobility are considered and translated into a common unit to be able to add them together. From this, the indexes that allow evaluating the sustainability of the current urban mobility system of Tuxtla Gutiérrez are calculated.

It can be seen in this table that the mobility that consumes the least eMergy is the bike, 22.19E + 16 sej/year, which represents 1.58% of the total eMergy consumed by the system. Followed by the motorcycle that contributes to the system 51.81E + 16 sej/year, 3.68% of the total, the private vehicle with 264.26E + 16 sej/year, 18.77% of the total, the taxi that contributes 290.26E + 16 sej/year, 20.62% of the total, the bus with 317.16E + 16 sej/year, 22.54% of the total and, finally, the Conejobús with 461.76E + 16 sej/year, 32.81% of the total.

The mobility modality that contributes the most eMergy to the system is the Conejobús, which is because much more eMergy is required for the unit's production, as well as more eMergy for its operation and maintenance (see graph 1).

One of the most important indexes in table 3 is the eMergy index per kilometer per person per type of unit. This index makes it possible to directly compare the different alternatives, that is, the eMergy that each alternative contributes to the system, per person who occupies it, and per kilometer traveled by the units. According to the results obtained, it is observed that although the Conejobús contributes more eMergy to the system, it is the most efficient modality given that its eMergy index per kilometer per person is 1.46E + 12 sej/km/person, 0.6% of all the eMergy per kilometer per person of all the alternatives.

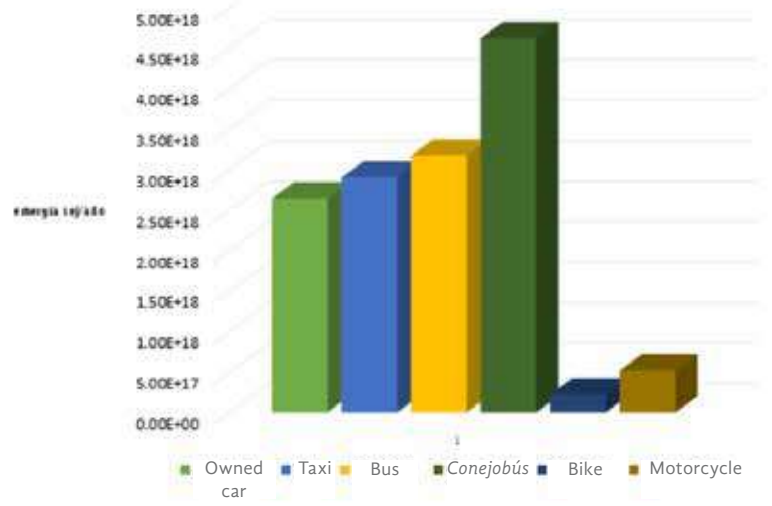
Table 3
Tuxtla Gutiérrez' urban mobility eMergy indexes comparative summary

Indexes		Unit	Public transport in the modality of:					
			Owned car	Taxis	Bus	*Conejobús*	Bike	Motor-cycle
EMergy use by unit type	1.00E+16	sej/year	264.23	290.26	317.16	461.76	22.19	51.81
The economic component of eMergy acquired (M+S) by type of mobility (unit)	1.00E+15	sej/year	294.90	555.15	824.21	1850.47	6.41	17.80
EMergy economic component acquired (M+S) by all units	1.00E+18	sej/year	35752.00	2127.32	1695.39	146.19	8.27	26.70
Free eMergy ecological component (R+N) by type of mobility (unit)	1.00E+16	sej/year	234.74	234.74	234.74	276.71	21.55	50.03
Free ecological eMergy component (R+N) by all units	1.00E+18	sej/year	284589.39	8995.39	4828.68	218.60	278.25	750.44
Investment rate (econ/ecol) (M+S)/ (R+N) by type of mobility (unit)			0.126	0.236	0.351	0.669	0.0297	0.0356
Investment rate (econ/ecol) (M+S)/ (R+N) for all units			15230.21	906.23	722.23	52.83	38.38	53.36
ICA (Environmental Load Index) ((N+M+S)/R			Undefined	Unde-fined	Unde-fined	Unde-fined	Unde-fined	Unde-fined
Energy per kilometer per person per unit type per year	1.00E+12	sej/km/ per	117.44	11.36	1.58	1.46	45.99	51.81
Energy per type of alternative per year	1.00E+12	sej/km	176.16	39.76	25.26	87.85	45.99	51.81
Total mobility eMergy by type of alternatives	1.00E+20	sej/year	3203.41	111.23	65.24	3.65	2.87	7.77
Total mobility eMergy through the different alternatives per person	1.00E+15	sej/year /per	802.58	942.06	48.05	7.42	221.94	518.09

Source: Own elaboration

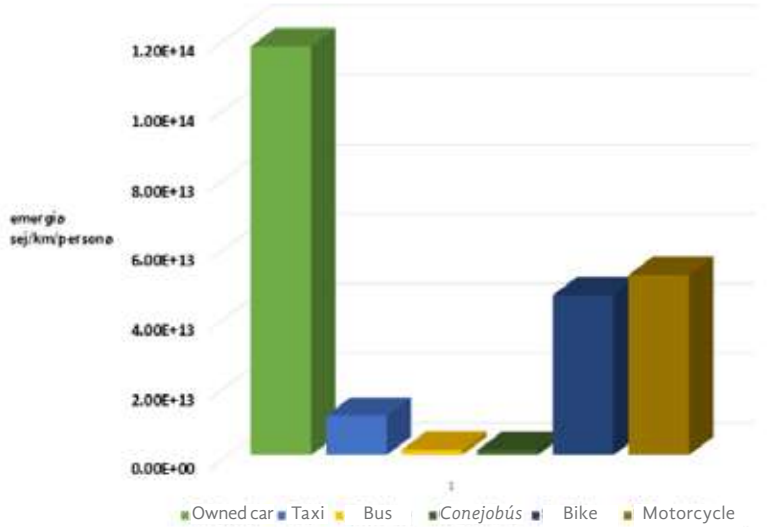
Similarly, the alternative that contributed very little eMergy was the bus (combi) with 1.58E + 12 sej/km/person (see table 3 and graph 2). This is

because the occupancy rate and routes are high, that is, this type of urban mobility works approximately 16 hours a day, and with a capacity of 14 seats, which is why it is a more efficient mobility option. We must keep in mind that many factors do not allow this alternative to be fully exploited, among them the lack of maintenance of the units, drivers who drive without caution, and poor planning of the routes.



	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
EMergy use U	2.642E+18	2.903E+18	3.172E+18	4.618E+18	2.219E+17	5.181E+17

Graph 1. Use of eMergy U in Tuxtla Gutiérrez' urban mobility. Source: Own elaboration

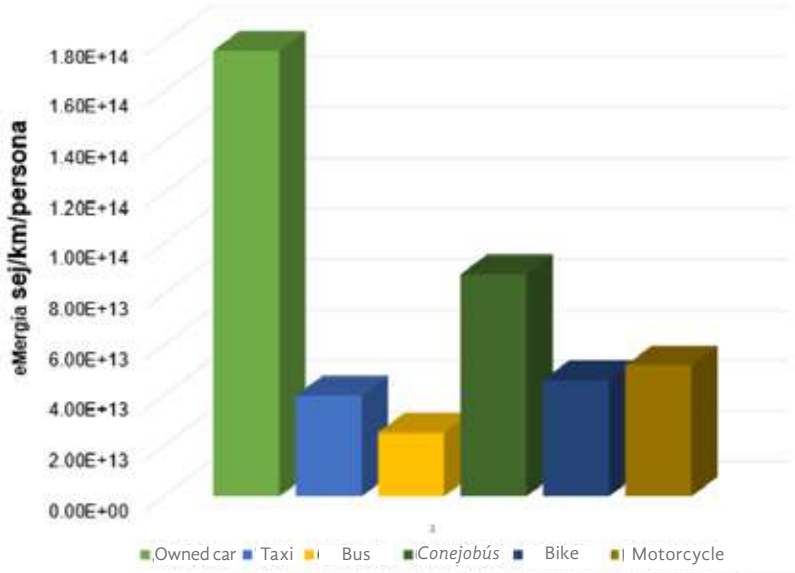


	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
EMergy per kilometer per person per type of unit per year	1.174E+14	1.136E+13	1.579E+12	1.464E+12	4.599E+13	5.181E+13

Graph 2. EMergy/km/person index of urban mobility's different alternatives. Source: Own elaboration

The next alternative that contributes a low eMergy index to the system (see table 3 and graph 2) is the taxi, with 11.36E+12 sej/km/person, 4.9% of the total calculated index, 8 times more than the contribution from the *Conejobús*. It is also observed that, although the motorcycle and bike alternatives do not consume much energy for unit production, operation, and maintenance, nor fuel, they are the least efficient, since they contribute to the system 45.99E+12 sej/km/person (20% of the total) and 51.81E+12 sej/km/person (22.60% of the total) respectively. Finally, the least efficient alternative is that of the private vehicle, which contributes 51.1% of the total eMergy, this is because the occupancy rate is very low.

Table 3 also shows the eMergy index by type of alternative per kilometer, this calculation identifies which modality consumes more eMergy for each kilometer traveled daily. Although the bike is the alternative that consumes less eMergy in the system, it contributes a lot of eMergy per kilometer traveled, 45.99E+12 sej/km. The mobility alternatives that contribute the least eMergy to the system are taxi and bus, with 39.76E+12 sej/km and 25.26E+12 sej/km, respectively. It is observed that the bus is the modality that contributes the least eMergy to the system per kilometer traveled. Graph 3 shows these results.

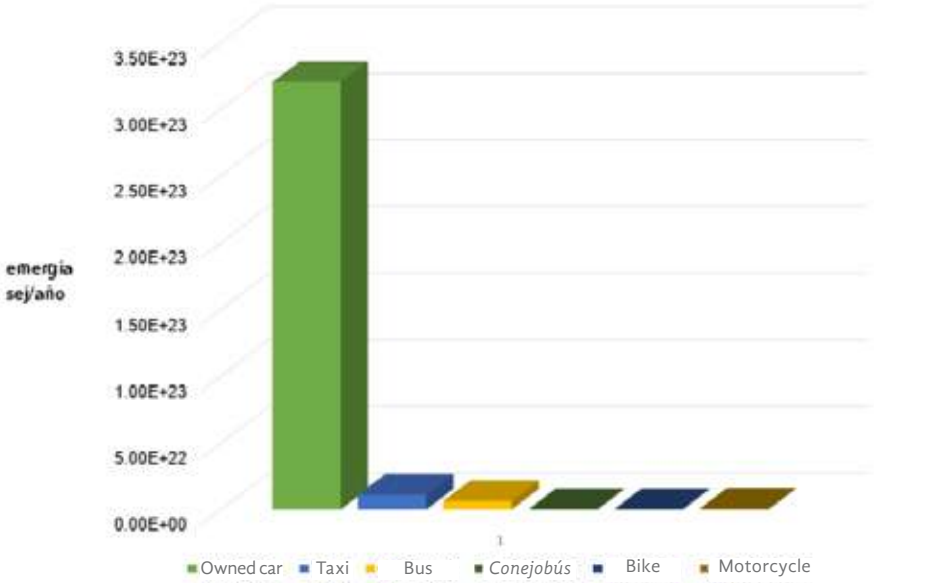


	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
EMergy per type of alternative per km	1.762E+14	3.976E+13	2.526+13	8.785E+13	4.599E+13	5.181E+13

Graph 3. EMergy per km index of urban mobility's different alternatives. Source: Own elaboration

Two more indexes were calculated to know the footprint of all the urban mobility alternatives currently existing in Tuxtla Gutiérrez. The first index

is the total eMergy of mobility by type of alternatives, for which it was obtained that the bike is the most efficient modality (see table 3), which is due to the reduced number of bikes that circulate in the city. This alternative contributes 2.87E+20 sej/year to the system, while the motorcycle contributes 7.77E+20 sej/year. Regarding public transport, the alternative that provides the most eMergy is the taxi (111.23E+20 sej/year), followed by the bus (65.24E+20 sej/year) and the *Conejobús* (3.65E+20 sej/year). As in the previously calculated indices, the alternative that contributes the most eMergy to the system is the private car with 3203.41E+20 sej/year. Graph 4 summarizes these results.

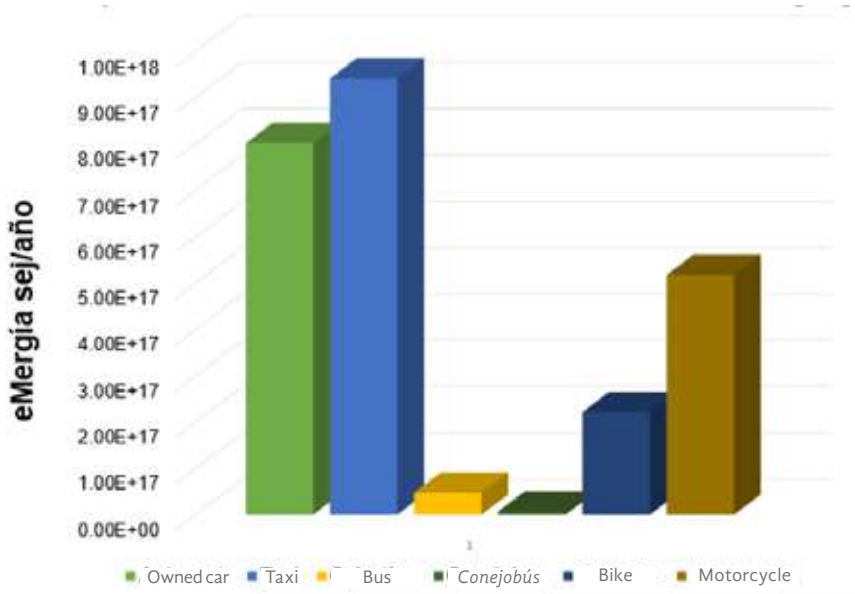


	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
Total mobility eMergy per type of alternatives	**3.203E+23**	**1.112E+22**	**6.524E+21**	**3.648E+20**	**2.865E+20**	**7.771E+20**

Graph 4. Total mobility eMergy index per the alternatives type of urban mobility. Source: Own elaboration

The second index calculated is the total mobility eMergy of the different alternatives per person. It was found that the most efficient alternative was the Conejobús, which contributes 7.42E+15 sej/year/person to the system, followed by the bus that contributes with 48.05E+15 sej/year/person. Although the bicycle proved to be more efficient in some cases, it ranks third in efficiency since it participates with 221.94E+15 sej/year/person, an amount that is much higher than those of the Conejobús and the bus. In fourth place is the motorcycle, which contributes to the system 518.09E+15 sej/year/person, then there is the private car with 802.58E+15 sej/year/person, finally, the first place in inefficiency corresponds to the taxi that

contributes with 942.06E+15 sej/year/person. It is worth mentioning that obtaining these two indexes, influences the amount of occupation of each alternative and the registered number of existing units for each modality greatly. This index is used to compare the amount of eMergy provided by each urban mobility alternative. Graph 5 presents these results.



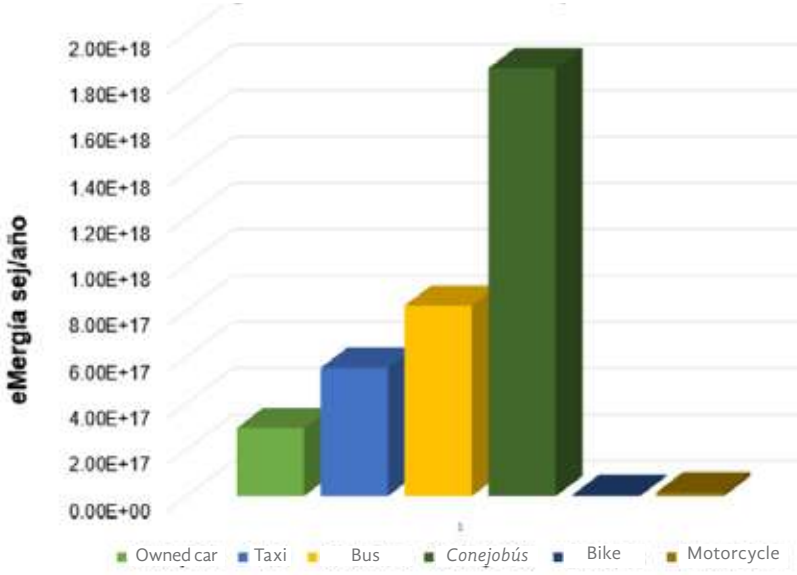
	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
Total mobility eMergy through different alternatives per person	**8.026E+17**	**9.421E+17**	**4.805E+16**	**7.415E+15**	**2.219E+17**	**5.181E+17**

Graph 5. Total mobility eMergy index through different alternatives per person. Source: Own elaboration

Graph 6 shows the results for the economic component index of acquired eMergy (M+S) by type of mobility. It is observed that the bicycle is the alternative that contributes the least eMergy to the system with 6.41E+15 sej/year, which indicates that this modality consumes little eMergy in terms of the purchase of inputs, a characteristic that makes it attractive. The private vehicle contributes with 294.90E+15 sej/year, the motorcycle participates with 17.80E+15 sej/year, the taxi with 555.15E+15 sej/year, the bus with 824.21E+15 sej/year, and the Conejobús with 1850.47E+15 sej/year, this last alternative is the one that contributes the most eMergy to the system.

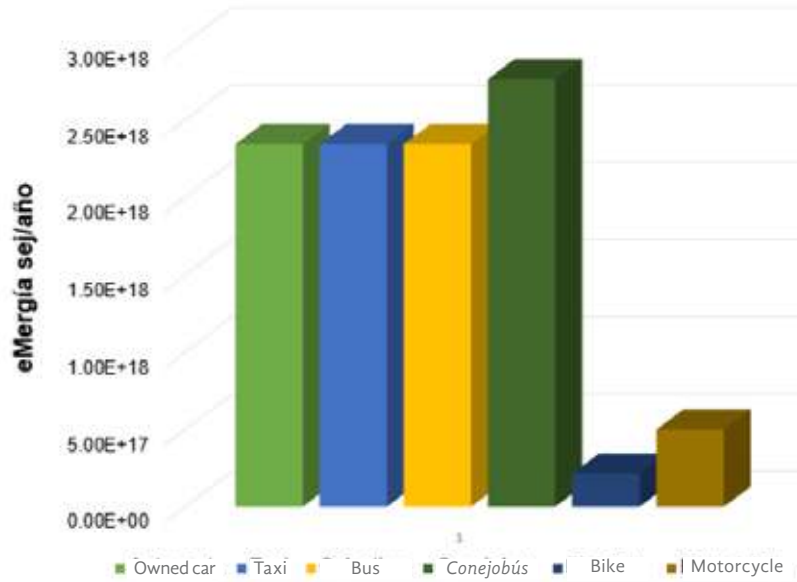
Regarding the ecological component (R+N), the alternative that contributes less eMergy to the system is the bike with 21.55E+16 sej/year. Next is the motorcycle with 50.03E+16 sej/year, while the Conejobús participates with 276.71E+16 sej/year. Finally, the alternatives of the private vehicle, taxi, and bus have the same emergetic contribution 234.74E+16 sej/year. It should be mentioned that, in the urban mobility of the city of Tuxtla Gutiérrez, Chiapas, renewable sources of energy do not intervene, for this reason,

only non-renewable sources were considered in the calculations. Graph 7 summarizes these results.



	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
Acquired eMergy economic component (M+S), per type of mobility	**2.949E+17**	**5.551E+17**	**8.242E+17**	**1.850E+18**	**6.408E+15**	**1.780E+16**

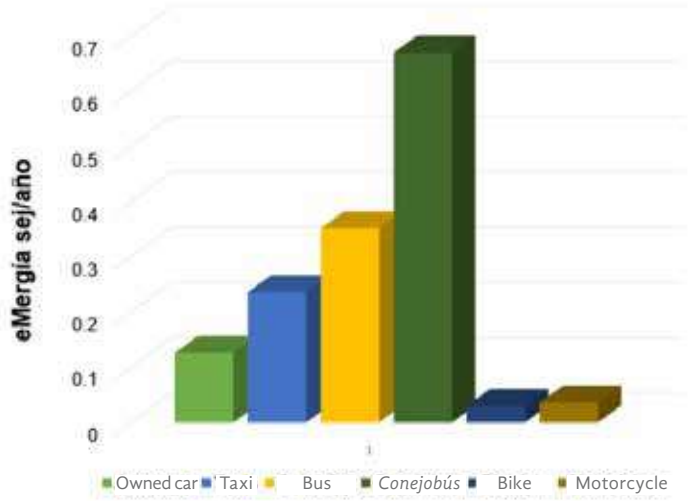
Graph 6. Unit eMergy economic component (M+S). Source: Own elaboration



	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
Free eMergy ecologic component (R+N), per type of mobility	**2.347E+18**	**2.347E+18**	**2.347E+18**	**2.767E+18**	**2.155E+17**	**5.003E+17**

Graph 7. Unit eMergy ecologic component (R+N). Source: Own elaboration

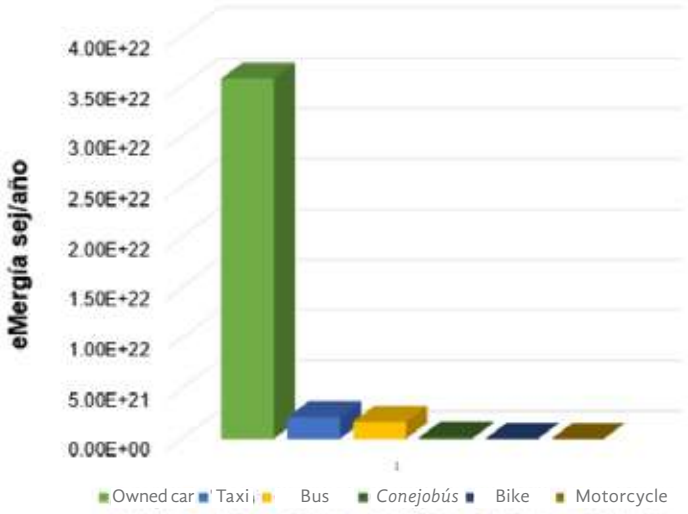
The results for the investment rate (IT) are presented below. It is appropriate to mention that the larger the index, the more it depends on purchased or imported inputs than on local resources. Graph 8 shows that the alternative with the lowest investment rate is the bike with 0.0297, followed by the motorcycle with 0.0356. In third place is the private vehicle whose investment rate is 0.126. The taxi shows an investment rate of 0.236, the bus of 0.351, and the Conejobús of 0.669. As seen, the Conejobús has the highest investment rate.



	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
Investment rate (econ/ecol) (M+S)/(R+N) per type of mobility	**0.126**	**0.236**	**0.351**	**0.669**	**0.030**	**0.036**

Graph 8. Unit investment rate (M+S)/(R+N). Source: Own elaboration

The results of the economic component of the acquired eMergy (M+S) index for all mobility in general in its different alternatives are shown below (see graph 9). Once again, the bike is the alternative that contributes the least eMergy to the system with 8.27E+18 sej/year, a result that indicates that in this mobility alternative (where the total number of registered bikes is considered), too much eMergy is not consumed in the purchase of inputs. The motorcycle modality contributes with 26.27E+18 sej/year, the taxi with 217.32E+18 sej/year, the bus with 1695.39E+18 sej/year, and the Conejobús with 146.19E+18 sej/year. The Conejobús is the one that contributes the least eMergy to the system, unlike what was found for the unit calculation (graph 7) where this alternative was the one that contributed the most eMergy. Finally, the private vehicle participates with 35752.00E+18 sej/year, the highest contribution of eMergy to the system.

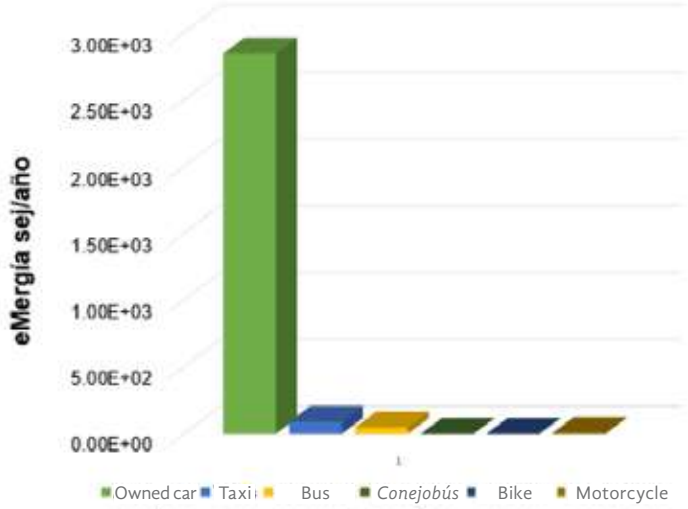


	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
EMergy economic component (M+S), per all units	**3.575E+22**	**2.127E+21**	**1.695E+21**	**1.462E+20**	**8.272E+18**	**2.670E+19**

Graph 9. EMergy economic component (M+S) per all units. Source: Own elaboration

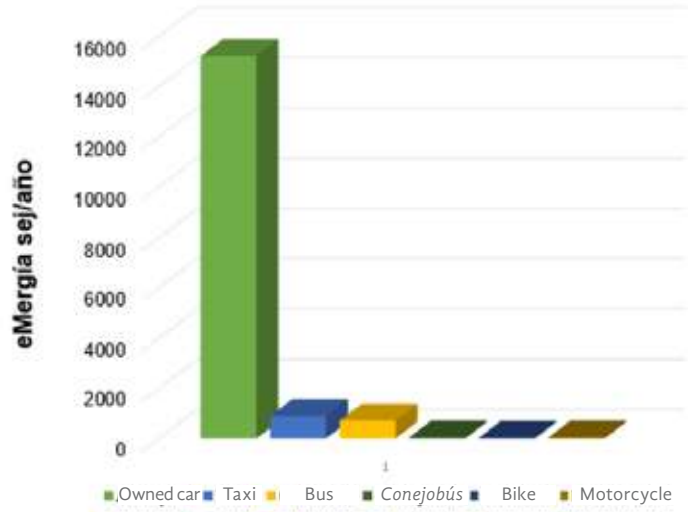
Graph 10 summarizes the results for the ecological component (R+N) of all the existing alternatives. The modality that contributes the least eMergy to the system is the *Conejobús* with 218.60E+18 sej/year, followed by the bike that contributes with 278.25E+18 sej/year. The motorcycle participates with 750.44E+18 sej/year, the private vehicle is the alternative that contributes more eMergy to the system with 284589.39E+19 sej/year. The taxi participates with 8995.39E+18 sej/year and the bus with 4828.68E+18 sej/year. It should be mentioned that the alternative that contributes less eMergy to the system is the *Conejobús* and not the bike, which is because there are fewer *Conejobús* buses units than bicycles. That is, if there were more registered *Conejobús* units, the index obtained would have been higher. It should be noted that urban mobility modalities do not use renewable sources of energy, therefore only the non-renewable source was considered.

Next, graph 11 presents the results for the investment rate (TI). It is appropriate to indicate that the larger the index, the greater the amount of eMergy purchased per resident eMergy unit, that is, the higher the index, the more dependent it is on purchased or imported inputs than on local resources. It can be seen that the bike is the alternative with the lowest investment rate with 38.38, followed by *Conejobús* with 52.83, this last contribution was greater in the unit evaluation (graph 8) than in the evaluation for all units (graph 11). Next, the motorcycle with an investment rate of 53.36, the bus with 722.23, the taxi with 906.23, and the private car with 15230.21, again this last modality is the one with the highest investment rate.



	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
EMergy economic component (M+S), per all units	**2.846E03**	**8.995E+01**	**4.829E+01**	**2.186E+00**	**2.783E+00**	**7.504E+00**

Graph 10. EMergy ecologic component (R+N) per all units. Source: Own elaboration



	Owned car	Taxi	Bus	*Conejobús*	Bike	Motorcycle
Investment rate (econ/ecol) (M+S)/(R+N) per all units	**15230.21**	**906.23**	**722.23**	**52.83**	**38.38**	**53.36**

Graph 11. Investment rate (MS)/(R+N) per all units. Source: Own elaboration

CONCLUSION

The growing use of petroleum-derived fuels, together with current mobility patterns in Tuxtla Gutiérrez, has a significant influence on the city's environmental environment. This situation affects climate change, global warming, the deterioration of the ozone layer, air and noise pollution, and particularly in the population that travels daily to carry out their daily activities. In all this, the transport sector has a high share of responsibility since it causes non-sustainability in urban mobility in Tuxtla Gutiérrez.

According to the results presented in this work, it is concluded that the current urban transport system, in its different modalities, is not sustainable. It was found that the alternative mobility that consumes the least eMergy is the bicycle with 22.19 E+16 sej/year, which represents 1.58% of the total eMergy consumed by the system. In contrast, the alternative mobility that consumes the most eMergy is the Conejobús with 461.76 E+16 sej/year, 32.81% of the total eMergy. The calculation of the eMergy index per kilometer per person by the type of unit shows that the Conejobús is the most efficient modality given that the eMergy index per kilometer per person is 1.46E+12 sej/km/person, 0.6% of all the eMergy per kilometer per person of all the alternatives. In second and third place are the bus (1.58E+12 sej/km/person) and bikes (45.99E+12 sej/km/person), 0.7% and 20% respectively of the total.

The eMergy index by type of alternative per kilometer allows us to identify that the alternative that contributes the most eMergy to the system is the private vehicle 176.16E+12 sej/km (41.27%), followed by public transport and motorcycles, with emergetic contributions, respectively, of 87.85E+12 sej/km (20.58%) and 51.81E+12 sej/km (12.14%). It was found that although the bike is the alternative that consumes the least eMergy of the system, it contributes a lot of eMergy per kilometer traveled, 45.99E+12 sej/km (10.77%). The results for the total eMergy mobility index by type of alternatives indicate that the bicycle is the most efficient modality, with 2.87E+20 sej/year (0.08%), followed by Conejobús 3.65E+20 sej/year (0.11 %), and by the motorcycle 7.77E+20 sej/year (0.23%). As with the previous indexes, the alternative that contributes the most eMergy to the system is the private car with 3,203.41 E+20 sej/year (94.38%). On the other hand, the index of the total eMergy mobility of the different alternatives per person indicates that the most efficient alternative is the Conejobús, which contributes to the system 7.42E+15 sej/year/person (0.29%), followed by the bus which contributes 48.05E+15 sej/year/person (1.89%). Although the bike proved to be more efficient in some cases, it occupies the third place in efficiency since it participates with 221.94E+15 sej/year/person (8.74%), an amount that is much higher than those of the Conejobús and the bus. It must be kept

in mind that urban mobility must be economic, ecological, and equitable. The intersection of these three conditions supposes an environment in which it is possible to live better or with a certain quality of life, a situation that Tuxtla Gutiérrez does not comply with. As has been shown, most of the inhabitants of this city prefer the use of internal combustion vehicles, particularly their owned cars, which implies a great consumption of space and energy. In addition, the use of these vehicles causes polluting emissions, noise, traffic accidents, and road congestion. Consequently, it is confirmed that the urban mobility of Tuxtla Gutiérrez is not sustainable.

This situation can be reversed, or at least slow down its growth, taking into account the following recommendations: reducing the use of imported resources and increasing the use of renewable energies, reducing energy consumption in transportation, mainly owned vehicles - to reduce its eMergy-, delay or stop urban dispersion to avoid long routes, create multimodal transport systems -according to the rates obtained-, that is, create a transport system in which the entry of private vehicles is not allowed in the areas of greater circulation, make public transport more efficient and create the adequate infrastructure for the massive use of bikes, which, according to the results achieved, is the most convenient alternative for urban mobility.

It should be remembered that the bike is the most convenient option for traveling short distances and that public transport is the most convenient option for traveling long distances. Thus, it would be convenient for Tuxtla Gutiérrez to integrate these two modalities so that people can make long trips door to door without having to use private vehicles. Integrating bikes with public transport implies having places to store bikes in bus stations or places close to them and enabling these systems so that people can transport their personal bikes through different areas of the city. The intention is that users of one mode or another stop using their private vehicles and start using public transport and bikes. A future line of work should propose this multimodal transport system, to articulate these two means of transportation, and thus be able to carry out the operations of transferring people more quickly and efficiently, considering the rates calculated in this work. Additionally, it is suggested that together with the emergetical analysis of urban mobility modalities, life cycle analyses (LCA) be carried out with units of equivalent tons of carbon dioxide emitted per unit of mobility per kilometer per person per year, to have another more direct measurement method that relates the effect of mobility with climate change.

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Guide to elaborate the operationalization of variables

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— Abstract—

The main objective of this scientific article is to produce a guide to develop the operationalization of variables and is aimed at teachers, researchers, undergraduate and graduate students involved with scientific research from the quantitative route. It is intended to show a tool that allows students and researchers to know the fundamental criteria and the steps to follow to develop a table of operationalization of variables, both from the theoretical part and from the practice. This guide is developed in six fundamental parts: The variables, the conceptual definition of the variables, the operational definition, dimensions, indicators, and the measurement scale. Each section collects the theorization of more than twenty authors of books aligned to the topic and the experience gathered by the author in the practice of university and research teaching.

Keywords:

Variables; dimensions; indicators; measurement scales; operational definition.

This review article presents a guide to elaborate the operationalization of variables and is aimed at researchers and undergraduate and graduate students who are in the stage of carrying out their research thesis from the quantitative approach, route, or paradigm. It is relevant to mention that an epistemic discussion is not carried out on the position or denomination that quantitative research should carry. Each researcher, according to the preferred author, can use the denomination that he or she sees fit. It is not the only way to operationalize the variables, nor is it presented as a unique model to follow due to the diversity of the methodological fields and perspectives of the authors; rather, it is constituted as a guide that describes a didactic and systematic procedure for the operationalization of variables.

This process has three fundamental elements that define the research: The variables, the population, and the context. It is precisely about the variables that main care must be taken due to their methodological and constructive representation and importance in the study. According to Arias (2020), "the variable is that phrase or word found in the title or research topic, it is also found in the general objective, general problem, and general hypothesis" (p. 33). For Hernández-Sampieri and Mendoza (2018), the variables must be measured, observed, and inferred according to a theoretical analysis; that is to say, through the variables data are obtained from the reality investigated; in this regard, Tamayo (2003) mentions that the variables are observable characteristics of an evaluated reality, which, from the quantitative approach, assumes values or units of measurement, this is done through the operationalization or operational definition of variables.

The importance of variables and their operationalization is understood once a research work is written. This article provides a tool with theoretical and practical support that can serve as a guide so that the undergraduate and graduate students do not have problems when operationalizing their variables; from the formulation of variables, dimensions, indicators, to the measurement scale, for which a guide will be developed to elaborate the operationalization of variables.

An analysis and description of the theoretical and practical foundations are also presented following the formulation of the objective of this article, having primary sources such as books that address scientific research topics, research methodology, and scientific research writing guides with a period comprised of thirty years until 2020, which contain theory aligned to the field of study.

THE VARIABLE AND ITS DEVELOPMENT

Variables must be known in two ways: The conceptual definition and the operational definition; concerning the first, variables must be defined as if

it were a word or phrase within a glossary; for the second, how the variable is going to be measured is specified, this is called: Operationalization of variables.

The operationalization of variables consists of a set of techniques and methods that allow measuring the variable in research, it is a process of separation and analysis of the variable in its components that allow to measure it (Morán and Alvarado, 2010). It is made up of the activities carried out by the researcher to collect population data (Hernández-Sampieri and Mendoza, 2018). The operationalization of a variable consists of a process of assigning categories or identifying data in its study characteristics (Cea, 2012). According to Cazau (2006), the operationalization of variables is divided into two: Simple and complex; when it comes to the simple one, the variable is only measured with indicators, that is, no dimensions are presented; A practical example of a simple variable is marital status, it is only measured by indicators: Married, single, widowed, divorced; there is no need for dimensions. When it comes to the complex form, it involves measuring variables with dimensions, indicators, and even sub-indicators. For practical purposes, this guide aligns itself to complex variables. The operationalization of variables is a table made up of three or more rows and six columns, in which the following are presented in an orderly manner: The variables, conceptual definition of the variables, the operational definition, the dimensions, the indicators, and the measurement scale. Here is an example.

Table 1
Variables operationalization

Variables	Conceptual Definition	Operational Definition	Dimensions	Indicators	Measuring scale
Variables 1					
Variables 2					

Source: Operationalization of variables based on APA 7th edition standards

Variables

The variable is a characteristic, magnitude, or quantity that undergoes changes and that is the object of analysis for research (Arias, 2012). For Aceituno, Silva, and Cruz (2020) the variable groups the attribute and the concept, which means that the variable is made up of a measurement property and logical and theoretical construction of the phenomenon under study.

For Bernal (2010) and Cabezas, Andrade, and Torres (2018), there are these types of variables that are, according to their purpose: Independent, dependent and intervening; In the case of the independent variable, only if it is ex post facto studies should it be operationalized and measured; If it is an experimental study, it is operationalized but not measured, the action carried out, in this case, is to control or manipulate its changes intentionally; Regarding the intervening variable, in many cases, they are not measured or operationalized, however, they are phenomena that may or may not be present during the study, such as sociodemographic data or some alteration in the environment. According to its complexity: Simple and complex; according to their nature: quantitative and qualitative.

The operationalization of variables can have quantitative variables and qualitative variables; simple and complex variables; but they cannot have only independent or dependent variables, there must be at least one independent variable and at least one dependent variable because one depends on the other, otherwise it would not have that name. As already mentioned, the independent variable is not measured, but it is necessary to show it in the operationalization of variables to observe how it will develop during the study. To measure the variables, at least two dimensions must be formed for each variable and two indicators for each dimension; in case only one dimension is chosen, this dimension would become the variable.

The number of variables presented in the operationalization table will depend on the problem that they have established for their study; It can be one, two, or three variables and it must be explicitly stated as it was written in the general research problem: That is if the problem is: What is the relationship between emotional control and students' academic performance? The variables must be the following:

a) Variable 1: Emotional control
b) Variable 2: Academic performance

Another correct way to present the variables would be to include the attribute: Grade, level, type.

a) Variable 1: Degree of emotional control
b) Variable 2: Level of academic performance

The connectors or the determined or indeterminate articles (*el, la los, un, una*) should not be written. An incorrect wording of the variables in the operationalization would be:

a) Variable 1: Relationship of emotional control

b) Variable 2: Academic performance

The classification of the types of variables may or may not be placed in the operationalization, the type of variable is understood through the same reading or the approach of the research methodology.

Conceptual definition of variables

In this column, terms different from those of the theoretical framework are indicated, which allow the variable to be understood in the context of the research, that is, from the population and space. To find this conceptual definition, use is made of specialized dictionaries, magazines, books, articles, among others. (Hernández-Sampieri, Fernández-Collado, y Baptista, 2006). For La Torre, Del Rincón and Arnal (2004) and Pimienta (2017), they are theoretical constructions or definitions from specialized books or dictionaries that theoretically support the study variables. It is recommended to use epistemological bibliography.

As mentioned above, it is important to establish the context where the variable will be measured. It is not the same to conceptually define emotional control in children and in teachers (the capacities and abilities that teachers have developed due to their activity and age are different) For example: If the variable is emotional control and the population is children; the conceptual definition would be: Ability to understand and express feelings between colleagues (Unicef, 2018). In case it is emotional control in a population of teachers; the conceptual definition of the variable would be: Ability so that family conflicts do not influence work activities (Aguaded and Valencia. 2017). Also, this definition may change according to each author. For example:

General problem: What is the relationship between **emotional control** and **children's academic performance** in an educational institution?

Table 2
Variables and its conceptual definition

Variables	Conceptual definition
Emotional control (Qualitative)	Ability to understand and express feelings between colleagues
Academic performance (Qualitative)	Evaluation of knowledge, skills, and attitudes acquired in the school year

Note: Verify context (population and space)

Source: Own elaboration

Operational definition of variables

It is a set of activities that are carried out after the theoretical and practical analysis of the variables. This is done to establish how the variables are to be measured, in other words, the operational definition allows us to know which instrument or tool should be used to obtain clear and true results of the variable. Various criteria and ways can be used to operationally define the variable. For example, if you want to identify the level of anxiety in a population, the way to obtain the results would be through an anxiety test made up of various items or questions. If you want to know the weight of the people, the tool used must be a scale. The example is shown in table 3.

Dimensions

The dimensions are the factors that are obtained and measured from the variables, they are written and are broken down into indicators. (Tamayo, 2003), (Aquino y Barrón, 2007). The dimensions should be considered taking into account the context of the research, as well as in the conceptual definition of the variable. It is important to differentiate the population since it is not the same to measure emotional control in infant students and teachers. Each variable must have at least two dimensions, these dimensions are normally composed of a word or a phrase, phrases of more than three words are not recommended for dimensions.

Main care must be taken when proposing the dimensions, since previously, to establish them, an exhaustive review of the theoretical foundations for the variable must be carried out. Concerning this, there are two ways to raise the dimensions correctly:

a) Carry out an exhaustive search for the theory (theoretical framework).
b) Choose dimensions of a scale already validated in scientific articles (it must take the context into account: Population and demographic space).

There is no set or recommended number of dimensions per variable; however, the researcher should try to measure the variable with the number of dimensions that allow them to fully address the variable. For example:

Overall problem: What is the relationship between emotional control and children's academic performance in an educational institution?

Table 3
Variables and dimensions

Variables	Dimensions
Emotional control	Showing emotions
	Empathy
	Interpersonal relations
	Behavior
Academic performance	Academic notes of courses
	Responsibility

Note: Verify context (population and space). Dimensions obtained from reviewing the theory of each variable

Source: own elaboration

INDICATORS

The indicators are the concrete elements of the dimensions and express the measurable reality of the variable (Baena, 2017). Indicators refer to a process that begins with variables and dimensions; some indicators are more objective than others, which makes them less or more difficult to observe (Rojas, 2013).

Indicators are established when, with the dimensions or categories, they have not yet been able to effectively measure the variables; this indicator is the proof that the researcher observes to determine that the variable exists. (Mejia, 2005)

The indicators are those values that allow the variable to be observed, arise from the dimensions, and can be expressed in words, phrases, or numbers. Some examples of indicators in words would be from the simple variable, marital status: married, single, widowed, divorced. For indicators in sentences they would be according to the emotional control variable: Basic emotions, social emotions, and for indicators in numbers, it would be according to the variable Age: Between 15 and 20 years, between 21 and 30 years.

As in the dimensions, an exhaustive search of the theoretical foundations of the variable and the dimensions must be carried out, which is normally written in the theoretical framework. For example:

Overall problem: What is the relationship between emotional control and children's academic performance in an educational institution?

Table 4
Variables, dimensions, and indicators

Variables	Dimensions	Indicators
Emotional control	Showing emotions	Basic emotions
		Social emotions
	Empathy	Identifying emotions
		Understanding emotions
	Interpersonal relations	Communication
		Collaboration
	Behavior	Respect
		Courtesy
Academic performance	Academic notes of courses	Mathematical
		Communication
		Others (keep counting)
	Responsibility	Assistance
		Punctuality

Note: Verify context (population and space). Dimensions obtained from reviewing the theory of each variable

Source: own elaboration

It is important to remember that these indicators are based on a certain context; they can change according to what the researcher wants to get out of the study. There must be at least two measures for each dimension, if there was only one measure, this would become the dimension.

Variable measurement scales

This study does not present an epistemic or theoretical contrast on the name that this section carries, the researcher can name it according to the author of preference. In this case, the name of the measurement scale is required according to the authors highlighted.

Caballero (2014) specifies that the variables must be evaluated using four types of scales: nominal, ordinal, ratio, and interval scales. Scales typically arise from both quantitative and qualitative types of variables. The qualitative variables are made up of Nominal and ordinal; the quantitative variables are made up of Interval and ratio. (Díaz, 2009).

a) Nominal scale: In this case, the scale adopts discrete states, which cannot be ordered; this means that it is not possible to establish a hierarchy or an order for the measurement of the variables (Corbetta, 2007), in this case, the variables could be: sports, which

can be divided into its dimensions: Water sports with its indicators swimming and surfing and table sports dimension with its table tennis and chess indicators.

b) Ordinal scale: It expresses a quality, but in an orderly way; in a sense from high to low, from good to bad (Cea, 2012), this type of scale is presented when the variables are qualitative: emotional control, academic performance, organizational climate, work motivation, among others. Normally, the Likert-type scale is used. Some authors such as Aceituno, Silva, and Cruz (2020) suggest the use of the attribute to identify the dimensions, a serious example: types of organizational climate, level of academic performance.

c) Interval scale: Equal distances are established for each value; that is, the interval value is equal to the previous one (Mejía, 2005). For example, if the variable is temperature, it can be divided into its dimensions according to the three natural regions of Peru and its indicators would be the ranges that temperatures can have: Between 10th and 15th, between 16th and 25th.

d) Ratio scale: Zero (0) implies that the category being measured does not exist. Example: Number of students, the weight of students, number of children (Cruz, Olivares, and Gonzáles, 2014). For example, if the variable is height, the dimensions would be male and female, the indicators can be segmented into groups: Between 20 and 30 kilos, between 31 and 50 kilos.

As mentioned above, there are two types of variables: quantitative (ratio and interval scale), and qualitative (nominal and ordinal scale); to differentiate them, one must be aware that qualitative variables are not susceptible to be measured numerically and for this, the Likert-type scale can be used; while the quantitative variables are. Example:

If the variable is the Work environment, it is an ordinal qualitative variable because it cannot be measured by establishing that the work environment is 2 work environments or 20 work environments, for this type of variable an ordinal scale must be used that allows measurement based on the representation of the variable. Example: Always, sometimes, never. Which will allow you to obtain a positive or negative rating.

If the variable is Gender, it is a nominal qualitative variable because there is no rating range or scale, only female and male, among others. You cannot say that there are zero genders, nor can you add or subtract genders.

If the variable is the Number of students, it is a quantitative interval variable because it can be indicated that there are 25 students in a classroom. It is interval because we cannot say that there are 25.5 students.

If the variable is Salary, it is a quantitative ratio variable because we can state that the salary is $1,550. It is of ration because the zero (0) indicates that it earns zero (0) soles and it does not exist.

Operationalization of variables

Taking into account the theory and the development set out above, the operationalization of the variables is made up of the following way:

Overall problem: What is the relationship between emotional control and children's academic performance in an educational institution?

Table 5
Operationalization of variables

Variables	Conceptual Definition	Operational Definition	Dimensions	Indicators	Measure-ment scale
Emotional control (Qualitative)	Ability to understand and express feelings among peers	Emotional control measurement scale made up of 25 items	Showing emotions	Basic emotions Social emotions	Ordinal
			Empathy	Identifying emotions Understanding emotions	
			Interpersonal relations	Communication Collaboration	
			Behavior	Respect Courtesy	
Academic performance (Qualitative)	Evaluation of knowledge, aptitudes and attitudes acquired during the school year	Academic performance questionnaire consisting of 18 items	Academic notes of courses	Mathematics Communication Other (keep counting)	Ordinal
			Responsibility	Assistance Punctuality	

Source: Author's elaboration

FINAL THOUGHTS

The variables should be raised through a presentation of the research problem and the dimensions and indicators should be formulated under an exhaustive review of the theory; they should not be drafted deliberately.

The operationalization of variables is a process that occurs only in the quantitative approach because the variables must be susceptible to being observed and measured. This process is carried out in an orderly manner, from general to specific; it works as a decomposition of the variables into

their parts, which are the dimensions, and the decomposition of the dimensions into their parts, which are the indicators.

The dimensions and indicators of the same variable may be different in other studies, this will depend on the context of the study. It is important to establish the scale of measurement of the variables because it will allow establishing the correct hypothesis test, in addition, it will allow selecting the type of techniques and instruments to collect the information for the investigation.

Operationalization can present the number of variables that the researcher sees fit; one, two, or three; this will depend on the research problem and the proposed methodology.

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Rosario Castellanos' short stories: characters and the significant moment

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— Abstract—

This article offers a view on different short-story books written by the Mexican author Rosario Castellanos. It uses the general structure of the story as a guideline, primarily focused on the author's personal definition. Having adopted such a perspective, I shall focus on the characters although the situation, the environment, and the main topic flow peculiarly. Said manner conforms to the social, psychological, and ideological concerns of the author who can describe them extremely accurately thanks to the use of certain techniques embedded in the genre. The aim is then, to define and establish the mechanism through which the construction of the "significant moment", within which both characters and actions converge as the central element of the story.

Keywords:

Rosario Castellanos; short story; characters; significant moment.

Rosario Castellanos' short stories (1925-1974) are an aesthetic exercise determined by the realization and significant value of the described event. In the rather rare interviews, the questions about her storybooks are considerably less than those asked about her poetry or novel. Emmanuel Carballo dedicates only one question to the topic, "What differences do you find between a short story and a novel?", To which the author responds.

> The story seems to be more difficult because it is specified to describe a single moment. That moment must be significant enough to be worth capturing. In opposition, the novel is capable of enriching itself with a multitude of details. The creatures' features that do not necessarily condition the action or the meaning of the novel can be mentioned. In the story, this opportunity has no place. The is not as much space. It is necessary to reduce facts and people to essential features. (Castellanos, 1986, pp. 530-31).

From the opposition, raised by the author, between the story and the novel, other traits attributed to the story are inferred: each character trait, necessarily, conditions the action or the meaning of the story; the character and the event are reduced to their essential features. Rosario Castellanos' concept coincides with the most current theoretical descriptions:

> the literary tale (the text) is undoubtedly a kind of short narrative message, elaborated with the very specific intention (by the author) of generating a momentary and shocking effect or impression on the recipient (the reader) and whose linguistic composition seems restricted by the targeting choice of a single topic (a fact, a field or a character, according to Balza), narrated from a series of unique macro propositions [...], not semantically linked to any other adherent or coexisting narrative text, which, in turn, it covers it with a relative semantic and formal autonomy. This means that all narrative text postulated as a story, after being elaborated in its final version, must be unique and that its sequences are organized within a closed semantic space, which implies as necessary a resolution that does not go beyond its significant sphere. (Barrera, 1997, pp. 33-34)

This definition focused on the generation of an impressive effect or impression from a chosen theme; both elements would be the result of a selection developed through characters and actions that represent in a way the chosen theme and an organization of events directed at a specific moment that, in Castellanos' definition, is a significant moment. This moment is not, then, about a climactic moment or a surprising turn —as suggested by other story poets—, but rather a moment with relevant or peculiar meaning, either for the narrator, the character, or the reader. The expression corresponds to what

has also been called "moment of epiphany" or revelation, as it will be named at times during the analysis and commentary of the stories.

The awareness of this difficulty in recreating the significant moment leads Castellanos to precision and forcefulness in her stories, to the most precise dramatic structure. The brevity of the genre provides her stories with the exact measurements for suspense, surprise, the exposition of ideas transferred to actions and characters. In addition, it is a type of prose in which the author's recognized humor emerges more prominently than the rest of her texts: cruel, pessimistic, and gloomy, in combination with a wide range of emotions, feelings, and concerns. The achievement in the recreation of spaces, in the construction of deep characters, without stereotypes or Manichaeism, in the design of just structures, without loose ends, although with the necessary ambiguity for the reader to fill in the information gaps and participate in the creation of the drama, are some of the elements that make this storyteller a privileged episode in the history of the Mexican tale and, of course, of the work of Rosario Castellanos. A good part of these successes and the achievement of the demands of the genre is based on the characterization of the characters, the element around which the other elements of the story revolve, and on which the following pages will focus.

Ciudad Real, the name that received a portion of the Chiapas territory[1] during a few years of the New Spain era, is the title of the first book of stories published by the author, in 1960 —an ironic title: it characterizes the space of the stories by pointing out their anachronism and alleged ancestry—, three years after Balún Canán and more than ten years after her first books of poetry and essays. The story was, then, a late genre in the vast work of the Mexican writer, who, by then, has acquired skill in handling the structures of various genres in prose and verse. The first two stories still maintain clear links with indigenism[2]: the theme centered on the character of the indigenous, sometimes recreated as a collective character - verbally constructed through “the use of common plural nouns and collective nouns, as well as the scarcity of characters with their own names” (from Juan Bolufer, 2000, p. 288) -. Castellanos resorts to this collective character in the

1 “Ciudad Real exists, or rather it existed. When in the 16th century the Spanish took over the indigenous settlement called Jejen, in the current Mexican state of Chiapas, they gave it the name of Villa Real de Chiapa. Soon after, the name was changed to Ciudad Real, and much later to San Cristóbal, to which “de Las Casas” was later added in homage to Fray Bartolomé. It was the capital of the state of Chiapas until the mid-nineteenth century." (Peter Standish, Hacia Rosario Castellanos por medio del análisis de uno de sus cuentos”, in Cervantes Virtual Library, online: https://cvc.cervantes.es/ensenanza/biblioteca_ele/aepe/pdf/congreso_49/congreso_49_41.pdf (consultation: 11/20/20)

2 Indigenism acquired relevance in the Hispanic American narrative of the first half of the 20th century, with a series of characteristics in common, such as the rural geographical environment and themes like the lives of marginalized and exploited ethnic groups, “it’s about reflecting their traditions, cus-

first story of this book: the Bolometic community, in “La muerte del tigre” which points out the conditions of ethnic groups, particularly in the state of Chiapas: displacement, slavery, misery, and gradual extinction. It is also a story about the role of urban space, the Ciudad Real, in the destruction of that sector of the population. The effect of the collective character is projected in the construction of the group’s identity through centuries and shared individual concerns.

This type of character remains, partially, in “La tregua", whose anecdote focuses on another of the characteristics of indigenous literature: the detailed description of their beliefs, superstitions, customs, and rituals, the contrast with the Caxtlan, a white man, the devastating effects attributed to the *pukuj*, a kind of ominous indigenous spirit similar to the nahual, the consumption of posh brandy, as a measure of Creole control over the indigenous community. On the other hand, the following stories already present individual characters, the transformation of initial situations, external and internal conflicts, and not only the denunciation of the conditions to which Creoles and mestizos had confined the indigenous people but also the errors that lead the character to his physical-moral destruction.

The indigenous question, throughout these types of stories, is recreated from different perspectives, in addition to that of the indigenous, mestizos, Creoles, and even foreigners[3] parade through this volume. The structure of the story allows —and determines— the treatment of the character as a character in action and as a problem; and not only that of the female character, as some critics insist. From the indigenous people, Rosario Castellanos analyzes —now through a third-person narrator focused on actions and thoughts— the depth of her consciousness: the constant uncertainty, the dehumanizing misery, the normalization of abuse —both as a victim and victimizer—: in short, the complexity of the thought and behavior of this individual who is continually reduced to animalization. The Creole character is characterized as a type of individual infantilized by the force of the memory of violent

toms, ways of life, and the socio-economic and cultural situation”, particularly the Indian in contrast to the generally Creole, white, religious and capitalist systems: “There is, as the generating core of the plot, a confrontation between two cultures and ways of conceiving life and social relations: one primitive, peaceful and resigned, the indigenous, and the other violent, exploitative [...] Concerning narrative techniques, they are stories of an omniscient narrator [...]. Aesthetically, certain techniques of Naturalism are evident." (Demetrio Estébanez Calderón, Diccionario de términos literarias, Madrid, Alianza, 2001, pp. 564-566).

3 "In this book, it is possible to draw up an inventory of the elements that constitute one of the sectors of Mexico's national reality: that in which the descendants of the defeated natives coexist with the descendants of the European conquerors. If the former has lost the memory of their greatness, the others have lost the attributes of their strength, and the decadence in which they all struggle is total. In the daily treatment of such dissimilar beings, phenomena and situations occur that began to interest anthropologists and that have never ceased to tempt writers who strive to reach the ultimate root of these extreme forms of human misery” (Castellanos, 2005, p. 222).

ancestors whose ancestry is sustained by colonization and exploitation; the Creole heir, even in decline, is incapable of recognizing the system of privileges that have been achieved thanks to the usufruct of the indigenous; it has naturalized violence so much that he is not even aware of his abuses: always in fear of being victimized, they cling to the role of victimizers, such as Don Agustín, Héctor Villafuerte, Niña Nides. The indigenous "outsiders" —those taken from childhood to serve in Creole houses—, such as "Modesta Gómez", those who have already assimilated to the urban center of Ciudad Real have ended up assuming their role in the exploitation system in which they are allowed to mistreat their peers, in exchange for the minimum privilege of living from their work, those women who violently deprive the indigenous women of the merchandise they intend to sell in the city.

Mestizos or migrants tend to collapse before this chaotic scenario, in a type of story that is particularly interesting because it brings together different visions of the other, recreated in socio-ethnic groups, such as "The wheel of the hungry": the characters are characterized in such a way that their behaviors cause strangeness to each other or the reader. The improvised nurse, Alicia Mendoza, from Oaxaca who moves to Ciudad Real, has her first contact with the divisions through a boy who carries his suitcase to a hotel and observes that he hits an indigenous man, without any reason and with the reassurance that there will be no consequence: "Am I indigenous to be compared?" (Castellanos, 2005, p. 72); Later, he will learn about the practice of the "coletos", the Creoles, who increased their prices to humanitarian groups —such as La Misión, for which Alicia will work—, who favor the indigenous. This strangeness is even found in the characters who have already settled in the region, as the administrator of the association that has hired her makes her see: "what happens here is so different [...] You will have to learn one thing from the indigenous people: that time is of no importance" (Castellanos, 2005, p. 75).

When the nurse finally reaches the indigenous community, she discovers that the character of Dr. Salazar is even stranger than the others: disenchanted, cynical, indolent, and, at the same time, still concerned about the health of the community. It is during an attempt to vaccinate the Indians that the origin of the doctor and the nurse is known: "since we arrived, the interpreter [went from house to house and explained to them that [...] we are not going to exploit them, like the others ladinos "(Castellanos, 2005, p. 83). Both observe the behavior of the few patients who come to the clinic, to conclude that their altruistic intentions crash against the wall of misery and ignorance. The final revelations that the characters of the nurse and doctor have, point to some possibility of improvement, resignation, or insanity, respectively:

> Suddenly Salazar came over and took Alicia by the shoulders.
>
> "What do you think is worth more?" The life of that little boy or that of all the others? Kuleg will tell you what happened. We gave him a lesson and what a lesson! Now the Indians will have learned that you do not play with the Oxchuc clinic. They will start to come, oh yes! And with the money ahead. We can buy medicines, lots of medicines...
>
> Salazar was gesturing. Alicia stepped away from him and when she finished putting away her clothes, she closed the suitcase. It was raining outside. (Castellanos, 2005, p. 90).

The characters have reached their conclusions, and with them, the story, consistent with the tone and atmosphere of the text, and the rhythm of the sentences is accelerated by brevity and punctuation, following the genre's didactics (Lapido, 2020, pp. 331-343). The characters have shown an evolution: Alicia loses all expectations of a provincial single woman, but perhaps she will not abandon Oxchuc or the doctor because of the rain, and perhaps Salazar is right, and her measure will have a positive effect. That minimal opening is just a possibility in the future, while the events narrated end in cruel epiphany. In this same tone and theme, the character of the anthropologist José Antonio Romero is located, in "El don rechazado", who manages to partially "redeem" a small family that he intends to take care of to recognize that the indigenous people do not even understand the sense of unconditional support.

Ciudad real ends with the story "Arthur Smith salva su alma": the last look at the indigenous world, that of the foreigner who, at the opposite extreme of the indigenous idiosyncrasy, ends up recognizing the contradictions of the US humanitarian aid system itself -The Mission is mentioned, sponsored by the evangelical church-. At the beginning of the story, the religious community is marginalized from the indigenous one: the indigenous people are not part of the North American community and they do not fully understand the new religious doctrine, which sets them apart from the Catholic community. In the eyes of Arthur Smith, the deficiencies of the Organization begin to emerge: they do not intervene with improvement actions; until he learns that his assistant, Mariano Santiz Nich, was killed with machetes due to religious differences. This event determines a revelation for him:

> Arthur realized, at last, that it was not a number in the statistics who had died, not a native in exotic costume and customs, not a subject that could be pressed on with a highly perfected propaganda device. That the one who had died was a man, with doubts like him, with useless rebellions, with memories, with irreparable absences, with a hope stronger than all common sense. (Castellanos, 2005, p. 123)

This revelation leads Arthur to another series of revelations about the supposed help of the Americans: the work of limiting the communist advance. Finally, he decides to break with the Organization, even if that means renouncing his privileged situation; in return, he identifies with the indigenous: "It will be a matter of reaching an agreement, at least these men and I speak the same language" (Castellanos, 2005, p. 128).

Thus, Castellanos seems to insinuate that consciousness is a human and collective state incapable of arising at the extremes of social inequality: neither Creoles nor indigenous people are capable of a moral or physical revelation, and they will remain condemned to the defects that their extremes impose.

> In this book, it is possible to draw up an inventory of the elements that constitute one of the sectors of Mexico's national reality: that in which the descendants of the defeated natives coexist with the descendants of the European conquerors. If the former has lost the memory of their greatness, the others have lost the attributes of their strength, and the decadence in which they all struggle is total. In the daily treatment of such dissimilar beings, phenomena and situations occur that began to interest anthropologists and that have never ceased to tempt writers who strive to reach the ultimate root of these extreme forms of human misery (Castellanos, 2016, p. 993).

Revelations are only possible for those in the middle, although they will be painful and even destructive.

For *Los convidados de agosto*, 1964 -in which, she confesses, exhausts the "vein of provincial and archaic life that was so rich to me" (Castellanos, 2016, p. 993) - the author will deal mainly with the Creole Chiapaneco character: the conflicts and miseries of this social group must have been very close to the author. Due to economic conditions, the character enjoys greater freedom of action and this favors the dynamics of the story as a narrative structure: unexpected turns, increased tension depending on the character's decisions. The heterodiegetic narrator predominates, focused mainly on the female protagonist character, with whom the speeches about the "woman's problem" are reduced to certain reflections that are difficult to attribute to the narrator or the character - "The word young lady is an honorable title... up to a certain age. Later, she begins to speak out with doubtful or mocking hesitations and to be listened to with a hidden and painful humiliation" (Castellanos, 2005, p. 146) -. The author proposes some generic variations: "El viudo Román" is almost a short novel, since it reaches three times the length of the other stories. However, the conditions of the genre are maintained: the narration is centered on a character and a significant event and moment.

The issues are already somewhat removed from indigenous or social issues, never entirely, of course; the indigenous appears as a circumstantial character who contributes to the construction of the scene: servants, residents of poor neighborhoods, the sick. In return, the number of Creole characters, to a great extent decadent, and their concerns, emotions, and searches, which are hardly specified in a trajectory of intensity characteristic of the short story, increases. These are mainly female characters, except for "El viudo Román", although even in that story the plot revolves around the concept of appropriation of women. The feminist discourse is clearly perceived in gender conditioning, particularly those of romantic love, marriage, and motherhood as a bio-political mandate, and the imposition of patriarchy, in a range of characters already analyzed by Christine Hüttinger and María Luisa Domínguez:

> Society classifies women in two major classifications: at the top is the married one, the one who proudly bears the label of "the legitimate", as opposed to the lover. [...] Two stigmas can break this order: the first is to be sterile, in the words of Gertrudis in Los convidados de Agosto “machorra” [...] The second stigma is getting divorced; in this regard, with the sense of humor that characterizes her, the author reflects that with Lupita, a character from El eterno femenino [...] On the other hand, there is the single one. (2015, pp. 89-90)

In certain cases, a certain hope is proposed for the character who manages to flee from that society, as stated in "Las amistades efîmeras": the author does not create a heroine whose courage saves her from the comiteca tyranny, but a Gertrudis "almost mute", "judicious" and "lazy", waiting for a boyfriend who would never materialize; however, the story hints at the almost disdain and reluctance necessary to renounce patriarchal mandates, the importance of a network of women that can sustain those who leave a conservative society - which, as will be seen, is a very distant exception to the rule— and offers a reflection on the motivation for writing communicated by the narrator who confesses: "I was building my life around human memory and the eternity of words" (Castellanos, 2005, p. 145). The outcome of the story is a writer's conclusion: "When I got home I took my notebook and opened it. For a long time, I was absorbed in the blank page. I wanted to write and I couldn’t. What for? It is so difficult! Maybe, I was telling myself with my head between my hands, maybe it is easier to live.” (Castellanos, 2005, p. 145)

The main concern of these female characters is singleness and the negative assessment of that state in the reduced Creole society of feudal principles at a time of Agrarian Reform that has stripped families without influence. Isolation hangs over all the characters, which brings consequently

the feeling of loneliness that characterizes the characters, as Almudena Mejías Alonso has pointed out:

> Loneliness oppresses the protagonists, forcing them to be isolated subjects from their social and even family environment and that is given by a powerful/ weak opposition relationship in which the law of the strongest prevails, thus fostering a lack of communication that leads to the dehumanization of the characters to the point that if one of them dares to —at least try— to break the fence, that one is going to be forever condemned by the others to isolation.
>
> This opposition will constitute the core of the story and in it, the weak protagonist will be the woman in front of the man, powerful by nature in a society that Rosario Castellanos paints traditionalist. (Mejías, 2015, p. 281)

Single female families are the weakest link in the chain. In Castellanos - contrary to what happens, for example, in Jane Austen's novels during the booming Georgian and Victorian English economy - a series of spinsters only impose an adverse fate on their heirs: feudal and patriarchal society imposes a barrier of gossip, festivities, and superiorities that prevents its own development: it is the familiar model of almost all the stories that make up the volume —except in "Las amistades..." -: “Vals « Capricho », "Los convidados de Agosto” and "El viudo Román". The timid rebellion of some men in these family cores is not enough to break the siege that they have imposed with the support of other women, including indigenous people and prostitutes, not only Creole women, eager for the loss of their fellows - for Castellanos does not hesitate to denounce this lack of solidarity, or even minimal compassion, between women.

The story cleverly employs such attitudes to achieve decisive effects on the structure of the story, as a trigger for Emelina's "downfall" - in the story that gives the book its title, "Los convidados de Agosto" -: the spinster who attends the fair in August intending to get out of the familiar routine of confinement, she attends the bullring where she faints and wakes up in the arms of a man with whom she exposes herself and plans to escape; but she will be stopped by a family friend. The female character, Emelina, is characterized by a series of actions and attitudes: the dreamy attitude with which the story begins, the fear of continuing to wait for an opportunity to marry, the clash with the description of her family - a sister who is also single, a brother alluded to for his libertine behavior and a crazy mother— and her friend with whom she will attend the bullring, the reception of both, with “an accurate shout that triggered the hilarity of all”: “Emelina and Concha had to do the unaware of a raucous *Two in the afternoon!* Yelled at them by some professional nickname” (Castellanos, 2005, p. 174). The actions confirm her vulnerability and lead her to the climatic outcome:

her encounter with the outsider, her determination to accompany him to drink or, rather, to let herself be carried away by him through the streets of Comitán, and her determination to elope with him, when Enrique, a friend of her brother, drags her away from the man with whom Emelina tried to discover the aspects of life she had evaded:

> When she became fully aware that the opportunity had passed, Emelina began to howl like a madwoman, like an animal.
>
> Enrique turned away from her. Let her stay here, get home however she could. He couldn't take that wild, inconsolable howl any longer.
>
> Enrique started walking aimlessly through the desolate streets. From afar came the echo of the marimbas, the rockets, the fair. But it did not even turn down when Enrique knocked, with the agreed knock, on the door of the brothel. (Castellanos, 2005, p. 180)

This complexity of the feminine in the social structure reaches its peak in “El viudo Román”, almost a tragic tale with a Greek imprint, almost a detective or Dostoevskian tale. The man who destroys the family of his wife's lover, who died shortly after the marriage, through the younger sister, disowned the day after the marriage. Women are the currency of the values of masculinity. Although the young Romelia has adopted the patriarchal system from which she believes to be favored, via advantageous marriage, it turns out to be the object of exchange, manipulable, symbolic, of men, through economic, ecclesiastical, and male paternal power to pay an affront of rivalry caused by another woman in the same circumstances as Romelia, twenty years ago. The structure, full of unexpected twists and with the last final revelation, Romelia's innocence, and Román's elaborate plan, responds to the forcefulness of the story: “The modern tale that was born in the 19th century is, according to Baquero Goyanes, essentially argumentative and it is generally built around an intense vital moment or around a gray moment that summarizes an existence." (Pavisani, 2019, p. 108).

The transformation that *Álbum de familia* meant — Rosario Castellanos's last narrative book, published in 1971, the year in which she was named Mexico's ambassador to Israel — was even more decisive, compared to the author's previous short story. The stories in this book leave the Chiapas province to settle in an urban setting, since the theme is related to problems such as "choosing a way of life to carry out a literary vocation" (Castellanos, June 4, 2020). The Fondo de Cultura Económica’s edition includes a fragment of an interview with Margarita García Flores about this book:

> Although the city is not mentioned, it is a condition for this new series of characters that I had not touched before. They could not occur in any

> rural area because they are quite sophisticated intellectually, nor in a province because they would immediately emigrate to the capital. But the city is not mentioned either as a landscape or as a figure or as something that has a direct influence (Castellanos, June 4, 2020).

In this sense, Rosario Castellanos moves towards the urban tale, of complex definition:

> Faced with the question of what is urban in literature, it should be answered that urban is not necessarily what happens within the city. A narrative can legitimately be located in the city but refer to a way of thinking, acting, and expressing oneself that is rural or alien to the universe understood by the urban. The latter, the urban, has its specific ways of manifesting itself, its languages, its unique problems: in short, a particular universe. Consequently, it could be affirmed that the urban narrative deals with the themes and behaviors that urban development has generated, and always through peculiar languages (Guido Tamayo, 1999, p. 2).

Lauro Zavala (2000) records a proliferation of a type of urban tale to which he dedicates an anthology that goes from 1979 to 1999, which is characterized by humor, irony, and parody, so it does not include or mention Rosario Castellanos, what would make her a precursor of those strategies in the story, since humor, sarcastic and disappointed, is fundamental in these stories.

In effect, the space is reduced to upper-class houses; once again, female characters as protagonists; but she is a type of woman at the opposite to those of *Los convidados*..., "realistic" women. Then they turn out even more hopeless stories: in the previous stories the characters had no opportunity to go out to look for possibilities of happiness; in these stories, on the other hand, the protagonists have made their transcendental and daily decisions freely. And yet, they did not reach the fullness that, it is suggested, was promised to them because of the fulfillment of the marriage mandate or an intellectual, professional, or artistic fulfillment. This awareness, plus the narrated situations, produces an interior narrative technique centered on the protagonist, either as a narrator-character or as a narrator focused on the protagonist, with elements of flow of consciousness and narration, which does not make judgments about the social structure in which it lives[4].

4 "Rosario does not try to show the slavery of women in the home, but what the woman herself suffers from her inner self. This confinement is focused on a preponderant symbol that functions as a common denominator in the newly married woman, who cooks for her husband, Edith, the «slave», even on Sundays, who only conforms in her free time to be a «lady of society» or Justina, who has a deep preference for her son over her daughters: submission." (Nélida Jeannette, 2009, p. 104)

In "Lección de cocina ", the woman previously "lost in classrooms; in streets, in offices, in cafes; wasted skills", by the time of the story she is a housewife facing the conflict of preparing food for her husband; then she turns the preparation of a steak into a metaphor for married life, sexual initiation, poor housekeeping skills, the balance between intellectual work life, motherhood, the suspicion of infidelity and the final failure of the femininity, hinted with irony. As for the storytelling structure, the female character does not go from an initial situation to a final one, but a transformation of the meat set on fire, in a kind of metaphorical story appropriate to the narrative technique.

"Domingo" is the story of Edith, an artist, from the upper or upper-middle class: "I have never pretended to be more than a bourgeoisie. A small, small bourgeoisie. And that is a tough job!", Declares the protagonist. As the story progresses, there is a continuous contrast between the description of the well-matched marriage, harmonious enough to receive friends on a Sunday within the story, and the revelation that it is an open marriage, Edith's first thought is directed to her lover, with whom she has just broken up; while Carlos, her husband, moves with self-confidence: in Edith's consciousness flow, which is the technique with which the story is narrated, it is discovered that he was unfaithful first. Each situation in the story suggests the possibility of the appearance of new lovers, as well as the constant confirmation that their marriage will never be dissolved, a strongly established order of appearances, unspoken infidelity agreements, knowledge of each other's weaknesses. The planned meeting includes only men: Octavio, Hugo, Vicente, Jorge, Weston, a male brotherhood in which Edith almost came to serve as a caregiver, attending to their concerns as a couple, vocation, and fatherhood. Her personal fulfillment is sustained by that already solidified marital structure, which includes her artistic work and the care of her garden: an anticlimactic ending —because in reality there is no conflict itself—, without increased tension, but with an intimate and psychological revelation:

> She saw herself obliterated by Rafael's absence, and an air of disappointment nearly darkened her face. But she remembered the fabric she started working on in her study, the peculiar brush of corduroy trousers against her legs; the old sweater, as natural as a second skin. Monday. Now she also remembered that she had an appointment with the gardener. Together they would inspect that hydrangea massif that did not want to grow well (Castellanos, 2005, p. 264).

No better luck runs Justina, in "Cabecita blanca", the widow who met all the guidelines of womanhood: virgin until marriage, after a devoted dedication to God, submission to her husband, successive pregnancies, and childbirth.

All this is recreated by the lady while she is already a widow who feels relieved by the death of her husband. She lives long enough to fulfill her last obligations, those of "cabecita blanca", a colloquial expression dedicated to elder women heads of families. However, it is clear to the reader, through Ernest Hemingway's[5] "iceberg" storytelling technique, that her family holds multiple secrets that Justina clings not to discover -her only son's homosexuality, long-term relationships and ephemeral that he maintains with supposed assistants, the bitterness and failures of her female daughters.

The longest story, as Castellanos usually organizes her storybooks, is at the end of the volume: "Family Album" —a particularly suggestive title, since there is no kinship between the characters, but rather an intellectual affinity—. The story revolves around a meeting of cultured ladies, satellites of her teacher, Matilde Casanova, "the Mexican poet recently awarded the Nations Prize." The group of alumni of the Faculty of Philosophy and Letters attends the invitation in a coastal city. It is an almost theatrical exercise —an aspect of the modern tale: its capacity for hybridization—, in which as a first act, there is a request of an uninvited journalist who intends to introduce herself to the meeting. Victoria, the poet's secretary, holds a dialogue with revelations about the Mexican artistic environment, quite critical and ironic, not only from the literary world but also from journalism and feminist thought, because, when asked by the assistant, the journalist responds: " Do I look like I was born yesterday or like I'm crazy? No, I am by no means a feminist. In my work, I need men's trust and women's friendship. In my private life, I have not yet renounced either love or marriage." (Castellanos, 2005, p.277).

Then comes a second act, the alumni meeting: Matilde Casanova does not seem to recognize her students; they do not recognize each other: some have renounced literature in exchange for marriage or isolation, others have made a teaching career and others resort to formulas that guarantee a medium recognition or scandalous measures, in the opinion of their classmates. In this council of women, there is minimal room for solidarity, hardly sarcasm, and irony, even for the successful and sublime Matilde. This story is, then, a recreation of the Mexican intellectual field - as P. Burdieu (1971, pp. 135-182) - as a system of influence and counterweight that directly and individually affects the creative project of each artist.

5 "If you find it helpful for people to find out, I always try to write according to the iceberg principle. There are seven-eighths of it underwater for every part that shows. Anything you know you can eliminate, and it only strengthens your iceberg. It is the part that doesn't show." (Hemingway,1968, p. 216).

In a third act, the secretary closes this narrative-theatrical hybrid: she has contemplated all the negative consequences of artistic success, she has seen the monstrous part of Matilde and the social subjugation of the monster. Recognizing that she submitted her possible talent, she concludes, finally, that her determination to shut up and renounce literature, in exchange for Matilde's care, is the appropriate option in a world of simulations, demands, judgments, and loneliness. Well, as two of the friends comment in the last dialogue: “Do you think it's worth writing a book?”, To which another responds: “I don't think so. There already are too many."

In this recreation of Virginia Woolf's lectures in "A Room of My Own", Rosario Castellanos transcends the incipient discussions about female writing: it is not enough to write and have the conditions to do so; writing and any intellectual activity is a continuous debate between the models imposed on the feminine and venturing towards a way of life without instructions or guarantees. The profession of the artist in a society that tolerates, only under certain circumstances and conditions, the exercise of writing is a constant of questions and concerns that women begin to experience without guides or models, in the current of nonsense.

Rosario Castellanos considered the recreation of a concrete significant moment that requires reducing events and people to essential features. In this sense, it coincides with forms of the construction of the story as the revelation of a vital enigma. The actions and conflicts of the characters converge towards this revelation. Sometimes, by the recourse of a confessional narrator, this revelation is communicated verbally; in others, with an external but focused narrator, this revelation is suggested to the reader and barely intuited by the character. The diversity of characters —the indigenous, the Creole, the urban woman—, with their respective stories and ways of seeing the world, pessimistic and in different wise ways, make up that universe recreated in just a few narrow streets, old and modern mansions: a universe of pressing concerns about the feminine, the indigenous, the rural and the urban; on artistic creation and human freedom. The stories of Rosario Castellanos, a production distributed between 1960 and 1971, not only reflect but also address, unionize, question. Astonishment and revelation, elements that bring the story closer to the poem, make these stories an opportunity, often neglected, to know a deeply human and universal aspect of an aesthetic of hopelessness.

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Trends in Patenting and Entrepreneurship among researchers of the Universidad Autonoma del Estado de Morelos

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— Abstract—

The purpose of this paper is to determine the trends of commercialization of knowledge from researchers of the Universidad Autonoma del Estado de Morelos (UAEM) through patenting and entrepreneurial activities. We study the segment of teachers-researchers, mostly members of the National System of Researchers (SNI) who have applied for patents aided by the internal Knowledge Transfer Office of this institution (KTO-UAEM), as well as the motivations and restrictions to develop intellectual property protection, based on the application of semi-structured in-depth interviews. The originality of this work lies in obtaining, a broad insight into the opinions of the academic community on the third mission of the University, specifically, on the patenting and commercialization of inventions. It also presents information on the development of technology transfer within the context of a public university, which already stands out in these activities at the national level, as well as its interest in transformation, towards an institution more congruent with the current environment, which seeks to transfer the generated knowledge for the benefit of society. The impact of national intellectual property policies and incentives, as well as, the little commercialization of results, have implied a reduction of the interviewees' interest in continuing to apply for patent registration. On the other hand, entrepreneurship by researchers, also mostly members of the SNI, and their students, is an outstanding activity.

Keywords:

Intellectual property; project portfolio; technology transfer; linkage; National Rresearch System

Currently, an increase in the diffusion of intellectual property (IP) has been observed, which supports the activities of Technology Transfer (TT) Raghupathi (2017). Patents are recognized as the most widely used form of IP, which encourages research, generates income, and positively impacts the economy Beltrán Morales, *et al*., (2018).

When it comes to university patent trends, the United States strongly predominates, with 18 of the 25 leaders, the first being the Massachusetts Institute of Technology, MIT. In Fisch, *et al*., (2015). The number of university publications and the technological focus in areas such as chemistry and mechanical engineering is strong determining factors of university patenting, while the size of universities and the quality of their publications are not found as significantly determining factors.

Arenas and González (2018) consider licensing and the creation of University Spin-offs as formal mechanisms for the exploitation of patents, in the first case, and for exploration, validation, and exploitation in the second. While Zúñiga (2011) recognizes that the promotion of TT through patents opens a new era of opportunities to accelerate the transformation of scientific results into innovations, especially in biotechnology, nanotechnology, and life sciences.

Although human resources are crucial both for the development and for the application of technology (Barton & Osborne, 2007), some important barriers to the commercialization of technology are short funds, the rewards that favor the science generation, avoiding applications, and the lack of linkage between researchers and companies to promote TT mechanisms, according to Siegel, *et al*., (2007) and Sarabia-Altamirano (2016). Mazurkiewicz (2018) shows an analysis of the TT barriers, as well as the beginning of this topic, the first studies of which were published in 1960 in the United States.

A key element to favor the link between researchers and companies has been the creation of Technology Transfer Offices (TTO), which have promoted public policies to stimulate not only the creation of knowledge but also its application (Lafuente & Berbegal -Mirabent, 2018). The AUTM (Association of University Technology Managers) in USA-CANADA and the TTO Network of Mexico are organizations that support the University's TT towards the industry, as well as the creation of new knowledge-based businesses.

In the case of Latin America, universities are still in a development phase for collaboration with the productive sector (Calderón, 2014). In them, the third mission is emerging. It is widely known that the first mission of universities focuses on the training of human resources, while the second is on the knowledge generation, alternately expressed as focused on teaching and research, respectively (Marhl & Paosits, 2011). The third mission is relatively recent, particularly in Latin America, and focuses on

TT (Arocena & Sutz, 2005), contributing to social, economic, and cultural development (Compagnucci & Spigarelli, 2020), or else, reflecting all the University contributions to society, Marhl, and Paosits (2011). To carry out this mission, it is essential to consider the needs and problems facing society, as well as a balance between basic and applied sciences (Caldera & Debande, 2010; Galván, 2017). At UAEM, since 2012, innovation and TT were emphasized among its priority axes from a sustainability perspective (Administration, UAEM, 2012-2018).

Mexico, since 2009, has been among the countries that have promulgated decrees or laws that stipulate that universities have the right to ownership of research results (Zúñiga, 2011), however, it is with the decree of the Congress of the Unión (2015), by which various provisions of the Law on Science and Technology and the Federal Law of Administrative Responsibilities of Public Servants are reformed, which has a legal framework that allows universities and their researchers to commercialize their discoveries, without conflict of interest, as established in article 51. However, institutional guidelines that have not yet been developed by most public universities, including the UAEM, are required.

Countries such as China and India have also implemented public policies for the commercialization of their discoveries (Krishna, 2018). Whereas, since 1980, the US Bayh-Dole Act allowed American universities to retain their intellectual property and appropriate their licensing income. The commercialization of MIT's discoveries, with the support of industry and government, has positioned Boston as the most prosperous region in the world. Parallel experiences were also identified in Silicon Valley, where Stanford University, in partnership with government and business, has made this region the most innovative in the world, creating great prosperity for California (Etzkowitz & Zhou, 2018). Both institutions are examples of modern universities, which have transformed their environment through the licensing of patents and the generation of new companies.

Patent marketing is incipient in Mexico, many companies are not yet interested in using scientific knowledge. Therefore, the effort to promote innovation, transforming discoveries into valuable products is more difficult (Puerta-Sierra, *et al*., 2017).

1.1 Technology Transfer Offices

OTT's began in the United States of America in the 80s and today others have been created around the world, to transfer university knowledge more efficiently to the industry. Their role is to support scientists in commercializing their results, building strong networks with regional and international companies, reducing "language" barriers between scien-

tists and industry (Yonghong, *et al*., 2015). They act as interfaces to bring together scientists, companies, and venture capitalists (Mascarenhas, *et al*., 2018); they are catalysts for change and innovation in their region. Its performance depends on the rapid commercialization of emerging technologies.

According to Heald (2005) and Galván (2017), university patents must be extended, but many patents will never be exploited commercially, in the same way, that numerous scientific articles will never be cited. Approximately 25% of the articles published are never cited (González de Dios & Benavent, 2007). Galván (2017) estimates that only 10% of patents are licensed (sold). The TT achieved by US universities (De Vol, *et al*., 2017) shows a balance concerning the generation of science and its application. But patenting does not necessarily generate profits for inventors and organizations. MIT or Stanford University's success is very difficult to replicate, even in the US. There is no single procedure to guarantee the success of commercialization, so each institution must implement practices according to its environment. The TTO is an actor that facilitates innovation processes (Rojas, 2017) and contributes worldwide to the application and commercialization of research discoveries and the development of universities (Alvarado-Moreno, 2018; Solís, *et al*., 2020; Pérez, 2019). One of the points in its mission is to strengthen the relationship between companies and researchers, so they must identify the technological needs of socioeconomic sectors to favor TT. However, the shortage of professionals with experience in TT and the lack of financing are the main difficulties faced by Mexican TTOs (Solís, *et al*., 2020).

1.2 KTO-UAEM

As part of a national effort towards the commercialization of science, the KTO-UAEM was created in 2014; it is an independent transversal unit, with a small amount of personnel, the results of which are new companies and patent licenses; it has a specialist in patent writing and another in marketing. UAEM professor-researchers have support for the drafting of patents, including advice to respond to evaluators.

The KTO-UAEM has also been working on the creation and development of structured policies for the protection and commercialization of patents, through licenses and the creation of new companies (Velázquez, 2019). As an internal policy, patents must be presented by the KTO-UAEM, the UAEM being its owner. If commercial exploitation of patents takes place, researchers can reap part of the benefits, according to internal guidelines. The KTO-UAEM indicates the licensing scheme with the support of researchers to detect potential clients.

The registration amount of a national patent for universities in Mexico is approximately $260. The Patent Cooperation Treaty (PCT) helps international patent protection by applying this scheme; applicants can protect their invention in many countries. The KTO-UAEM has used this scheme only once, but the rights and technical translation in the selected countries exceeded budget, so almost all the patents applied for have been processed only in Mexico.

As relevant data for this research, about the critical mass in Research and Development, R&D, it is important to mention that the UAEM has 284 researchers recognized by the National System of Researchers, SNI, of which 25 have a candidate level, 167 are level I, 66 are level II, and 26 belong to level III. Of this total number, 115 are women and 169 men (40% and 60%, respectively) (Rectoría UAEM, 2017), which shows a certain gender balance and as will be seen later, also in participation. It should be noted that SNI Level III researchers are those established researchers with many international articles, many citations to their work, doctoral graduate students, and founded research groups. The critical mass of researchers at UAEM is robust, with great scientific capabilities, but little experience in TT. This is the challenge that the KTO-UAEM must face, in an environment with a greater tradition towards scientific research and teaching, with a low density of technological companies and limited resources.

1.3 University patents

According to IMPI (2016), Mexican universities have increased their production of patents, requesting the Mexican Institute of Industrial Property in 2010, 349, in 2011, 338, in 2012, 435, in 2013, 374, in 2014, 449 in 2015, 533 and, until July 2016, 240. In the period 2013 to 2018, UNAM, with 299 applications, was the university with the most patent applications, the tenth university was the Universidad Autónoma Metropolitana with 49 (IMPI, 2020). On the other hand, 41 university patents were granted in 2017, 58 in 2016, and 122 in 2019 (Ortiz, 2018).

The UAEM has evolved from the national ranking on university patents, from position 18 in 2014 to 13 in 2017, corresponding to 42 applications filed and six patents granted, which represented an important advance at the national level, positioning it among the top 15 Mexican institutions in this field. In 2018 it presented 12 applications and three patents were granted (Urquiza, 2019), from 2019 to March 2021, 17 more applications were presented, while from 2019 to March 2021, five patents were granted.

It should be noted that the high Mexican scientific production does not correspond to the low levels of IP registered by the universities. Tarango,

et al., (2015), report that in the period 2007-2011, on average, the highest proportion of productivity of indexed articles and patents applied for corresponding to the Universidad Autónoma de Nuevo León (272.2 to 7.2) followed by the Benemérita Universidad Autónoma de Puebla (217.8 to 3). Currently, for each patent application, more than 20 articles are published, which is a clear reflection of the public policies that have promoted the generation of high-quality science in Mexico, without achieving a balance with its application.

The AC Scientific and Technological Advisory Forum (FCCyT) has analyzed the evolution of the researchers that make up the SNI in Mexico, growing from approximately 16 thousand in 2013 to more than 25,000 in 2016, which shows that the Mexican scientific community, although small, has been consolidated (Rodríguez, 2016). In 2018 there were already 28,578 members (SNI, 2018).

Regarding the patent applications of Universities in Mexico, the national survey of Mexico's TTO Network of 2016 and 2017 indicates that TTOs manage more than 60% of these patents, 310 in 2016, and 380 in 2017. The level of licensing went from 58 in 2016 to 41 in 2017. In 2019, 75 licensing contracts were reported, considering various figures from PI Ortiz Cantú (2020). Although the figure is relatively small, it shows that this market exists, that there are Mexican companies interested in marketing it.

The AUTM publishes an annual survey on patent applications from universities in the United States and Canada, from which it is observed that, on average, each university in the United States requests 40 patents per year, managing to commercialize approximately 10% of them. For more than 30 years, TTOs in the US have worked closely with partner companies to transform scientific discoveries into business; on average, each university has released three new products per year, with licensing revenue of $450,000. In addition, they have generated around four startups per year (AUTM, 2017).

In Mexico, according to the annual survey of the TTO NETWORK, universities with certified TTOs manage to present around six per year, granting around one license per year (Ortiz, 2018). The TTO effort is very recent, however, the results are starting to be important

1.4 University entrepreneurship

The creation of university microenterprises is increasingly important (García, *et al*., 2017). They make it possible to demonstrate low-maturity technologies in the market, reducing uncertainty for investors. Universities are becoming more entrepreneurial, becoming a hotbed for the formation of new companies (Narváez Vásquez, *et al*., 2016). They configure the business model of their TTO, in addition to patent licensing, with incubation

programs and seed capital for the launch of new university companies as another transfer mechanism (Baglieri & Christopher, 2018). Patent licensing has been the most popular mechanism for the commercialization of IP in Mexico, but the creation of new companies has grown the most (Ortiz, 2018). The TTO NETWORK reported the creation of 168 university micro-enterprises in Mexico, surpassing the licensing of patents. Most of the new Technology-Based Companies, EBT, come from approximately 60 public universities. On average, each public university has generated a new company.

Regarding entrepreneurship by academics in Spain, the initiatives have arisen in an adverse environment, in particular, towards companies based on university research (Morales, 2008). Lemes Hernández (2015) mentions that such initiatives are given by opportunity and not so much by necessity and that the cases of negative experiences do not affect the antecedents of the intention; it is assumed that this is because relationships in the work environment can be competitive, and to a lesser extent, affective. Monge Agüero, *et al*., (2012) carried out a case study in Costa Rica, in which academic entrepreneurs stated that they had a high need to achieve and put into practice the acquired knowledge, as well as a high degree of satisfaction with the business experience developed.

This article will focus on trends on patents and entrepreneurship, as well as on the attitudes and motivations observed during in-depth semi-structured interviews carried out with the UAEM professor-researchers, who have collaborated in these processes.

The results found may be useful to improve the science application processes at UAEM, as well as for other Latin American institutions in similar situations, which gradually seek to give more value to knowledge.

The theoretical review was carried out using Google Scholar, with the keywords Technology Transfer, TTOs, university patenting, patents. In the temporary coverage, the last 11 years were fundamentally considered.

In this study, three research questions were established:

Q1: Is the KTO-UAEM a key factor in promoting the internal culture of patents so that researchers achieve a better balance between the generation of science and its application?

Q2: Will the portfolio of patents generated by the KTO-UAEM be attractive enough to generate resources for the university and the researchers involved?

Q3: What would be the best way to commercialize the discoveries of the UAEM, through the TT, through existing companies, or the creation of new companies by students and professors of the institution?

This work is distributed as follows: section two presents the methodology used, section three shows the results and discussion. Finally, in section four, conclusions are provided.

2. METHODOLOGY

The data collection was carried out considering primary sources, from the application of semi-structured in-depth interviews (Pomposo, 2015), with researchers who have worked in the development of patents. In-depth interviews are useful when you want detailed information about a person's thoughts and behaviors, or if you want to explore new topics in-depth (Boyce, 2006). It is a discovery-oriented method that allows the interviewer to explore the interviewees' feelings and perspectives on a topic. In the semi-structured format, the interview must be conversational (Guion, *et al*., 2021).

Regarding the determination of the confidence interval and the sample size, the Creative Research System calculator (2021) was used.

To carry out the interviews, the corresponding logistics were determined: appointments were established between researchers and KTO-UAEM staff, which were carried out at the researchers' workplace. Subsequently, the analysis of the results was carried out.

3. DEVELOPMENT

3.1 Patent applications registered by the KTO-UAEM

Throughout the life of the KTO-UAEM, the registration of patents per year has increased, as shown in Figure 1. Before its inception, there were isolated patent and business incubation efforts. Subsequently, applications increased systematically, reaching a rate of six to eight patents filed per year, starting in 2017. There is only one patent filed internationally, since the resources, in general, are small and insufficient to cover the amounts required for this type of application. Some fees for procedures and services are found in Patentepct (2021) and ZBM (2021).

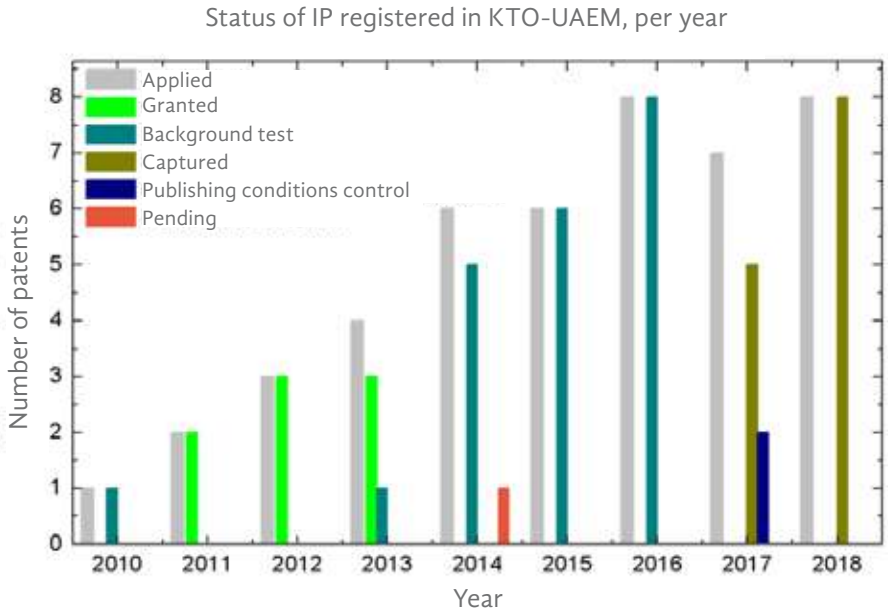

Figure 1. Status of IP registered in KTO-UAEM, per year. Source: Own elaboration

Therefore, in this case, only national patents were analyzed. The process from which a patent is filed until it is granted has required an average of four to six years, although recently this period has been shortened.

In 2018, when the surveys were carried out, 45 patents were filed, of which 6 had already been granted by the IMPI, and in 3 there was no longer interest in commercialization. Therefore, only 42 applications are considered in this work.

The patents registered by the KTO-UAEM have a greater concentration in health and materials, which contrasts at the national level, where the majority correspond to Energy, Chemistry, and Information and Communication Technologies (ICT), (Ortiz, 2018). It should be noted that researchers at the Centro de Investigación en Ingeniería y Ciencias Aplicadas (CIICAP) stand out in advanced materials, while the School of Pharmacy contributes with patents related to health. These agencies are the ones most closely linked to the private sector and have a greater patenting culture in the UAEM. The areas with granted patents are shown in Figure 2.

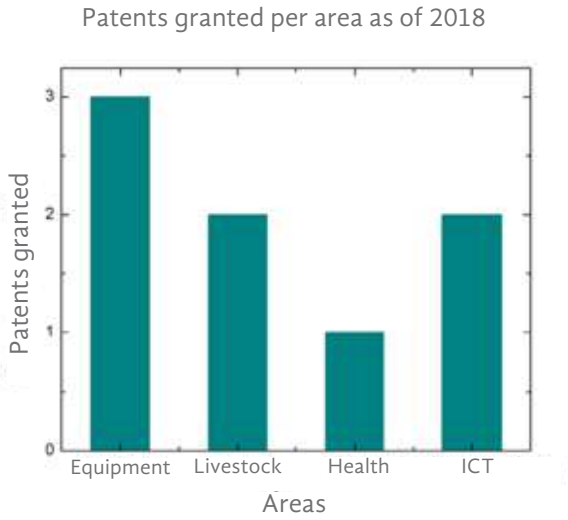

Figure 2. Patents granted per KTO-UAEM area. Source: Own elaboration

Until 2018, the sectors with the lowest number of patents were agriculture, biotechnology, and telecommunications. An analysis of the degree of maturity was carried out for all the patents filed, based on the Technological Readiness Levels (TRL) model (Mankins, 2009). The higher the level, the greater the progress towards commercialization. For its determination, in this work, a series of questions were generated based on CONACyT (2015). According to the answers provided, and to the extent that each level was satisfied, it was determined that 65% were between TRL 4 and TRL 5, with 35% and 30%, respectively. This means that most were in the laboratory-level validation stages. Very few have been tested in the market. It should also be considered that to increase the levels of readiness, the necessary investments grow exponentially.

There was only one patent on TRL 9 (Figure 3). This has implied a high technical-financial uncertainty, limiting the attention of potential investors.

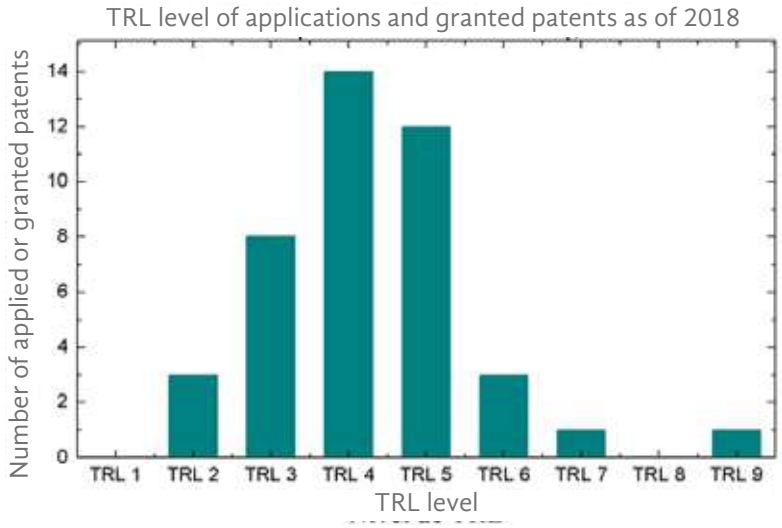

Figure 3. TRL level of applications and granted patents, KTO-UAEM. Source: Own elaboration

It should be noted that Morelos is a state in the south-central region of Mexico, traditionally dedicated to the manufacturing industry, services, commerce, and agriculture, according to the KTO-UAEM Board of Directors (2018), Figure 4. High-tech manufacturing is emerging. According to the type of patents that have been developed (Figure 2), many of them do not have local licensing possibilities. However, at the national level, there are companies in business sectors in which they have patents (SIEM, 2021), for which they may be of interest.

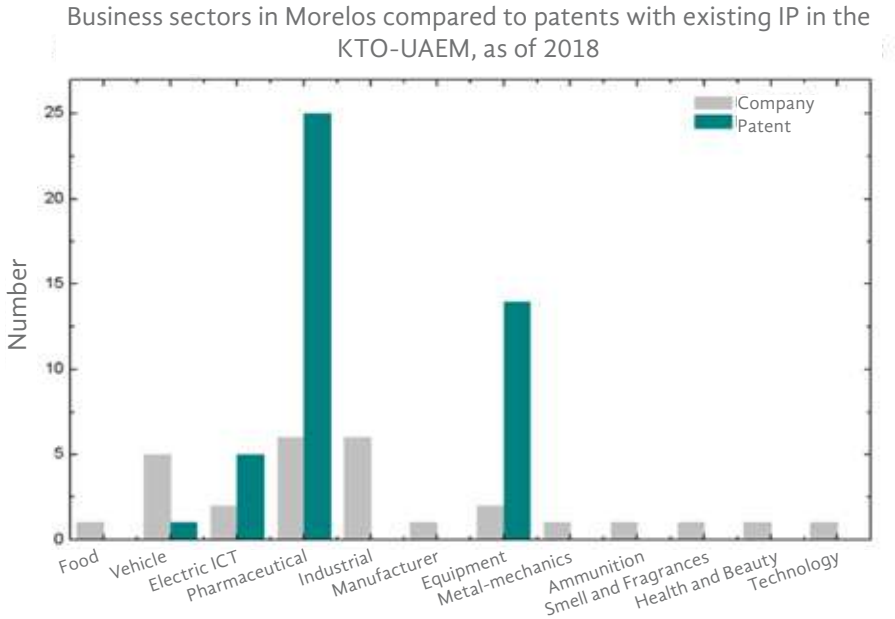

Figure 4. Business sectors in Morelos compared to patents with existing IP in the KTO-UAEM, as of 2018. Source: Own elaboration

As of March 2021, the status of IP in the KTO-UAEM is presented in Figure 5. These are 54 patents applied for, 17 granted, six in capture, 20 in control of conditions for publication, and one pending for one, according to information from the KTO-UAEM.

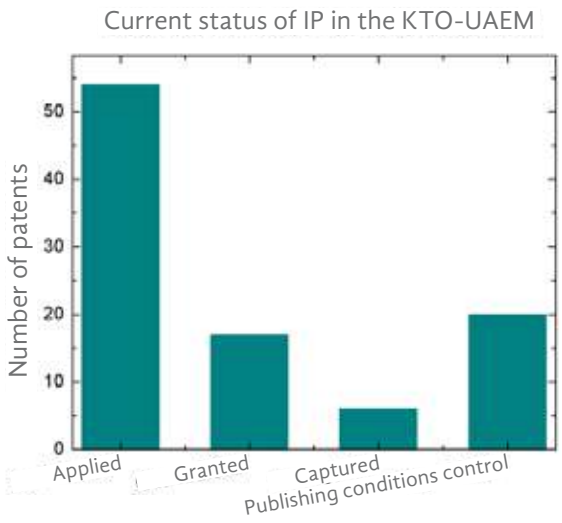

Figure 5. Current status of IP in the KTO-UAEM, until March 2021. Source: Own elaboration

3.2 Sample selection

With Espacenet (2018), the patents requested by the KTO-UAEM (Table 1) were searched, using the identification number of the patent. This Table shows a total of 80 registered women and 65 men, some of them are students, and there is repetition in terms of the researchers who lead the groups of applicants.

Table 1
UAEM patents and inventors, registered in Espacenet until 2017

Number	ID number	Men	Women
1	MX201014422	7	6
2	MX201110190	4	4
3	MX201113522	1	1
4	MX20125321	1	1
5	MX20125322	1	1
6	MX201214978	2	1
7	MX20132342	1	2
8	MX20135576	3	1
9	MX20135768	5	0
10	MX201315275	2	2
11	MX20143901	1	2
12	MX20145001	2	1
13	MX20146541	3	1
14	MX201412768	6	7
15	MX201412783	2	0
16	MX201414291	4	0
17	MX20158244	1	2
18	MX201510197	1	2
19	MX201510653	3	1
20	MX201514094	1	2
21	MX201514095	1	2
22	MX201515327	1	3
23	MX20161343	2	3
24	MX20163003	6	0
25	MX20166999	1	2
26	MX201610606	2	1
27	MX201614103	4	0
28	MX201616320	3	3
29	MX201617266	2	3
30	MX2017730	0	2
31	MX20173328	2	2
32	MX20177947	0	3
33	MX20177956	1	1
34	MX201715882	1	1
35	MX201716429	1	1
36	MX201716354	2	1

Source: Espacenet (2018)

From the above information, 25 representative researchers were identified, some of whom have generated more than one patent.

For the interviews, the confidence interval was determined with Creative Research Systems software. Taking into account the population (25), the confidence level (95%), and the sample size (19), the calculation showed a confidence interval of 11.24%. It was not possible to reduce this interval since one of the barriers to overcome was to make appointments with the researchers and meet with them, of which the results obtained from the 19 interviewees are presented. It should be noted that reduced samples have been analyzed in other works, such as in the case study presented by Aguero, *et al*., (2011).

Figure 6 shows the percentages of interviewed and non-interviewed. The interviews were planned to last approximately 30 minutes, but in some cases, more sessions were needed.

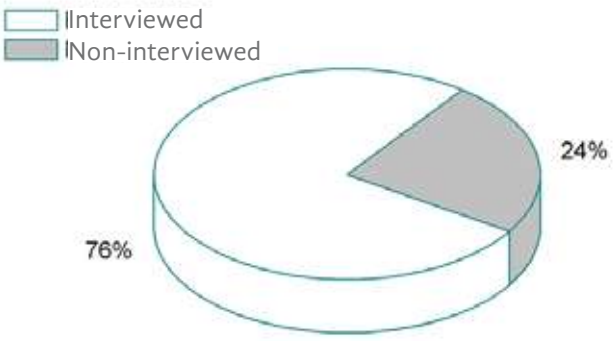

Figure 6. Percentage of interviews conducted. Source: Own elaboration

4. RESULTS AND DISCUSSION

4.1 Results of semi-structured in-depth interviews

Regarding gender, from the information shown in Table 1, without considering students and avoiding repetitions, it is found that, of all the female UAEM professor-researchers, only 2.95% (13) of the total number of full-time researchers (439, as of 2017), have participated in the groups that have applied for patents, while, men, have been 4.77%, (21). Together, they constitute 7.72% of the total PTC. Therefore, 92.28% of UAEM researchers are dedicated to traditional activities, research, and human resources training.

Of the 25 leading researchers identified, some of them have applied for more than one patent. Although the development of patents requires more time and financial resources, there is no impact on the productivity of the

leading inventors since, as can be seen in Figure 7, most of them are part of the National System of Researchers, SNI (2018).

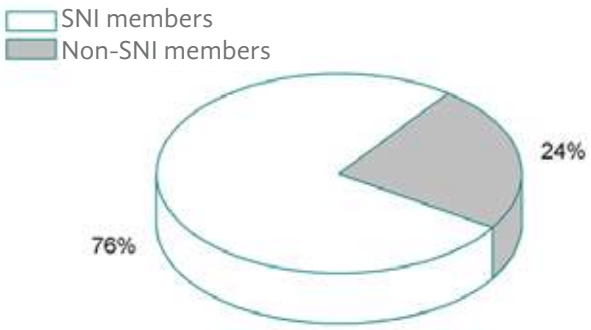

Figure 7. Percentage of researchers, leaders of patent application teams, in the SNI. Source: Own elaboration

The surveys were applied to 19 of the 25 team leaders who have applied for patents, who agreed to be part of the group under analysis, so they will constitute our 100%.

Of these, 13 were male researchers, and six were female researchers, 68% and 32% respectively.

The inventors' age ranges between 40 and 60 years.

Regarding motivation, 95% showed high motivation for their inventions, being proud of them.

Almost 84% of the researchers were interested, happy, and hopeful, in creating an KTO-UAEM patent portfolio with a commercial focus, to make the discoveries more attractive in the search for potential clients. The researchers who participated in the preparation of the patents felt alone once the patent was applied for because there was no follow-up for its eventual commercialization. Developing a properly designed patent portfolio is a big step for them. The KTO-UAEM does not have funds to promote the incubation of university companies but has recently made a more marketable portfolio.

Almost 16% of researchers saw themselves as entrepreneurs, based on their patents, while 84% preferred to find who licensed them.

In contrast, 16% of researchers consider that the best way to commercialize their discoveries would be by creating new companies, with their students, raising seed capital from families and friends.

Regarding attitude, approximately 95% of the interviewed researchers were friendly and open to dialogue, only 5% were indifferent and apathetic. This fact demonstrated the great interest of the UAEM researchers in transferring their knowledge, although there was some discontent or apathy (5%) towards this process.

Regarding the intention to patent again: only 36% of the researchers interviewed consider the intention to patent, some of whom give continuity to previous patents (Figure 8).

The KTO-UAEM has promoted TT, but, in general, traditional missions of human resources and research training have been prioritized internally.

In addition, the commercialization of results has been scarce, so it is estimated that this fact has negatively affected the culture of patenting.

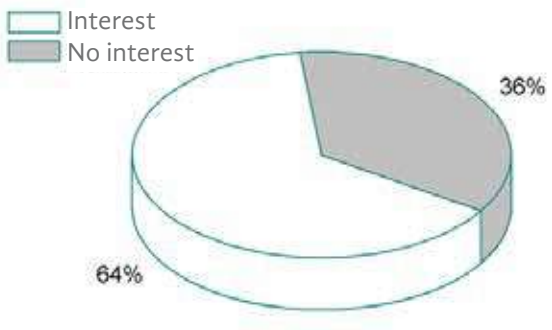

Figure 8. Researchers' interest in patenting again. Source: Own elaboration

On the other hand, the following barriers of communication with the researchers were detected when conducting the interviews:

- Time to respond to invitations.
- Difficulty making appointments. Their rescheduling negatively affected the quality of the surveys.
- During the interviews, more time was spent explaining the KTO commercialization processes, as well as disseminating the benefits of creating a more attractive patent portfolio for the private sector.

4.2 Discussion

The KTO-UAEM has promoted the culture of patenting among the scientific community as contemplated in the first research question (Q1). The results show that there are already indicators on the third mission of the university.

Although only 7.7% of all researchers have participated, as patent applicants.

The emphasis of the KTO-UAEM was orthodox. As a first stage, it established administrative procedures to promote the culture of patents within the University, and simultaneously to identify potential clients to "sell" licenses. Some courses were also offered for university entrepreneurs, where two Boot Camp workshops were organized. With these actions, it has been possible that 16% of the researchers considered that they could be entrepreneurs of their patents since after these activities they founded their

companies. With three spin-offs, the UAEM is above the national average, since as mentioned above, the average is one. Of the 42 UAEM patent applications, only three have been transferred to new microenterprises

It was also identified that the majority of UAEM researchers have patented without detecting the needs of the industry, at least corresponding to the state of Morelos (Figure 5).

Regarding the research question on the impact of the patent portfolio to commercialize the knowledge of the UAEM, it can be argued that more time is needed for its evaluation. However, as a positive effect, it was found that the researchers considered it a good procedure, partially affirming the second research question (Q2). International universities have developed similar catalogs with success.

Like the results of this article, other authors have discovered that patents are a limited channel for the TT process (Costa Póvoa & Siqueira-Rapini, 2010), a limitation that was associated with the need for further research to convert to the patent on a process or final product. They found that the best TT process is to carry out joint projects between universities and companies, to develop technology and train staff in parallel, to achieve a better assimilation scheme.

The UAEM has begun with the certification of its administrative processes, training its staff, and creating the internal patent center, recognized by the IMPI. Some courses and workshops on entrepreneurship have been given. Despite these limitations, three new micro-companies were created: SALUTIS, which markets compounds that strengthen the human immune system, INNTECVER with mini antennas for broadcast TV, and ACYIPRAOVEMI for mushroom concentrates as nutritional supplements. Which were founded with the effort and investments of researchers and students. The lead researchers were two men and a woman. Two of the three leading entrepreneurs of these spin-offs are members of the SNI (2018). Figure 9 shows their impact on technological development.

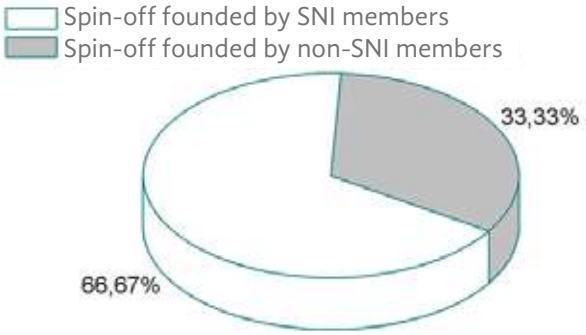

Figure 9. Percentage of spin-off founding leaders members of the SNI. Source: Own elaboration

In Morelos, with a low density of EBTs, the commercialization of knowledge was more effective through the new university spin-offs, answering question three (Q3). However, the university must define clear guidelines on the incubation process, which could be carried out within university laboratories. However, the university must define clear guidelines on the incubation process, which could be carried out within university laboratories. A modern university implies teaching and scientific production, but also the application of knowledge, Sánchez-Barrioluengo, and Benneworth (2019). New university companies, due to their origin, would be much more interested in acquiring and commercializing new knowledge.

It should be noted that the three university spin-offs created in the UAEM, compared to the national magnitude, where the National Autonomous University of Mexico, UNAM, is the Leader University, with 11 registered spin-offs (Torres, 2017), is a significant fact. In Maldonado-Sada, *et al*., (2019) it is recognized that academic spin-offs are a recent issue in Mexico, so there are few reported cases. In García Colina, *et al*., (2017), in the impact analysis of university spin-offs, only 10 were considered, from different states of the country.

In the study presented here, a clear division of attitude is observed within the chosen sample. While 37% of scientists want to re-patent, 63% consider this approach inappropriate. Almost 84% of scientists perceive problems between the third mission, focused on TT, with the traditional teaching and research missions.

Patenting, transferring, and entrepreneurship activities are not adequately rewarded. Therefore, 84% of the respondents perceive TT activities as an additional burden on their activities, with no short-term benefits. On the other hand, TT's mission has caused tension due to the lack of clear policies. There are conflicts and problems between "traditional" academic researchers and the small nucleus of "innovators", similar to that mentioned in Philpott, *et al*., (2011). This has generated isolation and rejection. This attitude may also be related to funding, coming from various funds, basically focused on research.

TT could create enormous value for the economy of developed countries through licensing, but also with new university companies (Etzkowitz & Ranga, 2010). Furthermore, innovation and entrepreneurship skills are essential for the complete training of students. Therefore, the current lack of funds for the commercialization of knowledge is perceived as detrimental to long-term economic development (Soetanto & Van Geenhuizen, 2015).

5. CONCLUSIONS

Despite having the KTO-UAEM, there is still low participation of scientists in patent matters, since only 7.7% of them have registered their inventions. However, as of 2018, a portfolio with 42 patent applications was integrated, which positioned the UAEM as the most important in the state of Morelos, in terms of patents (UAEM, 2018). Of the 25 leading researchers identified, 74% belonged to the SNI, which allows us to observe their impact on technological development.

The KTO-UAEM successfully focused on the patenting process, but the scarcity of mechanisms to achieve escalation and, therefore, commercialization, caused 63% of those interviewed not to consider patenting again. Fortunately, the creation of spin-offs is not significantly affected.

It is observed that productivity, in terms of patents of male and female researchers, is relatively comparable, according to the respective population in the UAEM.

It is notorious that the commercialization of patents is a great challenge in Morelos, due to the low density of technology companies and their commercial reach. Only three of them have been transferred to UAEM spin-offs, but unfortunately, they have not yet yielded the expected economic results. One-third of the entrepreneurs were members of the SNI.

It was identified that the KTO-UAEM has little diffusion within the University campus since not all researchers and students know its services in-depth, so it is necessary to intensify these tasks. It is recommended that the internal policies be published shortly, as well as the permanent search for sources of financing to mature the technologies in the early stages of maturity.

Surveys show that 95% of professors are motivated by the creation of the UAEM patent portfolio, so it is possible to support activities aimed at its commercialization.

Innovation and entrepreneurship skills are essential for the complete training of students. Therefore, the current lack of funds for the commercialization of knowledge is perceived as detrimental to long-term economic development, in congruence with what was detected by Soetanto and Van Geenhuizen (2015). It is concluded that to promote the commercialization of knowledge, a better balance between basic research and the application of science is required.

It was found that UAEM researchers have created patents without detecting real needs in the industry or without having previously carried out a market analysis to determine the viable niche for their creations and inventions, which makes their commercialization difficult. But it should be clarified that science can generate new markets, not explicit ones, that traditional market methods cannot perceive.

Due to the small size of the sample, the knowledge obtained is limited, however, a certain similarity can be observed in some of the elements analyzed, with other reported works, as well as other new ones, related to perception.

Unfortunately, these results cannot be extrapolated, however, they allowed us to obtain primary information to analyze trends in patenting and entrepreneurship at UAEM. As future work, it is expected to follow its evolution.

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Traits to evaluate in teaching performance. The students' voice

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— Abstract—

The objective of this work was to determine the main features to be evaluated in the teaching performance from the opinion of the students from the dimensions: personal, disciplinary, didactic-pedagogical, and professional that allow feedback to the instrument of evaluation of the teaching performance via the opinion of the student used in the School of Education Sciences of the UATx. A study was carried out under the quantitative approach, analyzing the responses of 204 students belonging to the two degrees offered by the School of Education Sciences of the Universidad Autónoma de Tlaxcala: Educational Sciences and Educational Communication and Innovation. It was found that the main features to evaluate are related to didactic planning, learning evaluation strategies, the interpersonal teacher-student relationship, as well as assiduity and punctuality.

Keywords:

Teacher evaluation; evaluation of teacher performance; modalities of teacher evaluation; features of teacher performance evaluation.

The evaluation of university teaching is a complex issue that we have been trying to understand over time from various approaches, methodologies, and techniques. The purpose of teacher evaluation is to improve the quality of teaching, pay for accountability, and decision-making in institutions. In this regard, it is important to differentiate between teacher evaluation, teacher performance evaluation, and academic performance evaluation (Sánchez-Rincón, 2019). The first, in the case of the university professor, considers the substantive functions: teaching, research, management, and tutoring (Caballero & Bolívar, 2015; Mas & Olmos, 2016). The second considers only teaching, that is, everything the teacher does from planning their classes to putting them into practice (Rueda, 2018). And the third is related to research, which includes the writing of articles, books, lectures, conferences, and consultancies. This work addresses, first of all, an approach to the teacher performance evaluation questionnaires, the student as an evaluating agent, the dimensions of the teacher performance evaluation, and the teacher performance evaluation practiced at UATX. Next, the methodology and methods that governed this research are presented, in which the approach, the subjects as well as the instrument used are specified. Afterward, the results and discussion are presented based on the information obtained; lastly, the conclusions.

Teacher performance evaluation questionnaires

The evaluation of teacher performance in higher education has been carried out through various instruments since the 1940s (García, 2003). There are different instruments to understand the reality of educational practice, however, the most widely used in the world to evaluate teaching effectiveness is the questionnaire via the student's opinion (Gómez & Valdés, 2019). Commonly, questionnaires assume teaching as a multidimensional activity and are based on the notion of generic characteristics of effective teaching (Marsh, 1984). That is, the important qualities of effective teaching are substantially unchanged, they do not change according to courses, disciplines, and institutions (Marsh, 1984).

The research has shown that the questionnaires reflect what the student sees and experiences in the classroom, and it is argued that these instruments are valid and reliable (Luna & Torquemada, 2008; Luna & Reyes, 2015). However, the wrong design, the times of application, and the misuse of the results show the bad practices and the continuous disparity between what is found in the investigations and the procedures implemented by the institutions (Luna & Torquemada, 2008: Silva, 2016).

Initially, the teaching evaluation questionnaires were designed based on a conservative pedagogy supported by knowledge transmission models (Luna & Torquemada, 2008). It was not until the early nineties that it was

questioned to include only the dimensions associated with teaching effectiveness in the questionnaires. In addition, there is a need to incorporate the particularities of the pedagogical context and focus teaching on the needs of students, favoring collaborative learning practices as a way of responding to the educational models of each institution (Luna & Torquemada, 2008; Luna & Reyes, 2015). In the same way, dimensions are included to evaluate the opinions of the students of what they learned in the course. However, its massive use arouses disbelief in teachers, because many of these instruments have been developed by the same institutions, or are adaptations of other questionnaires and not always under criteria of methodological rigor and adequate guidance.

Evaluation actions must be consistent with the institutional philosophy to support the achievement of its mission. Likewise, the results of the evaluation must be considered credible by teachers, students, administrators, and the academic community in general (Luna & Torquemada, 2008; Moreno, 2018). The credibility of the conclusions must be based on the use of scientific methodologies that ensure the reliability and validity of the processes and political independence, as well as the professionalism of the evaluators.

The student as an evaluating agent of teaching performance

The student is one of the oldest and most used evaluating agents of teaching performance in national higher education institutions in practically the entire world (García, 2003). This practice is based on the fact that students are one of the best sources of information in the teaching-learning process, as well as in the fulfillment of academic objectives by the teacher. The existing findings indicate that teaching evaluation questionnaires are reliable and valid instruments to assess teaching effectiveness and that those concerns or natural resistances of university professors and officials to use them are not entirely supported by empirical research (García, 2003). On the one hand, the students, based on their experience in educational processes and with different teachers, are one of the best judges of the relevance of the teacher's activities in the classroom. On the other hand, some authors question the use of this source of information, since they argue that the students' vision is partial and subjective, considering that they are not experts in the discipline (Luna & Torquemada, 2008), therefore, they cannot judge learning methodologies in a particular discipline, the bibliographic relevance or a didactic sequence, so they think that their opinion does not reflect the teacher's performance (Díaz-Barriga, F. 2004).

Dimensions of teacher performance evaluation

Although there is no consensus on the characteristics of a quality teacher, various studies related to teacher effectiveness can identify and classify them in dimensions, according to their importance for learning (Luna & Torquemada, 2008). Based on the research by Sánchez-Rincón (2019), four dimensions were identified that consider the main features to evaluate teaching performance: 1) personal, 2) disciplinary, 3) didactic - pedagogical, and 4) professional. The first is related to teacher-student interaction. The second considers the structural and conceptual domain of the object of study. The third, on the one hand, didactics is conceived as the study of the genesis, circulation, and appropriation of knowledge and its teaching-learning conditions (Diaz-Barriga, 2013). On the other hand, the pedagogical becomes a great umbrella that combines the contributions of different scientific disciplines to explain the educational act. The fourth is linked to compliance with the rules of the institution concerning its educational practice inside and outside the classroom (Galván & Farias, 2018).

The evaluation of teaching performance in the ses of the uatx

It consists of the application of an online questionnaire via the student's opinion. This instrument is available from the last partial evaluation and each student must answer it in order to have access to review their final grades. The results of the evaluation are delivered to each teacher by the coordinator of the academic program at the beginning of the following semester, through a document that shows the obtained and optimal scores in each of the dimensions represented in a frequency polygon graph. It is important to mention that this instrument was taken from a proposal by ANUIES in 2000 to evaluate the performance of teachers. However, it needs to be contextualized to the needs of the university community and consider the participation of those involved in its preparation.

METHODOLOGY AND METHODS

This work is part of a broader research process, so this article only presents results of the personal, disciplinary, pedagogical-didactic, and professional dimensions. It was carried out under the quantitative approach, of the exploratory, descriptive and evaluative type by statistical inference in the independent variables.

Population

The total number of students from the fourth to the eighth semester of the spring 2020 period of the two curricula of the School of Educational Sciences: Bachelor of Communication and Educational Innovation (LCEE) and Bachelor of Education Sciences (LCE). 235 students corresponding to the LCE and 64 students corresponding to the LCEE.

Sample

To determine the sample size of the population, the sample calculation formula was applied at a confidence level of 95%, resulting in 146 students for the LCE and 52 students for the LCEE. The final result considered 154 questionnaires answered by the LCE students and 50 by the LCEE students (two questionnaires were disregarded because they were incomplete).

Categorical Variables

The categorical variables considered were semester (from fourth to eighth), educational program (lce or lcee), gender (man or woman), and academic achievement (from D to A).

DESIGN, VALIDATION, AND APPLICATION OF THE QUESTIONNAIRE.

Design

The questionnaire is divided into seven main categories: personal factors, academic factors, personal dimension, disciplinary dimension, didactic-pedagogical dimension, professional dimension, and expectations in the evaluation of teacher performance. In this particular case, only four categories will be analyzed: personal dimension, disciplinary dimension, didactic-pedagogical dimension, and professional dimension. They were given a Likert scale of 5 adjectives ranging from not acceptable to excellent.

Construct validation

For the validation of the construct, it was reviewed by a group of experts, made up of postgraduate researchers in Education at UATX, who analyzed and evaluated each of the items, considering the objectives of the research. After attending to the observations made by the experts and adjusting the questionnaire, a pilot test was carried out with some students from the School of Philosophy and Letters of the UATX. Subsequently, a statistical vali-

dation was performed to ensure the reliability of the item with Cronbach's Alpha algorithm, yielding a value of 0.84.

Application

Information was collected directly with each of the students belonging to the two study plans. For the LCE, 154 questionnaires were obtained, of which 120 belong to women and 34 to men. Regarding LCEE, 50 questionnaires were obtained, of which 27 correspond to women and 23 to men.

RESULTS

The t Student test was carried out for the approval of hypotheses as a measure of comparison in a sample by grouping data in four dimensions: a) personal, b) disciplinary, c) didactic-pedagogical, and d) professional. The results are the product derived from the statistical analysis supported by the SPSS version 19 program.

a) Personal dimension

In all variables, hypothesis test values greater than 1.96 (table value) were obtained, so the null hypothesis is rejected. It was found that the variable weighted as "excellent" is respectful treatment. Likewise, the variables valued as "very good" are individual attention and the teacher's motivation for the student to attend tutoring sessions. Finally, the variable weighted as "acceptable" is the teacher's time dedicated to his or her students (see table 1).

Table 1
Personal dimension

Item	Question	Medium	*u* test value	T value	Assessment of the response
X17	The teacher must treat all students with respect	4.72	4.5	5.329	****Ho is rejected
X18	The teacher must dedicate the necessary time to their students outside of class	3.39	3.0	4.232	*Ho is rejected
X19	The teacher must provide individual attention to students who request it	4.34	4.0	6.573	***Ho is rejected
X20	The teacher must motivate his students to attend tutoring sessions and solve their doubts	4.18	4.0	2.704	***Ho is rejected

****Excellent, ***Very good, **Good, *Acceptable, Not acceptable
U= >4.5 *U*=>4.0 *U*=>3.5 *U*=>3 *U*=<3

Source: own elaboration

Teacher-student interaction is one of the traits best valued by students: respect, attention, and motivation. We are struck by how little importance is given to the teacher's dedication to their students outside of class.

b) Disciplinary dimension

Students valued the teacher's mastery of the subject as "excellent". Hypothesis test values greater than 1.96 (table value) were obtained, compared with a test value u = 4.5, so the null hypothesis is rejected (see table 2).

Table 2
Disciplinary dimension

Item	Question	Medium	*u* test value	T value	Assessment of the response
X29	It is the teacher's obligation to master the contents of the subject he teaches	4.78	4.5	7.740	**** Ho is rejected

****Excellent, ***Very good, **Good, *Acceptable, Not acceptable.
U= >4.5 *U*=>4.0 *U*=>3.5 *U*=>3 *U*=<3

Source: own elaboration

The university professor commits to be a specialist in his or her area of knowledge. He or she has to be dedicated to researching the content of his or her subject and teaching itself.

c) The didactic-pedagogical dimension

In all variables, hypothesis test values greater than 1.96 (table value) were obtained, so the null hypothesis is rejected. It was found that the variables weighted as "excellent" are related to the planning of the class, the clarity of the teacher in his or her speech, the use of various means of support in teaching-learning, that the teacher lets them know in advance fair learning evaluation criteria.

The variables valued as "very good" have to do with the teacher following a logical and orderly sequence of the class and the presentation of the topics, as well as relating previous knowledge with new ones. Likewise, the teacher must find a way to encourage the participation of students in class by developing and presenting topics, promoting dialogue, and debate on the topics discussed. Likewise, it must use different strategies for learning evaluation, deliver the results promptly and inform students about the behavior of the apprehension of knowledge. The variable valued as "good" is related to the promotion of group work. Finally, the variable weighted as "acceptable" is related to the implementation of strategies to help organize

the new information to be learned and strategies to better understand the topics (see table 3).

Table 3
Didactic-pedagogical dimension

Item	Question	Medium	*u* test value	T value	Assessment of the response
X25	The teacher should encourage students to ask questions and participate in class	4.29	4.0	4.787	***Ho is rejected
X26	The teacher must promote student's participation in the elaboration and presentation of topics	4.36	4.0	7.340	***Ho is rejected
X27	It is the teacher's responsibility to encourage group work	4.00	3.5	7.305	**Ho is rejected
X28	It is the teacher's responsibility to encourage dialogue, reflection, and debate on the topics covered	4.24	4.0	3.777	***Ho is rejected
X29	The teacher must plan their classes in order to obtain the maximum guarantees of success	4.77	4.5	7.746	****Ho is rejected
X30	The teacher must follow a logical sequence in the order of the course topics	4.57	4.0	10.862	***Ho is rejected
X31	It is the teacher's responsibility to relate the new topics with what has been seen previously before intruding new knowledge	4.41	4.0	7.259	***Ho is rejected
X32	The teacher must be clear in his presentations	4.75	4.5	6.868	***Ho is rejected
X33	It is the teacher's responsibility to prepare syntheses or summaries of what has been reviewed or what is going to be explained	3.56	3.0	7.494	*Ho is rejected
X34	The teacher must present the topics in order	4.56	4.0	12.504	***Ho is rejected
X35	The teacher must use various means of learning support	4.66	4.5	4.222	****Ho is rejected
X36	The teacher has the responsibility of verifying at the end of the sessions if the students have understood what they have studied	4.36	4.0	6.820	***Ho is rejected
X37	The teacher must make the evaluation criteria known to his students	4.86	4.5	11.950	****Ho is rejected
X38	The teacher must be fair in evaluations	4.85	4.5	11.158	****Ho is rejected
X39	It is the teacher's responsibility to use different evaluation mechanisms according to the objectives to be evaluated	4.49	4.0	12.804	***Ho is rejected
X40	It is the teacher's responsibility to deliver the evaluations' results on time.	4.55	4.0	11.373	***Ho is rejected
X41	It is the teacher's responsibility to inform students about problems detected in their evaluation	4.59	4.0	12.709	***Ho is rejected

****Excellent, ***Very good, **Good, *Acceptable, Not acceptable.
U= >4.5 *U*=>4.0 *U*=>3.5 *U*=>3 *U*=<3

Source: own elaboration

It is expected that the teacher privileges didactic strategies that guide students to the development of high-level cognitive skills, to the reasoned internalization of values and attitudes, to the appropriation and implementation of complex learning, as a result of their participation in experiential educational environments and located in real contexts (Diaz-Barriga, F & Hernández, 2010).

d) Professional dimension

In all variables, hypothesis test values greater than 1.96 (table value) were obtained, so the null hypothesis is rejected. It is evident, firstly, that the variables weighted as "excellent" refer to the teacher attending regularly and complying with the established schedules in class and tutoring. Second, the variables weighted as very good concern that teachers attend on time and finish their classes at the indicated time (see table 4).

Table 4
Professional dimension

Item	Question	Medium	*u* test value	T value	Assessment of the response
X21	It is the teacher's responsibility to attend their classes on time	4.57	4.0	9.208	***Ho is rejected
X22	It is the teacher's responsibility to attend their classes regularly	4.71	4.5	5.108	****Ho is rejected
X23	The teacher must finish their scheduled classes on time	4.42	4.0	6.919	***Ho is rejected
X24	The teacher must comply with the schedule established in class and tutoring sessions	4.63	4.5	2.914	****Ho is rejected

****Excellent, ***Very good, **Good, *Acceptable, Not acceptable.
U= >4.5 *U*=>4.0 *U*=>3.5 *U*=>3 *U*=<3

Source: own elaboration

It is interesting to observe that the items considered in this dimension are valued between excellent and very good, evidencing the importance of the teacher's commitment to their educational practice.

CONCLUSIONS

The objective of this article was to determine the main features to be evaluated in the teaching performance from the opinion of the students from the personal, disciplinary, didactic-pedagogical, and professional dimensions that allow feedback to the teaching performance evaluation instrument via

the opinion of the student used in the School of Education Sciences of the UATX. The conclusions can be grouped into the four dimensions mentioned above:

Personal dimension

The findings matchedCabalín, Navarro, Zamora, and San Martin (2010) work which shows that respect is the main characteristic of a good university professor. Similarly, Casero (2016) found that the personal qualities of the teacher are one of the main features to evaluate in their performance. A good teacher does not present moments of indifference with his or her students (Galván & Farías, 2018). Regarding teacher motivation towards students, Cabalín *et al*. (2010) find different results, since, in their research, motivation is in the last place of 10 characteristics of a good university professor. It is important to mention that motivation is intrinsic, the teacher must generate challenging, pertinent, and contextualized learning environments so that students are interested in the object of study. Finally, it is interesting to observe that students give "acceptable" ratings to teacher actions related to spending time with students after class.

Professional dimension

The results agree with that evidenced by Hickman, Alarcón, Cepeda, Cabrera, and Torres (2016), who found, from the opinion of the students, that the traits related to attendance and punctuality are the second most important aspect of a total of 10 to evaluate teacher performance. In this regard, Perrenoud (2008) wonders whether complying with the school calendar or with the number of class hours of a discipline ensures that students learn.

Didactic-pedagogical dimension

As in other investigations, didactic planning is one of the most important traits to be evaluated by students (Reyes, González, & Ramírez, 2018: Leguey, Leguey, & Matosas, 2018). Likewise, Abadía, Bueno, Ubieto, Márquez, Sabaté, Jorba and Pagés (2015) found the teacher's ability to explain the contents well to be on top. Regarding the learning evaluation strategies, there are coincidences with the work of Abadía *et al*. (2015) highlighting the importance for students of previously having the evaluation criteria in each of the products proposed by the teacher. Sanahuja and Sánchez-Tarazaga (2018) consider it necessary for teachers to demonstrate their evaluative competence: knowing how to evaluate and carrying out evaluation as a wide set of techniques and methods. Regarding the use of various means to support teaching, there is a small difference with what was found by

Martínez, Sánchez, and Martínez (2010) who show average ratings of 4.0 as "very good" for the findings of this research valued as "Excellent".

It is interesting to find evaluations of "good" to the actions of the teacher to promote group work, considering that the Universidad Autónoma de Tlaxcala has an educational model which favors sociocultural learning. In addition, students give "acceptable" weights regarding the teacher making graphic organizers to recover previous knowledge and relate the new information to be learned.

In general, it was found that the traits associated with the didactic-pedagogical are well-valued by university students (Fernandes, Sotolongo & Martínez, 2016; Ávila, Juárez, Arreola & Palmares, 2019). In this sense, Díaz-Barriga and Hernández (2010) argue that these teaching strategies intend to intentionally facilitate deep processing of the information to be learned or to reinforce what has been learned. It is important to mention that it is the teacher who, based on his experience, knows how, when, where, and why to use certain teaching strategies.

Disciplinary dimension

What was found in this research matches with the work of Galván and Farías (2018) who find that mastering the content of the subject they teach has a favorable impact on the evaluation of teacher performance. In the same way, Fernández and Luna (2004) find in the first place the subject's domain to the work of the teacher in the classroom.

The results obtained have made it possible to identify that the evaluations issued by the students regarding the main features to be evaluated in teaching performance are consistent with what was found in various studies. However, it is notable that complying with the established schedules in class and tutoring sessions is more relevant than for the teacher to work with graphic organizers to facilitate learning, or to encourage group work, even more, the dedication of time to students outside of school class to solve their doubts. Similarly, discuss whether it is convenient to maintain or differentiate weights for the traits identified as excellent to obtain the total score in the evaluation of teacher performance. It is suggested that in future investigations qualitative methods be deepened to collect the impressions of teachers and students from other Schools of the Universidad Autonoma de Tlaxcala since the different training contexts could influence different constructions of the participants.

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Development of a free app to learn the design of reinforced concrete walls subject to in-plane bending and axial load

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— Abstract—

The paper shows a support-free tool for the learning-teaching process of reinforced concrete wall design. These structural elements are used in Mexico for buildings and dwelling houses construction. Then, their structural design is an important topic for the students. The algorithm was implemented in a spreadsheet, which shows the operations and decision-making required to compute the bending-axial load strength curve (M_R-P_R). In addition, for a pair of factored mechanical elements (M_U, P_U), it calculates the action/strength ratio. Basic knowledge of arithmetic, analytical geometry, matrix algebra, and the Mexican standard were applied in the development. According to the user's preference, the data vector can be modified. Although a simplified envelope strength curve formed by seven points (M_R-P_R) was obtained, its accuracy is adequate compared to a commercial application result, 98% and 87%, for the nominal and strength curve, respectively. The application shows to the students an introduction to the abstract thinking required in the automation of calculation processes and it can guide them in the implementation of their applications for strengthening of specific competencies.

Keywords:

Reinforced concrete; design; bending and axial load; free software; open source

The training processes in Higher Education Institutions are focused on the learning of interdisciplinary knowledge and oriented towards its application to guarantee the professional training of the student. In this order, the current situation requires the construction of new learning environments with didactic-pedagogical methods and techniques, which allow the development of generic and specific skills of the graduate, highlighting capacity for abstraction, analysis, and synthesis, application of knowledge of basic sciences and engineering. The identification, evaluation, and implementation of technologies appropriate to the context is also required. In the specific case of the state of Guerrero, the graduate must contribute to the solution of the regional problem generated by high seismicity through the conception, analysis, design, construction, and supervision of reliable structures (UAGro, 2011).

One way to achieve this is to use free and open-source computer apps in the learning-teaching process. Among the advantages are (Culebro, *et al*., 2006; Díaz, *et al*., 2005; Free Software Foundation, 2020):

1. They are not black boxes because they show the code
2. They develop the calculations quickly and repetitively
3. Serve as a guide for students for developing their own tools
4. They help in the acquisition of competencies
5. They use local regulations
6. Avoid copyright infringement
7. They promote the technological development of the country

In the Civil Engineering field, the analysis-design process has different levels of complexity, where the used tool changes according the objective. Such activity includes performing arithmetic operations and making decisions that can be repetitive. Table 1 shows a classification of the computer applications and their main characteristics, the complexity increases from left to right. In this way, an Excel spreadsheet (Microsoft 2020) was developed, which does not require advanced programming knowledge.

Table 1
Classification of apps for design-review structures

Level 1. Low complexity	Level 2. Medium complexity (ESI Group, 2020; MatWorks, 2020; PTC, 2020)	Level 3. High complexity (Corona, 2020; Computer and Structures, 2018)
Manual calculation Tool: calculator. Advantages: The calculation processes defined by the technical standards are applied. Disadvantages: Simple structures are studied by the number of calculations.	Semi-manual or automated calculation Tool: spreadsheet, Scilab, Matlab, Mathcad. Advantages: Visualization of calculations, use of national standards, open-source. Disadvantages: In the case of Scilab, Octave, Matlab, and Mathcad basic programming knowledge is required. The last two are proprietary software, meaning they have a price	Automated calculation Tools for commercial use. Advantages: Specialization and speed. Disadvantages: Black boxes, copyright payment, use of international standards, closed source.

Source: Own elaboration

II. OBJECTIVE

The use of reinforced concrete walls in the construction of buildings and homes combined with the high seismic risk in large areas of the national territory (Alcocer, *et al*, 2020; Carrillo & Alcocer, 2011) requires special care in the design of these structural elements when they are subjected to in-plane bending and axial load. For this reason, an open-source tool was developed to help in the learning-teaching process in Civil Engineering schools. Due to its characteristics, calculations, decision-making, and repetition of processes are shown, it can also be improved by users (teachers, students, or professionals).

III. METHODOLOGY

Background

Reinforced concrete is the most widely used material worldwide in the building construction (McCormac & Brown, 2014). In the case of reinforced concrete walls, they are subjected to three types of mechanical stress: shear ($\boldsymbol{V}_u$), bending moment in its plane ($\boldsymbol{M}_u$), and axial load ($\boldsymbol{P}_u$), Figure 1. Combination of lateral and gravitational forces are the origin of these mechanical elements.

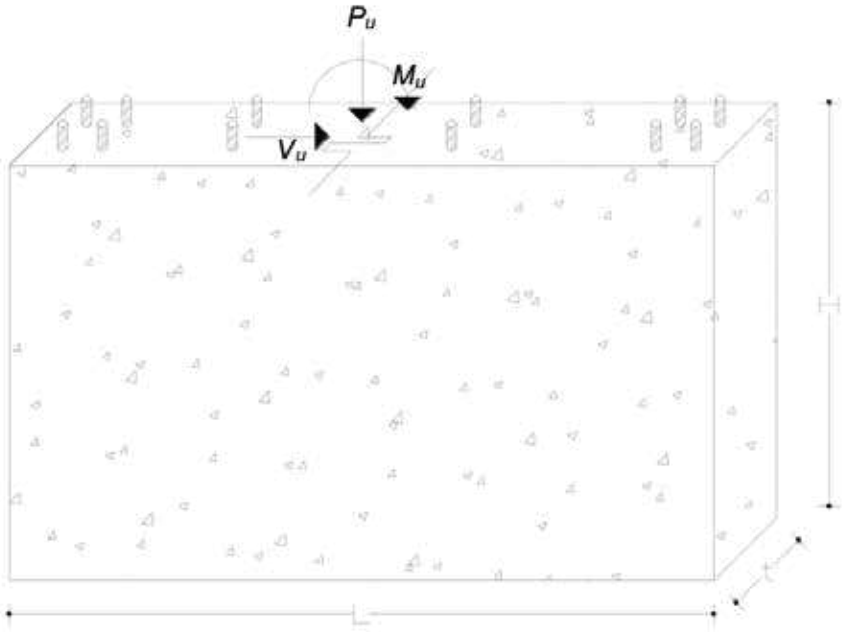

Figure 1. Mechanical elements acting in a reinforced concrete wall. Source: Own elaboration

The concrete structures design here presented is based on the NTCC-2017. Figure 2 shows the flow chart for developing of the spreadsheet. In the first step, the input vector must have the wall geometry, mechanical characteristics of the concrete, and distribution/properties of steel bars. In the second step, the strength interaction curve (***M-P***) is obtained. In the third step, the strength moment and axial load (M_R, P_R) for the design eccentricity (M_U / P_U) are calculated. Finally, it is evaluated if the reinforced concrete element resists the combination of the factored load (P_U) and factored moment (M_U).

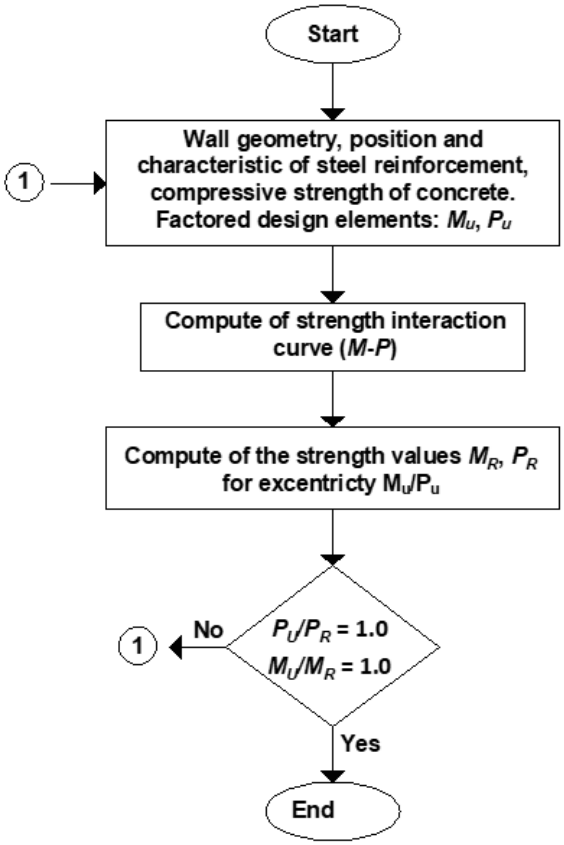

Figure 2. Flow chart used for the app development. Source: Own elaboration

Calculation of the strength interaction curve

For instructional purposes, the concrete wall has only four layers of steel, two at each end, which are subjected to tension or compression effects. The section experiences the strains and stresses shown in Figure 3, sections b and c. To calculate the strength axial load and moment, extreme values of concrete and steel strains are needed. The maximum strain of concrete (ε_c) is 0.003 and in the case of steel values from 0.003 in compression to 0.010 in tension are proposed, (ε_{s4}). The bending moment causes tension in the lower part and compression in the upper part. The variables in Figure 3 are defined in Table 2.

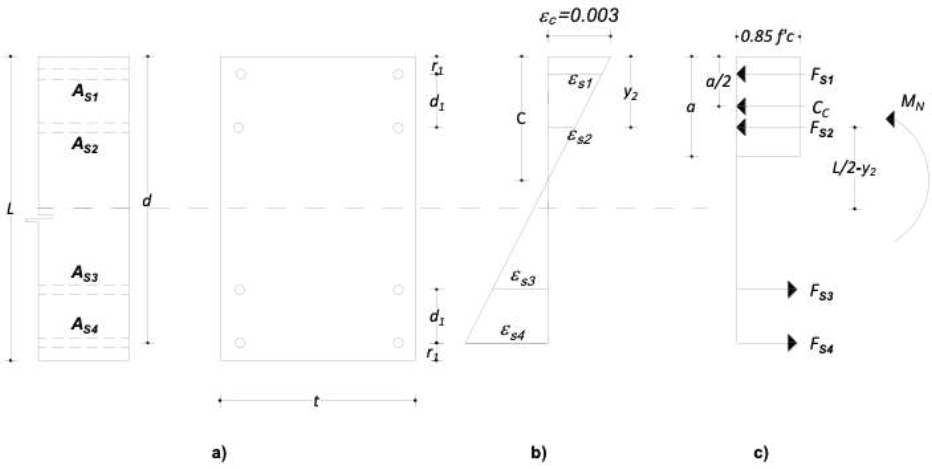

Figure 3. a) Geometry of the section, b) Strain diagram, c) Stress diagram. Source: Own elaboration

The depth of the neutral axis (c) and the strain of the steel layer i (ε_{si}) are a function of the extreme strains of concrete and steel and are obtained with equations 1 and 2. According to Hooke's law, the acting stress is proportional to the strain without exceeding the yield stress, f_y, equation 3. The acting force of layer i is obtained by multiplying the area of rebar by the acting stress, equation 4. Finally, the moment generated by the steel layer i is the multiplication of the force by the lever arm concerning the plastic axis of the section, equation 5.

Table 2
Definition of variables from Figure 3

Variable	Description	Variable	Description
L	Wall's length	ε_{si}	Strain of the steel in layer i
t	Wall's thickness	y_i	Distance from of steel layer i to compression face
A_{si}	*Steel area of the layer i*	d	Distance from extreme compression fiber to centroid of longitudinal tension reinforcement
r_1	Clear cover of reinforcement	c	Distance from extreme compression fiber to neutral axis
d_1	Distance between steel layers 1-2 and 3-4	a	Depth of equivalent rectangular stress block
f'_c	Compressive strength of concrete less than or equal to 28 MPa	F_{si}	Stress in the steel layer i
Cc	Compression force in the concrete compression block	M_N	Nominal flexural strength at section
ε_c	Concrete strain equal to 0.003		

Source: Own elaboration

$$c = d\,\varepsilon_c/(\varepsilon_c + \varepsilon_{s4}) \quad (1)$$
$$\varepsilon_{si} = \varepsilon_c\,(c - y_i)/c \quad (2)$$
$$f_{si} = \varepsilon_{si}\,f_y/0.002 \quad (3)$$
$$F_{si} = A_{si} f_{si} \quad (4)$$
$$M_{si} = F_{si}(L/2 - y_i) \quad (5)$$

Due to its position, the steel located at the ends of the wall provides the greatest amount of resistance moment, for this reason, the steel of intermediate layers is not considered, which is calculated to absorb the temperature's effects.

As can be seen in Figure 3c, the maximum concrete stress is 0.85 f'_c, then, it is possible to evaluate the volume of the stress block with equation 6, where a = 0.85 c when the compressive strength is less than or equal to 28 MPa, the moment is obtained using equation 7. The nominal load (P_N) and nominal moment (M_N) associated with ε_c = 0.003 and a specific value of ε_{s4} are the sum of the forces and moments of the steel and concrete, respectively, equations 8 and 9.

$$C_c = 0.85\,f'_c\,at \quad (6)$$
$$M_c = C_c(L - a/2) \quad (7)$$
$$P_N = \sum_{i=1}^{i=4} F_{si} + C_c \quad (8)$$
$$M_N = \sum_{i=1}^{i=4} M_{si} + M_c \quad (9)$$

The M_N and P_N define a point on the nominal moment-load interaction curve, Figure 4. In this case, for didactic purposes, only five intermediate points (points P_2, P_3, P_4, P_5 and P_6) associated with different values of the deformation of the extreme layer (ε_{s4}) were calculated. Points P_2 and P_7 with moments equal to zero are the nominal strength to compression and tension, the second one represents the second term of equation 10 and both define the compressive strength, where A_g is the gross area of concrete section. At point P_7 the contribution of concrete is zero.

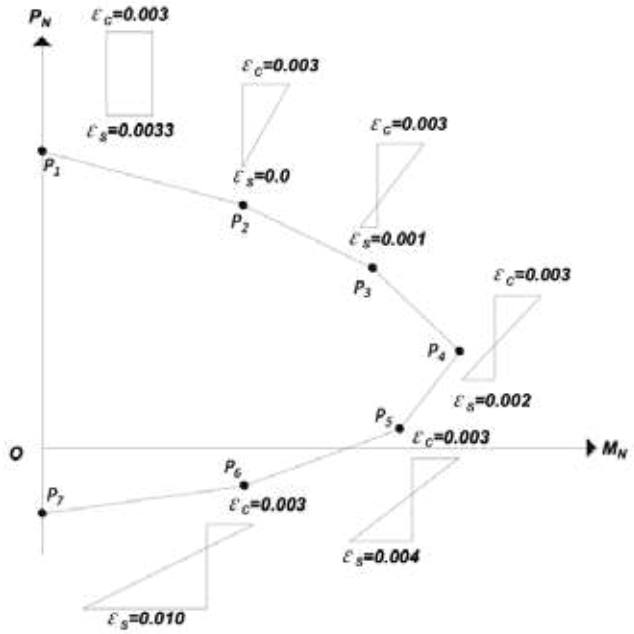

Figure 4. Points analyzed in the nominal interaction curve and associated strains. Source: Own elaboration

$$P_{O,T} = 0.85\, f'_c A_g + A_s f_y \tag{10}$$

By multiplying the values of the nominal interaction curve (Figure 4) by the strength reduction factor (F_R) the strength curve is obtained, equation 11 and Figure 5a. The F_R values are defined in section 3.7 of the NTCC-2017, equation 12.

$$\begin{bmatrix} M_R \\ F_R \end{bmatrix} = F_R \begin{bmatrix} M_N \\ P_N \end{bmatrix} \tag{11}$$

$$F_R = \begin{cases} 0.65 & falla\ en\ compresión \\ 0.75 & falla\ en\ tensión \end{cases} \tag{12}$$

Calculation of strength elements (M_R, P_R) to factored moment and load (M_U, P_U)

The third step of the process shown in Figure 2 is to calculate the strength moment (M_R) and strength load (P_R) corresponding to the factored moment (M_U) and load (P_U). According to Figure 5a, the line OA starts at the origin and ends at the coordinates (M_U, P_U) forming an angle θ measured in the clockwise direction for the line OP_1, its intersection with the strength curve defines the point B (M_R, P_R), between points P_2 and P_3. The position is obtained by comparing the angle θ with the angles θ_2 and θ_3, Figure 5b. Next, the slopes of the lines P_2P_3 and OA, m_1 and m_2, respectively, are calculated.

In segment P_2P_3, equation 13 is established, which passes through the point of known coordinates (M_{R3}, P_{R3}), while the definition of the slope m_2 of the line OA allows establishing equation 14 (Lehman, 2006).

$$P_R - m_1 M_R = P_{R3} - m_1 M_{R3} \quad (13)$$

$$P_R - m_2 M_R = 0 \quad (14)$$

The solution of the system of both equations represents the coordinates of point B (Griffiths & Smith, 2006), which are the strength moment (M_R) and strength load (P_R) related to the factored elements (M_U, P_U).

Finally, the relation M_U/M_R and P_U/P_R is compared, if the quotient is less than one, the wall resists the actuating mechanical elements, otherwise the user must modify the input data and repeat the calculation.

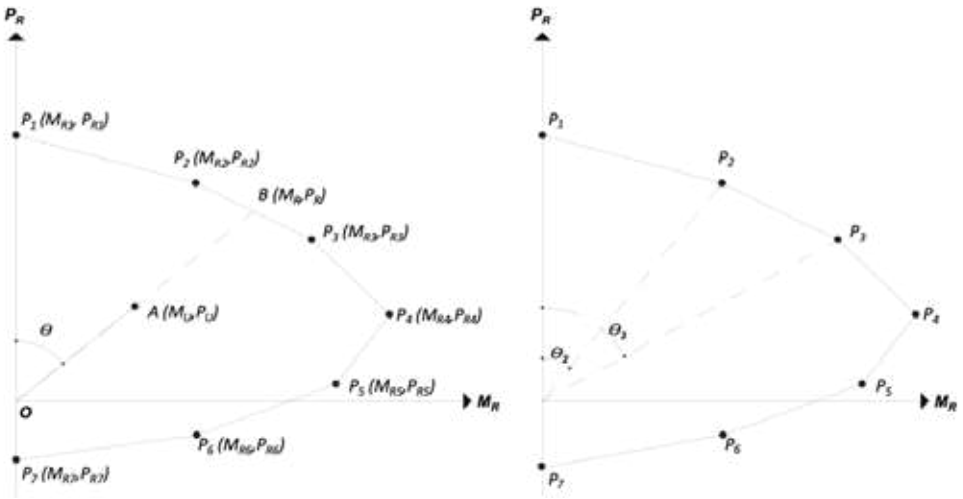

Figure 5. Strength interaction curve (M_R - P_R): a) eccentricity angle (θ) and point of intersection in the strength curve, b) definition of angles θ_2 y θ_3. Source: Own elaboration

Application to a specific case

The application has two spreadsheets, in the first the data is entered and the nominal curve (M_N -P_N) is calculated, in the second the strength curve and the pair of values (M_R -P_R) associated to the factored elements (M_U- P_U) are calculated. Table 3 shows the data vector and Table 4 presents the calculation of the nominal moment (M_N) and nominal load (P_N) of point P_4. The application has a choice of four different steel diameters (3/8", ½", 5/8", and ¾"), which can be modified with simple user manipulation. On the other hand, the length/thickness ratio of the wall must not exceed 40 or

70, depending on the axial load and the thickness will not be less than 100 mm, subsection 7.4.2.1 of the NTCC-2017.

Table 3
Data vector

Geometry, characteristics of steel and concrete (m, MPa)				Factored moment and axial load (KN, m)	
t =	0.15	$f'c$ =	19.62	M_U	P_U
r_1 =	0.04	f_y =	412.02	150.0	1000.0
r_2 =	0.04	ϕ_1	3/8	Note: 1) Si M_U=0 and/or	
d_1 =	0.12	# of bars:	8	P_U=0, a value equal to 0.001	
L =	1.00			is recommended	

Source: Own elaboration

Table 4
Calculation of nominal moment (M_N) and nominal load (P_N) at point 4, balanced strain condition. Units: KN, m

ε_c = 0.003			c = 0.58			D = 0.26	
ε_{s4} = 0.002			a = 0.49			M_c = 313	
			C_c = 1225				
# As	As (cm_2)	y_i	ε_s	fs	Fs	$Dist$	Ms
1	1.42	0.04	0.0028	412	59	0.46	27
2	1.42	0.16	0.0022	412	59	0.34	20
3	1.42	0.84	-0.0014	-283	-40	-0.34	14
4	1.42	0.96	-0.0020	-412	-59	-0.46	27
					18		87
	ΣF = 1243			ΣM = 400			

Source: Own elaboration

The system of equations is formed by the equations of intersecting lines (***OA*** and P_2P_3), the solution and the M_U/M_R and P_U/P_R relationships are shown in Figure 6. Figure 7 shows the calculated curves and the ***OA*** line and the intersection with the resistant curve whose coordinates are the resistant moment (M_R) and the resistant load (P_R) are presented.

Equation system			System solution (KN m)	Ratio
$[A]$	$[x]$ =	$[b]$	$[x]=[A]^{-1}[b]$	M_U/M_R 0.80
1	4.30	2056	P_R = 1249.4	P_U/P_R = 0.80
1	-6.67	0	M_R = 187.41	The wall resists

Figure 6. System of equations, solution, and final result. Source: Own elaboration

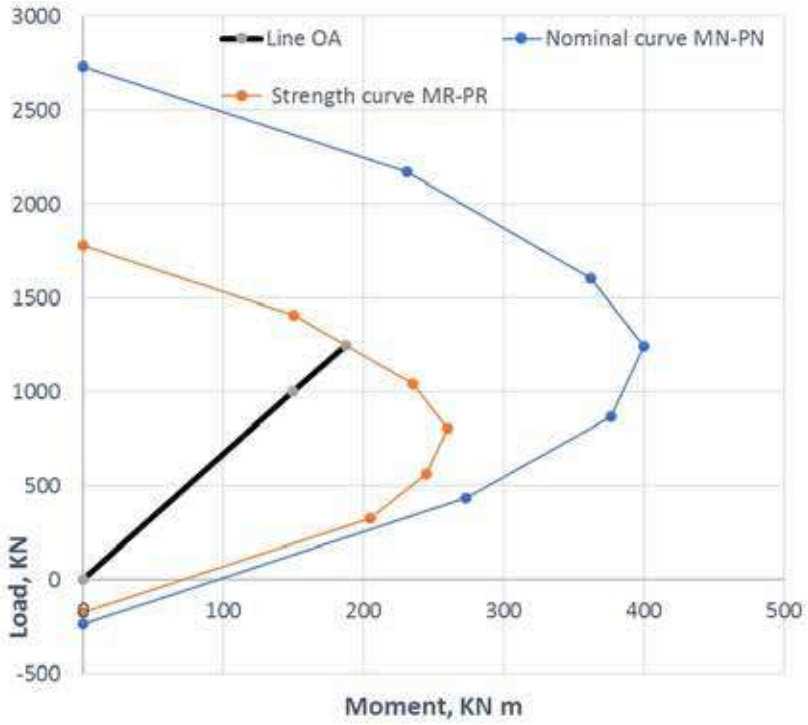

Figure 7. Calculated curves and intersection of the line ***OA*** with the strength curve. Source: Own elaboration

App access

The application can be downloaded from the site https://github.com/SULPICIO67/Muros-de-concreto/blob/main/Flexocompresion.xlsx by anyone interested: student, teacher, and professional to use, modify or implement it in a more complex app.

III. RESULTS

The nominal interaction curve calculated with seven points by the app was compared with those obtained using two proprietary software (Corona, 2020; CSI, 2018) to determine its accuracy. The first commercial app (Corona: 2020) evaluates 38 points, as seen in Figure 8a, both nominal curves agree, there is only a negligible error near the point of maximum

moment. The difference between both curves for a fixed value of eccentricity (M_u/P_u) is evaluated by equation 15, where R_C is the modulus of the intersecting line of the curve obtained from the commercial application and R_A is the respective associated with the developed app, the error is E = 1.8%.

Figure 8b shows the curve of the application and that obtained in the Sap2000 program (CSI, 2018), the latter has ten points and the error was E= 1.7%. In this case, it should be noted that the comparison between nominal curves was possible because the Sap2000 program uses the ACI 318-14 version, whose analysis hypotheses are identical to those used in the NTCC-2017.

$$E = 100\ (R_C - R_A)/R_C \tag{15}$$

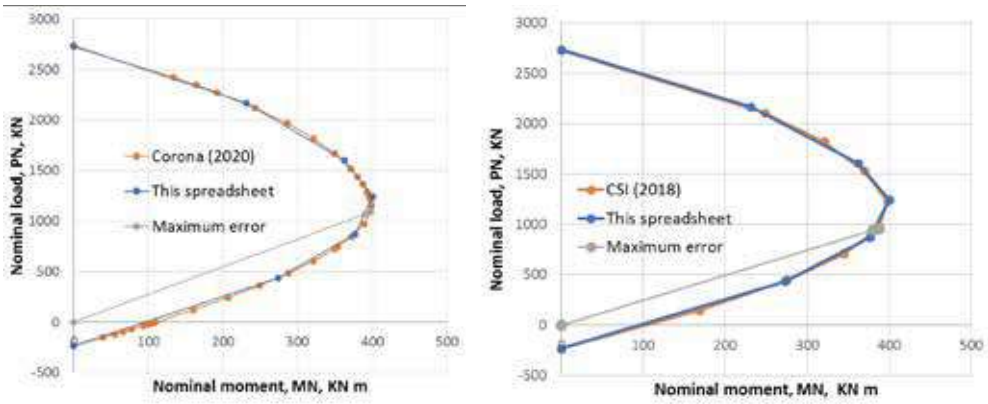

Figure 8. Nominal curves comparison. Source: Own elaboration

The error between strength curves, the first calculated with the application and the second with a commercial application (Corona, 2020), was evaluated with equation 15. Thus, two lines associated with two pairs of M_U-P_U values were proposed. The line M_{R1}-P_{R1} with eccentricity equal to 0.40 had an error, E_1 = 4.6% while the line M_{R2}-P_{R2} with eccentricity equal to 0.60 registered E_2 = 13.0%, figure 9. As can be seen, the professional software calculates 38 points of the curve, while the developed application computes only seven points. Even so, the approximation, from 87% to 95.4%, is adequate.

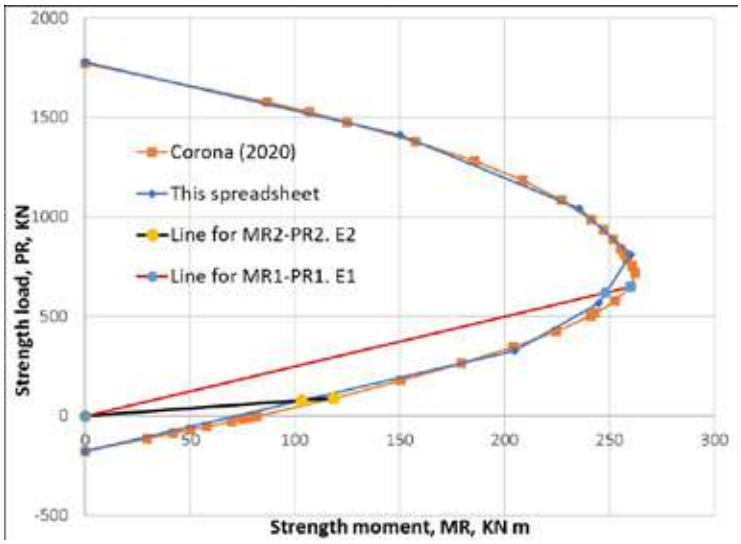

Figure 9. Strength curves comparison. Source: Own elaboration

Considering the didactic characteristics of the developed application, the limitations are:

- The maximum error of 13% is associated to the number of points used in the curve compute.
- Because the contribution of intermediate steel rebars are not evaluated, the section capacity is underestimated.

IV. CONCLUSIONS

The app meets the objective for supporting teaching-learning process of reinforced concrete walls design/revision, through the implementation of a simple algorithm with a reduced number of decisions. The strength curve defined by seven points has an approximation at least of 87% of that obtained by professional software, which evaluates 38 points of the graph. For the nominal curves, the error is less than 2%. This tool is already used by graduate students at the Faculty of Engineering (UAGro) in the courses of concrete structures/masonry structures design.

In another order, the algorithm is a guide for students, teachers, or Higher Education Institutions that intend to develop their own apps. In this sense, unlike internationally recognized universities, many Mexican universities do not have their own or free software to support teaching, so they must pay for the use of commercial licenses. This development shows an alternative to this situation.

The basic knowledge used was analytical geometry, arithmetic, and matrix algebra, all accessible in the Excel tool. In addition, it is possible to modify the input data if the result is not satisfactory.

Finally, an introduction to the abstract thinking required in the automation of calculation processes that students could face in their future professional development was shown, strengthening the acquisition of knowledge, skills, and competencies defined in the students' graduation profile.

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Acute Hepatopancreatic Necrosis affecting penaeid shrimp culture in Mexico

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— Abstract—

Emerging diseases that affect crops on shrimp farms cause significant economic losses to aquaculturers. In most cases, good management practices are not implemented in production systems, because of the established biosecurity standards that are not adequate ones, favoring the introduction and dispersion of pathogenic organisms, such as the case of Acute Hepatopancreatic Necrosis (AHPND), an infection that appeared at the end of 2013 in shrimp crops in Mexico. It also analyzes and discusses the impacts and the control measures that this transboundary disease faces in the Mexican territory from the outbreak.

Keywords:

Shrimp farming; biological contingency; AHPND

For the world's aquaculturists, dedicated to shrimp fattening, diseases are a real threat in terms of economic and social impacts, their appearance is related to the recent increase in globalization and the commercial volume of the aquaculture sector that it has created new market opportunities for farmed aquatic animals, but, simultaneously, they have facilitated new mechanisms, by which these microorganisms can spread to new areas, thus, aquatic animal diseases are one of the most serious limitations for expansion and the development of sustainable aquaculture. These transboundary diseases are usually caused by viruses, but the pathogen can also be a bacteria or a parasite (FAO, 2020), leading to a considerable decrease in the records of farmed shrimp production.

Addressing this problem in a particular way, regionalized in those farms where its presence has been manifested and verified, it is urgent to start programs for the prevention of local diseases to eliminate the vertical transmission of these pathogens. Shrimp farming is facing a great challenge regarding the development of control and prevention strategies for this pathology, at present AHPND is caused by at least two different species of Vibrio, this opens the possibility of spreading to other species, therefore molecular diagnostic techniques must undergo constant sensitivity and specificity evaluations (Varela *et al*., 2017).

This document presents the official aquaculture health mechanisms adopted to attend the biological contingency due to the appearance of Acute Hepatopancreatic Necrosis (AHPND) and the results obtained from its application.

RECENT ACUTE HEPATOPANCREATIC NECROSIS

AHPND represents a real threat, a team of researchers from the University of Arizona has managed to isolate the strain and use it to infect healthy shrimp with AHPND, and this is the method known as Koch's postulates (FAO, 2013). There are documented reports that AHPND initially appeared in 2009. It is a new disease that affected shrimp farms located in southern China and Hainan Island in 2010. The disease manifests itself within 20 or 30 days after being introduced to the fattening ponds with the postlarvae, the clinical signs include lethargy, reduced hepatopancreas, red and empty intestine, soft and dark exoskeletons, and spots on the shell with affectations to the species, both *Penaeus monodon* and *Litopenaeus vannamei* present the same pathology (Lightner, 2012).

During 2010 and 2011, similar mortalities were recorded in Vietnam and Malaysia; these new cases shared some characteristics with what happened in 2009. Later in 2012, Thailand was affected by AHPND with farmed shrimp mortalities of 20-30%. In Latin America and particularly in the shrimp farms

of the Mexican Republic, until that date there were no official reports on the incidence of the disease, however, in August 2013, Dr. Donald Lightner confirmed the presence of this disease at the "Sixth Meeting of the Inter-American Committee on Aquatic Animal Health", carried out in Yucatán, Mexico (Sánchez *et al*., 2014).

The impact by AHPND in Mexico has been critical with a decrease in the production rates of farmed shrimp in the order of 60%, from 100,321 t of live weight produced in 2012 to 60,292 t in 2013, a partial recovery for 2014 with 86,950 t recorded and an extraordinary rebound in 2015 with 130, 344 t reported by the production units (Figure 1).

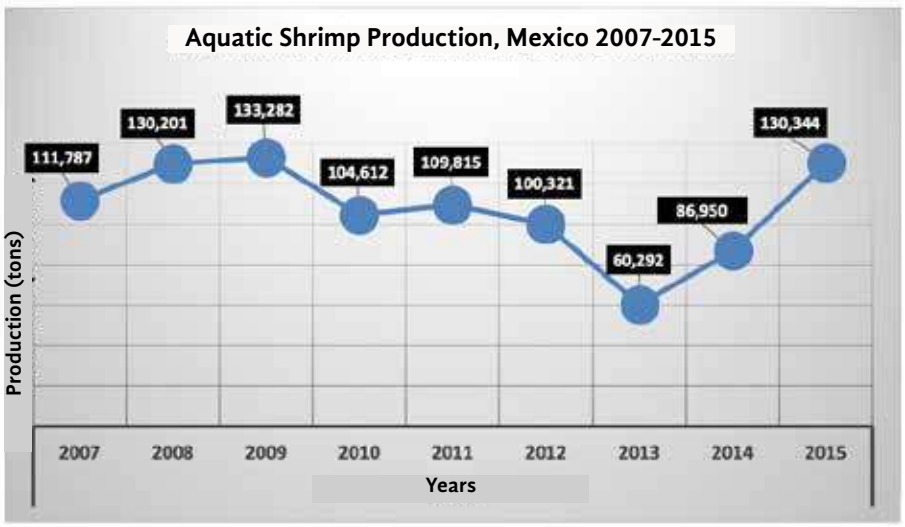

Figure 1. Shrimp aquaculture production in Mexico (Tons / Year live weight). Source: Yearbook: Fishery And Aquaculture Statistics. (CONAPESCA, 2007- 2015)

The causative agent is attributed to the pathogenic strain of Vibrio parahaemolyticus, which is introduced orally through the debris found in the water column and the bottom of the pond, colonizing the digestive tract, producing toxins and causing in the acute phase a hepatopancreas (HP) cell dysfunction where there is cell destruction, in addition, they produce the detachment of tubular epithelial cells, hemolytic inflammation and very marked HP necrosis. In the terminal phase, in addition to the shedding of epithelial cells, a massive bacterial secondary infection occurs (Navarro, *et al*., 2013). It is an enteric bacterium whose natural habitat is marine waters since they require salt for their development (Rodríguez, *et al*., 2014).

ACTIVATION OF THE NATIONAL AQUACULTURE HEALTH EMERGENCY DEVICE

The biological contingency was initially presented in three states in the northwest of the Mexican Republic, as part of the efforts to contain it on August 22, 2013, it was published in the Official Federal Gazette (DOF. 22.08.2013), the agreement that implements the national aquaculture health emergency device, in the terms of article 116 of the General Law on Sustainable Fisheries and Aquaculture, to control and eradicate the occurrence of atypical mortalities in shrimp production units in the states of Nayarit, Sinaloa, and Sonora, having validity of six months from its entry into force. The National Service of Agri-Food Health and Quality (SENASICA) coordinated these activities through the Directorate of Animal Health, establishing sanitary actions in the territory that includes the aforementioned states, including those as in the particular case of the state of Chiapas, where the AHPND disease spread.

In response to this emergency, in Mexico, a series of strategies and zoosanitary measures of urgent and coordinated application was established for the diagnosis, prevention, control, and eradication of the occurrence of atypical mortalities in the production units of shrimp farms (DOF 22.08.2013) that initially affected these three states. The lines of action were defined with the following biosafety measures:

- Control of the mobilization of products, by-products, and inputs for shrimp farming.
- Quarantine and elimination of organisms in which the presence of this etiological agent has been detected.
- Producer training.

In terms of economic impact, the most important diseases that affect the cultivation of shrimp belonging to the *peneidae* family in Asia, the Indo-Pacific region, and in America, are of infectious origin, among these, the most relevant are caused by viruses, protozoa, and bacteria (Table 1). The pandemics caused by the shrimp viruses of this family, such as the White Spot, Taura Syndrome, to a lesser degree the Infectious Hypodermal and Hematopoietic Necrosis Virus, and the Yellowhead disease have caused the shrimp industry to lose crops, jobs, and income from exports (Lightner & Pantoja, 2001) and more recently from the appearance of AHPND.

Table 1
Pathogens that affect shrimp cultures, according to their danger

Pathogen		Pathogen type	Category (Dangerousness)
Virus	TSV	Taura virus	C-1
	WSSV	White Spot Syndrome Virus	C-1
	YHV	Yellowhead virus	C-1
	IHHNV	Infectious haematopoietic and hypodermal necrosis virus	C-2
	BP	Bacauolovirus penaei	C-2
	MBV	Bacuolovirus of the P. *monodon* type	C-2
	BMN	Baculoviral intestinal necrosis	C-2
	HPV	Enteric parvovirus	C-2
Protozoa		Microspora	C-2
		Gregarious	C-3
Bacterias	NHP	Necrotizing hepatopancreatitis	C-2
		Vibrio sp.	C-3
	AHPND	Acute Hepatopancreatic Necrosis (*Vibrio parahaemolyticus*)	C-1*

* Of recent appearance in Mexico (2013)

Source: Modified table obtained from Lightner (2001) and Leyva (2010)

The pathogens considered within category C-1 are those that due to their effects on organisms and their high infectivity have the potential to produce catastrophic losses within cultivation systems (80% to 100%). While the pathogens in category C-2 show the ability to produce high mortalities in low shrimp cultures. In category C-3, pathogens that have minimal effects on crops are listed and in some cases, there are measures to eliminate them. The dangerousness of these pathogens on the list is determined by their virulence and potential to produce mortalities in aquaculture systems, however, many of the less dangerous pathogens can also cause economic losses due to the difficulty in marketing the product, since in some cases it can cause deformity, erosion of the shrimp cuticle or low growth of the organisms (Leyva, *et al*., 2010).

The shrimp farms established in the state of Chiapas, in the southeast of Mexico, have not been the exception to this problem, during the March-July 2014 production cycle, particularly in the El Fortín shrimp farm, with an area of 76 ha. of ponds for culture, there were accumulated mortality rates of 95%, according to fresh shrimp samples sent to diagnostic laboratories by the Comité Estatal de Sanidad Acuícola de Chiapas (CESACH), the results indicated that the cause of the infectious outbreak it would have been caused by the bacterium *Vibrio parahaemolyticus* (Figure 2) where clinical signs of

the disease were observed (pale hepatopancreas, empty intestines, tubular deformation in hepatopancreas, expanded and previously red chromatophores), as a consequence of the sowing of contaminated shrimp postlarvae with this bacterium from a laboratory established in the state of Sinaloa, located in northwestern Mexico, the region where the infectious outbreak originated. Given the degree of damage that occurred in the El Fortín farm, the application of the national aquaculture emergency device was immediately implemented, establishing technical restrictions for its control and eradication.

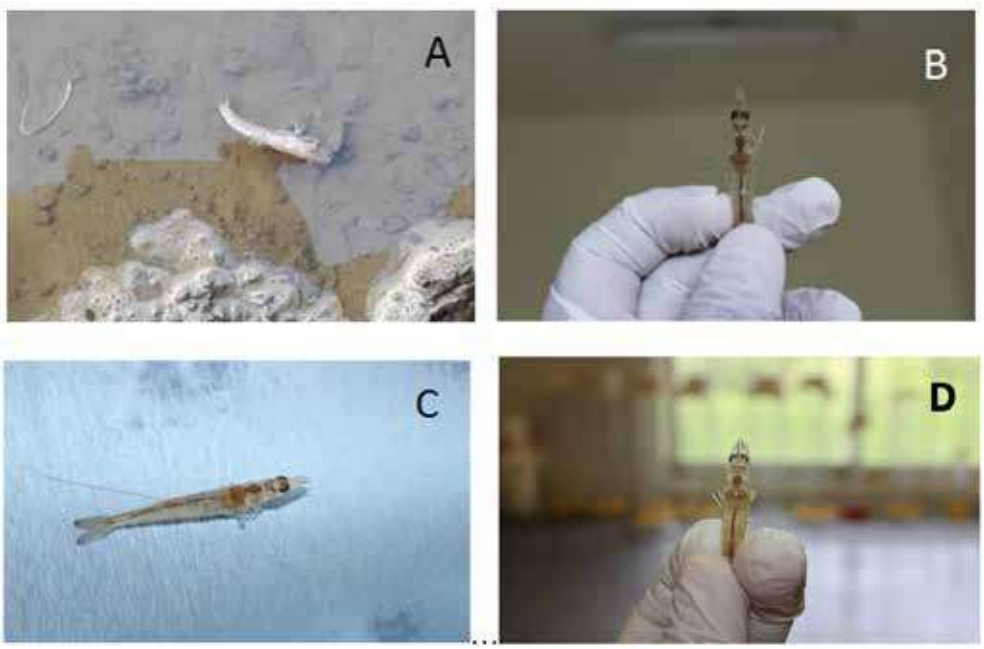

Figure 2. Massive shrimp mortality (A). Hepatopancreas affected in juvenile shrimp collected (B). Laboratory analysis of living organisms (C and D)

In this sense, a study carried out by Akazawa and Eguchi (2013), on AHPND in a comprehensive shrimp farm in the Malaysian peninsula, the results indicated that the disease originated with infected postlarvae and spread rapidly to all fish ponds of the farm.

For its part, the World Organization for Animal Health (OIE, 2016), to establish standards and codes to improve sanitary safety and international trade in aquatic animals, among which are penaeid shrimp, in 2016, published an updated list of pathogenic viral and bacterial diseases of crustaceans to be considered as a mandatory declaration by the affiliated member countries of this organization, the OIE list includes Acute Hepatopancreatic Necrosis Disease, among which are also:

1) Taura Syndrome Virus (TSV)
2) White Spot Syndrome Virus (WSSW)
3) Yellow Head Virus (YHV)
4) Infectious haematopoietic and hypodermal necrosis virus (IHHNV)
5) Infectious myonecrosis virus (IMN)
6) Whitetail disease (ECB)
7) Acute hepatopancreatic necrosis (AHPND)
8) Necrotizing hepatopancreatitis (NHP)
9) Acute hepatopancreatic necrosis disease (AHPND)

These diseases transcend due to the negative impact they have on shrimp farming production systems, with the probability of affecting the natural populations of this species. The competent authorities of the importing and exporting countries must be obliged to comply with the sanitary regulations of the Aquatic Code, during the activities of early detection, notification, and control of pathogens in aquatic animals, avoiding their spread, through the international trade of aquatic animals and derived products, as well as the establishment of unjustified trade barriers (OIE, 2015).

Given these examples of health emergencies and to face contingencies due to new and rapidly spreading diseases, in the 10th Meeting of FAO's Subcommittee on Aquaculture held in 2019, the causes, factors, and pathways of appearance of aquatic animal diseases were analyzed and four indicators were established for their study: i) trade and movement of products and live aquatic animals; ii) knowledge of pathogens and their hosts; iii) aquatic animal health management, and iv) ecosystem changes.

In the shrimp sector, one of the most complex paradigms is biosecurity, to strengthen it requires raising the level of action, health mapping, the formulation of contingency plans and drills, the implementation of compensation programs, and an increase in the level of knowledge about biosafety, the review of fresh food, greater control of the environment, the appropriate disposal of organic waste, the manipulation of microbial communities and the promotion of applied research (Figueredo, *et al.*, 2020).

Six years after the biological contingency arose, the country's health authorities have reacted favorably to stop the advance of the disease, the control measures implemented by farmers from Nayarit, Sinaloa, and Sonora, for the eradication of the bacteria, have been seen reflected with the increase in shrimp production two years after the outbreak; from 48,022 t of shrimp produced in 2013, it went to 112,426 t for 2015. In absolute terms, this annual increase corresponds to 64,716 t of live shrimp produced by aquaculture practices, equivalent to 134.1% in the recovery rates, concerning what was produced in the year in which the biological contingency occurred (Figure 3).

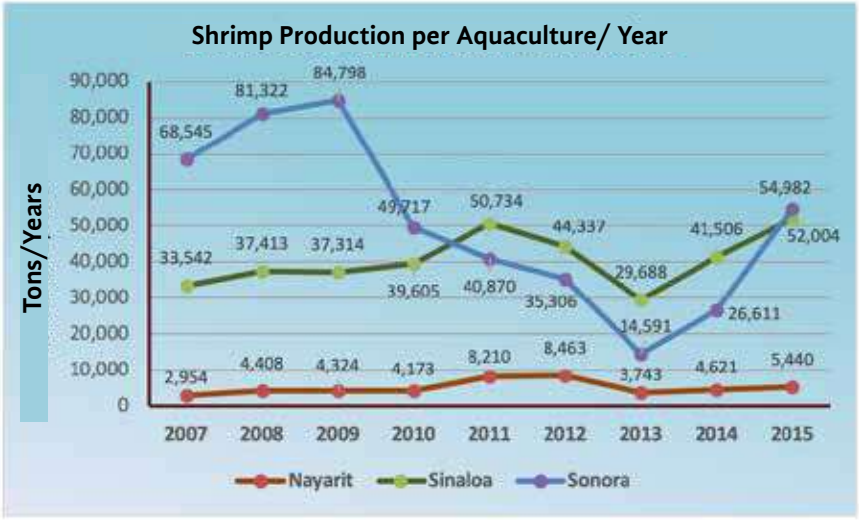

Figure 3. Shrimp Aquaculture Production in Three States Affected by EMS / AHPND (Tons / Year Live Weight). Source: Yearbook: Fishery And Aquaculture Statistics (CONAPESCA, 2007-2015).

AHPND resistance challenge investigations conducted from 2014 to 2016 in L. vannamei show that there is additive genetic variation in the Resistance Line and in the Growth Line, which can be exploited in breeding programs to increase AHPND resistance. (Castillo, *et al*., 2018).

CONCLUSION

Shrimp aquaculture is considered an expanding activity, the impetus for its growth and development lays its foundations from the use of intensive management techniques, which has caused the appearance and spread of infectious diseases to have begun to severely impact the shrimp crops, affecting in the short and medium-term the sustainability of this resource if biosafety protocols are not established to contain them, treat them in a timely, adequate and environmentally responsible manner. Given the threat of these transnational diseases in the case of AHPND, it is important to immediately activate a national emergency plan to respond in time with coordinated actions aimed at making efficient the care of the cases presented, executing the measures and protocols for the control of maximum security established to prevent its spread. Currently SENASICA, through the Mexico-United States Commission, carries out active surveillance for the detection of AHPND with monitoring and sampling in shrimp farms, to know the degree of affectation by this pathogen.

To respond quickly and effectively to the containment and eradication of transboundary aquatic animal disease outbreaks, it is important that countries strategically develop national contingency plans; achieving a rapid response to disease outbreaks and the detection of a new pathogen requires an effective level of surveillance, diagnosis, and dissemination, in addition to

the participation of academia and the establishment of diagnostic laboratories strategically distributed throughout the country with the infrastructure and the technical capacity of specialized personnel for the timely identification of diseases of aquatic organisms of commercial interest.

Another aspect to consider is the restrictions imposed for the movement of shrimp larvae throughout the national territory, which must be produced in laboratories certified in the field of aquaculture health, which will guarantee that they are free from high-impact diseases such as AHPND.

In years after the outbreak of Vibrio parahaemolyticus, the Mexican aquaculture sector has faced this contingency from the implementation of good management practices of the production units and through the obtaining of shrimp postlarvae produced in laboratories from Central and mainly South American countries, with genetic lines resistant to diseases, which has made it possible to improve production volumes in recent years.

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A C A D E M I C S
P A P E R S

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Mechanics Problems for Olympiad

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These notes contain a brief collection of Newtonian classical mechanics problems intended for the Physics Olympiad training of the 2020 Mexican national team that represented Mexico in the international Olympiad, adding to similar collections that already exist. Some problems were compiled from classic sources such as well-known worksheets or other Olympiads, others I have modified or invented to form a collection that includes original problems in the spirit of the (now defunct) Editorial Mir and the style of the "old school" Physics Olympiad problems. The answers to the problems are given at the end of the text with different degrees of detail in the resolution, while in some cases complete solutions are given, in others only the answer is shown. This is intentional and its purpose is to encourage the reader to find their own and original solutions to the proposed problems that are presented as well as a challenge in the learning process. Following the tradition of Olympiad problems, elemental, but not simple, problems have been proposed. This short collection of problems could also be useful as supplementary material in higher-level classical mechanics courses.

I want to thank Dalí Pinto and Jairo Villalobos, students of the Physics degree at the Universidad Autónoma de Chiapas, for helping me elaborate the figures and diagrams, as well as for endless discussions of physics and mathematics problems. Although the manuscript has been revised on several occasions, any errors that remain in it are my responsibility, and for this reason, I appeal to readers that if they find errors, they let me know at idrish.huet@gmail.com so that they could be corrected at a later version.

I hope these problems will be of interest to Olympiad students and as interesting and useful at this stage in their learning of physics as other similar collections of problems were for me at the time.

Idrish Huet Hernández
Puerto Vallarta, Jalisco, April 30, 2020

CLASSICAL MECHANICS PROBLEMS

1. There are five ants on the vertices of a regular pentagon of a, side, each one moves at a u speed always following its neighbor to the right (Fig. 1). Determine how long τ take for them to meet.

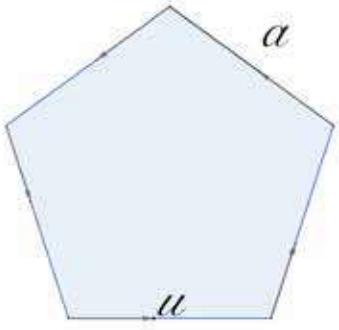


Figure 1

2. A solid and homogeneous sphere with an R radius falls under its own weight down a ladder with square steps of side $a \ll R$, the sphere never loses contact with the ladder (Fig. 2). Find the terminal velocity of the center of the sphere v_∞ when (a) the sphere has no friction with the ladder (b) the sphere has so much friction with the ladder that it rolls without slipping as it falls down the ladder.

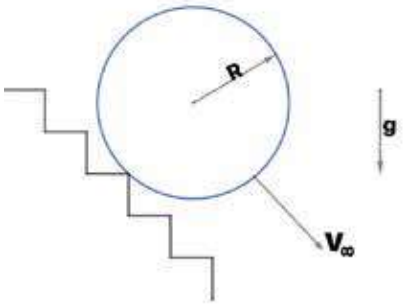


Figure 2

3. An inextensible thread of length L attaches a nail of radius $r \ll L$ to a mass m. The mass moves on a frictionless horizontal table where the nail is fixed. Initially, with the thread fully extended, velocity v_0 is communicated to the mass (Fig. 3). According to the principle of conservation of angular momentum, we should have that $mv_0L = mv\ell$ so that $v = v_0L/\ell$ will be

the speed of the mass when the length of the thread is ℓ. However, as the thread is inextensible, it cannot do work on the mass because its tension is always per-linked to the movement of the mass, so the velocity cannot change. Solve this paradox and find the time t qit takes to wrap the string to length $\ell = L/2$.

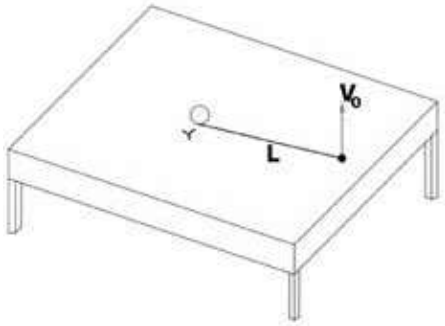


Figure 3

4. A cube collides elastically with a wall so that its velocity makes an angle α con la misma. with the wall. The coefficient of friction of the wall with the cube is μ. Find the angle β that the velocity of the cube makes with the wall after the bounce (Fig. 4).

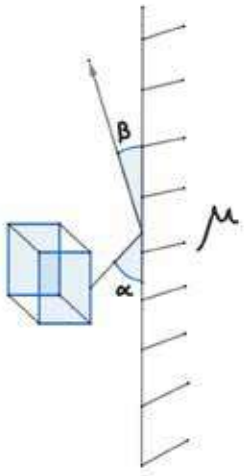


Figure 4

5. A thin spherical shell of weight W rests on two legs so that the points of contact are separated by the angle α (Fig. 5). (a) Calculate the pressure force on each leg. One of the legs is suddenly withdrawn, calculate the pressure force on the other leg an instant later if (b) The legs are so rough that they

do not allow the sphere to slide. (c) The sphere slides without friction on the material of the legs.

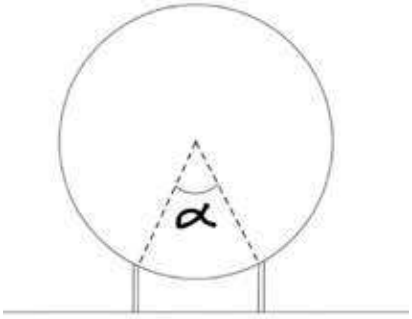


Figure 5

6. A chain of uniform weight W and length L hangs vertically above a table so that the lower end just grazes the surface. (a) The chain is allowed to free-fall, what is the maximum force exerted by the chain on the table? Now consider a different situation: The chain is resting on the table and one end is started to be pulled to lift it, with the force f at a $t = 0$. time. (b) How must $f(t)$ depend on the time for the end of the chain rises with constant acceleration $g/2$? (c) What should $f(t)$ of time for the end to rise with constant speed u? (d) Considering the three previous situations, what is the tension at the midpoint of the chain when $2/3$ of its length are in the air?

7. A hollow spherical shell of radius R is filled with a liquid of density ρ. The sphere and the liquid rotate with angular speed ω on a vertical axis passing through the center of the shell (Fig. 6) (a) Find the pressure $P(\theta)$ on the inner surface of the shell. (b) Find the value of the maximum pressure P_{max} and the angle θ_0 where it occurs.

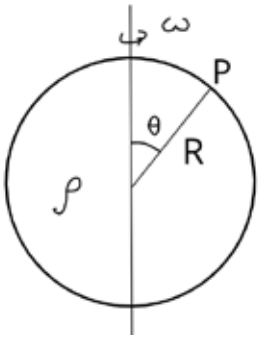


Figure 6

8. A projectile is launched vertically until it reaches the height $3R$ above the earth's surface, being $R \approx 6370\,km$ the radius of the earth. The projectile is launched at a latitude such that when it lands it falls very close to where it was launched. How long does it take to land once launched? The formula for the segment's area (shaded) of the ellipse (Fig. 7) is

$$A(h) = ab\arccos(h/a) - bh\sqrt{a^2 - h^2}/a$$

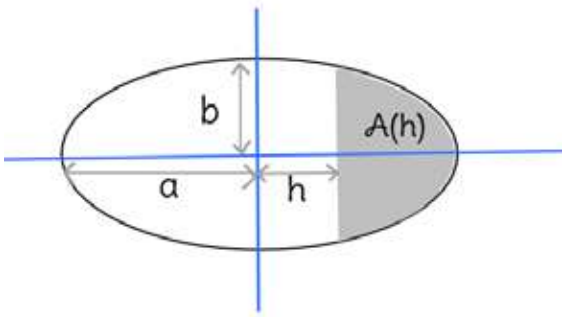


Figure 7

9. A marble is thrown with horizontal velocity against an inclined plane which bounces elastically exactly n times, the first and last (n-th) collisions occur at the same point (Fig. 8). After the last collision, the marble's speed has the opposite direction to its initial speed. Find α, the angle of inclination of the plane concerning the horizontal in terms of n.

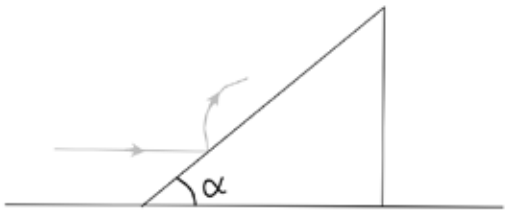


Figure 8

10. A block of mass M can slide without friction on a table. Against the block rests a homogeneous bar of mass m that has the same height L as the block and can rotate freely using a pivot that joins it to the table. Initially, the bar is vertical and completely glued to the block, after a small initial push the bar slides slowly pushing the block (Fig. 9) What value must M/m have

so that the angle ϕ with the vertical is $\frac{\pi}{3}$ at the time the block and the bar separate? (b) Calculate the velocity of the block when this occurs.

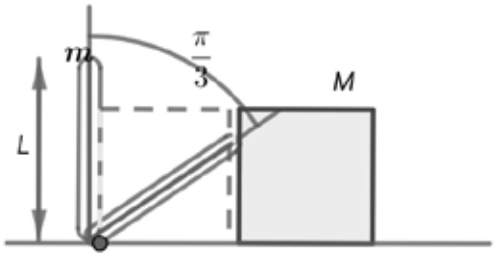
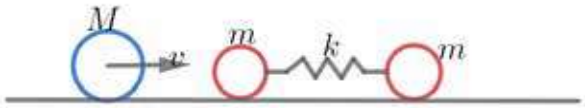


Figure 9

11. A particle with charge q and mass m starts from rest at a distance z z from a metal plate that can be considered infinite. Find the time τ it takes to reach the plate.

12. Two masses m eare linked by a spring of elastic constant k and rest on a frictionless table. Suppose that all movement of the masses occurs on a line. A mass M collides elastically with one of the masses m (Fig. 10). Find the values of $\xi = \frac{m}{M}$ for which a second collision occurs between the



masses m and M.

Figure 10

13. A planet is in a liquid state and the density of this liquid (magma) can be constant and equal ρ. In the process of planet formation, the magma rotates uniformly with angular speed ω and approximately acquires the shape of an ellipsoid of revolution with semi-axes $a > b$ (Fig. 11). The flattening factor is defined as $f = \frac{a-b}{a}$ and satisfies $f \ll 1$. Calculate f for Earth, using $\rho = 5.5 \times 10^3\ kg/m^3$ nd compare the result with the actual value $f_T = 3.35 \times 10^{-3}$. For simplicity, assume that the gravitational force can be

calculated for this ellipsoid by conceiving all the mass as concentrated at the center of mass.

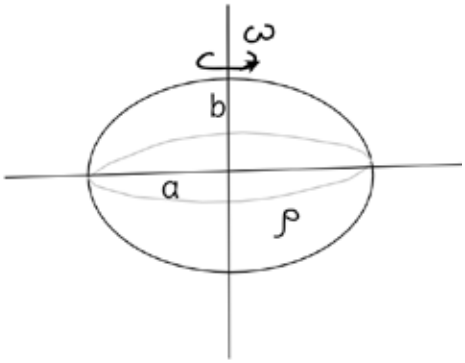


Figure 11

14. An object slides down a smooth curved ramp from point A to B dwhere its velocity makes the angle $\pi/4$ with the horizontal, as shown in the figure. Initially, a horizontal speed is communicated to it starting from A ynd it is observed that during its movement the speed remains constant. Point A is at the height h and horizontal distance ℓ from B. Upon reaching B the object bounces elastically against the ground so that it falls to a distance ℓ from BB at point C (Fig. 12). Calculate the coefficient of friction μ between the ramp and the object, assuming the object does not lose contact with the ramp between A and B. Assume further that the curvature mean radius of the ramp is comparable to h.

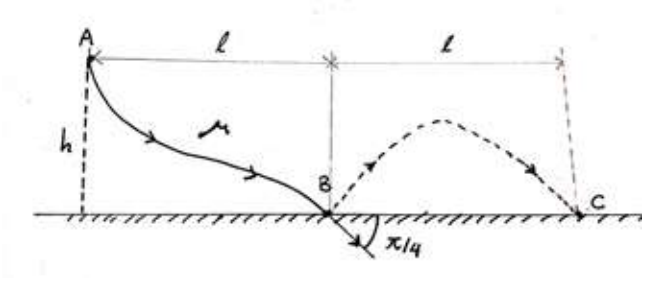


Figure 12

15. How far from the center must a hollow sphere be struck horizontally for it to begin rolling without slip when it is initially at rest on a very slippery ice surface?

16. You have a very fine chain of length L with a large number N of links on a frictionless table. The chain can be considered homogeneous. Initially, the chain is at rest with one of the links hanging vertically over the corner of the table (Fig. 13). The chain begins to slide. Find how long τ it takes for the chain to fall completely off the table.

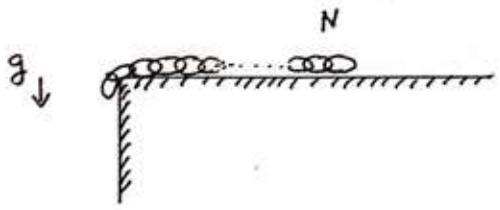


Figure 13

17. Many spheres slide without friction along a channel that starts from a fixed point O but can be tilted at any angle concerning the horizontal so that the spheres fall by gravity. If many spheres are released simultaneously from O through many channels covering many angles, the spheres always lie on a curve that changes dynamically in time (Fig. 14). (a) 14). (a) Find this curve when the spheres start from rest (b) Find this curve when each sphere has been given an initial velocity u.

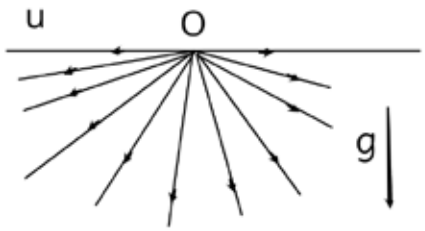


Figure 14

18. A sphere collides elastically with a wall in such a way that the angle between its velocity v and the wall just before the collision is α. The wall moves towards the sphere with constant velocity u (Fig. 15). (a) (a) Find the value of u necessary so that the sphere bounce angle is 2α. (b) For which α values is this possible?

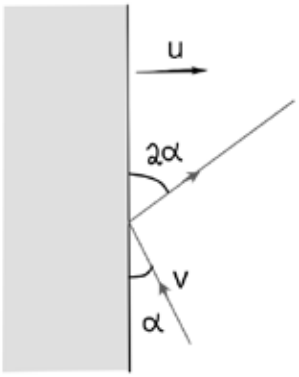


Figure 15

19. A ring of radius r and mass m is lying on a table, see figure. The ring rotates with angular speed ω and slides on the horizontal surface of the table that has a coefficient of friction μ with the ring. Initially, the velocity v_0 is communicated to the ring (Fig. 16). (a) Describe the path of the ring. (b) Explain in which case, and why, the ring travels a greater distance, when it rotates or when it does not rotate.

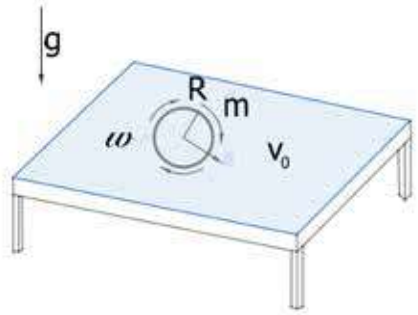


Figure 16

20. Consider a wire in the shape of S (Fig. 17) that has two elbows that gently bend at an angle $\pi/2$ each. A bead slides along the wire with initial velocity v_0. Find the final velocity of the bead if the coefficient of friction between it and the wire is μ. The movement occurs in a horizontal plane, so gravity does not play a role.

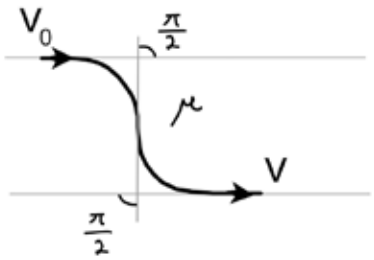


Figure 17

21. A beam of light is fired from the center of a disk in a radial direction. The disc rotates with speed ω (Fig. 18). An observer rotating with the disk will determine that the light does not move in a straight line, what path will the light follow for this observer?

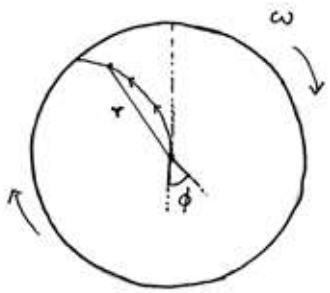


Figure 18

22. You have a cylindrical container with a small hole in the bottom, you put liquid in it and stir it a little so that it forms a swirl as it drains. Consider that the swirl is axially symmetric and make the necessary approximations (Fig. 19). (a) Find the profile (shape) of the surface of the liquid in the container. (b) If the liquid in the contained swirl has the volume V, find the swirl's height h at the edge of the container if its radius is a and the hole has radius b.

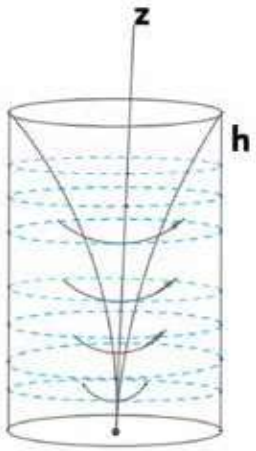


Figure 19

23. A mass M is suspended vertically from an elastic with Hooke's k constant and mass m. An approximation (not so bad in this case) is to consider that the elastic's linear density is always uniform. Calculate the frequency of the oscillations of the mass M.

24. A comet orbiting the Sun has impact parameter b and velocity at infinity v_0 (Fig. 20). Calculate (a) the comet's maximum velocity v_{max} (b) its minimum distance r_{min} to the Sun. Take the mass of the Sun as M.

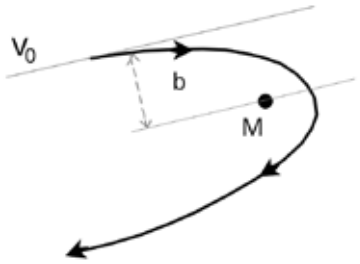


Figure 20

25. A homogeneous rope of weight W hangs from the ceiling from its two ends at points A and B very close together as shown in the figure. The rope is attached to the ceiling through a ring at A, which breaks when subjected to tension greater than or equal to F. At one point the rope is released from the B end while the A end remains attached (Fig. 21). Find the minimum necessary value of F so that the ring does not break.

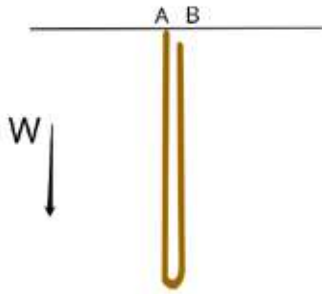


Figura 21

26. You are in an empty room, and you only have at your disposal a blackboard, chalk, and a measuring tape. Explain how to calculate the distance between your pupils.

27. Two soap bubbles with $r_1 > r_2$ radius are glued (Fig. 22). (a) Find the radius of curvature ρ of the surface that forms the interface between them. (b) now consider that $r_1 = r_2 = r$, the stuck bubbles suddenly merge into a single bubble. Find the radius R of this new bubble. Assume that the pressure due to the surface tension of the bubbles is much less than the

atmospheric pressure so it is not necessary to consider changes in the volume of the air within the bubbles. Use the formula for the volume of a spherical dome:

$$V(r,h)=\frac{\pi}{3}(2r^3-3r^2h+h^3)$$

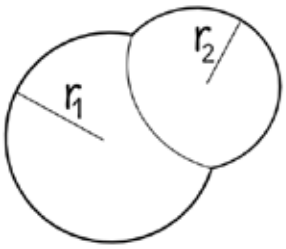


Figure 22

28. A cycloid is generated by a point on a circle of radius R in the plane xy that rolls without slipping on the axis x. The point touches the axis x at A and reaches its highest point B opposite to E (Fig. 23). Calculate the radius of curvature ρ of the cycloid at the point D of the cycloid whose coordinate x is at the point C that bisects AE (it is possible to do it by kinematics).

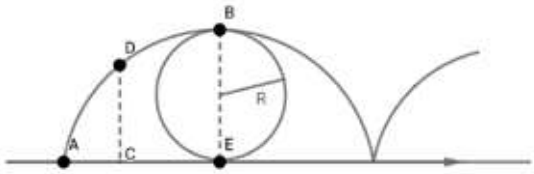


Figure 23

29. In a similar way to the previous problem, consider an epicycloid, the curve generated by a fixed point of a circle of radius r that rolls without slipping on a circle of radius R and center O. Calculate (it is possible to do it by kinematics) the radius of curvature ρ at point Q, the furthest to O from the epicycloid (Fig. 24).

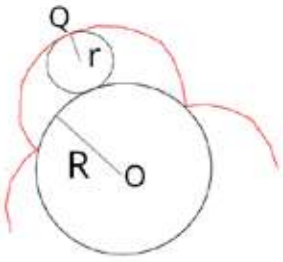


Figure 24

30. A homogeneous and thin wand of length L has a pivot in the center and can rotate freely without friction. Initially, the wand is in equilibrium in a horizontal position when a spider lands $t = 0$ at the midpoint between the center and one end with vertical velocity v_0 (Fig. 25). Upon landing the spider begins to run towards the nearest shore in such a way that the angular speed ω_0 of the wand remains constant. The mass of the spider is half the mass of the wand. (a) Find ω_0 (b) Find the $u(t)$ speed the spider must run for the angular speed to be constant. (c) Find v_0 so that when the spider reaches the end of the wand it is upright.

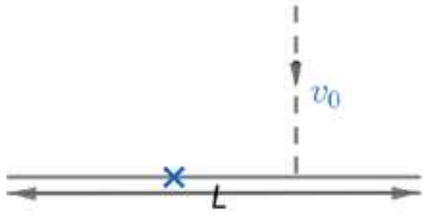


Figure 25

31. A particle is launched from the ground in a parabolic throw so that it skims the upper surface of a sphere of radius R resting on the ground (Fig. 26). (a) Find the minimum launch speed u (b) Find the corresponding launch angle θ to the horizontal.

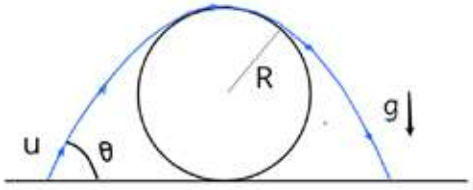


Figure 26

32. From the base of an inclined plane at an angle β to the horizon a small sphere is thrown in a parabolic shot. Find the launch angle α, concerning the horizontal, so that the sphere hits the point of the inclined plane as far as possible from where it started (Fig. 27).

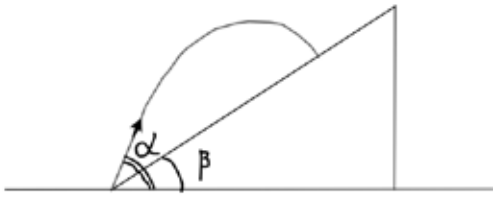


Figure 27

33. A satellite of mass m is in the atmosphere where it is subjected to a force of air resistance $\vec{f} = -\alpha\vec{v}$, the air resistance slows it down so that it will end up crashing to Earth. Originally, it orbits at a height above the surface equal to half the Earth's radius and the fall of the satellite occurs slowly. How many turns will the satellite make before impacting the earth?

34. A cylinder of radius R that rolls without slipping hits an edge that is at the height h (Fig. 28). Find the maximum value of h for the cylinder to still clear the rim when (a) during the collision there is no friction between the cylinder and the rim. (b) during the collision, there is no slip between the cylinder and the rim. In both cases, once the cylinder contacts the edge, consider that during its ascent it does not lose contact.

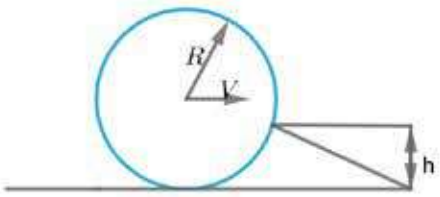


Figure 28

35. A fountain F moves at velocity v while emitting sound with wavelength λ, where u is the speed of sound and $v < u$. The distance from the source F to the receiver A is L and the angle between FA and the velocity of F is ϕ (Fig. 29). Find the apparent frequency f' that A receives.

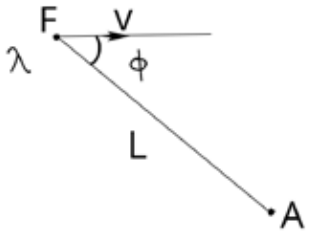


Figure 29

36. A ship is tied to a mooring by a rope that is wrapped around a bollard (low-height post) at an ϕ angle. The free end of the rope is pulled by a sailor who can exert a maximum force f. The coefficient of friction between the

rope and the bollard is μ (Fig. 30). What is the maximum force F with which the ship could be pulled so that the sailor can still stop it with the rope?

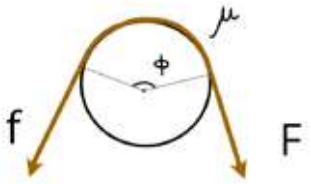


Figure 30

37. There is a thin-walled pyramid-shaped container with no base that rests on a table. At the top of the pyramid, there is a small hole through which water is slowly poured (Fig. 31). By the time the container is filled with water, it begins to escape from the bottom of the container. When the container is full of water, the weight of the water it contains is W. Calculate the weight W_0 of the container.

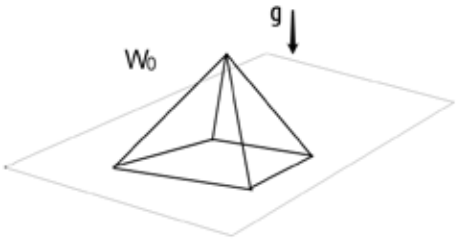


Figure 31

38. Two rafts drift on a lake, initially start from the same point, and begin to move apart so that their speeds make an angle of $\pi/3$. The speed of one raft is always twice the speed of the other, both speeds are constant in magnitude and direction. On each raft, there is a clock with hands where the second-hand measures $\ell = 10\ cm$, the clocks are identical. At each instant of time, it is always possible to orient each watch so that the tips of the second hands are at relative rest (Fig. 32). (a) What is the speed of each raft? (b) Find the distance between the rafts after two days.

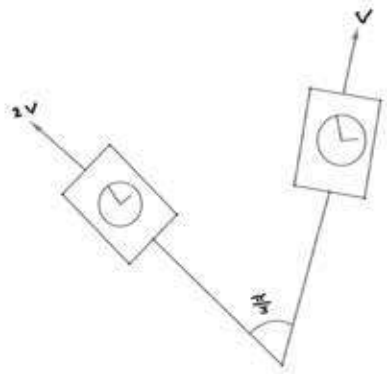


Figure 32

39. At which point P of a long and homogeneous rod should we hit so that if we take it from one end, we do not feel the rebound? (Fig. 33)

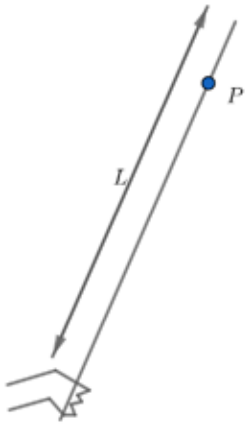


Figure 33

40. A bead slides from a frictionless point Q down a wire that is inclined at an angle β to the vertical and comes down the wire to some point P on a plane inclined at an angle α to the horizontal. What angle β should be chosen so that the Q's time to plane is minimal? (Fig. 34) Consider that the wire is always long enough to go from Q to touch the plane.

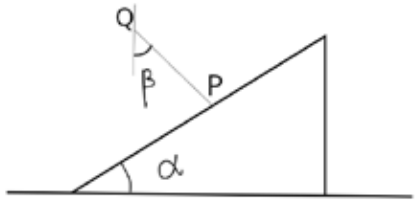


Figure 34

41. A force F is applied horizontally to the center of a hollow cylinder of weight W and radius R which rests on the ground against a step height $h < R$ (Fig. 35). What is the minimum value of F such that the cylinder will clear the step?

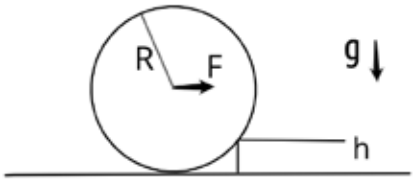


Figure 35

42. Identical n beads slide without friction down a vertical wire and fall under their weight. Each bead is initially given a velocity v_i, $i = 1,2,\cdots,n$ which can be directed up or down the wire, the velocities v_i can, at first, all be different in magnitude. The collisions between the beads are fully elastic (Fig. 36). (a) Calculate the maximum number of collisions N that is possible between the beads (b) If the average initial velocity of the beads is v equal to time $t = 0$ find the time required t for the kinetic energy of the beads to return to the initial value. (c) If the n beads initially all have downward velocities u_i and are equally spaced the distance d. Find values for each u_i such that all beads are found at the same time t.

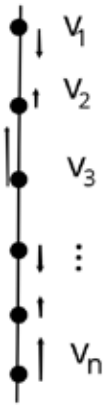


Figure 36

SOLUTIONS

1. Ants are always found at the vertex of a regular pentagon. Going to the rest system of some of them, it is found that the speed with which the edge between two neighbors decreases is constant and equal to $u\left(1-\cos(2\pi/5)\right)$. From this, we have $\tau=\frac{a}{u}\left(1+\frac{1}{\sqrt{5}}\right)$. Another way is to decompose the movement of each ant instantaneously into a rotation concerning the center of the pentagon and scaling of the pentagon (radial speed), using this method it is also possible to show that the ants move following a logarithmic spiral.

2. In both cases, the trajectory of the mass' center is the same. The sphere can never have contact with more than two points, but always with at least one. In both cases, the conservation of angular momentum concerning the point of each impact allows us to find the relationship between the velocities of the mass' center before and after each impact. (a) In this case, the sphere never rotates when it falls, the law of conservation of energy tells us $\frac{1}{2}mv_{\infty}^2(1-\cos^2\varphi)=mga$. As a result, $v_{\infty}=R\sqrt{g/a}$ (b) In this case the sphere rotates as it falls and the kinetic energy of rotation must be considered if $v_{\infty}=\omega_i R$ we have $\frac{1}{2}I(\omega_i^2-\omega_f^2)=mga$, where $I=\frac{7}{5}mR^2$. Conservation of angular momentum $I\omega_f\approx I\omega_i-m\omega_i a^2$ implies hence $v_{\infty}=R\sqrt{g/a}$. In case (b) the friction forces do not work, so the result is the same for v_{∞}.

3. Conservation of angular momentum cannot be applied to the nail even though its radius is very small; the point of contact of the thread with the nail rotates. The binding forces do not work, so the velocity of the dough is constant. The movement can be considered as a series of instantaneous circular movements concerning the spin radius L that varies with time. As can be seen in the figure $dL=-rd\varphi$, and at each instant$v_0dt=Ld\varphi$, it results in $\tau=\int_L^{L/2}\frac{dt}{dL}dL=\frac{3L^2}{8rv_0}$.

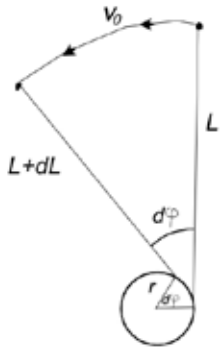


Figure 37

4. The tangential moment change to the wall is $-\mu$ times the normal moment change to the wall. $\beta = \operatorname{arccot}(\cot\alpha - 2\mu)$ if $\mu \leq \cot\alpha/2$, $\beta = \pi/2$ if $\mu > \cot\alpha/2$.

5. The static equilibrium condition implies (a) (a) $N = \frac{W}{2}\sec(\alpha/2)$. (b) Here we must use the rigid body equations of motion. The angular acceleration is $\dot{\omega} = \frac{3g}{5R}\operatorname{sen}(\alpha/2)$, and the friction force $f = \frac{2}{5}W\operatorname{sen}(\alpha/2)$, from this we have $N = W\cos(\alpha/2)$. (c) In this case, the acceleration of the center of mass of the sphere is $a = g\operatorname{sen}(\alpha/2)$, so $N = W\cos(\alpha/2)$.

6. (a) $F_{max} = 3W$. (b) $f(t) = \frac{3gt^2}{8L}W$. for $0 \leq t \leq 2\sqrt{L/g}$, $f(t) = \frac{3}{2}W$ for $t > 2\sqrt{L/g}$. (c) $f(t) = W\frac{ut}{L}$ for $0 \leq t \leq L/u$, $f(t) = W$ for $t > L/g$. (d) The tension in each case is: $T_{(a)} = 0$, $T_{(b)} = W/2$, $T_{(c)} = W/3$.

7. (a) $P(\theta) = \rho gR(1-\cos\theta) + \rho\frac{(R\omega\operatorname{sen}\theta)^2}{2}$ (b) The maximum pressure $P_{max} = \rho\frac{(g+\omega^2R)^2}{2\omega^2}$ occurs in $\theta_0 = \pi - \arccos\left(\frac{g}{\omega^2R}\right)$ if $g \leq \omega^2R$, and $P_{max} = 2\rho gR$ in $\theta_0 = \pi$ if $g > \omega^2R$.

8. The projectile moves in a highly eccentric ellipse with a semi-major axis $a = 2R$, using Kepler's three laws: $\tau = \sqrt{8R/g}\left(\frac{4\pi}{3} + \sqrt{3}\right) \approx 3\,hrs\,45\,min$.

9. It is useful to analyze the even or odd n cases, considering the motion as a parabolic shot about the surface of the incline where there is a component parallel to the surface and a perpendicular component of acceleration from 'gravity'. The condition for closed and reversible paths to form in both cases is $\alpha = \arctan\left(1/\sqrt{n+(-1)^n}\right)$.

10. Contact is lost when the relative velocity and acceleration of the block and the tip of the bar cancel. (a) $M/m = 4/3$. (b) $v = \frac{1}{4}\sqrt{3gL}$.

11. The particle's motion is analogous to that of a planetary system in a highly eccentric ellipse. From Kepler's laws $\tau = \sqrt{2m\epsilon_0}(\pi z)^{3/2}/q$.

12. If $\xi = m/M$ there will be a second collision if there is a solution to the transcendental equation $\operatorname{sen}\varphi + \xi\varphi = 0$. Approximately $\xi \leq \frac{2}{3\pi} \approx 0.21$.

13. For the equilibrium $\frac{GM}{b} = \frac{GM}{a} + \frac{\omega^2a^2}{2}$. We have as a result $f = \frac{3\omega^2}{8\pi G\rho} \approx 1.8\times10^{-3}$ (Actually this approximation is wrong by a 5/2 factor due to the assumption given for simplification. I. Newton calculated the correct result for the first time.)

14. $\mu = \frac{4h}{(4-\pi)\ell}$.

15. $h = 2R/3$ above its center.

16. $\tau = \sqrt{L/g}\ln N$.

17. Solution 1: Consider diagram I: (a) As long as time t is $OA = h = \frac{1}{2}gt^2$ the component of gravity that accelerates the beads, it tells us that the curve obeys $d(\theta) = h\cos\theta$ (this already implies that $\angle OBA = \pi/2$). This curve is a circumference of diameter h, because as seen in diagram I: $\cos\theta = y/d = d/h$, then $d^2 = hy = x^2 + y^2$. Which results in $x^2 + (y - h/2)^2 = (h/2)^2$

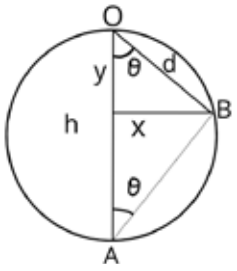


Diagram I

Solution 2: Consider diagram II: $OA = h$, $OB = h\cos\theta$ (this already implies that $\angle OBA = \pi/2$). Let C be the point in OA such that CB bisects $\angle OBA$ so $OBC = \theta$ and OBC are isosceles. ABC is also isosceles. So $OC = CA = CB = h/2$, that is why every point B is equidistant from C.

(b) In this case the curve is no longer a conic: $x^2 + (y - h/2)^2 = (h/2)^2 + ut\sqrt{x^2 + y^2}$, but a Pascal limaçon (snail), in polar coordinates: $r(\phi) = ut - \frac{1}{2}gt^2\text{sen}\phi$

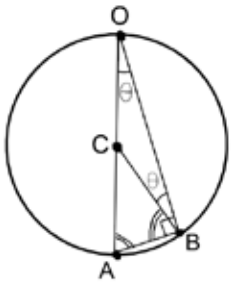


Diagram II

18. (a) $u = v(\tan 2\alpha\cos\alpha - \text{sen}\alpha)/2$ 2. (b) $0 < \alpha < \pi/4$.

19. The frictional force on the entire ring must be analyzed. (a) The path is a straight line in the same direction as $\overrightarrow{v_0}$. (b) It travels more distance when it is turning.

20. $v = v_0 e^{-\mu\pi}$.

21. It is an Archimedes spiral $r(\phi) = \frac{c}{\omega}\phi$.

22. (a) $z(r) = z_0 - \frac{c}{r^2}$.
(b) Being $\gamma = (b/a)^2$.

$$h = \frac{V}{\pi a^2}\frac{1-\gamma}{1-\gamma(1-\ln\gamma)}$$

23. $\omega = \sqrt{\frac{k}{M+\frac{m}{4}}}$.

24. (a) $v_{max} = \left(GM + \sqrt{G^2M^2 + v_0^4 b^2}\right)/v_0 b$.
(b) $r_{min} = \left(\sqrt{G^2M^2 + v_0^4 b^2} - GM\right)/v_0^2$.

25. $F \geq 2W$.

26. Of course there are many ways. A simple one is to measure the apparent change in the angular position of the chalk by closing one eye and then the other by making marks on the board. The distance is measured with the tape.

27. (a) $\rho = \frac{r_1 r_2}{r_1 - r_2}$. (b) $R = \sqrt[3]{\frac{27}{32}}r$.

28. Invariance of acceleration passing the system where the center of the circle is at rest results in $\rho = 2R$.

29. We go to the O' rest system of the radius r circumference center. In this case, acceleration $a = \frac{u^2}{\rho}$ has three contributions in this system: centripetal, centrifugal potential, and Coriolis: $a = \omega^2 r + \Omega^2(R + 2r) + 2\omega r\Omega$, respectively, where Ω is the angular speed of the radius r circumference center around the radius R and ω is the angular speed of rotation of radius r circumference. The non-slip bearing condition is $\omega r = \Omega R$. $u = \omega r + \Omega(R + 2r)$ is the speed of the generating point in the system O'.

Giving as a result

$$\rho = 4r\left(\frac{R+r}{R+2r}\right).$$

30. (a) $\omega_0 = \frac{24}{11}\frac{v_0}{L}$. (b) $u(t) = \frac{g}{\omega_0}\cos\omega_0 t$. (c) $v_0 = \frac{11}{12}\sqrt{gL}$.

31. (a) At the highest point, the centripetal acceleration is $u_x^2/R = g$, using conservation of energy, $u = \sqrt{5gR}$. (b) $\theta = \arctan(2) \approx 63.4°$.

32. Note that the distance is proportional to the coordinate x of the point of impact, which is at the intersection of the parabola and the line

$$x(\alpha) = \frac{v_0^2}{g}(\text{sen}(2\alpha) - 2\tan\beta\cos^2\alpha)$$

Therefore, $\cot(2\alpha) + \tan\beta = 0$, from where we get $\alpha = \frac{\pi}{4} + \frac{\beta}{2}$.

33. $n \approx \frac{m\sqrt{g/R}}{6\pi\alpha}(1 - (2/3)^{3/2})$.

34. (a) $h_{max} = R$. (b) $h_{max} = \frac{3}{2}R$.

35. The frequency is the inverse of the travel time difference of two consecutive wavefronts:

$$f' = f\left(1 - \frac{L - \sqrt{L^2 + (vT)^2 - 2LvT\cos\phi}}{uT}\right)^{-1}, \qquad T = \frac{1}{f} = \frac{\lambda}{c}$$

36. $F = fe^{\mu\phi}$.

37. The normal force on the table is $W + W_0$, this is also the pressure force of the liquid on the base, for a pyramid it is $3W$. Therefore, $W_0 = 2W$.

38. From the hodograph, the condition is seen so that there is only one relative clocks position. The relative speed between the clocks is $w = \sqrt{3}v$, and must also be equal to $w = 2u$ where $u = 2\pi\ell/T$ is the speed of the tip of the second hand and $T = 1\ min$. Also, $d = wT_0$ where $T_0 = 48\ hrs$

(a) $v \approx 1.2\ cm/s$, $2v \approx 2.4\ cm/s$. (b) $d \approx 3.6\ km$.

39. At the $2L/3$ distance from the end where it is held.

40. Using the result from problem 17, we have $\beta = \alpha/2$.

41. Once the cylinder begins to move with an applied force it will clear the step. $F_{min} = W\frac{\sqrt{(2R-h)h}}{R-h}$.

42. (a) First, we turn to a free-fall system O' where the velocities of each bead are constant, then consider another reference system O'' in uniform motion relative to O' such that in O'' all the beads have velocities in one direction, just of different magnitudes. Next, let's observe that when two identical beads collide their velocities are simply swapped after the collision. Giving as a result $N(n) = \frac{n(n-1)}{2}$. (b) $t = 2v/g$. For this event to occur, we need $v > 0$. (c) Listing velocities as $v_0, v_1, \cdots, v_{n-1}$, so that $v_0 = 0$ is the lowest bead velocity, one possible choice (not the only one) is $v_k = kd/t$ for $k = 0,1,\cdots,n-1$.

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The UNiTE campaign, "Orange the World in 2020": activities to eradicate violence against women and girls

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RESUMEN

From November 25 to December 10 of last year, the 16-day campaign of activities to end violence against women and girls was carried out, which the United Nations Secretary-General has promoted since 2008. Derived from my participation in the 2020 campaign, in this document, I present some data about the current state of violence suffered by women; of the progress and pending issues that we still have in Mexico in this matter.

Keywords:

UNWomen; UNiTE Campaign; Orange the World; violence against women and girls.

The annual international *UNiTE by 2030 to End Violence Against Women* campaign is a 16-day campaign that begins on November 25, the *International Day for the Elimination of Violence against Women*[1], and ends on December 1, *International Human Rights Day*[2], in which we carry out activities to prevent and eradicate violence against women and girls. The campaign was created by the Women's Global Leadership Institute of the Center for Women's Global Leadership in 1991. In recognition of the society's initiative, as of 2008, the Secretary-General of the United Nations leads the campaign managed by the United Nations Entity for Gender Equality, UN Women under the name: ***UNiTE to end violence against women***.

Taking action to eliminate violence against women and girls is an international necessity because the violence suffered by women stems from gender-specific human rights violations. Unfortunately, the evidence tells us that much of this violence is carried out because the aggressors believe they can do it. And in many cases, this belief is so ingrained and normalized that it is not even seen.

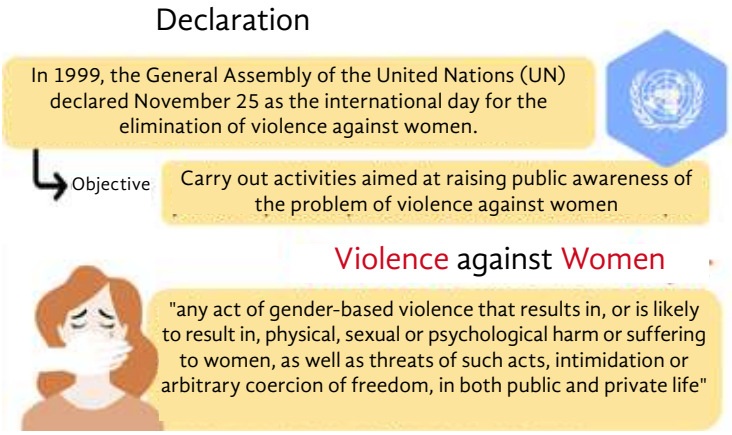

Figure 1. Source: Made by the authors with data from the United Nations Organization (UN). 1993

As can be seen in Figure 2, violence against women can be anywhere, but data from Mexico[3] is cited.

1 The International Day for the Elimination of Violence against Women is commemorated every November 25, since in 1960 the murder of the Mirabal sisters, political activists from the Dominican Republic, occurred.

2 Human Rights Day is celebrated every December 10, the day on which, in 1948, the United Nations General Assembly adopted the Universal Declaration of Human Rights.

3 It is possible to consult data about violence against women and girls worldwide in the United Nations Women. (nd). "Facts and figures: Ending violence against women".

- 66% of women have suffered at least one incident of violence of any kind throughout their lives, INEGI (2020).
- 44% of women suffered violence from their partner, INEGI (2020).
- The data on Female Deaths Presumed as Homicide (DFPH) for the period 1985-2019 show that the highest rate of DFPH was recorded in 2019 (5.7 DFPH per one hundred thousand women).[4]

The 16-day campaign for the eradication of violence against women and girls promoted by the United Nations (UN) aims to transform the reality of violence in which women and girls live, achieve gender equality, the right to a life free from violence, and all other human rights. At this point, I must emphasize that, in conditions of violence, the right to education, to health, to food, to employment, to housing, to social security, simply cannot be achieved.

This year the *UNiTE* campaign had as its global theme "Orange the World: Fund, Respond, Prevent, Collect!" In other words, in addition to financing actions against gender violence, in 2020 it was called to prevent, to respond with access to services, to collect and analyze information on the reality of violence in which women live.

4 Ministry of the Interior, the National Institute for Women, UN Women, and the National Commission to Prevent and Eradicate Violence against Women (2020). Femicide violence in Mexico: approaches and trends.

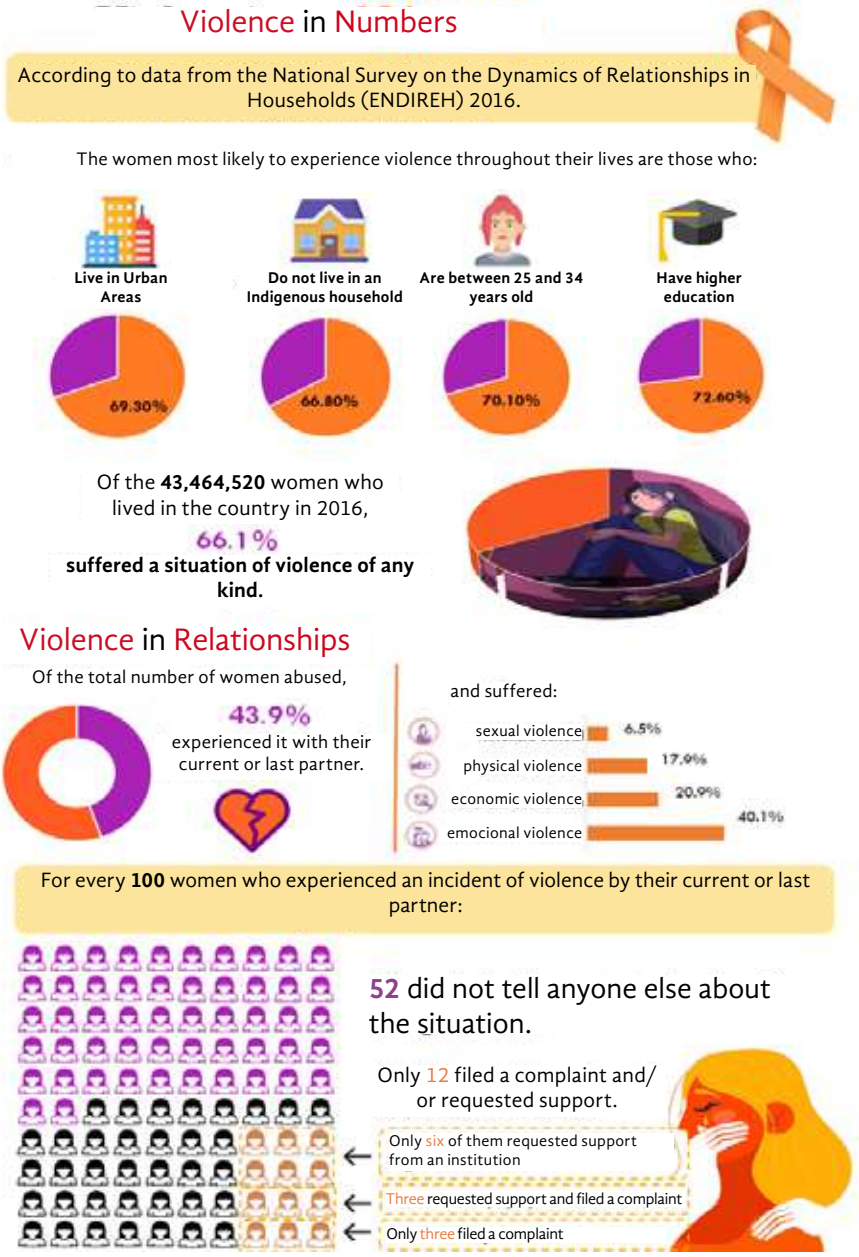

Figure 2. Source: Own elaboration with data from the National Institute of Statistics and Geography (2020) Images: Freepik, Flaticon

In educational institutions, civil society, the private and public sectors of Mexico and around the world, in response to the UN call, conversations, reflections, and content of many types were generated, ranging from cartoons, infographics, stories, plays, talks, and conferences. The confinement to contain the COVID-19 pandemic did not impede taking part in the activities

of the UNITE campaign, quite the contrary. The enthusiasm of our activism was greater because in times of pandemic we saw how violence against women and girls was exacerbated.

Particularly at the Universidad Juárez Autónoma de Tabasco, activism, in virtual mode, consisted of a cycle of conferences where the issue of the human right of women to live a life free of violence was addressed, a workshop to create infographics with a gender perspective and the participation of the CONEVAL's executive secretary with the conference "Social and gender gaps in Mexico and Tabasco, and the effects of Covid-19".

Thanks to the virtuality in which many of the actions undertaken in 2020 were developed, I was able to join the activities undertaken by the government, civil society, and educational institutions from other states and other countries to address issues as acute and painful as:

- Femicide violence, sexual abuse, sexual harassment, physical violence, psychological violence, economic and patrimonial violence, labor violence, political and institutional violence, and access to justice and reparation of damage to women survivors of violence.
- Inequality and gender gaps in salary matters, in academic, political, and business spaces.
- The risk and vulnerability in which young women, older adult women, indigenous women, migrant women, and minority women live due to violence of different types.

A topic that particularly concerned us during the day was the violence caused, or rather, the violence that was revealed and exacerbated by the confinement derived from the covid-19 pandemic. UN Women itself has dimensioned violence against women as the other pandemic, which is growing in the shadow of the covid-19 crisis and the economic crisis that the world is experiencing as a result.[5] In this sense, we were concerned with topics such as:

- Domestic Violence,
- insufficient resources to deal with situations of violence,
- the impact of the pandemic on women's employment,
- the precariousness in which women work,
- women's vulnerability due to lack of social security,

5 United Nations Women. (April 6, 2020) and United Nations Women. (2020)

- women's morbidities and mortality factors,
- the risk and vulnerability in which women work in the front line of the fight against covid-19,
- wage gaps in jobs in the care sector recognized by the market, such as jobs in education, health, domestic services, maintenance and support, food services, to name just a few.

Another issue that concerned us was the crisis of care work, historically unpaid and unrecognized work, but that women do every day and that in Mexico is estimated to amount to almost 22.8% of GDP.[6] In this sense, we were concerned with the analysis of the unequal distribution between men and women of care work, which in a pandemic even began to put at risk the future of girls and adolescents who have been called to take care of these tasks instead of their education.

All the problems that, although it may not seem like it, are generated as a result of gender conditions and become generators of violence, although not necessarily sexual or femicide, in the end, they are violent and threaten freedom, equal rights and opportunities, integrity, the physical and mental health of women and girls.

Dismantling gender violence is urgent, due to the dimension and social damage it is generating, but above all for justice. Our generation is called to transformation, to watch over and demand the transformation of the State so that it can guarantee equality between women and men, respect for the integrity, dignity, and life of women and girls. The activism that we are called to carry out is for the respect and guarantee of the inalienable, universal, and indivisible human rights of women and girls.

In Mexico, there is a set of laws to guarantee a life free of violence and gender equality, of which the following stand out: the General Law on Women's Access to a Life Free of Violence, the Law on Equality between Women and Men, the Law to Confront the Trafficking of Women and Girls, and the Law to Promote the Rights of Girls, Boys, and Adolescents.

Some institutions deal with this, such as the National System to Prevent, Address, Punish and Eradicate Violence against Women (2007), and the respective State Systems, which are based on the General Law of Access to Women to a Life Free of Violence, the National Institute for Women (Inmujeres) and its state counterparts, the National Commission to Prevent and Eradicate Violence against Women (CONAVIM), the National Institute

6 National Institute of Statistics and Geography (2019).

for Social Development (Indesol) through of the Support Program for Women in Federal Entities (PAIMEF), among others.

However, as part of the academic community, I must point out that we have work to do. In Actuary and Economics matters, the areas of knowledge that concern me, we must formulate a macroeconomic theory that accounts for and revalues the unpaid care work of women; design and implement a universal income that guarantees the right to care and be cared for; as well as advancing in the reform of the social security system with a gender perspective that prevents economic and patrimonial violence against women.

I reiterate that the guarantee of Human Rights is the way to dismantle the conditions of oppression and violence that women and girls suffer. For which, support is required from all of society, from men and women helping to access a balanced and harmonious coexistence, without prejudice and the privileges of men over women. Likewise, the transformation of the State, institutions, and public policies is required to achieve the desired equality.

The 16 days of activism to end violence against women and girls of the *UNiTE 2020* campaign concludes with faith in the activism that women and men around the world are carrying out; *not to fight*, but to permanently *eliminate* violence against women and girls.

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