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EDITOR'S LETTER

Welcome to the XXII issue of the magazine Espacio I+D: Innovación más Desarrollo of the Universidad Autonoma de Chiapas. With this issue we start a new year that launches the IX Volume of the publication, releasing the *Pre-prints* section, with which we will present previews of articles approved to be published in later issues of the magazine.

This issue is made up of publications from national and international institutions such as the Universidad Tecnologica de Ecuador, the Universidad Juarez Autonoma de Tabasco and the Universidad Autonoma de Ciudad Juarez, in addition to the Universidad de Ciencias y Artes de Chiapas and this publishing house.

Scientific production of sister universities allows us to bring together topics such as "Proximity towards the sustainability of inhabitants from Tuxtla Gutierrez, Chiapas, México", "Social marketing as a strategy to foster reading habits in university students", "Business ecosystem in the UTE university, case study faculty of hospitality and services" and "Research and development (R&D) and its collaboration to the generation of innovations in the organizational context of the manufacturing industry in Ciudad Juárez".

Research inside our university achieved results that we make available to our readers in articles entitled "Evaluation of d4 dopamine receptor blockade in the nucleus accumbens on palatable food motivation", "Corrosion and structural inspection of an internal element of reinforced concrete located at 0+145 in the San Roque tunnel, in Tuxtla Gutierrez, Chiapas", "Chol youth and education. Two historical moments" and finally the article "Proposal for alternative housing with three-cell mortar hollow block walls, for low-income families. Case study: Copainala, Chiapas, Mexico".

In the Academic Documents section we have a book review from the Universidad de Ecuador "Planning for development in Latin America and the Caribbean. Focus, experiences and perspectives", we have one Cultural Report entitled "The return of the letters celebration" about the social work that the university carries out in favor of the generation of spaces and opportunities for the literary world, while in the Academic Report we have the experiences of scientific popularization that the Faculty of Physics and Mathematics of the UNACH carries out for high school students through the scientific fair that it organizes every year.

We hope that you will continue to collaborate with this institutional publication, which every day achieves greater visibility and projection of knowledge, as well as technological transfer of researchers to the world.

Enjoy this Space of Innovation!

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

The editors

ARTICLES

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BUSINESS ECOSYSTEM IN THE UTE UNIVERSITY, CASE STUDY FACULTY OF HOSPITALITY AND SERVICES

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— Abstract—

An innovative project contributes to the solution of social problems, the students are suppliers of business ideas that can become companies. However, in this process, the students are not well oriented towards this end, therefore the importance of accompaniment of the academia, from the conception of an innovative project to the measurement of its contribution in the development of the country. In this role, the university can interact with other agents, integrating itself into a business ecosystem that seeks a sustained growth of the companies born from the student initiative. The objectives of this research are: to set up a business ecosystem for the Faculty of Hospitality and Services of UTE University, and establish the factors that lead to the failure of the projects. The descriptive exploratory method, a case study in this department, was used as techniques: bibliographic review, interviews with teachers and technicians in entrepreneurship. As results, there were identified six possible agents of the ecosystem that could interact in three stages: pre-incubation, incubation and sustainability. The lack of entrepreneurial culture, fear and lack of support highlight as factors of failure that affect entrepreneurship.

Keywords

Business; company; development projects; organizations.

According to the MIF's guide to dynamic ventures, FOMIN's MIC classifies ventures into dynamic and livelihoods where the former is a new or recent business project that has realizable growth potential to at least become a medium-sized business, generating income and growing well above the average for its sector. Survival or self-employment ventures are intended to cover the subsistence levels of the owner and his or her family or to address the specific needs of certain disadvantaged social sectors (MIF, 2007).

A business ecosystem is a community where both organizations and individuals that produce valuable goods and services for customers who are, in turn, part of the same ecosystem, interrelate (Moore, 1993). Parts of the ecosystem include suppliers, leading producers, competitors, among others. An entrepreneurial ecosystem is therefore a place where entrepreneurial activity takes place.

The business projects carried out by students at universities can have uncertain destinies, and it is not known how many projects became companies, how many created businesses closed and which projects remain stagnant due to lack of support or innovation. It is important to accompany students throughout the process. In this context, the academy must interact with other agents, performing in a business ecosystem that encourages sustained growth of companies born from an innovative project.

The purpose of this study is to propose the configuration of a business ecosystem for the Faculty of Hospitality and Services of the UTE University, to determine its possible members, as well as their roles, and to discover those elements that are a reason for the failure of the enterprises. This work is exploratory -descriptive, based on a bibliographic review of business ecosystems. Interviews with professors of this faculty and a technician from the Economic Development Agency CONQUITO are presented, and the information gathered allows the proposal to be made.

DEVELOPMENT

In classrooms, generally, the way to elaborate and evaluate a project is taught establishing its viability. If the indicators of this evaluation affirm that the project is feasible, then the implementation is recommended through the search of financing, in many cases this is where the role of the academy finishes, without realizing that these business ideas proposed by the students need more than an academic methodology to make them a reality, that is, to translate the idea into an enterprise. The current university scenario is not totally focused on that line of training professionals and this is manifested in the orientation of education "about" entrepreneurship and business, instead

of education "for" entrepreneurship (Martinez, Bajaña, Chavez, Guerrero, & Oña, 2016).

The word 'entrepreneurship' is related to the French term *entrepreneur* and dates from the early 16th century. In 1803, Say, in his *Treatise on Political Economy*, defined the individual who directs a company, especially, as a contractor acting as an intermediary between capital and labor (Vicens & Grullón, 2016). Innovation and invention are the key to economic growth determined by entrepreneurs (Schumpeter, 1911).

The knowledge economy is based on the knowledge industry. To understand the concept we must refer to the definition of Eco-entrepreneurship (entrepreneurial ecosystem) as "the study, analysis and explanation of the different complex relationships between institutions and entrepreneurs with their academic, social, political and economic environments" (Camargo, 2011). There is certainly a need to further link academia with business. Well-known firms have their own area of research and development. (López, Blanco, & Guerra, 2009).

At present, innovative low-cost prototypes are being developed in universities, however, there is little relationship between these prototypes, and given that at present one of the challenges for future professionals is the generation of innovative ideas that provide solutions to social problems (Ram, 2017).

In some ecosystems consumers or clients are not perceived as agents, this agent must be analyzed from another approach in which market variables, tastes, preferences and the changes caused by the technological, environmental, economic and political contexts of the country are used (Zalamea & Peña, 2015).

The so-called University Spin Off Companies are defined as the type of companies created to exploit part of the intellectual property generated in a higher education institution. (Shane, 2002). Entrepreneurial activity is measured, in the case of Ecuador, by the Global Entrepreneurship Monitor (GEM), in its 2016 report the country obtained 31.8% in the Early Entrepreneurial Activity (EEA) indicator, being 2.2 times higher than the efficiency economies, in the year 2015 it obtained 33.6%. Despite this, Ecuador continues to be the country with the highest EEA in the region, and the second among the 66 participating countries (GEM, 2016). The degree to which society considers entrepreneurship as a good career option is an indicator of the cultural environment, obtaining 59.51%, which is below its neighbors Colombia 67%, Peru 68% and Chile 66%, the average for the region being 64%. Another interesting indicator is that in Ecuador 43% state their entrepreneurship intention in the next three years, although the fear of failure is a natural impediment with 32% of the population having this fear. When analyzing

the entrepreneurial ecosystem, relevant factors for the consolidation of small and medium enterprises are identified, it is observed that in Ecuador some factors such as financial support 2.86 is below the score of the region 3.42, another factor, government programs, Ecuador 2.68, Region 3.31 (Guaján, Charly, Viteri, & Esteban, 2017).

In the distribution by occupational category according to the entrepreneurial phase, students represent 3.3% in the EEA phase and 4.9% in the emerging phase, low indicators if the comparison is made with part-time occupations only with 14.1% and 20.4%, in the respective EEA and emerging phases. Another important contribution in this study (GEM 2016) is that the indicator of entrepreneurial aspirations contains five pillars for achieving dynamic entrepreneurship (product innovation, process innovation, high growth, internationalization and risk capital) that drop in 2016 to 18.2 while in 2015 was higher with 20.7, which implies that Ecuador has the challenge to promote the creation of dynamic entrepreneurships. With regard to the entrepreneurship ecosystem, the GEM study indicates that the environment in Ecuador until 2015 had remained moderately favorable; however, in the year 2016 there was a deterioration in the evaluation of all the framework conditions for entrepreneurship, even those in which Ecuador showed strengths such as physical infrastructure and higher education. The experts point out as weaknesses the lack of financial support and public policies in terms of regulation, factors that should be prioritized for improvements in the ecosystem in the short term, to solve the weaknesses they should also work on the quality of the ventures and sources of financial support for the various stages of business initiatives (GEM, 2016).

CHARACTERISTICS OF SOME BUSINESS ECOSYSTEMS

There are many cases in the world of how business ecosystems perform successfully, perhaps, the Silicon Valley ecosystem is the best known. It is not an organization or institution, but rather a business ecosystem that feeds back on itself (MIF, 2007), whose structure has the entrepreneur as its main protagonist; around it appear the *University* with a solid contribution in technology, biotechnology and business; the *Government* with its contribution in organized economic structure that favors the entrepreneur; *Flexible work force* characterized by qualified technical talent; *Mentors* or informal networks that contribute with the contact of strategic partners and the generation of important alliances; *Specialized services* that offer consulting, advice in production, design, finance and legal matters; *Financial resources* with offers of financing through seed capital, risk capital and the so-called angel investors; *Diffusion*, that strengthens the ecosystem and accompanies in the diffusion of large businesses.

Madrid Emprende, Economic Development Agency of the city of Madrid, Spain, works its model based on the so-called factors in which the structural conditions (variables) of an ecosystem can be decomposed (Entrepreneurship, Model, & Undertake, 2015). These factors are: *Financial*, among its variables stand out: credit, investment and development of financial markets; *Business* support with the variables: incubators, accelerators and business networks; *Policies*, understood as coming from the State, among its variables stand out: regulatory environment, investor protection, political environment; *Market*, as relevant variables we find the macro environment, market size and business sophistication; *Human capital*, with important variables such as higher education, skilled workers, education and training; *Infrastructure*, with its infrastructure and technological training variables; *R&D*, we highlight the variables: innovation links and knowledge absorption; *Culture*, with its entrepreneurial culture variable. Within the entrepreneurial process, *Madrid Emprende* shows that in the formulation phase of a project there are institutions such as public entities, NGOs, networks of entrepreneurs, universities, which must get involved to develop tools that are currently identified as deficient, among them are: specialized workshops, hackatons, business plan competitions, startup weekends, the application of these tools from these institutions are intended to help potential entrepreneurs to formulate their business idea and develop their business plan.

Camilo Pinzón from *IDI*, says that in order to generate a good entrepreneurial environment, the interaction of what is known today as the quadruple helix: State, Company, Academy and Consumers is needed. These agents will achieve better results to the extent that they can interact in an ecosystem that fosters trust, protection of intellectual property, and generates funding mechanisms for the different stages of a company's development (Pinzón, 2011).

The *Centro de Emprendimiento CdE*, from Ecuador, points out that the recognized drivers to guarantee a Sustainable Dynamic Ecosystem are: innovation, technology and collaboration (Landsdale & Vera, 2008).

The *ICSED-Prodem,* Entrepreneurial Development Program, focuses on measuring the systemic conditions for the emergence and expansion of new dynamic enterprises. In this context, it suggests the application of the so-called Ten Dimensions of the Organization for Economic Cooperation and Development (OECD), in the field of dynamic entrepreneurship: having as central axis the entrepreneurial human capital and around it the culture, social conditions, demand conditions, IT platforms, business structure, educational system, policies and regulations, financing, and social capital.

Ruta N, an innovation ecosystem developed in Medellin, Colombia, leads this process that has generated more than 1,500 jobs related to science,

technology and innovation, with more than 3,300 children in science and technology programs, more than 50 institutions that provide science, technology and innovation services, nearly 700 research groups and 32 universities. As Federico Gutiérrez, Mayor of Medillín, announces, "There is no such thing as a formula to explain what we are living through, but there is a fundamental ingredient to which we can attribute much of what we have achieved as a society: the union between all our sectors. Businessmen, academics, the public sector and citizens, working together and betting on the development of the city..." (Medellín, 2017)

APPRECIATION OF TEACHERS AND TECHNICIANS OF CONQUITO REGARDING THE PROJECTS

Regarding the interviews to know the status of the projects presented by the entrepreneurs, it can be indicated that in the Economic Development Agency CONQUITO, in its Entrepreneurship and Innovation department for the year 2017, 47 projects were managed, of which 20% correspond to the category of *differentiators* that enter an incubation process. Of these projects, 80% are sustained and of this last value 60% are active companies for more than a year after the incubation. In other words, out of every 100 projects managed, 10 projects are innovative and remain as companies for more than a year. Based on this information, there is no follow-up by this agency to know how it continues to perform in the market. According to this technician, the entrepreneurial attitude is what determines the success or failure of a project. The support that the entrepreneur demands from the academy is determined by: the generation of an entrepreneurial culture coming from the professor himself, that the university must be solidly linked to the companies so that the entrepreneur awakens innovation and creativity in favor of the companies, that the results of research that the university carries out are transferred to the improvement of the business performance, that the universities, through a specialized unit, must identify the agents of a business ecosystem and guide the entrepreneurs according to their roles; among other supports: business tutors, advice on legal issues, patents and market research. The Economic Development Agency CONQUITO recommends the following roles that can exist in an ecosystem of dynamic enterprises: support and technical assistance, different forms of financing, regulations, entrepreneurial culture, and human talent with technical knowledge such as engineering, university linked to innovation and business (Ruales, 2018).

In the Faculty of Hospitality and Services of the UTE University, professors of the subjects of Project Development and Entrepreneurship comment that each semester about 15 projects are obtained between the three careers (Gastronomy, Hotel Management and Tourism); it is estimated that in one

year approximately 30 projects are obtained, half of them have an innovative character and at least two are known to become companies, there is no mechanism for monitoring projects after the completion of classes in each semester. In other words, out of 100 projects, six are innovative and become companies, although their performance in the market is unknown.

The structure of an ecosystem would be made up of professors who are related to entrepreneurship, such as market research, finance, legal aspects, alliances with technical careers, contacts with seed capital offers, CONQUITO, Chambers of Commerce and Savings and Credit Cooperatives. The innovations identified in the projects cover recyclable or edible packaging such as rice paper, issues related to environmental care, bakery or artisanal drinks, fruit-based alcoholic beverages, healthy and nutritious products, snacks for diabetics; no major proposals for innovative services are identified other than application projects (App) for tourist routes (Acuña, 2018).

On the basis of these interviews, it can be noted that the Economic Development Agency of the city of Quito (CONQUITO) estimates that of the projects developed, barely 10% become companies, while in the faculty barely 6% of the student projects become reality, in both cases the follow-up[1] is nil or sporadic. The interviewees agree that the determinants of failure are the lack of an entrepreneurial culture. Table 1 shows the status of the projects developed by entrepreneurs in these entities.

Table 1
Status of projects

Interviewees	*Number of developed projects*	*% of Innovating Projects that become business*	*Determining factor of failure*	*Subsequent follow-up*
CONQUITO	47	10%	Entrepreneur attitude	None
Faculty of H&S - UTE	30	6%	Lack of entrepreneurship culture	Sporadic, follow-up to graduates

Source: Made by the authors

In the case of the CONQUITO technician in a business ecosystem, the academy should promote an entrepreneurial culture among teachers, authorities and students, the knowledge produced from research should be transferred to the industry, and students should receive technical assistance in a pre-incubation stage of their businesses.

1 Monitoring involves technical assistance to the entrepreneur and measuring the impact on the local economy.

The teachers recommend that the faculty should know more about public or private institutions that support entrepreneurs, it is also necessary to establish a fund for entrepreneurship and strengthen training issues for students regarding sources of funding (Jimenez, 2018). Table 2 shows the support needed from the academy identified by the interviewees, this information substantiate the configuration of the roles within the ecosystem.

Table 2
Support needed from the Academy

Interviewees	*Within the Business Ecosystem the Academy must support in:*
CONQUITO	• Breeding of an entrepreneurial culture. • Knowledge transfer to the industry. • Directing entrepreneurs according to the roles within the ecosystem
Faculty of H&S – UTE	• Know the related institutions for the support of entrepreneurs • Presence of a venture fund • Training in finance

Source: Made by authors

PROPOSED BUSINESS ECOSYSTEM FOR THE FACULTY OF HOSPITALITY AND SERVICES

Among the business ecosystems cited, there are similarities in their components and roles. The comparison of these elements allows the configuration of the business ecosystem proposed for the Faculty of Hospitality and Services with its potential members, as well as their roles and the definition of relevant support factors to promote a significant flow of dynamic business projects.

The agents that should integrate a business ecosystem in the Faculty of Hospitality and Services are: *The entrepreneur student*, the protagonist, in charge of outlining his or her business idea with innovative or differentiating components. Around him is the *technical commission for dynamic enterprises*, made up of professors from technical fields, such as engineering, markets and finance, who help him design the prototype and test its acceptance in the market. After the validation of the innovative product or service in the market, *the financing and legal system* assists the dynamic entrepreneur to obtain financing, either via seed capital, venture capital, working capital or other forms. This agent can also assist in obtaining financing in the development stage of prototypes and market testing. As part of the ecosystem is the *Economic Development Agency* CONQUITO that can support in the incubation phase, with technical assistance and selection of promising projects for funding management. *Follow-up of graduates,* through its SISEG system, can monitor how projects and companies created from a dynamic entrepreneurship are progressing. In addition, it can be in charge

of developing programs of entrepreneurial culture stimulating entrepreneurial thinking from the first levels of study.

These agents and their roles would be carried out in three sequentially defined stages: Pre-incubation, Incubation and Sustainability, as described in Table 3.

The *Government* also has its responsibility in this challenge since it must dictate policies in order to encourage the generation of ideas, facilitating access to sources of financing to carry out the implementation of promising companies that are sustained over time and contribute to the generation of employment and economic development of the country. Public authorities must locate the individuals or groups of individuals who are most likely to develop innovative initiatives (Fuentelsaz & Montero, 2015).

Table 3

Agents of the proposed Ecosystem for the Faculty and their roles by Stages

Agent ->	Student/ Entrepreneur	Technical commission of dynamic enterprises	Financing and legal affairs system	Economic development agency CONQUITO	Follow-up system to graduates SISEG	Government
Roll ->	Creation of an idea with innovative components /distinctive characteristics	Teachers of technical subjects: Engineering Market Finance They help design prototypes with market acceptance Partnership with the public and private sector.	Guides and manages the financial securing in an accurate way: Seed capital Venture capital Other approaches Attains funding for the prototype design and market test stages.	Technical assistance in incubation stage. Project selection with potential funding pursuit.	Supervising of projects and enterprises born from pre-incubation. Promotes entrepreneur culture. Helps with dissemination and recommends improvement for the ecosystem.	Adequate policies for the promotion of dynamic entrepreneurship. Helps connecting the University, Government and Industry.
Stage ->		PRE-INCUBATION		INCUBATION	SUSTAINABILITY	

CONCLUSIONS

Although, the ecosystems analyzed indicate different components and roles, each structure is configured according to its own needs in the region of influence, it is substantial to first discover the entrepreneurial culture of those who aspire to turn an innovative business idea into a company.

The agents of the ecosystem suggested for the faculty are: the student, technical commission of dynamic enterprises, financing and legal affairs

system, the economic development agency of the city (CONQUITO), the follow-up system to graduates SISEG and the Government. These agents will play their roles interactively in three moments: pre-incubation, incubation and sustainability.

The configuration of a business ecosystem in this faculty is important so that projects with an innovative character are consolidated into profitable companies for the benefit of their mentors and the community in general. The academy must become a provider of knowledge to the industry by offering innovative products from research and development on the initiative of the students themselves.

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EVALUATION OF D4 DOPAMINE RECEPTOR BLOCKADE IN THE NUCLEUS ACCUMBENS ON PALATABLE FOOD MOTIVATION

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— Abstract—

At the central level, regulation of information processing of food's motivational and rewarding properties depends principally on brain structures such as the Nucleus Accumbens Shell (NAcS), where dopaminergic transmission plays a preponderant role in activating dopamine receptors related to reward. Anatomical and neurochemical studies indicate that D4 dopamine receptors (D4R) are presynaptically expressed and regulate the release of glutamate to GABAergic neurons in the NAcS. The purpose of this study was to evaluate the effects of the pharmacological blockade of D4R in the NAcS on the regulation of motivation for palatable food (MPF) in male Sprague Dawley rats using a progressive ratio (PR) schedule of reinforcement. According to our results, blockade of the D4R with the antagonist, L-745,870 (1 µg), in the NAcS decreases the number of lever presses, the number of obtained reinforcers and the breakpoints. Accordingly, the blockade of D4R in the NAcS decreases the MPF, consequently it could be a pharmacological target in the treatment of feeding pathology by decreasing the reinforcing properties of palatable food.

Keywords

Nucleus Accumbens Shell; Dopamine D4 receptor; L-745,870; Motivation; palatable food.

Palatable food consumption is associated with the increase of dopamine release in the nucleus accumbens (NA) (Hajnal *et al.*, 2004), a region of the brain that is part of the reward circuitry and the main site of action of some drugs of abuse such as cocaine, methamphetamine and alcohol (Kelley *et al.*, 2005). Dopamine can bind to five receptor subtypes (D1, D2, D3, D4, or D5), and the signaling pathways activated by these receptors require either Gs (D1 and D5) or Gi (D2, D3, D4) proteins (Missale *et al.*, 1998). Particularly the D4 receptor subtype (D4R) has been linked to alterations in the processing of reinforcing stimuli (Ducci & Goldman, 2012), reason why this receptor is of interest in the present study.

The mRNA that encodes for D4R has been located in several brain regions such as the frontal cortex, the amygdala and the hippocampus (among other areas), nuclei that send glutamatergic projections to the NA. According to experimental evidence, in NA D4R is present in axons and presynaptic terminals that do not express tyrosine hydroxylase, suggesting that its main function is the modulation of the release of non-catecholaminergic neurotransmitters (Svingos *et al.*, 2000).

In studies of radioactively tagged neurotransmitters release in rat brain explants, it was found that activation of D4R in NA decreases the release of glutamate but not GABA or dopamine (González *et al.*, 2012). Accordingly, there is evidence that activation of D4R produces inhibition of glutamate release in other areas of the brain such as the paraventricular nucleus of the hypothalamus (Tejas-Juárez *et al.*, 2014). Also, Bonaventura *et al.* (2017) found that D4R plays a key role in modulating corticostriatal glutamatergic neurotransmission. Additionally, it has been reported that D4R knockout mice with have a higher striatal glutamate basal release than wildtype mice (Thomas *et al.*, 2009), consequently under physiological conditions, the blockade of presynaptic D4R in glutamatergic terminals could explain the increased release not only of glutamate to GABAergic neurons, but also of GABA in the areas of the brain to which the glutamatergic cells project, including the shell region of the NA shell (NAcs). The increased extracellular concentration of GABA in the NAcs induces intense short latency hyperphagia (Reynolds & Berridge, 2002). Taken these findings together, the involvement of D4R appears to be critical for the regulation of activity in the reward circuit and, consequently, in this study we hypothesize that D4R-mediated dopamine transmission is a key element in increasing palatable food consumption by enhancing its reinforcing properties. Thus, the objective of this study is to evaluate the effects of pharmacological blockade of D4R present in NAcs on motivation for palatable food (MPF, breakpoints) in rats, using an operant protocol (progressive ratio schedule of reinforcement).

METHOD

Experimental animals

Ten male Sprague Dawley rats (weighting 80-120 grams at the start of the experiment) were used. Once they arrived at the laboratory, they had a week of habituation to the 12x12 hour light/dark cycle (the lights were turned off at 9:00 am). The rats had *ad-libitum* access to standard food and water (Formulab-Diet 5008®). Animals were provided by the FES-Iztacala Vivarium. The procedures used in this study were in accordance with the Technical Specifications for the Production, Care and Use of Laboratory Animals established in the Mexican Official Standard NOM-062-ZOO-1999.

Drugs

In this study we used the selective antagonist of the D4R, L-745870 (3-(4-[chlorophenyl]piperazin-1-yl)-methyl-1H-pyrrolo[2,3-B]pyridinetri-hydrochloride, Sigma-Aldrich Química, S. de R.L. de C.V., Mexico), which has a ki=0.43 nM for D4R (Patel *et al.*, 1997). A stock solution of L-745,870 dissolved in dimethyl sulfoxide (DMSO) was prepared and then aliquots were taken and diluted with 0.9% saline to obtain a final concentration of 1 µg, the injection volume was 0.5 µL infused at a rate of 0.1 µL/min, this solution was prepared just before administration.

Surgery

The rats were anaesthetized with a mixture of ketamine and xylazine (112.5 and 22.5 mg/kg body weight, respectively) and then placed in the stereotactic apparatus for implantation of a 1.5 cm guide cannula in the overlying area of the NACS. The stereotaxic coordinates, relative to bregma, were +1.5 mm anteroposterior, 0.6 mm mediolateral and 6.0 mm dorsoventral (Paxinos, Watson, Pennisi, & Topple, 1985). The guide cannula was fixed to the skull with a stainless-steel screw and acrylic cement. The animals were treated with enrofloxacin (25 mg/kg at the end of surgery and 48h after) to prevent infections and had 7 days of recovery.

Intracanular injections

The microinjections were applied with a high precision Hamilton syringe adapted to a 1.53 cm micro-injector, which remained inserted in the guide cannula for an additional minute to ensure the correct diffusion of the drug.

In all cases, the microinjections were applied 10 minutes before starting the progressive ratio program.

All rats received two intracanular injections (L-745,870 or Vehicle). The drug dose used (1 µg) was based on previous studies by our working group, where a significant effect on food intake was observed (Tejas-Juárez *et al.*, 2014).

Assessment of motivation for palatable food (MPF)

At the beginning of the dark phase (09:00 hours), food was removed from the home-cages to facilitate the emission of the operating response (lever) during training sessions. Ninety minutes later, the rats were introduced into the operant conditioning boxes (Med Associates Inc., St. Albans, VT., USA), which were equipped with general lighting (back panel) and discriminating stimuli (front panel, top of the levers), two retractable levers and in the middle of these, a 45 mg pellet dispenser. The boxes (dimensions 30 x 23 x 20 cm, lateral and top sides in transparent Plexiglas) were located in a sound attenuating cubicle with a fan to supply fresh air and white noise.

Events and contingencies inside the operating conditioner box were monitored and controlled through a Smart Control Panel SG-716B interface (Med Associates Inc., St. Albans, VT., USA) connected to a PC with Med-PC software (Med Associates Inc., St. Albans, VT., USA) and custom programs built in MedState Notation language

Training. Initially, animals were exposed to a fixed ratio schedule of reinforcement 1 (FR1) in daily sessions of 30 minutes. One press on the lever resulted in the delivery of a 45 mg pellet as a reinforcer (45 mg chocolate-flavored sucrose pellets, Bio Serv, Frenchtown, NJ, USA). The criterion for switching from FR1 to FR5 was that a stable lever response rate was achieved (variation of no more than 20% on average over 3 consecutive days, each rat was its own control). In the FR5 schedule of reinforcement, pressing the lever 5 times resulted in the delivery of 1 reinforcer, this phase of the training lasted 3 consecutive days. Subsequently, the microinjection cannula was implanted in the NAcS and after the recovery period, they were again exposed to the FR5 schedule of reinforcement. The duration of the training sessions (FR1 and FR5) was 30 minutes. When rats achieved stability of the lever press response in the FR5 program (no more than 20% average variation for 3 consecutive days, each animal was its own control), the vehicle or L-745,870 microinjections were applied and they were exposed to a progressive ratio (PR) schedule of reinforcement 10 minutes after injection to evaluate the MPF.

Experimental session. In the PR schedule of reinforcement, the response requirement to obtain a reinforcer was increased according to the following set of values: 1, 2, 4, 9, 12, 15, 20, 25, 32, 40, 50, 62, 77, 95, 118, 145, 178, 219, 268 and 328. The above values were obtained by the equation: Ratio= [5e (0.2 x test number)] - 5 (Richardson & Roberts, 1996). The PR program session ended when the rat failed to obtain at least one reinforcer within 30 minutes or in absence of responses in a 4-minute period. The breakpoint was defined as the ratio completed (last reinforcer obtained) before the end of the session. From the operating procedures, the following values were obtained: 1) number of lever pressings, 2) reinforcers obtained, and 3) breakpoints.

Histology

At the end of the experimental sessions, the rats were euthanized with a lethal dose of intraperitoneal sodium pentobarbital, the brain was removed and fixed in a 10% formaldehyde solution for 24 hours. Coronal sections of 300 µm thick were cut with a vibratome (Campden) and, based on the atlas by Paxinos and Watson (1986), the place of the drug injection was located. Only data from rats that were correctly injected into the NAcS were included in the present report.

Statistical Analysis

All values of the number of lever pressings, reinforcers obtained, and breakpoints, were expressed as the mean of the observations ± the standard error of mean (SEM) and analyzed with a repeated measures ANOVA (data obtained during training) followed by Tukey's post hoc test or a student t test when appropriate (for comparisons between 2 conditions). GraphPad Prism5® was used to calculate the significance of the differences with α of 5%.

RESULTS

In the present investigation, the effects of pharmacological blockade of D4R in the NAcS on MPF in rats were evaluated using a behavioral protocol. To achieve this objective, an operating paradigm for the MPF evaluation was established, initially by training the animals to FR1 and FR5 schedules of reinforcement, and then administering the drug directly to the NAcS and evaluating the breakpoints in a PR schedule of reinforcement. Fig. 1 shows the number of lever presses (A) and the number of reinforcers obtained (B) in the FR1 and FR5 (training) programs. In FR1 4 sessions were required to achieve 80% stability in its response rate without reaching statistically significant differences. Subsequently, they were exposed to 3 sessions in FR5

(5 responses, one reinforcer) and the following day they had the stereotactic surgery. After the rats recovered from surgery, 4 sessions of FR5 were required to achieve 80% of stability in the operant behavior. Statistically significant differences were obtained in sessions 7, 9, 10 and 11 compared to the sessions in FR1 [$F_{(7,4)}$= 8.502; p<0.001]. There were no statistically significant differences between FR1 and FR5 sessions in the reinforcers obtained [$F_{(7,4)}$= 10.83; p>0.05]. Thus, it can be established that rats adapted appropriately to the established operating paradigm. Once FR5 stability was achieved, the drug was intracanularly administered in the NAcs.

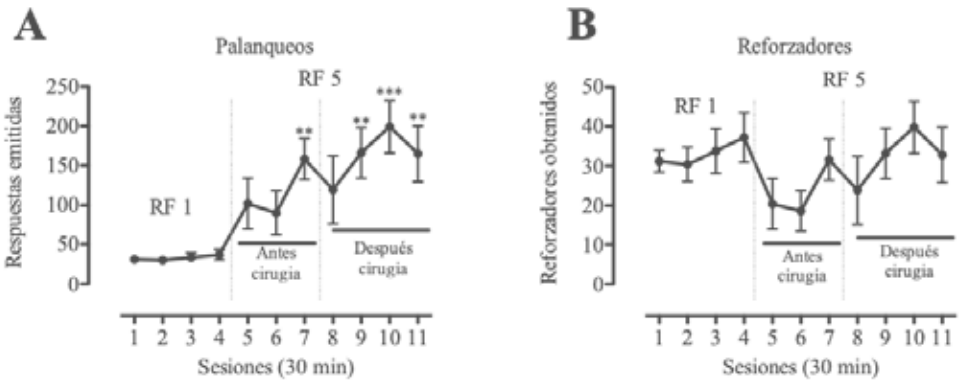

Figure 1. Responses emitted by rats exposed to the FR1 and FR5 programs before and after surgery (training). Lever presses emitted (A) and reinforcers obtained (B) in each 30-minute session in both FR1 and FR5, before and after stereotactic surgery. Data expressed in terms of means ± the EEM. There were no statistically significant differences among sessions 8, 9, 10 and 11 of the lever presses and reinforcers obtained

Figure 2 shows the effects of intracanular administration of the D4R selective antagonist, L-745,870 (1 µg, intra-NAcs) on the performance of animals in the PR program. According to our results, the local administration of L-745,870 significantly decreased the number of lever presses (t= 3.450; p<0.05) and the number of reinforcers obtained (t= 4.700; p<0.05), in the behavioral task characterized by the progressive increase of the operating demand.

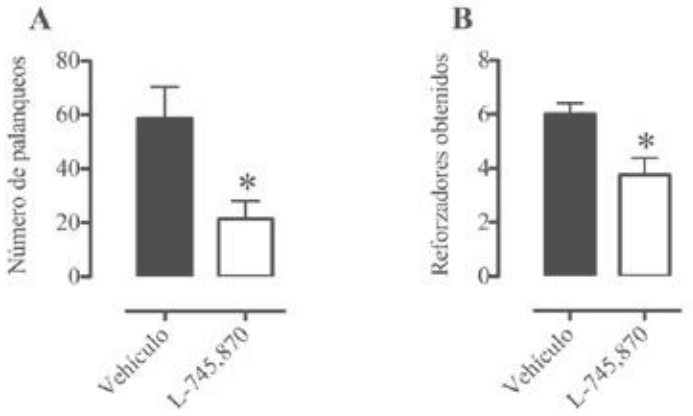

Figure 2. Number of lever presses (A) and reinforcers obtained (B) by rats exposed to the PR program that received the injection of the D4R antagonist (L-745,870, 1 µg) or vehicle in the NAcS. Data expressed in terms of means ± the MES (n= 4 per group)

To determine the effects of D4R blockade in the NAcS with L-745.870 (1 µg) on MPF, we evaluated the breakpoints in different pharmacological conditions. Breakpoints are valid values that reflect the reinforcer strength and the motivational state of the animal (Zhang *et al*., 2003). In the present study we found that the administration of L-745,870 significantly decreased the breakpoints ($t= 4.071$; $p<0.05$; $n=4$). This result indicates that by preventing D4R-mediated dopaminergic transmission, MPF decreases. Figure 3B shows the histology of correctly administered injections into the NAcS (representative photomicrograph).

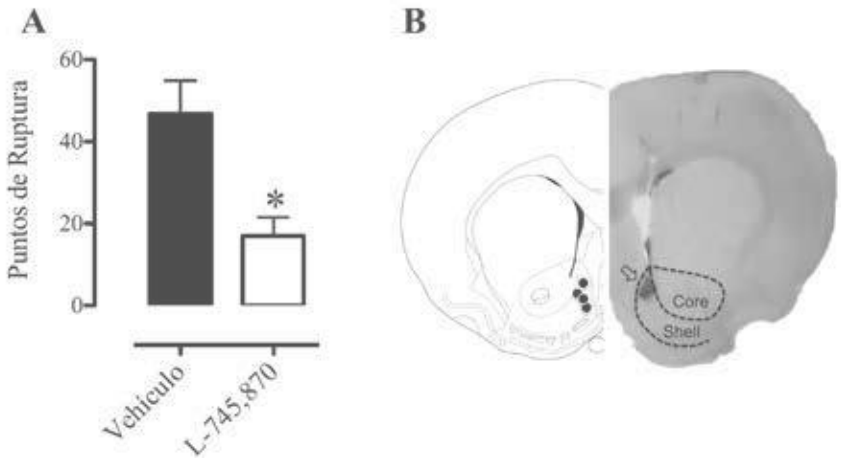

Figure 3. A) Breakpoints (last value of lever presses with reinforcer obtained in the PR program) of the rats injected with the D4R antagonist (L-745,870, 1 µg) or vehicle in the NAcS (data expressed as means ± the EEM; n= 4 per group; * p< 0.05). B) Representative photograph of a coronal section showing the injection site (right) of the drug in the NAcS (marked with an arrow) and schematic representation (left) of the injection places (black circles) in an image from the atlas by Paxinos and Watson (1998)

DISCUSSION AND CONCLUSION

The present study was aimed to obtain evidence that D4R-mediated dopaminergic transmission in the reward circuit, particularly in the nucleus accumbens shell, is an important part for the information processing of palatable food rewarding properties. Accordingly, we found that local and specific D4R blockade in NAcS with the antagonist L-745870 significantly decreased palatable food motivation.

Our results are compatible with the hypothesis that the central administration of the selective D4R antagonist in NAcS blocks the presynaptic D4 receptors located at the glutamatergic terminals (Svingos *et al.*, 2000), disinhibiting this stimulatory pathway and consequently increasing the activity of GABAergic neurons in NAcS associated with increased palatable food motivation. Accordingly, activation of presynaptic D4R has been associated with inhibition of glutamate release in other regions of the brain (due to its attachment to Gi proteins), in which the D4R blocking may increase glutamate release. In this regard, it has been shown that blocking D4R with the selective D4R antagonist (A-381393) produces increased expression of cFos immune-reactivity in the paraventricular nucleus of the hypothalamus (Bitner *et al*, 2006). Thus, increased activity of NAcS GABAergic neurons mediated by disinhibition of glutamate release via D4R blockade would reach several brain areas, including those related to food intake such as the lateral hypothalamus (LH), which expresses different orexigenic neuropeptides such as melanin concentrator hormone (MCH) and orexin (Ox) (Suyama & Yada, 2018; Stuber & Wise, 2015). The increase of the GABAergic tone in LH would have an inhibitory effect on the neurons that express MCH and Ox, which might explain the decrease in palatable food intake, since these peptides have a hypophagic effect.

On the other hand, the selective D4R antagonist (L-745,870) has been shown to produce a decrease in the severity of dyskinesias in induced Parkinson's model rats, when co-administered with L-DOPA, the drug of choice in Parkinson's disease (Huot *et al*., 2015). Additionally, other selective D4R antagonists have been studied in cancer and addictions (Lindsley & Hopkins, 2017). Currently, no information has been published regarding the utility of this drug in the regulation of food intake, so this study provides information that supports the potential use of this compound as an adjuvant in the treatment of food pathology characterized by excessive consumption of palatable food.

Although the results of the present study have implications for the understanding of the relationship between dopaminergic transmission and the regulation of palatable food motivation processes, their limitations should be considered. The main one is that it showed the effect of a single dose

of the D4R antagonist which, although it had a clear and statistically significant effect, it will be necessary to validate that such changes in behavior follow a concentration-dependent pattern, as pharmacological evidence of the specificity of the compound's action on the receptor. Additionally, it would be necessary to demonstrate that the reported effect depends on the increase of GABA concentration in the NAcS, so it is suggested that in future experiments not only GABA levels in the NAcS be measured, but also that the blocking of GABA receptors be shown to prevent the effect of L-745,870.

Finally, according to the results obtained in the present study, it is concluded that pharmacological blockade of D4R in the nucleus accumbens shell with the specific antagonist (L-745,870) decreases palatable food intake by decreasing food motivation. Future experiments should be conducted to confirm that the neurochemical mechanism by which D4R produces the above-mentioned effect via the regulation of GABA concentrations in the NAcS.

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SOCIAL MARKETING AS A STRATEGY TO FOSTER READING HABITS IN UNIVERSITY STUDENTS

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— Abstract—

The objective of this article is to determine which Social Marketing strategies should be more appropriate in order to foster reading habits in university students. This is a quantitative, cross-sectional correlated study. Results show that university students are below the national average of books read per year, according to national surveys. They are aware of the lack of reading habits and that reading campaigns have not been successful despite the efforts. Results also show that the participants prefer printed book versions, contrary to what was expected, preferably literature related themes, and access to reading materials via social media. Specific actions are suggested according to participants' preferences so reading habits can be fostered through Social Marketing Strategies in order to make students aware of the positive impact reading has in their personal as well as in their professional life.

Keywords

Reading habits; strategy; marketing mix; social marketing; social media; promotion.

Social Marketing has taken on great importance over the years for companies and organizations. Kotler and Keller (2014:638) mention that it has been present through campaigns since 1950 in India, with family planning campaigns; 1970 in Sweden, with the No Smoking and No Drinking program; in Australia, with the Wearing a Seat Belt orientation or in Canada, with Say No to Drugs, Stop Smoking and Exercise.

In 1980 it was used by international organizations, such as the World Bank [WB], the World Health Organization [WHO] and the Centers for Disease Control and Prevention [CDC], which began promoting the term and encouraging interest in Social Marketing.

In the words of Paramo (2016) since the Industrial Revolution onwards, the use of Social Marketing made its way through the implementation of campaigns to abolish the imprisonment of debtors, grant women the right to vote, and the elimination of child labour.

The characteristic of Social Marketing is that the objective of the campaigns must be related to the knowledge, values, actions or behavior of people. Nowadays, it is even common to see promotional videos of companies, where instead of promoting their products or services, they show a local or global daily life issue, in order to raise awareness and sensitize the population about it.

The promotion of reading, a current problem within the university population, is also an objective of a Social Marketing campaign. In Mexico, similar campaigns have been carried out by the National Council for Culture and the Arts (CONACULTA), the Ministry of Public Education (SEP), the National Council on Science and Technology (CONACYT), the Council for Communication, among other national bodies. However, despite the efforts of the various agencies involved in this problem, there is no practice of reading, much less the habit of it, perhaps derived from the fact that illiteracy still exists today, which would explain why people do not even flip through a book (Aguilar, Cruz & Aguilar, 2014).

In the 2015 Intercensal Survey, conducted by the National Institute of Statistics and Geography (INEGI), 119 million 530 thousand 753 inhabitants were counted in Mexico; of which "18 million people are potential readers, but the rest of the population does not read, does not buy books, does not go to the library often, Mexicans are indifferent to quality reading" (Aguilar, Cruz & Aguilar, 2014:110).

The objective of this article is to determine which Social Marketing strategies should be more appropriate in order to foster reading habits in university students. The study is quantitative, of correlational-causal cross-sectional design, with which preliminary information is obtained that seeks to give an answer to the hypothesis raised in the research.

SOCIAL MARKETING STRATEGIES

The strategies that are commonly used for the sale of ideas, attitudes or behaviours, are aimed at improving the quality of life of any society (Torres & Granada, 2014). According to Forero (2009) and Góngora (2014), Social Marketing uses strategies typical of Commercial Marketing, however, other authors have considered it necessary to add others in order to provide it with a social focus.

Forero and Góngora divide them into four key elements called: product, price, place and promotion; with two additional elements: packaging and population for Forero, and presentation and population for Góngora, which together are called the *Marketing Mix,* known as the controllable variables of marketing or the 6 P's. These in turn are crossed and combined with the 6 C's or variables of analysis of Marketing: consumers, competitors, company, channels, costs and context, as shown in table 1.

For Gaitán & Ríos (2016), the *Marketing Mix* are controllable tactical tools, which an organisation integrates to obtain a desired response in the target market; it consists of the organisation capacity to influence the demand of its product.

Table 1
Social Marketing Elements

6 "P"	6 "C"
Product: Promotion? Prevention?	Consumers: Who? How? What? Why?
Population: How to segment? Who to serve?	Competitors: How do they compete? What are their strengths and weaknesses?
Price: What is the price? What is the benefit?	Company: What are our strengths and weaknesses?
Place: Which community?	Channels: Distribution, How does it work? What are their relationships?
Presentation: Packaging, Who is involved? How? Where?	Costs: What is the cost? What is the benefit?
Promotion: Communication (publicity) What? When? How? Where?	Contexts: Which politic, economic, social and cultural variables?

Source: Adapted from Góngora (2014)

Marketers develop strategies to distribute manufactured goods, for which the terms are slightly modified as in the case of location or distribution and promotion by communication. For services, it is necessary to modify the original terminology, and instead talk about product element, place and time, price and other costs for the user, promotion and education.

Expanding the mix by adding four elements associated with service delivery: physical environment, process, people and productivity, and quality. These eight elements altogether, denominated the 7 P's of Service Marketing, symbolize the components needed to establish workable tactics that profitably address the needs of the marketplace (Silva, 2017).

The strategies implemented must be selected according to the type of campaign to be implemented, as well as the objective to be achieved. Table 2 below shows the types of campaign and the objective that each one pursues (Kotler & Keller, 2014):

Table 2
Example of social marketing campaign objectives

Cognitive campaigns	Explain the nutritional value of different foods. Demonstrate the importance of environmental protection.
Action campaigns	Encourage participation in mass vaccination campaigns. Motivate people to vote in favor for something in a plebiscite. Motivate people to donate blood. Motivate women to get a Pap test.
Behavioral campaigns	Discourage smoking. Discourage drug use. Discourage excessive alcohol consumption.
Campaigns about values	Changing ideas about abortion. Change the attitude of intolerant people.

Source: Adapted from Kotler & Keller (2014)

BENEFITS OF READING

History shows that civilizations pass on their knowledge from generation to generation, through the reading of documents, either handwritten or printed. This process includes the type of reading and the amount of time allocated to that activity (Rosli *et al,* 2017).

Walia & Sinha (2014) state that reading is a process, a way of thinking and a real experience that involves many complex skills: a) the ability to perceive printed words, b) searching for information and c) reading intensively.

Reading improves thinking skills by acquiring new concepts and ideas, enriching the lexicon, which is essential in verbal communication (Kutay, 2014). Reading habits (Dolla *et al.,* 2017) play a major role in students' academic performance.

The act of reading should be a voluntary and enjoyable activity for the individual. When it is done in this way, the person finds satisfaction (Perez, Baute, & Luque, 2018). Reading is also a process that it is developed gradually. In table 3, Palacios (2014) points out five steps in this process:

Table 3
Steps in the reading process

1 Perception	Recognition of graphic symbols by means of a specific technique.
2 Comprehension	Through this, the meaning of the written word is recognized; it is an intellectual capacity that makes it possible to create images in the mind that are transferred from the signs that are seen.
3 Interpretation	Ability to attribute a meaning to something.
4 Reaction	Capacity to manifest an attitude towards what is read; that is, it has to do with critical capacity and understanding.
5 Integration	Ability to establish value relationships between the ideas expressed and one's own thinking.

Source: Adapted from Palacios (2014)

READING IN UNIVERSITY

The main thing, when reading, is not only based on the content of the reading, it must be taken into account the amount that is read, of what type and the reason why this activity is carried out. In universities, reading scientific documents such as journals or articles is essential. However, when young people enroll in universities, the process of teaching and learning is complicated by the lack of reading habits. In these cases, it is necessary to work assiduously in academic life (Quintero & Vela 2016).

In the university the habit of reading is a necessity, since the young person who does not have this pleasure will find it difficult to have a successful professional education. When a person reads, he develops various intellectual skills among which is reading comprehension, which should be considered a valuable tool to obtain and store knowledge (Arista & Paca, 2014).

READING HABIT

Over the years, habits change as technology changes. Electronic reading has expanded by presenting diverse options. Although people are in the habit of reading, reading in electronic media is slower according to Dyson & Haselgrove (2001), demonstrating a relationship between speed and familiarity while reading on a computer.

Al Shehri & Gitsaki (2010) mention that there are studies that prove that, according to exposure or frequent contact with some electronic media along with the electronic quality of reading, reading speed increases.

Karadeniz & Can (2015) in their study, mention that there is a positive correlation between reading habits and literature in media; on the other hand, they mention that there is a negative correlation between reading habits and the habits of using social media as a reading medium in

the context where their study was conducted, making use of Gömleksiz's Attitude Scale Towards Reading Habit (2004) and Korkmaz & Yeşil's (2011) Media Literature Scale.

As for the National Reading and Writing Survey conducted by SEP (2015) it was obtained, in a multiple choice question, that 44.3% of the population that reads does so for entertainment and 30.5% to study, while only 11.8% does so for information and 11.3% for work. On the other hand, the data obtained from the question "Why don't we read or wouldn't we read? 79.9% mentioned that the main reason is the lack of time, followed by apathy with 21.3%, because they do not like it with 14.6%, the preference of other activities with 12.3% and only 11.5% because of tiredness.

Palacios (2014) classifies people who read depending on their reasons and purposes as follows in table 4:

Table 4
Readers' classification

1 Extensive reader	Reads not only for utilitarian reasons, but also for fun and aesthetic pleasure. Likes to explore a wide variety of texts, and this preference increases his curiosity and need to know, as well as his selective ability and interest in increasingly complex texts. All this leads him to read not only in traditional media, but also on the Internet and in digital media.
2 Literary reader	It could be said that he has many of the characteristics of the extensive reader, such as his motivation for aesthetic enjoyment and his selective capacity.
3 Intensive reader	Spends less time reading, compared to extensive and literary readers, and focuses on newspapers and magazines rather than books. Usually specializes in some content related to their work or hobbies.
4 School reader	This category includes two subtypes. The first is made up of those whose reading activity is mainly directed at texts related to their studies, while the second subtype includes diversified school readers, who not only read texts for school, but also others related to extracurricular themes or hobbies.
5 Sporadic reader	Has little reading activity; reads books very occasionally, sometimes out of obligation. Does not read newspapers nor magazines, and almost never uses the Internet.
6 No reader	Never reads claims to have difficulty in understanding the content of texts. He never goes to libraries or bookstores.

Source: Adapted from Palacios (2014).

PUBLISHING PREFERENCE

Publications are defined as all those documents that are read and contribute knowledge, they can be periodicals such as magazines, articles, manuscripts, newspapers, gazettes, among others, that have constant publication dates, and not periodicals such as books.

They can be catalogued, in turn, as academic, scientific, popular and entertainment documents, and in this technological era, they can be accessed

physically, that is, in print or digitally, as well as by so-called electronic. means. Today, blogs and social media are also considered as reading platforms.

For Jiménez (2011:93) "a manuscript is a document written by the authors of the study with the results of the research, which will become the original scientific article, unedited or unpublished version". He also mentions that the publication of a research in a scientific journal, brings new knowledge that has not been previously published.

Collado (2006), mentions that the first scientific journals date back to the 17th century and that at first they only did descriptive work, but as the centuries passed they became more specific, with the aim of presenting enough information so that the research can be replicated by other academic peers and compare the results obtained.

Today, electronic or digital publications are available in addition to printed ones, facilitating people's access to books, magazines, newspapers, among others, by moving the paper page to the screen (Palacios, 2014).

A printed publication is a "written material that uses primarily paper as a carrier, that exposes its content in a linear fashion, that assumes mainly the form of a magazine, book, pamphlet or newspaper, that is distributed partially or totally by means of copies and that intrinsically fulfils three pairs of functions: communication and dissemination, legitimization and authority, and archiving and memory" (Travieso, 2003:1).

According to the National Reading and Writing Survey (2015) carried out by the SEP, there is a diversification in reading materials and formats. Digital platforms and formats are increasingly preferred for reading, for example, in the case of comics, blogs and social media.

As a result, what do people read? (multiple answer), in first place are books with 57.3%, followed by newspapers with 55%, with 44.9% social media which indicates the impact that these have on the population over 12 years (age of respondents), continuing with magazines with 38%, websites with 25.2%, comics with 16.6% and finally blogs with 13.4%.

METHODOLOGY

Based on the data obtained by the SEP and understanding the population's reading preferences, a data collection instrument was designed in electronic format, using the Google Forms platform. Through this collection and its statistical analysis, we sought to verify the hypothesis raised in the work.

The research was carried out in a non-experimental manner, with a correlational-causal cross-sectional design. The sample was taken from 3,816 university students from the Economic and Administrative Sciences Division (DACEA) of the Universidad Juárez Autónoma de Tabasco (UJAT),

with a 95% confidence level. As a result, a sample of 94 participants was obtained, applying Aguilar Barojas' finite population formula (2005).

The instrument was applied in the second semester of the year 2018, in the school period from August to December. It consists of 11 multiple-choice items and was administered to students in administration, accounting, economics, and marketing at DACEA-UJAT. Table 5 below shows the relationship of the dimensions of the variables that are sought to be correlated:

Table 5
Variables' dimensions relation

Marketing strategies	Reading habit
- Awareness	- Social problem
- Reading as social product	- Quantity - Publishings - Formats - Reasons - Benefits
- Communication	- Social problem
- Low cost benefit - Book vending machines - Book fair	- Motivation

Source: Own elaboration

The results were automatically coded by Google Forms, platform on which the surveys were conducted and managed.

RESULTS

Data from INEGI and SEP agree that the average number of books read annually in the country per citizen is 3.5 books. According to the data obtained in the study, 39.4% of those surveyed read an average of one to two books per year, which places them below the index of national surveys.

They are aware that the lack of the reading habit is a problem in the country that has been tried to improve through time with the help of different government programs that encourage the reading habit. This means that they are within an essential point where Social Marketing can work through campaigns and programs, since the consumer is involved with the situation.

In order to carry out the reading activity, the result shows that the preference of university students is for books, specifically literature. Followed by social media that are currently considered another reading format for them.

Despite the technological advances and the reading formats available, 60% of those surveyed prefer to read the physical book as such. This means that printed publications continue to be the preference among consumers.

According to the National Reading and Writing Survey conducted by SEP in 2015, half the population reads for entertaining reasons, information that is confirmed by the results obtained. This data can also be interpreted in reading as a leisure or pleasure activity, which is an advantage when applying a Social Marketing campaign or program, since the audience conceives the situation in a positive way and is eager to read.

To combat the problem of the lack of reading habits in the country, different public and private organizations have carried out different campaigns in recent years to promote reading. The means used to communicate these messages have been television and social media. In the future, if other types of campaigns or programs aimed at young university students are to be implemented, social media may be chosen as an effective means of transmitting the desired message.

As a measure of motivation for the acquisition of reading material, activities of exchange or sale of second-hand books can be carried out, since the response to this proposal had an acceptance of 87.2%, which can be achieved through adequate promotion.

In previous years, the UJAT put into operation book vending machines in strategic points of the DACEA, but for internal reasons that are unknown, these were removed. When asked if they would be used again, 85% of respondents said they would, and some said they had not had the opportunity to use them while they were in operation.

Every year in November, the UJAT holds the International University Book Fair, with the exception of 2018 due to an austerity measure. During this event, different activities related to books and the promotion of reading are carried out. Despite the fact that the vast majority of those surveyed say they only go to and observe the fair's stands, this leads to the acquisition of material related to reading and specifically to the purchase of books. This activity is significant for the university and of great promotion of reading because it seeks to emphasize the importance of carrying it out.

PROPOSALS

To raise the low reading level, the different strategies of Social Marketing within universities are proposed to be applied, in order to encourage the habit of reading.

As a communication strategy, it is proposed to provide information on the subject of Reading Habit, through attractive printed advertising within the university facilities: posters, banners and images that invite the student to

carry out this activity, as well as to attend talks, join reading clubs, provide literary recommendations or simply with interesting data on the subject that draw the attention of the university student.

Within this type of communication and propaganda strategy, it is proposed to make use of the university's official social media, since they are an effective and far-reaching means of reaching the objective audience, in this case, the students, since interaction is a mechanism that many users opt for. In these digital spaces information on the subject can be provided, as well as everything mentioned in the previous point.

In the Social Product part, it is proposed to resume the operation of book vending machines previously used by the UJAT, since many of the students of the division did not have the opportunity to use them. For this strategy to be successful when it is taken up again, it will be necessary to place publications that are of interest to the student, since most of them read for entertainment.

Exchange or sell used books at a lower cost than commercial ones, so that the acquisition of these is motivating for the young people. This activity can be done on set dates so that the student can prepare to participate. This strategy of low-cost pricing, in addition to encouraging the promotion of books, would also promote coexistence among the university community.

Similarly, the university is encouraged not to lose the tradition of the university book fair held every year, because it is a strategy of place within the Social Marketing that, through various activities, promotes the culture of reading, not simply by selling books, but also by the presentations, joint readings and sale items related to the subject. It is important to rescue this activity that has had a great impact on many young university students.

Reading habit concerns us all, if priority is given to activities that stimulate it, great results can be obtained that will gradually improve our development as people and as a country.

CONCLUSIONS

Education and training is provided in Higher Education institutions, a responsibility shared with university students. Likewise, the promotion and stimulation of the reading habit should be a priority.

To do so, it is necessary that someone initiate it, in order to spread the taste for reading and explain the rules, or provide the strategies, to achieve it. Accompanying is needed for the student to appreciate the benefits that this activity entails.

The authors Walia & Sinha (2014), Kutay (2014) and Dolla, *et al.* (2017) confirm that with the habit of reading, people acquire different intellectual skills that help them in their academic, professional and social development.

University students in the habit of reading indicate that oral expression is the skill they have developed most, followed by good spelling, ultimately leaving argumentation as the least acquired skill despite being of great importance in all of the above areas.

It should be mentioned that promoting reading is a collaborative strategy, since it is achieved when two parties work together. In this case, it is the responsibility of the institution and the student to achieve that understanding of how meaningful and constructive the habit of reading is, and that will undoubtedly be reflected in their written expression, but mainly in their personal and professional growth.

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PROXIMITY TOWARDS THE SUSTAINABILITY OF INHABITANTS FROM TUXTLA GUTIÉRREZ, CHIAPAS, MÉXICO

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— Abstract—

This work aims to assess the proximity to the sustainability of the inhabitants of an urban community through the measurement of actions, attitudes and dispositions that, from a socio-environmental perspective, contribute to this field. The variables measured are: austerity, altruism, ecological behavior, equity and spirituality. The work, which follows an exploratory character, exposes the results obtained from a non-probabilistic sample of 653 inhabitants of Tuxtla Gutiérrez, Chiapas, a city with high levels of inequality and poverty in southern of Mexico. The results obtained suggest that the inhabitants of this city are not close to sustainability, with equity and austerity being the fields with the best valuation, while altruism and pro-environmental behavior are the most distant to it. The implications of these results are analyzed and discussed and research lines are projected towards the incorporation of sustainability as the axis of development in urban centers.

Keywords

Urban sustainability; urban development; ecological behavior; equity; austerity.

The concept of sustainability, according to Borden (2017), has a specific history rooted in economic development, global initiatives, environmental conservation, human health and individual well-being. From this diversity of origin, sustainability is a polysemic concept that has been the subject of debate in recent years. However, there is a general consensus that sustainability can be considered as a new field in which there is room for all those proposals aimed at making viable the freedoms of present and future generations. According to McKeown (2002; cited in Cortés & Peña, 2015, p. 7), sustainability can be understood as a paradigm for thinking about a future in which environmental, social and economic considerations achieve a balance in the search for development and a better quality of life.

In what refers to the social scope, Rivera-Hernández and others (2017), indicate that sustainability is only possible through the conscious participation of the social actors in a fight for justice, respect to human rights, cultural diversity and respect to the environment, concrete actions that allow to introduce changes in the social life (Giddens, 1987; quoted in Ortiz, 1999, p.62). In this sense, Borden (2017) emphasizes the importance of a change in attitude and behavior for the future viability of the species through psychological self-awareness and ecological knowledge as principles of sustainability. According to Horlings (2015), because life on this planet has become unsustainable, a transformation is required that is anchored in a change in the values of the different social actors, the internal dimension of sustainability, that is, change from the inside out, from the individual to the collective.

This transformation in the social dimension implies the modification of attitudes, beliefs and behaviors towards a lifestyle of the actors that corresponds to the precepts of sustainability, that is, equity, justice, common good, respect for the environment, moderation and even spirituality (Ben-Heli, 2015; Moller, 2010). From this perspective, Corral (2008) refers as psychological dimensions of sustainability to all those behaviors and dispositions that, when combined, generate an orientation towards sustainability, that is, a sustainable lifestyle. Among these dimensions, altruism, austerity, equity, pro-environmental behavior and a sense of transcendence stand out.

When dealing with attitudes, beliefs and behaviors, this work has clear theoretical references to the disciplinary field of psychology and, specifically, to social and positive psychology. From these references, Tapia-Fonllem *et al.* (2013), explain that austerity or frugality, refers to the deliberate action of avoiding excessive consumption of resources and services not essential for survival, in contrast to hoarding and waste. Bouckaert *et al.* (2008) point out that austerity is an ideal of life that implies a low consumption of materials and resources to open the mind to spiritual goods such as inner freedom, social peace and justice or even the search for God. On the other hand,

altruism is a social and interpersonal construction related to various types of pro-social behavior that is conceptualized as a motivational state that a person possesses with the aim of increasing the welfare of another person (Filkowski *et al*., 2016). Altruism is opposed to selfishness, as it is assumed to be the conviction of seeking the benefit of others without the interest of obtaining something for oneself (Batson, 1991; cited in Corral-Verdugo *et al*., 2013, p. 365). Equity is associated with respect for differences among social actors, fair distribution of resources and non-discrimination by physical, biological, cultural or demographic conditions (Corral-Verdugo, 2012), framed in the notion of *communality*, which is opposed to individualism exacerbated by capitalism and, instead, promotes participatory processes in daily practice towards social change having as a guiding principle the collective interest (Source, 2012). In that sense, spirituality, linked to the construction of a *common house* (Arboleda and Gutiérrez, 2017) as a metaphorical way to describe the planet and the way in which man is inscribed in it, refers to the sense of transcendence, the human condition through which social actors believe and feel part of something bigger, even sacred, which moderates the conduct and the way in which they relate to the environment and their fellows (Barrera-Hernández *et al*., 2016). In relation to the environment, Cerda and others (2007, cited in Heyl *et al*., 2013, p.488) point out that the solution to environmental problems must be sought through a change in people's behavior and the way in which this is perceived and signified, because the more value is associated with *something*, the greater the care and interest developed towards it.

Pro-ecological behaviors are those that involve a deliberate action for the benefit and care of the environment (Morales *et al*., 2017). Consistent with the above, people who act ecologically often tend to sacrifice their individual interests in exchange for public or social interests (Yang *et al*., 2018). In this sense, this work assumes that if social actors are austere, altruistic, equitable, spiritual and pro-environmental, they are close to sustainability.

Cities are the main centers of population where most of the human activities and decisions that take place in the world are concentrated. Despite occupying a small percentage of the earth's surface, urban centers consume a large part of the planet's available resources (Rogers and Gumudjian, 1998; cited in Voula, 2010). The modern city has allowed the development of productive forces and the growth of economic wealth at the same time that it has paid to an increasing proliferation of problems typical of the urban environment, such as the deterioration of the natural environment, poverty, unhealthy lifestyles, loss of the sense of community and disintegration of emotional ties, to name a few (Mohamad & HjAyob, 2013; Prezza & Schruijer, 2001). In contrast to this state of crisis, the sustainability of cities denotes a desirable state in which society strives to achieve a balance

between environmental protection and integration, economic development and regeneration, and between equity and social justice (Elias & Krogstieb, 2017).

The city is a complex system, with multiple and dynamic relationships between different factors and elements that coincide in a relatively limited space. People, social actors in such a chaotic scenario, contribute the indeterminism inherent to human behavior, which comes from a historical process mediated by experience and learning in a social arrangement that exalts individualism and dilutes the community. In this framework, the objective of this work is to value the proximity to sustainability of an urban community from the measurement of actions, attitudes and dispositions that, from a socio-environmental perspective, have correspondence with sustainability. The variables measured are austerity, altruism, ecological behavior, equity and spirituality.

Tuxtla Gutiérrez, Chiapas, is considered a suitable city for study, because it has various urban and coexistence problems, such as high levels of pollution, environmental deterioration, deficient urban services and social inequality. In this way, this work starts from the assumption that its inhabitants are not austere, altruistic, do not carry out actions favorable to the environment, do not have a sense of equity and the consideration of spirituality is limited, therefore, it is not close to sustainability. The results constitute a knowledge base to guide the formulation of public policies and other possible lines of intervention.

STUDY CITY CONTEXT

Tuxtla Gutiérrez, capital of the State of Chiapas, is an intermediate city in the southeast of Mexico (Álvarez de la Torre, 2011) with a great ethnic-cultural heritage that, in recent years, has reached high levels of social backwardness and poverty (Zambrano, 2018). Since this city was declared the seat of public authorities of the state of Chiapas in 1892, its transformation has been constant. This process of change has been driven mainly by the growing number of inhabitants who demand housing, urban infrastructure, services and employment. Thus, life in this city is part of a changing and complex environment, which requires understanding in order to guide its transformation process under a perspective of sustainability. In this sense, it becomes relevant to address urban issues from a knowledge base generated from its inhabitants.

METHOD

Type of study

This is an exploratory study, quantitative in nature, with a transversal, non-experimental design. It is exploratory since it addresses the sustainability of a city from an alternative perspective, is carried out in a particular context and aims to generate a knowledge base for future research. It has a quantitative focus since it analyses an objective reality of a problem based on numerical measurements and statistical analysis. It follows a non-experimental, cross-sectional design, since this research does not contemplate the deliberate manipulation of any variable and data collection was carried out at a single time (Hernández-Sampieri *et al*., 2014).

Subjects

A conventional non-probabilistic sample of 653 inhabitants of the city of Tuxtla Gutiérrez, Chiapas, Mexico, all of whom were of legal age, was used. Although the sampling was non-probabilistic, the number of participants was obtained by applying the formula for determining the sample size for finite populations (Spiegel & Stephens, 2009), considering a population of 600,000 inhabitants of the city and a 95% confidence level. Participants were approached at well-known public sites such as parks, public transportation sites, and shopping malls located in different parts of the city. For this purpose, the city was divided into 5 zones, center, north-west, north-east, south-west and south-east, in order to ensure the representativeness of the whole city. The application of the surveys was carried out between March and April 2017 and each one lasted approximately 20 minutes.

Instruments

To carry out this research, a data collection instrument with five scales related to the construct proposed by Corral-Verdugo (2010) was set up to measure orientation towards sustainability. These scales are: General Ecological Behavior scale (Kaiser, 1998) of 16 items, Austerity scale (Corral *et al*., 2008) of 10 items, Altruistic Actions scale (Corral & Pinheiro, 2004) of 10 items and Equity scale (Osuna *et al*. 2008) of 7 items; additionally, to measure Spirituality, the Scale of Spiritual Transcendence (Piotrowski, Skrzypinska and Zemojtel-Piotrowska, 2013) of 16 items was applied. The response options of the scales are presented in a 5-level Likert format, which measures the level of agreement-disagreement on the items that pose an affirmation (e.g. "Treat all my classmates as my equals, regardless of their

social background.") and the level of frequency, from never to always, for the items that pose the performance of an action (e.g. "I collaborate with classmates or coworkers to explain and help them with tasks they do not understand"). In the instrument, the items from the different scales were randomly ordered to reduce the effect of association bias. As part of the procedure, socio-demographic variables of interest were retrieved, which are shown in the results section.

Procedure

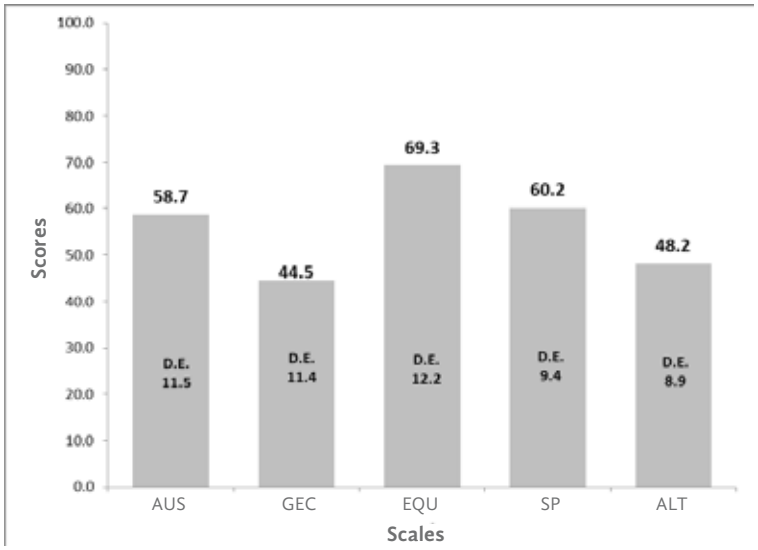
Once the instrument was applied, with the informed consent of the participants, they were captured in an SPSS version 21 file for analysis. For each participant, the scores obtained in the five scales applied were calculated by means of the simple sum of each of the items that make up the scale. To allow comparison between scales, and because each scale has a different number of items, the summed score was transformed into an indexed score from 0 to 100, considering the minimum and maximum possible scores. The verification of the assumption of normality was done by means of Q-Q graphs, evidencing a good fit. Subsequently, descriptive statistics, mean and standard deviation, were calculated for each of the scales. To evaluate the relationship between the scales applied, the Pearson correlation coefficient was obtained. For the socio-demographic variables of interest, frequency distribution tables were prepared and the results highlighted were recovered. This procedure was reviewed and approved by the academic council of the Faculty of Human and Social Sciences of the Universidad de Ciencias y Artes de Chiapas by means of the minutes of the council session with numeral CA-FCHYS-002/18 and was endorsed by the Direction of Research and Graduate Studies of the same institution. The treatment of the data followed the guidelines established in the Declaration of Helsinki, preserving at all times the confidentiality of the participants by virtue of the fact that the names were not recovered and the informed consent of each one of them was obtained before the application of the instruments.

RESULTS

Of the 653 subjects included in the sample, 56.4% are women and 43.6% men. The average age is 35.8 years with a standard deviation of 15.6 years. In relation to marital status, the distribution is 41.5% of single people and 40.4% of the participants are married, the rest (18.1%) declared a marital status different from these. Of the total, the majority (56.4%) have children. In reference to religion, 67.1% are Catholic, 11.5% mentioned being a believer without religion, and 10.5% stated being an evangelical Christian; the rest

were distributed among Jehovah's Witnesses (3.1%), Adventists (2.4%), atheists (2.4%), Mormons (1.7%), and other religious practices (1.4%). It is worth noting that 69.7% of the population uses public transportation to get around the city. Regarding occupation, most of them are employees (25%), followed by those who work at home (21.4%) and those who are still students (18.1%), the rest are distributed among professionals (15%), merchants (7.2%) and those who perform a trade (3.1%). The majority of the subjects have a medium-high level education (37.7%) or a bachelor's degree (30.2%), the rest have only basic level education (27.7%), or none (4.4%). Regarding origin, 52.1% are native to the city while the rest (47.9%) were born elsewhere. Finally, it should be noted that 75.7% of the participants have more than 10 years living in the city, 14.5% from 3 to 10 years and 9.8% less than three years.

Graph 1 shows the scores of each of the scales applied. It can be seen that the highest average scores are obtained for equity (EQU), followed by spirituality (SP) and austerity (AUS). This suggests that the sense of equity, the respect for differences, and the consideration about everyone having the same opportunities without conditions of any kind, is the field where inhabitants are closest to sustainability. After equity, the second highest scores are for spirituality. The sense of transcendence, through the spiritual, can propitiate better ways of relating with the environment and with other social actors, this is, through respect to the ways of life, the re-valuation of ethics and the recovery of fraternal bonds, as a way of approaching sustainable schemes of coexistence.



Graph 1. Descriptive statistics of the scales applied

The last scale with values above the 50 point average is the Austerity Scale (aus). This suggests that the inhabitants of Tuxtla Gutiérrez denote a certain level of consciousness so as not to consume in a reckless and unnecessary manner. Avoiding waste and ensuring proper management of resources is the basis of a more just society. In contrast, below the arithmetic average are the values that correspond to the dimensions of General Ecological Conduct (gec) and altruism (alt). This is an indication that citizens find it difficult to harmonize community life with a sense of responsibility for the environment and reduced consideration for others. These two fields represent the areas of opportunity on which society's efforts should be focused for the transformation process to be promoted in each city inhabitant, so that the precepts of sustainability are adopted in the urban space they share.

In terms of correlations, positive and significant coefficients are observed for all pairs of the scales applied. The highest correlation is in general ecological behavior and altruism, i.e. at higher scores on the Altruism scale participants also score high on General Ecological Behavior. The same situation occurs between Spirituality and Equity. In general, the magnitudes of Pearson's coefficients are low to moderate, suggesting that the association between the scales applied may be non-linear or correspond to a different theoretical construct. In either case, it is outlined as future work to replicate the study with a larger sample and incorporate other scales into the analysis.

Table 1
Correlations between the scales applied

	AUS	GEC	EQU	SP	ALT
AUS	1	.191**	.328**	.331**	.190**
GEC		1	.165**	.259**	.561**
EQU			1	.414**	.149**
SP				1	.239**
ALT					1

Note: **Significant to .01 AUS=Austerity, GEC=General ecologic conduct, EQU=Equity, SP=Spirituality, ALT= Altruism.

CONCLUSIONS

This paper addresses sustainability by assessing the attitudes, actions and dispositions of actors in an urban context, a scenario that is assumed *a priori* to be unsustainable. In this sense, the scales proposed by Corral-Verdugo (2010) to assess proximity to sustainability from a socio-environmental perspective are useful and applicable in an urban context. The results obtained indicate that the participants in this study, inhabitants of the city

of Tuxtla Gutiérrez, are closer to sustainability in terms of their sense of equity and spirituality and further away from it in terms of ecological and altruistic behavior. These results suggest that, from the notion of equity, social changes in Tuxtla Gutiérrez could be propitiated based on the respect to differences, such as those of religious creed or ethnic origin, the consideration towards those who present a condition of vulnerability, for example elderly people, people with low income or migrant population in transit; as well as through the moderation and regulation of conduct through spirituality, from which the values and ethical principles of social coexistence are promoted, since they are the dimensions that were better valued by the participants. In contrast, the results warn that the inhabitants of Tuxtla Gutiérrez do not often carry out actions in favor of the environment and have a low sense of disinterested support for other people.

In this scenario, the need to undertake strategic lines of action to enable the inhabitants of Tuxtla Gutiérrez to be close to sustainable schemes and, thus, promote the development of the city with criteria related to sustainability becomes evident. From the different institutional orders and structures, such as the State, the school and the family; empathy and the sense of the other must be promoted through strategies that aim at social cohesion and participation, for example, facilitating community organization in the neighborhoods or opening permanent channels of communication between peers. As regards caring for the environment, it is appropriate to encourage changes in consumption habits, to motivate the different social actors towards a culture of saving and foresight, as well as the proper management of resources.

Particularly in urban areas, it is imperative to preserve a healthy urban landscape, based on the environmental awareness of its inhabitants. As Sofeska (2016) points out, cities are complex, multi-layered systems whose dynamics are clearly unsustainable. Therefore, it is necessary that authorities, planners and the inhabitants of urban centers themselves, adopt a perspective of sustainability in order to promote the development of cities in the long term.

On the other hand, the knowledge and learning recovered in this exploratory work invite to recognize the need to advance in the construction of statistical models and methodologies that provide more formality to the research on urban sustainability that includes the intangible dimensions in the measurement of the proximity to it. As future work, it is proposed, on the one hand, to increase the number of participants in order to have greater representativeness in the sample. On the other hand, it is suggested that similar studies be carried out in other urban centers in order to be able to make comparisons between the results obtained in different cities.

Finally, the results obtained in this work allow us to identify the need to strengthen the construction of knowledge to achieve urban sustainability and to call for a permanent reflection on the modern model of city to imagine it differently, with horizons close to sustainability.

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RESEARCH AND DEVELOPMENT (R&D) AND ITS COLLABORATION TO THE GENERATION OF INNOVATIONS IN THE ORGANIZATIONAL CONTEXT OF THE MANUFACTURING INDUSTRY IN CIUDAD JUÁREZ

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— Abstract—

The purpose of this article is to analyze the relation between the Research and Development (r&d) variable and the generation of innovations within the organizational context, and which factors contribute to strengthening these constructs. This study was conducted through a methodology that uses factorial analysis and structural equations model. Findings are important for academic and practical goals due to the model's design that explains a significant relation between r&dand innovations development at the manufacturing industry. This will contribute to those enterprises that will to be more effective in developing innovations in order to be competitive.

Keywords

Research and Development; Innovations; Organizations; Manufacturing Industry.

Organizations today have an opportunity to be competitive by generating innovations. Innovation is decisive for companies to adapt to changes in the environment and thus survive; therefore, its generation must be promoted and it must be properly managed (Parga, Martín & Rios, 2013). Research and Development (R&D) is an activity that is considered to promote engineering advances, which significantly intensifies innovation generation within organizations, providing valuable capabilities for companies to achieve high production performance and be competitive (Zhang, Hoenig, Di Benedetto, Lancioni & Phatak, 2009; Perez, 2008).

The business environment is increasingly competitive, making the generation of innovations a significant and preponderant factor, because with them they manage to face unexpected events and develop an adaptability to them (Drucker, 1985). Innovation generation should be a common practice in the industry, because companies that carry it out in an adequate way will be more competitive, generating greater productivity and better product quality. Therefore, it is important to analyze what factors provide significant robustness for the generation of successful innovations in organizations, such as companies in the manufacturing industry.

Therefore, it was decided to carry out a literature review to examine the relationship between Research and Development and the development of innovations in the industry, because R&D has taken off as a significant factor in high performance companies and is a source for achieving competitive advantages.

The next section reviews different theoretical approaches to try to answer the research question: How does R&D influence the generation of innovations in manufacturing companies in Ciudad Juárez? Subsequently, the aspect of the research methodology is detailed, to finally present results and findings between the relationship of R&D and the development of innovations; conclusions and limitations of this research and proposals for future research are detailed at the end.

RESEARCH & DEVELOPMENT (R&D)

A significant factor for the generation of innovations within organizations is Research and Development (R&D), where the investment made by companies in this department boosts their capacity to innovate (Schmiedeberg, 2008; Shefer, 2005). To strengthen and increase the implementation of innovations, effective and efficient investment is necessary (Huanambal, 2014). On the contrary, there are companies that face difficulties and deficiencies for innovation development due to a deficient investment in R&D (Fernández & Montalvo, 2019). For Huergo (2006), in the United States high technology industry, investment in R&D is a significant factor for the

generation of innovations, unlike countries like France and Japan where R&D is not a preponderant factor for this task. The biotechnology industry generates a large number of innovations, due to the vast amount of resources allocated to R&D, so these resources invested provide companies with a great opportunity to develop new and better quality products for their clients (Song, Im & Song, 2011; Xu, 2009). Investment by companies in R&D is currently increasing year by year, in 2017, as an example, the investment was double than 2015, five times more than 2012 and ten times more than 2011, as mentioned by Tou (2019).

Within this approach, knowledge should be considered as an important driving force in the generation of innovations. R&D becomes an internal source of that knowledge for companies, involving discovery, learning and application of technologies and techniques (Roper, 2008; Tang, 2006; Padmore, 1998). For this reason, the activities of the R&D department, together with other company´s departments cooperation, are essential for innovations' success (Simonen, 2008).

Wang (2009) maintains that the R&D department is a key piece in the generation of innovations because of its direct impact in companies' performance, due to the fact that an investment increase in this department provides increasing the innovations number that are generated, and, with it, an increasing in productivity level. This point is valid only in high technological level industries. The R&D can be considered then as a cornerstone in the generation of innovation projects in companies, and also being a form of acquiring an advantage over competitors (Dossi, 1997).

In addition to the above, investment in R&D also offers other benefits, such as the realization of an improvement in a product's manufacturing process, reducing costs and increasing production efficiency. In this way, products can be offered to customers at more competitive prices. This type of improvement is known as incremental innovation

GENERATION OF INNOVATIONS

It is complicated for a company to remain competitive, due to the important globalization effects. Therefore, organizations are forced to develop strategies that allow them to improve their performance. These strategies must be based on organizations improvements, resulting in innovations that allow them to face economic crisis, providing different forms of production, product modification or some administrative modification to be more competitive (Eugenia, 2012; Mathison, 2007). There are several ways for a company to develop innovations, for example, a new product, process or product improvements and changes at organization's management (Cobo,

2018). This way, innovations allow production cost reduction, improve product functions and achieve a more competitive product (Hu *et al*, 2019).

In increasingly competitive market conditions within a globalized context, companies should not allow themselves to be indifferent, but rather, according to the cotec Foundation for Innovation (2004, p. 11), they should:

> (...) react by continuously improving and renewing its products, services and processes to fight in increasingly demanding and dynamic markets. In other words, innovation becomes a mandatory requirement not only for growth but also for business survival. It is therefore necessary for companies to accept the challenge of innovation, which implies that they must innovate frequently, efficiently and with confidence, and that innovation must be the rule rather than the exception.

For companies, the generation of innovations opens the way to new markets, in addition to expanding the existing ones, improving their competitiveness and taking their current businesses further; it also promotes the new markets development through innovation to prevent stagnation, regardless of whether these innovations end up being imitated, becoming industry standards, thus having the merit of creating value and pushing societies through the growth and welfare produced by this value (González, García, Lucero & Romero, 2014; Varela, Contesse & Silva, 2009)

Generation of innovations in companies greatly depend on the problem wished to face, being administrative or technological, where administrative innovations arise, related to organizational structure, control systems and company coordination and on the other hand, technological innovations centered in idea transformation into new and useful products and processes; being considered both as key factor for any company with the desire to be competitive, where productivity increasing and cost reduction will greatly depend on these innovations (Freeman, 2004; Damanpour, 1998; Daft, 1978).

The speed in which such innovations are generated is highly important because it allows them to remain competitive. The Research and Development department allows to fulfill this goal, due to internal collaboration with other departments, integration of work-teams and flow of knowledge, which facilitates the generation of innovations, allowing companies to specialize in tasks that require an intensive use of knowledge, increasing the innovation by means of the sequential model consideration where the generation of ideas goes through its construction in engineering, then by its implementation and ending at the market diffusion or introduction (Zhang, 2017; Hobday, 2005).

R&D AND GENERATION OF INNOVATIONS WITH A COMPETITIVE APPROACH

Competitiveness can be understood as the result of all those innovations and technological processes generated by various stakeholders, which are developed within a given context, such as companies, institutions or organizations, which through technical and/or organizational transformation activities meet their needs in increasingly competitive markets with more consumers demanding quality products and services (Bianco, 2007; Millán & Marín, 2014:).

Therefore, organizations must be always in search for information and procedures to achieve excellence facing market competition. According to Manucci (2010, p. 95):

> [...] Competitiveness is the result of a game of neecessary positions and movements to maintain the leading role (personal, group or corporate) in the current environment dynamics. It does not have to do with strength, size or material power, but with the interaction capability to be perceived and valued at volatile actors and variable game rules context.

Factors that make up the generation of innovations in organizations reveal their important role within the new techno-economic paradigm in current contexts, since factors such as adaptability and innovative capability are seen as priorities and essential for competitiveness in markets, from local to global (La Rovere & Hanseclever, 2001).

Within this conceptualization, Porter's contributions (1990; 2004) are relevant and pertinent, since they define competitiveness as a generating axis for competitive advantages defined by different factors (supply, demand, company structure, their environment, relations with suppliers and customers, among others). Porter (1985) explains how a company can be competitive, that is, how it can implement competitive strategies that differentiate its products and/or services, so they are perceived as "unique" in different dimensions valued by customers. These differentiation strategies, coming from a creative and innovative instinct, become necessary capabilities through the ability to market and engineer the product.

As previously mentioned, divergences in organizations innovative capability arise from the fact they are different in their ability to innovate, since is not easily generated due to the tacit, cumulative and localized nature of their technical and scientific knowledge, making organizational learning difficult for the design of the fundamental strategy of knowledge acquisition and the construction of advantages that help the company to be competitive in medium and long term (La Rovere & Hanseclever, 2010; Perez & Cortes, 2007).

According to Saldívar, García, Valenciana and Roa (2012), competitiveness in companies has been addressed from two approaches. First, from an external (macro-economic) approach where companies have little influence to solve problems they face, due to a low react capability to competition. La Rovere and Hanseclever (2010) argue that large companies have necessary resources to generate innovation and competitiveness, unlike small companies that depend more on external groups. Second, from an internal approach (business management and the economic sector to which they belong), where there is a close relationship, according to Millán and Marín (2014), between competitiveness and the performed business management, which indicates the importance that this management has over the impact on its employees and on the company's priority issues. This ill set course for a innovation generation in pursuit of competitiveness. Then, is identified the need to develop a knowledge management (R&D) that acquires relevant information to design competitive strategies.

It is relevant for companies to review and analyze these approaches, to understand and assimilate them with the firm purpose of obtaining a response, which will be only discovered as a result of R&D that must be performed to generate innovations that provide competitiveness (Cardona & Gutiérrez, 2010). Therefore, the capability to generate these innovations to face these changing scenarios must be an essential part of companies in order to be competitive.

Associating R&D to that competitiveness described by Porter (1990), it can be observed that the theory referring to these variables conceives the generation of innovation as a valuable company asset, but protecting this asset is complicated if an adequate knowledge management is not implemented. However, it is understood that all these factors that conform the generation of innovation based in knowledge are uncertain, within the business context, whether internal or external,. They must be specifically addressed as an organizational asset that provides certainty, risk adaption with less uncertainty, in order to focus on its ability to innovate and remain competitive. R&D is a strategic capability and ability when developing innovations, as well as a strength for company competitiveness (Tumelero *et al*, 2019).

R&D must therefore occupy a central and decisive role in achieving business competitiveness, so the proper systematic and organized management of the generation of innovation factors becomes obligatory. In this way, these factors turn into intangible assets and must be valued as well with company's tangible assets, since they provide significant competitive advantages.

In this sense, it is pertinent to affirm that competitiveness is related directly to the generation of innovation, for an adequate strategic design as a response to changing environmental scenarios. A company is competitive when it has the capability to recognize and account its environmental, economic

and social realities, incorporating them into its R&D, as part of its innovation generation (Aras & Crowther, 2009).

PROBLEM STATEMENT

Currently, organizations have seen diminished their capability to successfully face their competitors, so they are looking for solutions to generate greater capability to react to existing competition and rivalry. The generation of innovations then become a key aspect for organizations, as well as for companies, since they increase the possibility of remaining competitive with it, along with adaptability generation to face constant changes appearing in their context. The generation of innovations is important for any type of industry, because with them it can be achieve productivity increase, better quality new products development, as well as production processes improvements.

In Ciudad Juarez' manufacturing industry there are several (positive ands negative) interveining factors that generate successful innovations. That makes this activity complex, and many of these companies fail when trying to generate them, triggering bad implementation. This causes a lack of expected results, such as production increasing, product and process quality, competitiveness and profitability.

RESEARCH QUESTION

How does R&D influence the generation of innovations in manufacturing companies in Ciudad Juarez?

OBJECTIVE

To determine the influence degree of R&D on the generation of innovations in manufacturing companies in Ciudad Juarez.

METHODOLOGY

This research is correlational, due to a seek of the relationship between two variables. The information was collected in a single period of time, therefore is cross-sectional, and ex post facto due to the analyzed events that have already occurred.

The manufacturing industry at Ciudad Juarez, Chihuahua, Mexico is this article's research object. The association of Maquiladoras Juarez Index A.C. was consulted to acknowledge the number of existing companies, which are approximately 326, in different industrial sectors.

HYPOTHESIS AND STRUCTURAL MODEL

To clear the resarch hypothesis, where r&d significantly affects the generation of innovations in manufacturing companies in Ciudad Juarez, a structural model was designed, graphically described in Image 1.

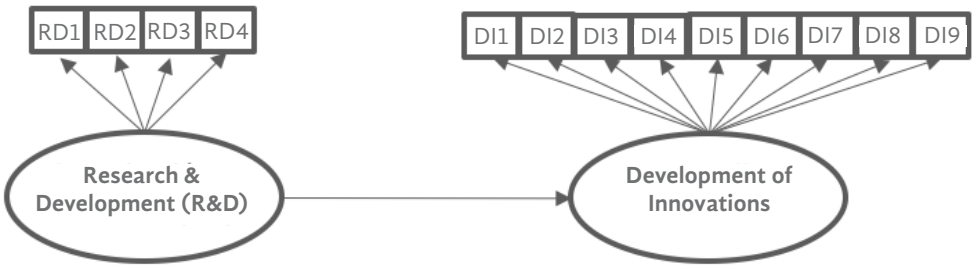


Image 1. Structural model. Source: Own elaboration

Survey design

The measuring instrument is composed by two sections, each having its own construct and observable variables. These variables are measured through a 5-point Likert scale. The r&d construct was evaluated using the criteria of Molina and Manuera (2009) and Song *et al.* (2011), based on investment level, collaboration of ideas, employees and other r&d departments. In respect to the generation of inovation construct, is based on Pla-Barber & Alegre (2007); Chen, Huang, Cheng & Chen (2009), Jimenez & Sanz (2011) and Laforet (2008), which focused on the amount of innovative activities that were successfully implemented, such as product changes and process improvements. Finally, questions are included to collect data regarding company size, business sector the surveyed person's position.

To determine the questionnaire's validation, according to Levy & Varela (2003), a 40 application pilot of the questionnaire was conducted. The Cronbach's Alpha index obtained from this sample was 0.96, which is higher than 0.70, per suggested by Hair, Black, Babin & Rolph (2010) as the minimum validity index.

Application of the questionnaire

The questionnaire was applied in several companies from the manufacturing industry in Ciudad Juárez. The sample surveyed is composed by managers, engineers, supervisors and technicians involved in the processes related to the generation and implementation of innovations. To determine the necessary sample, Hair *et al.* (2010) criteria was used, which suggest a number of 4

surveys applied for each item of the questionnaire. In accordance with the above, 250 surveys were collected.

Data analysis

Collected data was analyzed with the Statistical Program for the Social Sciences, SPSS quantitative analysis software At first instance, those surveys with missing data were eliminated, resulting in a total of 236 valid surveys. Then, to corroborate whether the sample was adequate to perform an Exploratory Factor Analysis (EFA), the Kaiser-Meyer-Olkin test and the Bartlett's Test of Sphericity were performed, as well as the Varimax Rotation method to improve the correlation matrix understanding (Levy & Varela, 2003).

Results

The results are shown below, in the following order: first, a description of the sample, then the questionnaire validation and finally the structural model.

Sample description

250 surveys were applied in different companies in Ciudad Juárez. Of the total of questionnaires applied, not all participants answered completely. Due to this, 14 questionnaires had to be discarded, leaving 236 as valid. Of the people surveyed, 66% hold a position of manager and engineer, the other 34% were operational personnel related to manufacturing processes related to innovation.

On the other hand, information regarding the type of manufacturing industry where each of the respondents works is described, as shown in Table 1.

Table 1
Type of manufacturing business of respondents

Industry Sector	Respondents	Percentage (%)
Automotive	103	43.64%
Electricity	25	10.59%
Electronics	32	13.55%
Packaging	7	2.96%
Health care	30	12.71%
Plastics	8	3.38%
Other	31	13.13%

Source: Own elaboration

Instrument reliability and validation

Cronbach's Alpha index was obtained for each of the constructs in the questionnaire (See Table 2).

Table 2
Different constructs validation

Constructs	*Cronbach's Alpha index*
Research and Development	0.907
Development of Innovations	0.905

Source: Own elaboration

As shown in the table above, all constructs have high reliability, since they exceed the 0.70 minimum value recommended by Lévy & Varela (2003) and Hair *et al* (2010).

Checking the sample's adequacy

Kaiser-Meyer-Olkin sample adequacy tests and Bartlett's Test of Sphericity are used to corroborate the adequacy of the data obtained. Table 3 shows the index of Kaiser-Meyer-Olkin sample adequacy tests is 0.926. This indicates that partial correlations are small and therefore they are measuring the same factor. In Bartlett's Test of Sphericity, the significance of the test tends to 0, which indicates that data come from a multivariate normal distribution and lacks of collinearity between variables. This indicates that there are variables that explain the same thing and therefore they can be grouped together.

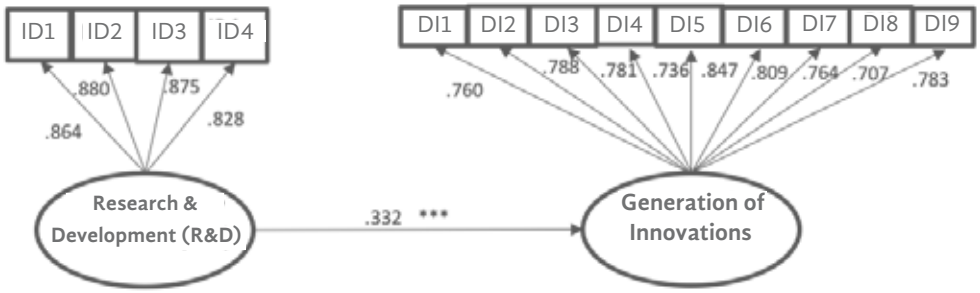
Table 3
Prueba de KMO y de esfericidad de Barlett

Kaiser-Meyer-Olkin's measurement of sample adequacy		**0.926**
Bartlett's Test of Sphericity	Rough Chi-squared	4171.1
	Degrees of freedom	666
	Significance	0

Source: Own elaboration based on fieldwork

Structural model

Image 2 shows the survey's obtained results within the structural model of R&D and innovation development. The innovation development construct is affected in a positive and significant way by research and development.



* Significat al 0.05%
** Significat al 0.01%
*** Significat al 0.001%

Source: Own elaboration

Table 4 shows convergent validity of this structural model.

Table 4
Convergent validity

Construct	Item	AVE	λ	λ (Average)
Process Innovation	ID1	0.743	0.864	0.861
	ID2		0.880	
	ID3		0.875	
	ID4		0.828	
Production Performance	DI1	0.606	0.760	0.775
	DI2		0.788	
	DI3		0.781	
	DI4		0.736	
	DI5		0.847	
	DI6		0.809	
	DI7		0.764	
	DI8		0.707	
	DI9		0.783	

Source: Own elaboration

In Table 5, the structural model´s goodness of fit is shown. In this table, the CMIN is reported for pure formalism, due to its sensitivity to reject any model when the sample size increases. Therefore Hair *et al.* (2010) recommend reporting the CMIN/DF statistic, whose value should be less than 4 to indicate an adequate fit.

Table 5
Goodness of fit

CMIN	DF	CMIN/DF	NFI	RFI	IFI	TLI	CFI	RMSEA
								Confidence Interval of 90%
836.34	**423**	**1.977**	**0.853**	**0.839**	**0.922**	**0.913**	**0.921**	**0.065**
p=.000								(0.058 - 0.071)
Recommended Values		4	1	1	1	1	1	

Source: Own elaboration

Discussion

This study shows that activities carried out in the Research and Development department positively and significantly affect the generation of innovations in manufacturing companies. Organizations have undertaken appropriate r&d activities to convert them into key drivers for development of innovations. Reliability tests of the instrument used to measure activities carried out by the r&d department indicated adequate obtained data. The model fit test shows that the model in deed fits. In respect to the variables of each construct's variables, they were grouped where they loaded best, according to the factorial analysis, having high collinearity. That is, the Research and Development construct variables have high relationship and significance. In addition, the Research and Development construct has high relationship with the development of innovations, significantly affecting them. Therefore, results show that r&d has a positive influence on the development of innovations. Furthermore, results show that strategies focused on Research and Development will have satisfactory results in the development of innovations and, with it, companies will achieve high competitive performance.

CONCLUSIONS

Worrying about survival against their rivals is not the main objective for companies, their goal is to achieve high competitive performance. High performance of organizations depends on the ability to use available resources, such as knowledge, skills and their ability to develop innovations. Several factors intervene in the generation of innovations, which make investment in r&d difficult. In companies, innovations are developed with the purpose of remaining competitive, because they allow to obtain com-

petitive advantages, increase productivity and improve financial performance (Freeman, 2004).

The objective of this study was to analyze the relationship between r&d and the development of innovations. Findings show that research and development (r&d) is a significant factor for companies to develop successful innovations. As shown in the used structural model, it demonstrated the high level of positive significance the construct has for the development of innovations. Per the above mentioned, the structural model helps explain to the industry in a better way the high positive impact that research and development has for the implementation of successful innovations.

Due to the above, companies must use their resources better to generate learning and knowledge that will reflect in the development of innovations, both process and product, that help them to remain competitive. Investment in r&d is a preponderant factor in the development of innovations. This department generates distinctive knowledge and skills that will help generate innovations.

Finally, Research and Development is a fundamental factor in the generation of innovations. This implies high investment, which will return with a high productive level in the company. Therefore, organizations should try to implement a virtuous circle of research and development for the generation of innovations and obtain high performance.

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CHOL YOUTH AND EDUCATION. TWO HISTORICAL MOMENTS

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— Abstract—

In this article I analyze the historical conformation of youth in a Chol rural locality, involving two processes related to education: the emergence of bilingual teachers in the seventies and eighties of the 20th century, and access to university education, a bet for survival taken by a large number of young people in the 21st century. I reconstruct the broad context in which both processes took place to indicate differences between generational relations in each period. I also discuss the experiences and aspirations of current university students, which are based significantly on the achievements of bilingual teachers.

Keywords

Chol youth; education; generations; aspirations.

In the 21st century, higher education has become an alternative for a large sector of young Chols in Rio Grande[1]. I propose that the aspirations of these students today are based, in an important way, on the experiences of previous decades of other young people -bilingual teachers-, considered, in general, successful. In this article I examine the social conformation of this sector in both periods, changes in generational relations, and conditions and expectations of contemporary university students, in the context of the socio-economic and cultural transformations of a rural locality.

YOUNG PEOPLE, YOUTH, GENERATIONS: AN APPROACH

In Mexico, anthropological studies on young people began just a couple of decades ago, although the vast majority of them are emerging in the 21st century. This fact contrasts with the anthropology of earlier times that carried out little research on the subject. Dedicated primarily to the study of indigenous peoples, it is likely that it was judge unwise to speak of youth considering that among these groups children were moving directly into adulthood (Perez Ruiz, 2011). This situation may explain why, even today, several authors fail to recognize the existence of young people in these societies.

It is not my purpose to summarize the debate and the different positions that exist in Mexico regarding the characterization of young people, since there are several works that already do so, for which I refer to Pérez Ruiz (2015 and 2011), Mier & Terán & Rabell (2005), Alpízar & Bernal (2003) and Urteaga Castro Pozo (2011), so I will go on to explain how I will be handling it in this article. I take up again the constructivist perspective of Pierre Bourdieu clearly outlined in his article "La 'jeunesse' n'est qu'un mot" of 1978. In this article, the author describes youth as a social construction that acquires different contents in different cultures and social groups, a fact that imposes to talk about "youths", in plural, rather than a singular one. Because it is a social construction, "the divisions between ages are arbitrary", says Bourdieu (1990: 163), and not natural, marking a distance from demographic studies, for example, which propose life stages defined exclusively from biological age and seek to standardize and reduce the social and cultural phenomenon to a numerical data. The Bourdieuan approach thus establishes the need to know the notions specific to the group being studied, that is, the boundaries with which the different generations are separated locally.

1 Rio Grande is a rural town in the Ejido and Municipality of Tila, located six kilometers from the municipal seat, Tila. In the 2010 population census it registered 880 hbs. (878 from the town and 2 from outside). The natives are speakers of Chol and most also of Spanish, although with different levels of competence (INEGI, 2010).

Bourdieu also states that youths are defined in relational terms, as opposed to other age groups (children, adults, elderly) in the same society, and cannot be treated as a group in themselves. In this way, the constructivist perspective introduces the dimension of power inequalities: "In fact, the frontier between youth and old age in all societies is the object of struggle" (Bourdieu, 1990: 163). In the rural society in question, for example, inheritance of land, arrangements for the organization of agricultural work and enjoyment of its products, as well as the decision on their children's marriage, among others, are elements that are disputed on the generational border between adults and young people. Bourdieu adds that in societies there is a consensus on the practices and behaviour of the various generations. "When the 'sense of limit' is lost, conflicts arise over age limits, the limits between ages, where the transmission of power and privileges between generations is at stake" (Bourdieu, 1990: 173).

Likewise, the French author emphasizes that youths have a historical character because they are not a given reality but respond to specific and changing social conditions for the society in question. In addition, they are not homogeneous; there are differences between different youths -urban and rural, of social class, for example-, but also internally it is possible to recognize differences of gender, economic, degree of schooling, of consumption, among others.

Maya Lorena Pérez Ruiz points out about the characterization of this social group the following:

> So, to "denaturalize" the young, it is necessary to accept that it is not a "universal and homogeneous descriptor" (Reguillo, 2004), nor a data that is exhausted in the biological accumulation of years; neither can it be reduced to a lifestyle associated only to a form of globalized consumption. It is, on the contrary, a social classification that supposes the existence of a complex system of differences, whose articulation grants precise characteristics, contents, limits and sense to the continent of "being young" (Pérez Ruiz, 2011: 72).

Starting from the analytical perspective presented above, in this article I examine the case of the Chol locality, Rio Grande, to trace the configuration of young people groups around two processes: the centrality of agriculture in peasant reproduction, on the one hand, and the new spaces created by the educational institutions (the training of bilingual teachers and the training of university students), on the other.

AN AGRICULTURAL SOCIETY IN TRANSITION

By ethnographic references I have been able to locate that Rio Grande has been settled in the current site since the end of the 19th century. It was a dispersed settlement of *milperías*, which practiced a subsistence economy based on corn and bean crops. Very important aspects of peasant social organization were defined around self-sufficiency agriculture, based on gender, age, and kinship (Imberton, 2016). In the domestic group, decisions about agricultural work and the distribution of its fruits were a male prerogative (even if women and children worked in agriculture). Land ownership fell to men in general and inheritance was arranged mainly from father to son.

In this patriarchal society, it was the duty of the father, the head of the family, occasionally with the participation of his wife, to arrange their children's marriage, even without the consent or knowledge of the future spouses. Transition between generations was marked by marriage (at a very early age), although the transfer of plots was made when the son had already formed his own family, and had a wife and one or two children. This marked the passage from child/young man to adult man: children inherited the land from their father, a situation that allowed them to reproduce economically, as long as they had recognized and abided by the father's authority. The aspirations of most of these new families were to lead a peasant life.

Throughout the 20th century, Rio Grande was immersed in social, economic and political transformations at the regional, national and international levels, as part of the processes of modernization and globalization. In 1934, as a result of the impulse to the Agrarian Reform, the occupied lands were recognized by means of a common endowment. Thus, the Ejido of Tila was created, Tila was settled as the capital, and a new form of relationship between State and Chol peasants was established (Imberton, 2016).

More relevant was the introduction of coffee cultivation in their plots (in the 1940s), as they slowly began to participate in the market economy and to allocate more land to this crop. This caused greater pressure on the common limited lands, and coupled with population growth and agricultural crises at the national and international level, it was necessary for many to seek other forms of survival.

Towards the 1970s and 1980s, migration (temporary or permanent) to nearby towns or cities intensified in Rio Grande; some trades were developed (bricklaying, baking, clothing making, among others), as well as forms of wage-earning work in the locality. Small businesses were also established (groceries and clothing). The State was present through various development institutions, and also through the school, since at the same time as the school was founded, the training of bilingual teachers began. The town had access to electricity in the 1980's and slowly the first household appliances

(TV and refrigerators) were introduced. These changes led to greater socio-economic differentiation at the local level.

These transformations shaped the loss of agriculture centrality, which in the following decades has been reaffirmed, and has necessarily affected the generational situation. If, before young people were tied to the domestic group and to the paternal authority to inherit the plot of land that would allow them to reproduce as farmers, now some young people obtain economic income by working in other towns and cities that allow them to earn, sometimes, more than their farmer father. They also have different aspirations for their future. For many of them, rural life is no longer attractive: they master Spanish, in addition to Chol, which makes it possible to live outside of town; they have achieved upper secondary education in nearby towns and cities, and wish to settle there by engaging in other activities; they establish relationships on their own initiative; they make use of digital technology (cell phones, internet, pay TV, among others) and aspire to new forms of consumption (personal care, music, spending time with friends).

This has blurred the previously accepted generational transit, which had to do with marriage and plot inheritance. Young people now have greater decision-making power in choosing a partner, and if they earn an income on their own, they can "negotiate" different agreements with the father in terms of contributing financial resources to the household in exchange of not participating in agricultural work, dressing differently or listening to different music without being scolded or criticized, among other things. It is in this context that higher level studies have become an option for young people in Rio Grande, and that it is important to discuss how young people's reduced dependence on parental authority (and on agriculture) has affected their aspiration to become university students.

CONTEXT AND HISTORY OF THE EMERGENCE OF SCHOOL

The arrival of the school to Rio Grande in the 1960s was part of important national and international processes related to the implementation of public policies on education that had strong political and economic repercussions. The post-revolutionary governments identified the conditions of severe backwardness of the Mexican rural environment, from the socio-economic to the educational aspects, and a series of measures to overcome it that were applied differently in several regions of the country was proposed[2]. It was

2 Primary education was declared nationally obligatory in 1934, although its implementation was not immediate or equal throughout the country. See the very interesting work of Stephen Lewis for the period from 1910 to 1945 in Chiapas, prior to the emergence of the National Institute of Indigenous Peoples (NIIP).

also recognized that it was the indigenous populations that were living the greatest backwardness in the rural environment, the so-called "indigenous problem", and that it required the decisive and committed intervention of the State to correct it for the well-being of the nation.

In this way, and mainly in relation to other Latin American governments that were experiencing similar situations, in the middle of the 20th century the indigenist policy was developed that derived in 1948 in Mexico in the creation of the National Institute of Indigenous Peoples (NIIP) as an operative instrument[3]. This institute sought to make the Spanish-speaking population in order to guarantee -through a series of actions- their acculturation and insertion in the national economic and social processes. Several anthropologists participated in the design and implementation of this program[4]. Although the objectives and goals were readjusted during its implementation, it was initially proposed to train local promoters with leadership skills to encourage social and cultural change among indigenous groups, i.e., comprehensive community development, with a view to integration into the national mestizo society. While the promoters were being trained, they had to create the necessary spaces for NIIP to operate its programs (agricultural production, poultry, education, health, among others) within rural localities. After receiving further school training, they could become elementary school bilingual teachers, confident that by sharing teachers and students the same language, the teaching-learning process would be more effective.

As we will see below, one of the consequences of this policy -besides the strictly educational ones- was to foster during the 1970's to the 1990's the emergence of a new local leadership (with ideological, economic, and political reach) embodied in the region's cultural promoters and bilingual teachers. During this period, indigenous action was expanded and strengthened in the different indigenous regions of Chiapas.

In this case, it is necessary to acknowledge the educational situation in Tila, the municipal capital, and its relationship with the surrounding indigenous localities, particularly Rio Grande[5]. Throughout the 20th century, several institutions participated in the local educational processes (federal/

3 In 1940 the First Inter-American Indigenous Congress was held in Patzcuaro, Michoacan, which gave rise to the Instituto Indigenista Interamericano (III) in Mexico that same year, and in 1948 to the NIIP as its subsidiary. The III Convention was initially ratified by El Salvador, Honduras, Nicaragua, Ecuador and the United States, with the function of coordinating indigenous policies at the continental level. National Commission for the Development of Indigenous Peoples, http://www.cdi.gob.mx/difusion/19abril/historia_interamericano.pdf, accessed September 7, 2018.

4 Gonzalo Aguirre Beltrán, Julio de la Fuente and Alfonso Caso Andrade (archaeologist), among the most important.

5 Historically, Tila has been inhabited mostly by Chol peasants. At the end of the 19th century and beginning of the 20th century, foreign capital coffee plantations were established in the region, incor-

state; monolingual/bilingual), and the relations between them at very tense and conflictive moments: the State Education System (monolingual); the literacy teachers, known as "community teachers" hired by the Tila Municipal Council (Pérez, 2007); and on behalf of the federal system were the Secretariat of Public Education, the National Institute of Indigenous Peoples (NIIP), and the National Service of Bilingual Promoters and Teachers of the General Directorate of Out-of-School Education for Indigenous Affairs (DGEEMI).

The first school in Tila was founded in 1930, belonging to the monolingual state system (Pérez, 2007: 61) and aimed mainly at local Ladino population. Teaching was in Spanish and at first literacy was its main task. Shortly afterwards, a local literacy program and literacy centers were implemented to serve some nearby Chol towns. According to some inhabitants of Rio Grande, around 1955, before the official school was established in town, "gratified" teachers arrived[6]. These were paid in kind by the peasants, although their activities were very irregular. Students had to contribute daily with fruit, eggs and other food, since without this contribution they could not enter the classroom; they also had to dress according to certain rules[7]. An older man recalled with sadness that as a child he sat outside the classroom, trying to capture as much as possible of the teacher's teaching because he never had the conditions to enter and participate. At this time there were about 25 families living scattered around the territory, which made it difficult for them to go to school as well.

In 1960, the official school was founded in Rio Grande, Federal Rural Justo Sierra Elementary School, with a teacher to attend from first to fourth grade. At the beginning, only eight-year-olds and young people up to the age of twenty participated in a single group -"still from *nagua*"[8]- although attendance

porating many peasants as hired workers, while others continued to live in their milperías. Starting in the 1930s, merchants from San Cristóbal de Las Casas, who eventually came to do business, began to settle permanently in the municipal capital, Tila. They slowly took over land and houses in the capital, and began to dispute the municipal public offices of the Chol peasants.

In the 1970s, the local classification terms were "peasants" and "merchants". Peasants were the original inhabitants of the area and Chol speakers, while the merchants were outsiders, of Spanish speakers. The latter were also referred to as kaxlanes (Spanish speakers) or ladinos (understood as a cultural category that describes non-indigenous people), but the denomination predominated because of their commercial activity. (See Imberton 2002 and 2016). Later the category "indigenous" was introduced to refer to Chol peasants and Chol speakers in general.

In this paper, I will use the category ladino to refer to people who do not speak Chol because it is the most used in the region of study.

6 I have not found any more information about "rewarded" teachers in the literature about the region. Pérez (2007) records the existence in the 1930's of "literacy centers" and "community teachers" in Tila and nearby towns, but not in Rio Grande, and does not speak of "gratified" ones.

7 Children and young people were checked for underwear.

8 It refers to the traditional skirt of local women, the *nagua*, which is currently worn only by a few old women.

was low and sporadic. Many adults now comment that as children they were afraid to leave their homes in the *milperías* to go to the classroom and were also afraid of the teachers.

There is very eloquent mention of Teacher Augusto Vázquez Pérez, who organized and promoted the construction of the school. He began the work in 1963 and concluded it in 1968, for which he counted on the population's economic contributions of the. He managed the support in a very skilful and ingenious way, according to a peasant. He summoned about 10 heads of family to present the school project, but they all concluded that it was impossible to do so because they did not have the economic resources. However, he insisted that it was feasible. This group worked on the construction of the airstrip on Rio Grande land and received "juicy" salaries for their activity[9]. Vázquez Pérez then proposed that instead of benefiting only some, all heads of households would "pull together" in airport jobs and donate part of that income to the school. And so it was done, in addition people contributed work: they brought stone, they made lime with small rocks (burned and crushed), they looked for trunks for the beams, among other activities. Teacher Augusto hired a bricklayer and brought materials from Tuxtla Gutiérrez by plane. The work took about five years[10]. It must have been a long time before the peasants gave importance to their children's schooling, which later became mandatory.

But in the seventies and eighties, disputes arose in Tila between the two official education systems: the state and the federal. The competing groups, both from the monolingual Spanish-language education system, were made up of Ladinos who disputed the "appropriation" of new schools that were emerging, of teacher positions and of land donated by the people for this purpose, among others. There were even violent confrontations between them.[11]

Thus, around 1972, the conditions for the emergence of bilingual education (Chol/Spanish) in this region began. The National Institute of Indigenous Peoples and the la General Directorate of Out-of-School Education for Indigenous Affairs of the Secretariat of Public Education, through the Indigenous Development and Improvement Brigade, initially developed activities for the training of "Bilingual Cultural Promoters" in Chol and Spanish.

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9 Access by land to this region was extremely difficult, so coffee farm owners used small planes and rustic airstrips to bring out the production.

10 Currently this classroom is still standing, although the school facilities have grown a lot in number of classrooms, in addition there is a roofed sports field, an orchard, among others.

11 These conflicts are part of a period of heated political mobilization in the state of Chiapas between the two teachers' unions: the ruling National Education Workers' Union (SNTE) and the opposition National Education Workers' Coordination (CNTE).

In addition to the disputes between teachers (shopkeepers or children of Ladino shopkeepers) in the state and federal systems, bilingual teachers were also involved, who used their Chol speaking status to express what they considered to be their legitimate aspirations.

Bilingual teachers

In the 1970s, young Chol people from the region, as well as young speakers of different indigenous languages from other regions of the country, were invited by official institutions such as the General Directorate of Out-of-School Education for Indigenous Affairs of the Secretariat of Public Education and the National Institute of Indigenous Peoples to train as "Bilingual Cultural Promoters" -in this case, in Chol and Spanish- with the only requirement of having basic knowledge of reading and writing[12]. Very few had completed elementary education, others had only second grade. According to Pérez (2007), they received a brief training of several weeks to work as development promoters in the localities, dealing with productive issues (gardens and vegetables, animal husbandry), and health issues. They were also asked to conduct population censuses in the assigned communities.

A central aspect of the training sought to "raise awareness" of the promoter, so that he would acquire a deep commitment to the work he had to do, living together in communities, performing diverse functions, beyond classroom teaching, but with the purpose of improving local living conditions. They used the puppet theatre to transmit their social messages (Pérez, 2007).

Young promoters selected began their work with 6-month contracts. A decade later, those who continued their training in normal schools or equivalent won places as bilingual teachers, depending on the training levels achieved (Pérez, 2007)[13]. During this period, 21 bilingual teachers were trained in Rio Grande, 20 men and one woman.

But recently trained Chol promoters, who belong to the federal system of the General Directorate of Out-of-School Education for Indigenous Affairs, managed in several locations to get the support of the peasants to promote the creation of the Chol-Spanish bilingual system. At first, peasants of Rio Grande disapproved the proposal because they wanted their Chol speaking children to learn Spanish and for the school to prepare them to function in

12 The DGEEMI was established in Tila in 1972, the regional director of education was the anthropologist Manuel Coello Hernández (Pérez, 2007: 62). NIIP only stayed in Tila for six months, so its impact was less, and then it moved to Salto de Agua (Agudo, 2005).

13 At that time, young teachers were guaranteed a place when they graduated.

the urban Ladino environment, but they finally accepted[14]. They requested that bilingual system teachers were Chol promoters, which brought the contest to another point. There was confrontation between the monolingual and bilingual systems, and then conflicts were presented between Ladinos and indigenous people, respectively.

Many peasants in Rio Grande began to see teaching in the bilingual system as a space in which their children and grandchildren -increasingly less able to devote themselves to agriculture because of land scarcity- could obtain stable, well-paid employment with various benefits, and without having to leave the region, as was the case with migrants. Ladino teachers in the monolingual system (state and federal), on the other hand, saw those in the bilingual system as unfair competition, which would limit the number of schools they could run, places and resources in general.

In several places in the region, Chol peasants began to question the monolingual Ladino teachers. They argued that they missed classes a lot and did not cover the whole week but only 3 or 4 days. In addition, they said that they did not know Chol language and could not explain it well to students, which was reflected in low performance; they also claimed they had poor relations with the parents and the community in general. In several villages, monolingual teachers were expelled and replaced by bilingual teachers. In the period 1976-1988 there were about 60 bilingual teachers in the Tila region, but by the 1990s the number had risen to over 200 (Pérez, 2007: 66). In Rio Grande's case, the monolingual school was changed to the bilingual system and took the name of "Sor Juana Inés de la Cruz" Bilingual Elementary School. In 1992, the donation of physical space where the school is located was legalized.

Bilingual cultural promoters -who have already become bilingual teachers- occupied a privileged position in Rio Grande compared to most peasants. Economically, they had a regular, much higher, fortnightly income than the other inhabitants. Over time, several of them began to invest in different businesses, such as commerce (small grocery stores, clothing, carpentry) and transportation, mainly in open competition with ladino merchants of the capital. In addition, their income allowed them to maintain a higher level of consumption, which stands out among other farmers (cement houses, cars, household appliances, fashionable clothes, children enrolled in university, among others).

14 Agudo (2005) describes that in the case of El Limar, in the lowlands of Tila, at first peasants supported the creation of the bilingual system, but later opposed it, arguing that it was for small and backward communities. There, the opinion was widespread that the bilingual system was inferior to monolingual systems, as it promoted "extracurricular" education. After several years they accepted the creation of the school, which is now the largest in terms of students.

But they also stood out in other ways. Thanks to their command of Spanish, their knowledge of the official bureaucracy and their experience in urban Ladino environment, bilingual teachers began to participate actively in the conduct of local affairs and acted as intermediaries between official institutions and peasants. They also came into contact with political organizations, unions and religious associations, among others, and developed strong leaderships among local population[15].

Little by little, bilingual teachers acquired a position of exceptional relevance and prestige in the peasant world, and even more so, considering that they were very young men and women. People who previously had authority and recognition -"principals", butlers, and healers- were adults and elders. For the first time, young people carried out an activity that allowed them to climb the social ladder at a dizzying rate and occupy a privileged space.

However, I believe that this fact did not have such an important impact on generational relations. Agriculture was then the main activity for most domestic groups, teachers (men) received land from their fathers[16] and marriages were established in the traditional way. Although they acquired prestige and an unusual relevant position, which allows us to talk about social and economic mobility, this did not translate at that time into notorious generational differences that questioned agreements and practices in force in peasant reproduction.

University students

As a result of these processes, people of Rio Grande began to value the importance of education for the future of their children. However, training programs for bilingual teachers, with a guaranteed place at the end of their studies, came to an end in the 1990's. After this time, only about four young people who studied in different teacher training schools have been able to become bilingual teachers. Although that option was closed, many decided to continue their studies in middle school and high school, and others in university.

Beginning in the 1990's, the Mexican State promoted secondary and middle education at national level, in line with various international orga-

15 In my opinion, the case of Río Grande differs from that of Tila (Pérez, 2007, Agudo, 2005) and from that described by Pineda (1994) of Los Altos de Chiapas. Although local teachers accumulated material goods and prestige, the vast majority continued to collaborate in an organized manner in community affairs, actively seeking to protect some of the common interests (for example, in relation to the privatization of the common, which they radically opposed). No 'cultural caciques' emerged, as Pineda describes for Los Altos, nor did they benefit abusively from business and contacts as in Tila (Pérez, 2007).

16 Teachers who lived outside town had to hire local day laborers, often relatives, to work their plots, so as not to lose their common rights.

nizations (United Nations, among others), as a measure to combat poverty and inequality. During this period, number of schools in rural areas grew and the massification of these services began[17]. It is important to emphasize that in these schools there is no education focused on indigenous people, as there was before with the NIIP and the DGEEMI; education is in Spanish, and the contents are standardized nationally and internationally.

In Tila, several schools were opened: the Telesecundaria School 555 in Cantioc (2 km away) was opened by the Secretariat of Public Education, and in 1991 the Colegio de Bachilleres #14 in Tila (6 km away) was opened by the Chiapas' State Government[18]. Education at both levels (middle school and high school) is in Spanish, and does not incorporate ethnic particularities. These two schools have been attended by the majority of students in Rio Grande and the levels of schooling of young people have increased notoriously. Many have been supported by government programs (*Oportunidades, Progresa* and now *Prospera*) aimed at the most impoverished sectors[19].

In regard to university education, it was in 2003 that the first public intercultural universities were founded at the national level, sponsored by the General Coordination of Intercultural and Bilingual Education of the Secretariat of Public Education and the state governments, aiming for bringing higher education closer to historically excluded populations, including indigenous or native peoples.[20] The first in Tila was founded in 2009. But, as I point out later, young people have attended public and private universities in the region, in other states and abroad.

Towards the end of the 20th century, social and labor options for young people were the following: continue working in agriculture, in those cases where the domestic group had common lands; emigrate temporarily or definitively to look for wage-earning work in services or agriculture; start some business in the village (transport, grocery store, clothing store, sale

17 If elementary school was declared obligatory in 1934, 59 years later, in 1993, middle school was made obligatory; then came the pre-school level in 2002 and the upper middle school (high school) in 2012. https://www.inee.edu.mx/portalweb/informe2018/04_informe/capitulo_00.html, accessed October 8, 2012.

18 The *Colegio de Bachilleres* is a decentralized public organization with presence in all states of the Mexican Republic

19 There has been no specific analytical follow-up of the resource's impact on the training of young university students in Rio Grande, although it is possible to state that most of the teachers' children did not have this full support, as a result of a local decision that sought to favor only the neediest. They generally received support for transportation only.

20 According to Dietz (2014), the 1994 Zapatista uprising in Chiapas provoked national debates about a new relationship between the State and the original populations, which proposed to transcend the NIIP's indigenous policies (both the integrationist principle, and the bilingual and bicultural one that also sought *Spanishization*) and to respond to the demands of indigenous organizations by emphasizing inter-culturality and diversity.

of nails and construction material); and undertake university studies, with the expectation of concluding a major that would allow them to find better-paid work, among the most important ones. Most have had to combine two or more of these activities and agriculture is no longer the only and main economic activity.

Young people who have opted for university training, interviews with them and their families have allowed me to access specific data, and at the same time to know how they made the decision to enter university and chose their career and educational establishment, what was the process of entry, the difficulties they faced, and their expectations regarding obtaining a university degree[21]. While I was doing this research, more than half of them were doing their studies, that is why it is not possible to comment on what percentage of graduates have obtained work in their field or in another, or if they are unemployed, underemployed, among others.

I registered 51 students (36 men and 15 women); most of them are pursuing a career and a few have already graduated. Although they generally study in Chiapas and Tabasco universities (public and private), there have also been local young people in Michoacán, Sinaloa and Cuba[22].

According to young people interviewed, university and majors are not so much chosen for affinity or thematic interest. They generally look for the closest and least expensive options, or those where they know someone in the study center or city. A few have attended the Bachelor's Fair in Ocosingo to learn about the regional programs. In the end the decision depends on having passed the entrance exam; many try two or three times before passing. Among women, the following careers are presented: language and culture, education, nursing, social work, history, psychology, administration. For men, the following are included more than women: education, civil engineering, computer engineering, nursing, architecture, social work, physical rehabilitation, clinical bio-analysis, administration, biochemical engineering, medicine, electrical engineering, and law.

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21 The information presented includes up to 2016, when the investigation ended. I would like to thank the university student Sofía Martínez Vázquez for her important support in obtaining data on the group in question, as well as for having facilitated several interviews.

22 The following universities have registered:

PUBLIC: Universidad Intercultural de Chiapas, Yajalón, Chiapas; Universidad Autónoma de Chiapas, Facultad de Ciencias Sociales, SCLC; Escuela Normal Indígena Intercultural Bilingüe "Jacinto Canek", Zinacantán, Chiapas.

Instituto Tecnológico de Villahermosa, Tabasco; Universidad Juárez Autónoma de Tabasco; Instituto Superior de los Ríos, Tabasco.

Universidad Autónoma Intercultural de México, Sinaloa; Universidad Michoacana de San Nicolás de Hidalgo, Michoacán; Universidad de Ciencias Médicas de La Habana, Cuba.

PRIVATE: Sistema Educativo Universitario Azteca –SEUAT, Yajalón; Universidad de Bachajón, Chiapas; Colegio Universitario Versalles, Yajalón, Chiapas; Universidad Tecnológica de la Selva, Ocosingo; Universidad Pablo Guardado Chávez, Tuxtla Gutiérrez; Universidad del Valle de Grijalva, Tuxtla Gutiérrez.

As for their expectations, when I asked what their reasons were for entering college, many of them said that they wanted to be teachers first and foremost: "Since I was a child, I always had a vision of being someone in life, a teacher". Others stated: "I like to teach and help others"; "I wanted to be a teacher"; "education is very important for life"; "I see my dad (bilingual teacher) as an example"; "my dream was to be a teacher", "studying was my goal and objective since elementary school". With a few exceptions, the vast majority have had this aspiration and hold bilingual teachers in high esteem.

Their narratives also include assessments of their university education. One young woman said that it was during high school that she decided to study psychology, out of a desire to "prepare, to get ahead". One young man mentioned that he planned to study at university "because of economic necessity", but also "because he had more knowledge". Another emphasized "going out to look for opportunities, in cities there are more job opportunities". Another commented that since he was a child he knew he would study medicine, and dreamed that "after finishing high school he would take a plane straight to university", with modern medical equipment and staying in some important city working on relevant projects. In general, young people think about their individual future -to prosper, advance, improve, and learn- more than about making contributions within the locality.

Some mentioned as reasons to study the taste for "knowing other places", learning to move around in big towns and cities, "not being afraid to travel", although in several of the interviews these same situations are presented as obstacles during their stay abroad.

A few attributed their decision to significant people close to them. For example, one indicated that he studied because "my mom didn't want me to be a farmer. I'm going to send you to university," he said, as he is the only son among four sisters. Another boy said, "I wasn't planning to study, but my little brother encourage me". And another boy did it because his brother died: "I had the obligation to study, because he had the dream to continue studying".

Among the main obstacles to the formation of young university students, I place those of a financial nature. Although most of them have studied in public institutions (which generally require some payment), all of them are located outside town, which involves various expenses in transportation, housing, and food, among the most important ones. A relevant criterion for university selection has to do with the distance that separates it from home. It should be noted that those who study at private institutions are mainly the teachers' children, who are more likely to pay for these expenses[23].

23 37% of all registered university students are children of bilingual teachers.

But everyone is looking for scholarships that to a greater or lesser extent, will lighten the economic burden. Several of the students have entered programs of the National Council for the Promotion of Education (CONAFE), in which for each year as a preschool or elementary school teacher they receive two or three years of scholarship for further studies[24]. Others have obtained scholarships from the National Higher Education Scholarship Program (PRONABES) or from their centers of study. Many have worked temporarily during their studies to pay for their stay and expenses, including those on scholarships, as the amounts received are insufficient for them. It should be noted that, as a whole, not all of them face similar situations in terms of the resources available to them, since, for example, one young woman commented that she ate nothing but bread for weeks, while another young man who studied in a big city said he felt uncomfortable because his classmates had "cell phones, laptops, good school supplies and clothes", and he did not. There are several cases of students dropping out of school soon after they start due to lack of resources.

Another recurring difficulty is that young people do not pass universities' entrance exams. Schooling received at elementary, middle and high school levels does not guarantee that they will have a sufficient level; some do not even reach the required averages to begin the process. As a result, many young people do not enter the university they have selected, but rather the one where they have been approved, and study a different major from the one they had originally chosen. One wanted to take the entrance exam in Mexico City but, he said, "I was afraid to go to faraway places".

For the same reason, there are young people who fail some subjects and desist from continuing, arguing several elements: they do not like the majors; teachers are absent a lot and/or do not explain well; the second-chance exams are expensive; they say there is corruption, because teachers "sell" the grades and only approve those who can pay.

Although young people interviewed had family support, as we will see later, it is not always easy to convince parents of the convenience of going out to study. This is particularly true for women, who parents think they will "marry far away" and not return to the village or "get pregnant" without

24 Working at CONAFE is a frequent alternative among university students in Rio Grande and the region. This official institution brings together young people (16-29 years old) who have graduated from middle school, high school or higher education to train as leaders for community education. Their task is to teach preschool and primary school in rural areas, and in return the institution provides them with monthly financial support and training for their work. The attraction of this program for young people is that, at the end of their contract, CONAFE maintains this support for a period of 30 to 60 months so that they can study, as long as it is in schools recognized by the SEP. https://www.gob.mx/conafe/articulos/quieres-participar-como-lider-para-la-educacion-comunitaria?idiom=es, accessed on September 17, 2018.

them even knowing about the relationships they will have while they are studying. They also suffer from the fact that they will stop helping with domestic work. In the case of men, it is claimed that they will not help in field work or that far from family supervision they will "get into bad habits". Some mothers claim that they will be left alone.

The vast majority also find it difficult to live away from their locality and to get used to their new place of residence. They miss family and friends and do not always have contacts to help them when they arrive. One young woman said, "I forgot to study. I didn't want to be away from my family". Some talk about the fear of living in big cities, like Tuxtla Gutiérrez: "I was nervous. I didn't go out, I was locked in the room. I didn't know the transportation routes, I couldn't do teamwork because I didn't have a cell phone..." Others refer to the conditions of insecurity in Sinaloa, for example, where narcs, shootings and crime are always present. Or they point to climate conditions: the suffocating heat, and lack of recreational activities in towns like Balancán or Cunduacán, where "there is nothing to do".

All young people interviewed insisted and stressed that family support was essential for studying at university, because without it, it would simply not have been possible. Support is provided in different ways. In money, which is the most required, and which requires the domestic group to carry out specific activities to obtain it: for example, sending one or more of its members to work temporarily (as a wage-earner in agriculture, as a domestic employee); opening a small business that allows them to generate some cash (selling home-baked bread, sweets); selling part of the agricultural production to cover expenses and emergencies, among others. Children are also supported with food (tortillas, tamales, corn) and clothing, some family members visit the students' place of residence so that they do not feel alone and to provide care when they are sick. Family members are also involved in local bureaucratic procedures for admission or scholarships, among others.

Elisa's case[25] is useful to comment on the trajectories that students present in their university careers, highlighting elements that have to do with structural conditions and others that are random.

> Elisa was 33 years old when she was interviewed, her father and mother are farmers, and she has 4 siblings (3 brothers and 1 sister). She is single. She and her sister both attended university, but her brothers did not. She finished her high school education at Cobach #14 in Tila, where she had the *Progresa*

25 Fake name

> scholarship for the last few years; her parents later supported her. During this time she wanted to study psychology, "but couldn't" for financial reasons, so she spent a year at the family's house, helping out with housework. Then she entered the National Council for the Promotion of Education (Conafe), where she worked for two years with the purpose of obtaining a scholarship to cover her education for six years. With this support (1,500 pesos per month approximately), she studied computer science for two years in Yajalón. It was at this time that the Intercultural University was opened there and she decided to study Language and Culture. To support herself financially during her studies, she worked every summer in a clothing store first, and then in a shoe store in Villahermosa, Tabasco. From there she obtained resources for her computer, materials and to pay for her graduation. She finished her four-year degree, and a month after finishing her studies she competed for a position as a primary school teacher and won. She started as a teacher and now she is the principal of a school near Tabasco. Although her dream was not to be a teacher, she is very happy and satisfied with the job and position she currently holds.

In Elisa's case, it is striking that in a peasant family it was precisely the two female daughters who undertook university studies, with the consent and support of the family, and not the boys, which is more common. Bilingual teachers' daughters tend to go to university more than those of peasants. It was precisely this condition that allowed them to benefit from the *Progresa* scholarship when they studied for their bachelor's degree, since by decision of the local Assembly teachers' children were excluded, considering they have more economic resources to cover the expenses.

The path that Elisa followed trying to "find" her career is the most frequent: giving up the subject of interest because it is not viable due to costs; staying at home for a while after finishing high school to evaluate the possibilities of paying for university and to see options. It is not so common, however, to try one major before defining another, as this involves very high costs.

The fact that Elisa has obtained a full-time position as a teacher as soon as she finished her studies is exceptional. The vast majority has returned to home (domestic work, for women, or agriculture in the case of men), and eventually is employed in temporary jobs (as interviewers at the National Institute of Statistics and Geography (INEGI), the National Electoral Institute (INE), covering teacher internships, in construction, waiting for a stable job opportunity to present itself.

The situation of university students in the 21st century is more diverse than that of bilingual promoters and teachers decades ago. Since agriculture has lost its centrality, peasant reproduction is no longer the condition of all domestic groups. Although agricultural work provides products and income to many families, other productive activities complement it or have already

displaced and replaced it in importance. This fact has allowed young people -with higher levels of education, command of Spanish and experience of knowledge of the urban environment- to harbor different expectations from those of the previous generation, and to move outside of town in searching for work and different life options. Among them are, without a doubt, university students. However, the possibility of studying in university seems to be conditioned to having the support of the domestic group, a fact that makes the individual's decision subordinate to the father's approval (or father and mother, in some cases).

FINAL THOUGHTS

In this section I propose to close with a comparison of the two moments where young people were involved in educational processes, and of the corresponding generational relations. First, it is important to highlight the difference in terms of gender in both periods. At the beginning, there was only one woman among bilingual teachers (21 in total), while now they make up almost a third (15 of 51) of the whole. This indicates that female school attendance is more acceptable, even if it means moving temporarily from the locality, and that the teacher's job is well accepted. I think it is also related to the delay in marriage ages, which is now more common among women from 15 to 16 years old.

Another relevant aspect has to do with the symbolic value of the position or grade acquired. Among cultural promoters/bilingual teachers, the dedication and commitment they acquired before the "community" stands out. Training received, in accordance with INI and DGEEMI education policies, based on their indigenous status, was aimed not so much at training them for their own personal benefit, but rather at enabling them to manage social change and development in their locality. This allowed them to enjoy great approval and prestige in their communities, and fostered the emergence of leaderships as they went on to occupy important positions and had great weight in local decisions. Farmers and teachers now remember the "mystique" that surrounded their performance, and how they assumed responsibilities convinced that their work was a relevant contribution to community welfare.

Now, however, in order to enter university, they must have completed at least 12 years of study (elementary, middle and high school), with sufficient grades to apply to study centers and pass entrance exams. Some of them point out that their situation is harder than that of bilingual teachers, since they have to spend many more years studying, and even then they will not immediately get a teaching position, nor is it certain that they will find employment. The most difficult test is that they have to look for work

on their own. They use Internet, for which they must go to the head office since there is no service in town; they go personally to institutions with a presence in head offices (Inegi, among others); they ask friends or relatives who live in nearby towns to look for calls, etc. Several graduates are unemployed or with temporary jobs, and when a place is available, they all go to compete among themselves. Many combine their studies with agricultural work, even when they have already graduated. Or they are employed in activities that do not require the training they have: business dependents, porters, agricultural work, among others.

Another element that should be highlighted is that bilingual teachers have gained a lot of prestige at the local and regional level through their profession/work. As for university students, it is too early to give an opinion because many have not yet finished their studies. But there are comments and contrasting judgments that show how these young people are in the spotlight. Some parents stress the importance of university education to achieve social mobility; others dismiss it mockingly by pointing to cases of unemployed graduates who work in agriculture but made their parents spend too much to finance their studies. Students defend their decision by saying that they "will not stay at home waiting" for someone to offer them work, but will go as far as necessary, but they also recognize that it will not be as easy as they thought.

In terms of generational relations, I want to highlight the differences in both periods. In the first period, agriculture was still the activity that governed local peasant life, and land ownership and control of family work demarcated relations between young people and adults. Fathers decided when their children should marry and when to give them the corresponding plots of land. Marriage unions were between children aged 11-14 years, and from that moment on they were considered adults with the consequent responsibilities. These understandings were not altered during the period of the bilingual teachers.

By the second moment, the situation had changed. Agriculture has lost importance to other economic activities, and children do not depend entirely on land inheritance for their survival. They develop activities that generate income for them (salaried work in agriculture, services, among others) and some related to the greater schooling they have received. Marriages are often preceded by courtships at will; sometimes unions are "runaways", which allows them to choose their partner and, later, plan their reproduction and spacing of children. Marital unions are between 16 years old teenagers.

Local perception of today youth's greater independence reinforces the observations and investigations that I was able to make in Rio Grande and that allow me to affirm that this group has greater decision-making power

over their lives than previous generations, although in the case of university students the situation is different and more complex because they require family support to pursue their studies. Even though they receive some official support or scholarships from educational institutions, the domestic group is fundamental to achieve this training.

It is not yet possible to know what the future holds for young university students in Rio Grande, whether there will be jobs in their professional field or in other activities different from the degree they have, nor whether they will have access to the social, economic and prestige mobility that bilingual teachers previously enjoyed and that motivated them to train as professionals. But the circumstances described in this article suggest that their road will be more arduous and complicated than it was for teachers in the previous century.

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PROPOSAL FOR ALTERNATIVE HOUSING WITH THREE-CELL MORTAR HOLLOW BLOCK WALLS, FOR LOW-INCOME FAMILIES. CASE STUDY: COPAINALA, CHIAPAS, MEXICO

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— Abstract—

Construction system with masonry of hollow mortar blocks for walls housing, has been extensively studied and used in Mexico, Latin America and in other countries; however, families of low income living on the outskirts of cities, built makeshift homes, with high levels of insecurity and poor health. This paper discusses low-income families' homes characteristics and conditions, in three outlying colonies to Copainala, Chiapas, Mexico, resorting to self-construction of homes with masonry of hollow block mortar, with two cells, constructed with insufficient structural confinement, which warns problems of insecurity, vulnerability to earthquakes and possible risks in inhabitants' safety. In addition, results of compression tests performed on masonry blocks prepared on-site by inhabitants were compared. Results of parts with three cells proposed by this research team, made with the same quantity of materials, but with an enhanced compaction process and curing concrete, show that the average compressive strength increased 14.73%; also, included two alternative housing with integral masonry, i.e. structurally confined from placing reinforcing steel and concrete inside of cells, in both directions and the length and high of walls, in order to increase homes earthquake-resistant capacity and to avoid potential risks in inhabitants' safety.

Keywords

Housing; masonry; bloques-huecos-concrete; safety; self.

Housing has been constituted as the basic cell of human settlements and is one of the most precious goods for human beings. Today, housing is considered a universal right, which provides physical space indispensable for people, individually or in groups, to establish and develop specific activities related to rest, food, satisfaction of physiological needs, life in common and interrelation with immediate environment, which includes social ties with others. However, in Mexico, as in Latin America countries and the Caribbean, due to population growth and lack of economic resources, numerous families can be observed on the outskirts of cities and in small towns, living in spontaneously built houses with precarious conditions and high levels of insecurity and unhealthiness; that is, they have dirt floors, use poor quality materials and even waste, have inadequate, insufficient and poorly ventilated spaces, and do not have access to basic water and sanitation services. The above are important risk factors that negatively influence people's health, which limits their economic and social development, to quality of life detriment.

In this context, low-income families are the most affected, and due to this economic condition, they resort to self-construction of houses, where owners occupy and direct the work or, in the best case scenario, employs bricklayers. In both situations, houses are built without basic requirements established in technical regulations, to make buildings functional, structurally safe, durable and healthy.

On the other hand, confined masonry structures with reinforced concrete construction technique, is a system widely studied and used for housing construction in the world and particularly in Latin American countries. This system, repeatedly applied in less economically affluent sectors, constitutes an important alternative to solve housing problems and also provides a means to facilitate self-management (Acosta, *et al*. 2005). In this regard, masonry structures construction for housing in the state of Chiapas, is very traditional and widely requested by inhabitants, as corroborated by INEGI records (2017), which indicate 73.13% of all housing walls, are built with partition, brick, block and stone.

The present work deals with technical construction application for housing, understood as the systematic way of building according to social context in a given place, which relates inhabitants, elements, tools and materials used in the production of housing (Hernández, 2006). The research focuses on self-construction of housing in the city of Copainala, Chiapas, in three colonies located on the periphery: Vicente Fox, El Triunfo, Siglo XXI, especially those inhabited by low-income families, who have no possibility of hiring professionals or technicians, and do not have means to help and guide people to build their homes; therefore they resort to improvised self-construction, apply inappropriate uses and customs, and

produce informal buildings. In the case study, most houses are built with conventional system of masonry walls with two-cell hollow mortar blocks[1], preferred by inhabitants because it includes safe, durable and economical materials. In addition, because it is a well-known and widespread technique in the region, cracks were identified in walls intersection and in doors and windows openings during the work carried out on site; it was also observed that they do not have sufficient structural confinement, as established in technical standards for construction (NTC, 2017). In respect to the hollow block pieces, commonly used in houses' walls, compression tests carried out in the Materials Laboratory of the Faculty of Architecture show that they do not comply with the NMX-C-404-ONNCCE-2012 standard, which warns of structural insecurity problems, vulnerability to seismic action movements and possible risks to their occupants' safety.

As part of the research, and with the purpose of seeking solutions to the aforementioned problem, this research presents two housing models with a construction system based on masonry walls with hollow mortar blocks; likewise, the proposed model can consider the possibility of expanding, over time, and thus meet the future family's spatial needs, in accordance with its economic availability (Bazant, 2003; -progressive housing-).

Walls construction of housing models was carried out based on the proposal of Escamirosa, *et al.* (2016), which consists on using pieces of three-cell hollow mortar blocks, to facilitate the placement of cells' interior reinforcement in both directions, established in the standards (NTC, 2017), and to avoid the use of falsework in transverse construction, enclosure and intermediate chains, as well as in intermediate castles and walls intersection, which will allow for greater savings in materials and required structural safety. In addition, laboratory tests were carried out to determine average compressive strength of the proposed three cell pieces, made with the same materials proportion: cement-sand and water, used *in situ* by inhabitants, but with better concrete compaction and curing. Results obtained show that the average compressive strength of the proposed pieces increased by 14.73%.

Progressive housing models that are presented, are oriented so that low-income families in the neighborhoods of Copainala, Vicente Fox, El Triunfo, Siglo XXI, have the possibility of accessing a decent home: safe, economical and healthy. Models consider necessary elements and constructive processes, with the purpose that they serve as a guide in self-construction of houses, in benefit of families and with it, contributing to improve the inhabitants' quality of life.

1 Empty spaces left inside blocks, in order to lighten them and sometimes improve structural conditions.

2. BACKGROUND

For many years, Zoque ethnic groups have settled in the Copainala territory; for this reason, their customs and traditions predominate in the region to this day, and the original language is still spoken. The name of the place comes from the Nahuatl, *Koa-painal-lan* which means "Place of the snakes that ran" and the population was recognized in the sixteenth century as an important site for the purposes of Spanish conquerors. Natives' evangelization was carried out by Dominican friars, who built the main religious buildings in the area (INEGI, 2010).

The city of Copainala is the head of the municipality of the same name and is located in the north of Chiapas. It borders the municipalities of Coapilla to the east, Ocotepec to the northeast, Francisco León to the north, Tecpatan to the west, San Fernando to the south, Chicoasen to the southeast, and Berriozabal to the southwest. It is located in a small hollow on the banks of the Zacalapa River, with considerable slopes due to the presence of important numerous hills that surround it: Coapilla, Huimango, Tres Picos, El Soltero and Piedra Parada. The surface is 131 hectares, delimited by coordinates 17°05' and 17°06' North latitude and 93°12'15" and 93°12'55" East longitude. Average altitude is 440 meters above sea level (INEGI, 2010). Due to Copainala's population center rugged topography, different problems are present: Excessively fragile slopes that imply high construction costs to stabilize soil and avoid erosion or landslides in rainy season. Also, as a result of the place orography, introduction of basic services networks represents high investment costs.

In Copainala, according to information from INEGI (2017), there is a population of 21,800 inhabitants and 5,682 homes, of which 10.07% have an dirt floor; walls, 0.05% are made of cardboard or waste material, 3.66% are built of bajareque, asbestos or metal sheets, reeds, bamboo or palm trees, 28.67% are made of wood or adobe and 67.49% of partition walls, brick, stone or concrete. House roofs are made 64.63% of metal sheets, asbestos, fibrocement or organic material such as palm, straw or wood, 15.10% of clay tiles and 19.39% of concrete slabs. In regard to services, 97.17% of homes have electricity, 95.04% have piped water, and 97.17% have drainage. Specifically, Copainala has 6,550 inhabitants, of whom 13% are indigenous and 5.10% speak an indigenous language; there are 2,215 homes and of these, 97.86% have electricity, 98.78% have piped water and 97.40% have a toilet.

3. NATURAL ENVIRONMENT CHARACTERISTICS

Chiapas is located in a region of high seismic activity, due to frontal interaction of three tectonic plates: Cocos Plate, North American and Caribbean, so this

fact is very unfavorable for buildings and infrastructure works. According to the Mexican Republic seismic regionalization (CFE, 2008), Copainalá is located in zone C, below zone D, where frequent earthquakes with high magnitude have historically been recorded, whose ground accelerations can exceed 70% of the acceleration of gravity. Zone C is considered an intermediate zone that registers earthquakes not so frequently, with accelerations lower than 70%.

On the other hand, earth's crust is formed by sedimentary rocks and limestone in 68.15%, very suitable for masonry foundation constructions; however, there is shale in 25.90%, very unstable soil with humidity and low resistance, especially in rainy season. Regarding climate in Copainala the following are registered: Warm sub-humid with rain in summer, 51.02%; warm humid with summer rainfall, 43.24%; warm humid with rainfall all year, 4.21%; and semi-warm humid with rainfall all year, 1.54% (INEGI, 2010).

4. CURRENT HOUSING SITUATION

As an important concentration center, Copainala has hosted displacement of inhabitants from rural areas; a consequence of migration that seeks greater work, education, health and trade opportunities. Population has spontaneously formed new settlements on the outskirts of the city, without planning or even observing building regulations and without basic services. Houses, mostly inhabited by indigenous or peasant families -with low economic incomes- were built with available resources; labor of inhabitants themselves, limitations for acquisition of materials and application of inadequate technical procedures, which has originated the construction of informal, unsafe and unhealthy housing.

5. METHOD

Research consisted, at first, in analyzing *in situ,* houses characteristics and current conditions located in the case study: Vicente Fox Colonies, El Triunfo and Siglo XXI, in Copainala. Information was collected in a sample manner, in accordance with delimitation of the study area and aimed at low-income families. For this purpose, a previously designed information registration card (survey) was applied, which included various aspects and elements of analysis and evaluation: number of inhabitants, general conditions and dwellings characteristics, structure and construction processes used, materials, etc. In a second moment, from the results analysis and interpretation obtained, work was focused on the elaboration of two housing models, according to context and appropriate for low-income families, with growth possibility -progressive housing- and with technical-constructive

characteristics commonly used by inhabitants, with the purpose of taking advantage of local labor force experience. Also, laboratory tests were carried out to determine average resistance to compression of the pieces of two-cell hollow mortar blocks, traditionally made and used by inhabitants. Results obtained were compared with the corresponding results of three-cell pieces, proposed in this study, made with the same amount of materials, but with better concrete compaction and curing.

5.1 Determining area of study

Field visits were made to the periphery of the northeastern side of Copainala, in order to recognize and select the colonies that still have common land and, also, due to the topography, connectivity to hydraulic and sanitary networks is difficult, among other aspects of urban infrastructure. Area of study was determined from houses that were made through self-construction processes, located on cheap land, either because of its legal irregularity or because of the site's poor conditions, which does not have basic water and sanitary drainage services, and where groups of people with low economic income settle. With these considerations, three colonies were selected: El Triunfo, Vicente Fox and Siglo XXI, with common characteristics and with homes built by their owners, without technical advice and with masonry walls conventional system based on pieces of two-cell hollow mortar blocks (Image 1).

Selected colonies are relatively recent, with little more than 10 years of foundation. El Triunfo colony (code 001), is located on one side of the Zacalapa River and according to INEGI data (2010), it has 89 homes; it lacks a sanitary sewage network and street paving. Vicente Fox colony (code 002), adjacent to the previous colony, lacks the same services and has a total of 42 houses. Colonia Siglo XXI (code 003), has 67 houses and, unlike the other colonies, has a sanitary drainage network, most of its streets are paved (Image 1).

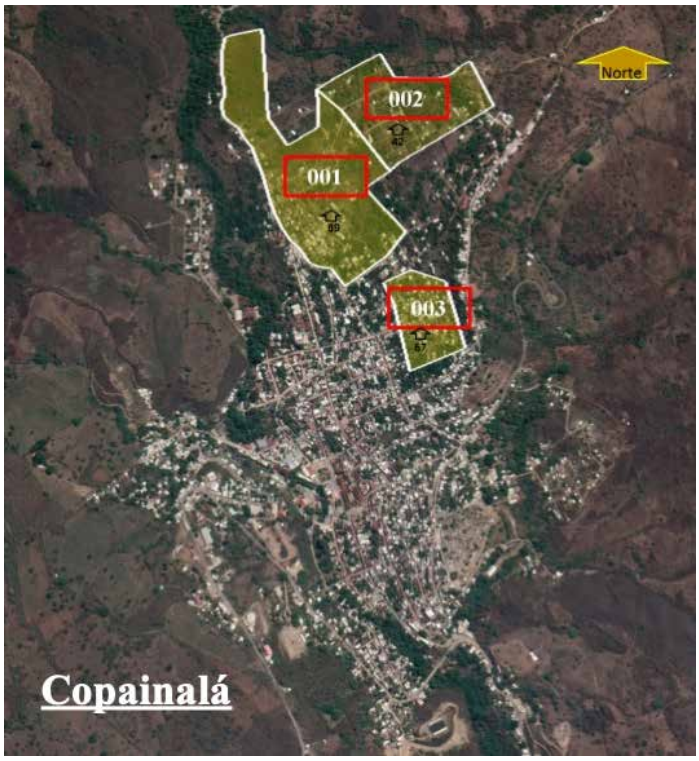


Image 1. Copainala, Chiapas. Source: Globe Digital Image (2013), Modified

5.2 Information recording instrument design

House analysis was oriented towards architectural characteristics identification, structural and constructive elements conditions. To this end, a registration certificate was drawn up in order to obtain information on site, related to specific data on the houses, land, materials and labor used, construction processes and quality of construction, among others. The article has three sections; the first records information on the family, construction's technical characteristics, materials, labor employed, with technical advice or self-construction; the second, to identify and record in schematic drawings, frequent problems observed in the dwelling construction processes; the last section was created to integrate a photographic report.

Information was collected *in situ*, according to a sample of the total number of dwellings established in selected colonies. Sample size was determined based on the generic formula of Kendall, *et al.* (2005), with 80% confidence level. Based on the 198 existing dwellings in the three colonies, a sample of 43 dwellings was obtained (table 1), of which, 19 corresponded to El Triunfo, 9 to Vicente Fox and 15 to Siglo XXI (Images 2, 3 and 4). Dwellings in the sample were selected randomly and the surveys were applied to families with incomes below the minimum wage (MW) or between two

and three MW, and were directed at the owners, through interviews that allowed a relationship to be established between the researcher and the study subject (user-household), the fundamental principle of the research.

Table 1
Number of owners surveyed, by colony

Code number	Colony	Total house number	Homes where the owner was surveyed
001	El Triunfo	89	19
002	Vicente Fox	42	9
003	Siglo XXI	67	15
	Total	198	43

Source: Own elaboration

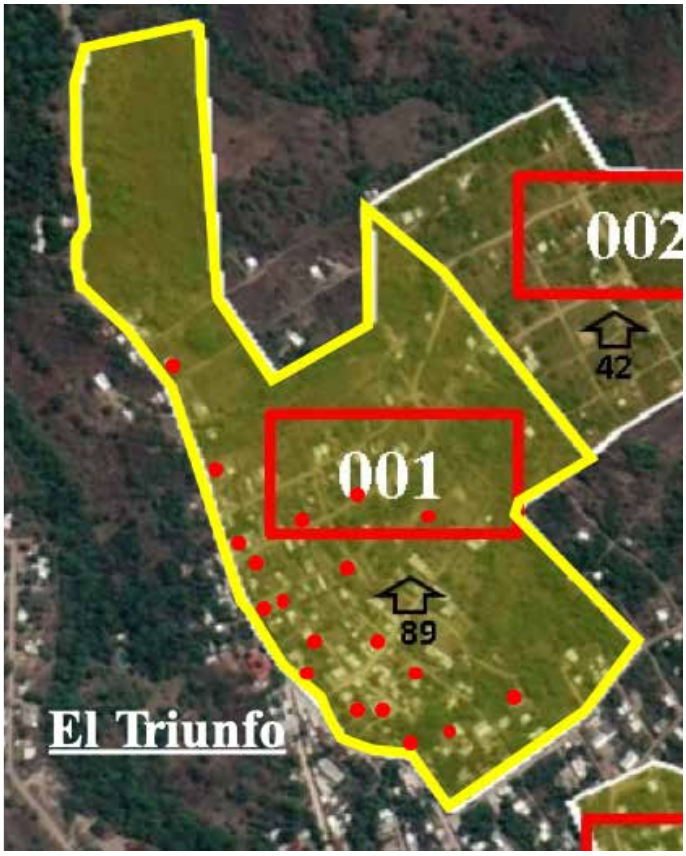


Image 2. El Triunfo colony (001). Source: Globe Digital Image (2013), Modified

Image 3. Vicente Fox colony (002). Source: Globe Digital Image (2013), Modified

Image 4. Siglo XXI colony (003). Source: Globe Digital Image (2013), Modified

5.3 Field information gathering

Information gathering in the field began with heads of families interviews, based on a brief explanation of the research work reasons, which was exclusively for academic purposes. During the visit, people were invited to express their opinions, with the aim that they would have freedom of speech; in other words, care was taken while doing field work in a sensitive manner. Some inhabitants did not want to participate, so the next house was selected.

5.4 Analysis and interpretation of the obtained results

In the analysis and interpretation of the information obtained in field work, the following results were obtained.

- Of the total number of homeowners surveyed, 36% homes are occupied with more than 6 people, 9% between 4 and 6 people, and 55% with less than 4 people.
- In the house construction, 83% of families did not resort to a professional to advise them; they considered that it was not necessary, besides they did not know to whom to resort and they did not have money for that; however, the remaining 17% indicated that they had professional advice, referred to a master builder or a bricklayer.
- When asked who built the house, 52% responded that the family had participated in self-construction and 48% mentioned that it was built by a mason or construction worker and that, in some cases, it was a family member.
- In the construction stages, it was observed that 55% of houses were built completely and 45% progressively; that is, they started with only one room, then an additional room, followed by the kitchen and bathrooms as annexes.
- In relation to the construction standards or regulations, 60% do not know them and 40% said they did; however, in these cases it was observed that houses do not comply with technical standards.
- In spite of the lack of knowledge of the norms and lack of professional advice, 76% of families did not go to the municipal authorities to carry out construction procedures; likewise, 98% stated that they did not have any type of technical supervision by the authorities and 2% responded that they did, but they were families that benefited from housing offered by state programs.
- On the other hand, 81% of surveyed homeowners do not know the situation of seismic region of Copainala and the remaining 19% stated that they are aware of these effects; however, their homes do not have the necessary elements to guarantee the safety of their occupants.

With the above results, it can be objectively observed that municipal authorities do not approach inhabitants during the process of building their homes, either for a review or assistance during construction process or for the inhabitants to acquire the necessary technical information or practical knowledge. In this regard, in the interview conducted with officials from the Public Works Directorate of Copainala, they commented that construction

permits are issued only when people request them and that inhabitants generally process property deeds; they also stated that there is no protocol to follow regarding procedures and supervision of construction, which is why permits are issued without any technical review of corresponding plans.

It was also observed that some houses are built on upper parts of the hills adjacent to the municipality, where topography is very rugged and ground unstable, with possible landslides and rock falls. On the site, inhabitants level the ground and create platforms in an improvised way to build foundations and raise walls; however, in some cases, due to slopes, soil is contained in walls houses and produces lateral thrusts that affect their stability and safety.

5.5 Frequent problems in housing construction process

Colonies analyzed did not have a previous planning, they are the result of inhabitants' economic situation, the urgency to settle down and to build their own houses. By observing this situation closely, it becomes evident that families have had to create their own spaces to protect themselves from the outside, regardless of construction quality or whether it was of a specific type. Most families built their homes based on their needs and economic capacity, which allowed them to acquire materials for construction; others had the possibility of hiring a mason or master builder who would be responsible for construction, but always with the direction of the owner, and in both cases, it is corroborated that the construction quality is deficient.

Image 5. Cracks at the intersection of walls

Image 6. Cracks at the intersection of walls

In Images 5 and 6, we can see wall cracks of houses built with pieces of two-cell hollow mortar blocks, specifically in the upper part of the intersection, on door and window openings, and on the lower part adjacent to the floor of house walls. This is a consequence of the lack of structural confinement, since it was observed that vertical reinforced concrete elements (castles) were only built at intersections of walls and vertical reinforcement in door and window openings was omitted (Images 7 and 8).

Image 7. Absence of vertical reinforcement in openings. Source: Own elaboration

Image 8. Absence of horizontal reinforcement in window. Source: Own elaboration

Masonry walls of analyzed houses, built with hollow mortar blocks, in addition to existing vertical and horizontal reinforcement (castles and chains), must necessarily have additional structural reinforcement inside cells, in both directions, as established by the *Normas Técnicas Complementarias para el Diseño y Construcción de Estructuras de Mampostería* (NTC, 2017). For this reason, and due to poor quality of dwellings construction, as well as the presence of various wall cracks and failure to comply with the minimum regulatory requirements for safe and durable buildings, it is noted that analyzed dwellings are vulnerable to the effects of seismic movements and, therefore, there are possible risks that do not guarantee their occupants' safety.

5.6 Typology of analyzed dwellings

The rectangular shape of dwellings analyzed is predominant, with dimensions that vary between 7 to 8 m in front and 5 to 6 m on each side, with a construction area of less than 50 m2. The facades have an average height of 3 m, are rectangular and above the door and window openings, a solid stands out. The windows are generally square, 1 m per side; however, in very specific cases, windows measuring 1.5 x 2.0 m were found. The roof is gabled and predominant roofing system is zinc sheet, followed by clay tiles. Interior and exterior walls of the majority of the houses do not have covering (finish), which allows us to appreciate the poor quality of labor used; it is also observed that floors are made of concrete with a polished finish in gray and walls are painted with bright colors and, in some cases,

borders and skirting board are defined with contrasting colors, in search of an identity that is expressed in the images (Images 9 and 10).

Image 9. Facade of a dwelling at street level. Source: Own elaboration

Image 10. House with a small garden. Source: Own elaboration

The living room is the space is linked to the kitchen, the dining room and one or two bedrooms that usually have a window. The dining room and kitchen have well-defined areas; the kitchen contains the stove, the refrigerator and, in some cases, the fireplace located behind the house. Toilets are separated from the house, because in El Triunfo and Vicente

Fox colonies, they do not have a drainage system, unlike in the Siglo XXI colony which has a sewage system and toilets are located inside the houses.

Most of the analyzed homes have construction processes carried out in several stages. In the first one, the main construction dominates the front, which is located in the adjacent area to the street, where the room is the basic space of the dwellings, which grouped together form a single housing complex characteristic and typical of the place typology (Image 9). In some cases, houses have a garden area at the front (Image 10), and at the back they have a sufficiently large courtyard that they use as fruit tree plantations and plants for self-consumption. All these spaces are built according to family needs and economic resources available, and are generally added progressively to the housing.

5.7 Evaluation of hollow mortar blocks, manufactured by inhabitants

The handcrafted elaboration of hollow mortar blocks is a practice widely used in house constructions and main applications are load-bearing walls, dividing walls and fences. With the purpose of analyzing the procedure of the three-cell hollow mortar blocks artisan elaboration, used on the walls, Mr. Isidro Vázquez, who is dedicated to the production of hollow mortar blocks in Copainala, was interviewed to observe the procedure that he applies and the amount of materials used. Subsequently, average compression resistance of the pieces was evaluated based on simple compression tests carried out in the Materials Laboratory of the Faculty of Architecture of the Universidad Autonoma de Chiapas.

Handcrafted elaboration process of hollow mortar blocks.

River sand used comes from the "Tres Picos" bank, located 8 km from the Copainala-Chicoasen highway; water and Portland cement were acquired on site. Production of hollow mortar block pieces is usually done on site. Mixture of materials to make the pieces was done in the following proportion: 15 sand cans (19 liters per can) and 3 water cans, with a cement bundle. Mixing of materials began with the sand measurement and its placement, in a circle, on a previously prepared surface; then, cement was placed on top and, using shovels, materials were stirred until a homogeneous mixture was obtained; finally, water was added with the necessary care to obtain uniform humidity and corresponding mixing was carried out.

Next, the mortar was poured into the steel mold and the material was compacted with a wooden bar; furthermore, on one occasion, the mold was raised to approximately 30 cm and dropped to achieve better compaction; then, missing material was added to the mold and the bar was again used

for compacting and levelling. Excess material was removed and once the task was completed, the mold was taken to a surface destined for drying the mortar blocks pieces (Images 11 and 12).

Image 11. Block processing. Source: Own elaboration

Image 12. Storage and drying. Source: Own elaboration

In the drying area, the mold was rotated 180° and slowly removed vertically. There, the block was left to dry and rest on drying surface for two days and then stored or used immediately in construction. Obtained pieces were 12 x 20 x 40 cm (12 cm wide, 20 cm high and 40 cm long) (Image 12).

Evaluation of hollow blocks of handmade mortar.

Five blocks were selected, at random, to perform compression and maximum absorption tests, according to the following procedure:

- Records and measurements of each piece were made. Pieces average dimensions were: 11.74 cm wide, 18.54 cm high and 39.28 cm long, their exterior and interior walls were greater than 25 mm; average total area was 469.01 cm^2 and net area was 255.47 cm^2, which corresponds to 54.47%. Dimensions and calculations were verified with the corresponding standard (NMX-C-404-ONNCCE-2012), and it was found that obtained results were within specified parameters and tolerances.
- Each block piece was weighed and, on average, a weight of 11.82 kg was obtained.
- Then, the absorption test of the pieces was performed. Each dry piece was weighed before being immersed in water for 24 hours; then each piece was weighed again to obtain absorption percentage. Average absorption obtained was 8.58%, which, according to current standard, is in range established between 8 and 10% (NTC, 2017).

Prior to resistance test, each piece was pitch tested to create a uniform surface, on both sides and with 48 hours of drying, before being placed in the machine and performing the compression test (Image 13).

Image 13. Pitching of the mortar blocks. Source: Own elaboration

Image 14. Compression test. Source: Own elaboration

- Finally the test was executed and an average compression resistance of 41.45 kg/cm² was obtained. Tests were carried out in an Elvec digital electric press with a compression frame of 120,000 kgf. In each test the load was applied with uniform and continuous speed, without producing impact nor loss until reaching failure by the maximum load applied to the specimen, which was divided by net area to determine compression resistance. In this regard, the standard (NMX-C-404-ONNCCE-2012) specifies that minimum compression resistance of block must be 70 kg/cm²; which means that this standard was not met (Image 14).

6. PROPOSED HOUSING MODEL

In the elaboration of housing models, characteristics and conditioning factors of the analyzed houses were considered; in addition to applying preferential and accessible construction technique for inhabitants from the use of hollow mortar blocks, with the purpose of creating appropriate models to the context of the area of study that attend to spatial and service needs of the families. Proposals were mainly oriented to guarantee inhabitants safety. For this reason, the study focused on addressing the walls structure, using masonry with hollow pieces with reinforcement inside the cells, as established in the *Normas Técnicas Complementarias para el Diseño y Construcción de Estructuras de Mampostería de la Ciudad de México* (NTC, 2017). In this regard, for the walls construction it was determined to use three-cell hollow block mortar pieces, proposed in similar cases by Escamirosa, *et al.* (2016) (Image 15)

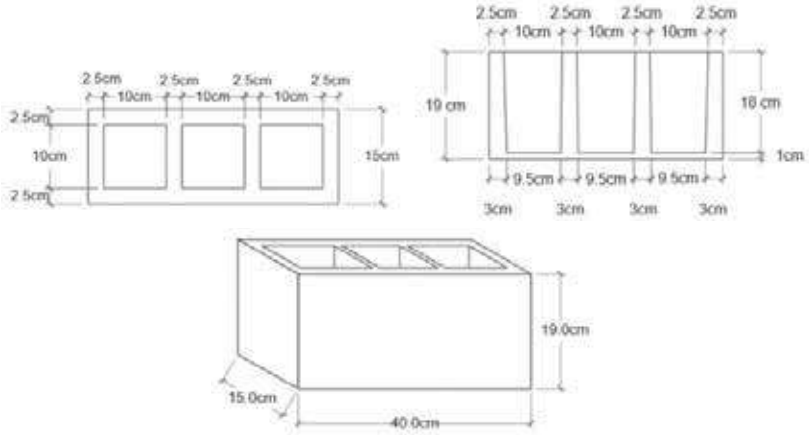


Figure 15. Characteristics of the three-cell hollow block. Source: Escamirosa, *et al.* 2016

The same amount of materials used on site by inhabitants was applied to the production of the three-cell hollow mortar blocks: 15 cans of sand (19 liters per can) and 3 cans of water, for a cement bundle. The mason who helped to make the pieces, Virgilio Castellanos Guzmán, followed the same procedure used by inhabitants:

- Homogenization: Materials were mixed, cement-sand, and water was added.
- Blocks manufacture: The mixture was poured into the mold and compacted with the help of a bar. Then, the mold was raised with handles and dropped freely three times, to achieve greater mixture compaction and avoid gaps inside the mold, then removed excess mixture with the bar. With this process, the density of the pieces was increased and, therefore, greater resistance was obtained. In the elaboration of the pieces in the locality, to compact the mixture, only the mold containing the mixture was dropped freely, on one occasion only (Images 16 and 17).
- Storage and drying of the pieces: On site, the mold was removed and the pieces were obtained, which were then left to dry and, after three or four hours, the concrete was cured for six days. This curing process (wetting of blocks) was not carried out in the town's pieces production.

Image 16. Block manufacturing process. Source: Own elaboration

Image 17. Mold Removal Process. Source: Own elaboration

In the previously described procedure, compaction of the mortar contained in the mold was improved and necessary piece curing was ensured. It is important to point out that due to the lack of experience in the elaboration of three-cell blocks, Virgilio Castellanos had difficulties at the beginning to obtain the pieces, since they were crumbling when trying to remove the mold; however, after several attempts, the process was easy and fast to execute. A total production of 37 block pieces was obtained, with dimensions of 15x19x40 cm. production process began at 8:00 a.m. and ended at 12:30 p.m. on the same day.

After the necessary time for the mortar blocks to reach maximum resistance, compression and absorption resistance tests were carried out; five pieces were selected at random and tested in the laboratory. In the first stage, each piece was recorded and characteristics of the 5 specimens were measured; average dimensions were 15x19.1x40 cm, average net area was 51% of the gross area, which is equivalent to obtaining an average net area of 306.04 cm^2; likewise, each specimen was weighed and the average weight was 11.48 kg (Images 18 and 19). Then, absorption test was performed, obtaining an average absorption of 8.55%, which is within the range established in the standard (NTC, 2017). In the second stage, the compression test was performed on each specimen and average compression resistance of 48.70 kg/cm^2 was determined.

Image 18. Registration of the pieces of the block. Source: Own elaboration

Image 19. Pitching process. Source: Own elaboration

Table 2 shows average results obtained from tests applied to the two-cell hollow mortar blocks made in the locality, and the corresponding results of the three-cell hollow mortar blocks. Results show average compression resistance obtained from blocks, in both cases, with the same amount of materials, but with different molds and manufacturing process (three-cell pieces had greater compaction and were properly cured); it is also observed in the results obtained that three-cell hollow blocks had better compaction and therefore, a greater resistance (48.70 kg/cm^2); likewise, results show that these pieces have very low water absorption, which, corroborates the above mentioned; the greater the compaction, the less the absorption.

Table 2
Average results of resistance to compression and absorption

	Compression test (Average results obtained)		
Characteristics	Hollow block standard (NMX-404 ONNCE-2012)	Two-cell hollow mortar blocks (Copainala)	Three-cell hollow mortar blocks (Study)
Dimensions en cm	12x19x39 - 15x19x39	11.74x18.54x39.28	15x19.1x40
Total area in cm^2	468 - 585	469 > 468	600 > 585
Wall thickness in mm	Minimum wall thickness 20 - 25	25 > 20	25 = 25
Net area in cm^2	-	255.47	306.04
Net area in %	Mayor de 50	54.47 > 50	51 > 50
Weight in kg	-	11.82	11.48
Total volume in cm^3	-	8,698.31	11,460.00
Net volume in cm^3	-	5,548.40	6,181.18
Net volume in %	-	63.79	53.94
Compression resistance in kg/cm^2	70	42.45	48.70
Maximum absorption in %	8 a 12	8.58	8.55

Source: Own elaboration

On the other hand, in of Latin America countries and the Caribbean that have worked on the confined masonry system, such as Domingo Acosta (2005), a system of structural masonry confined walls with steel reinforcement for low-cost housing has been proposed, and the performance of the masonry and its seismic-resistant capacity has been improved; the work carried out by Escamirosa, *et al,* (2016), in rural housing prototypes construction in Ocuilapa de Juárez, Chiapas, with masonry walls with three-cell hollow mortar blocks, confined with steel reinforcement inside, in the vertical and horizontal direction, according to technical standards and with the use of local techniques and materials of the place; sand with

high clay content (22%). results of the seismic evaluation carried out on these prototypes, based on *in situ* measurements with an accelerometer, showed that dwellings structural efficiency is satisfactory (Escamirosa, *et al.*, 2018). Without a doubt, reinforcement steel inside the walls increases the seismic-resistant capacity of the masonry walls and, consequently, reduces the seismic vulnerability of the houses.

6.1 Progressive housing models proposal: "A" and "B

In alternative housing models: "A" and "B", for families in the colonies: El Triunfo, Vicente Fox and Siglo XXI, the minimum necessary spaces are considered, with the possibility of expanding and building in stages - progressive growth. Designs of the two models "A" and "B", were developed on a modular quadrangular grid of 3 m x 3 m, with a surface of 36 m2 starting house, which allows to organize functional, technical-constructive and structural aspects, adapting them to different requirements and functions that users carry out.

Proposals were based on the study carried out, from houses social and technical-constructive aspects, involving inhabitants (users), typology, rescue of some traditional elements and techniques, use of local materials, etc., with the purpose of reducing construction costs. House characteristics are the following: Gable roof, walls with pieces of three-cell hollow mortar blocks, necessary interior spaces: living-dining room, kitchen, bathroom and bedrooms; also, with possibility of expanding (progressive), with two options: towards the front or in double height. To achieve a good structural configuration, the house architectural spaces were defined in a modular sense, which manages to obtain symmetry in floors, as well as in elevation.

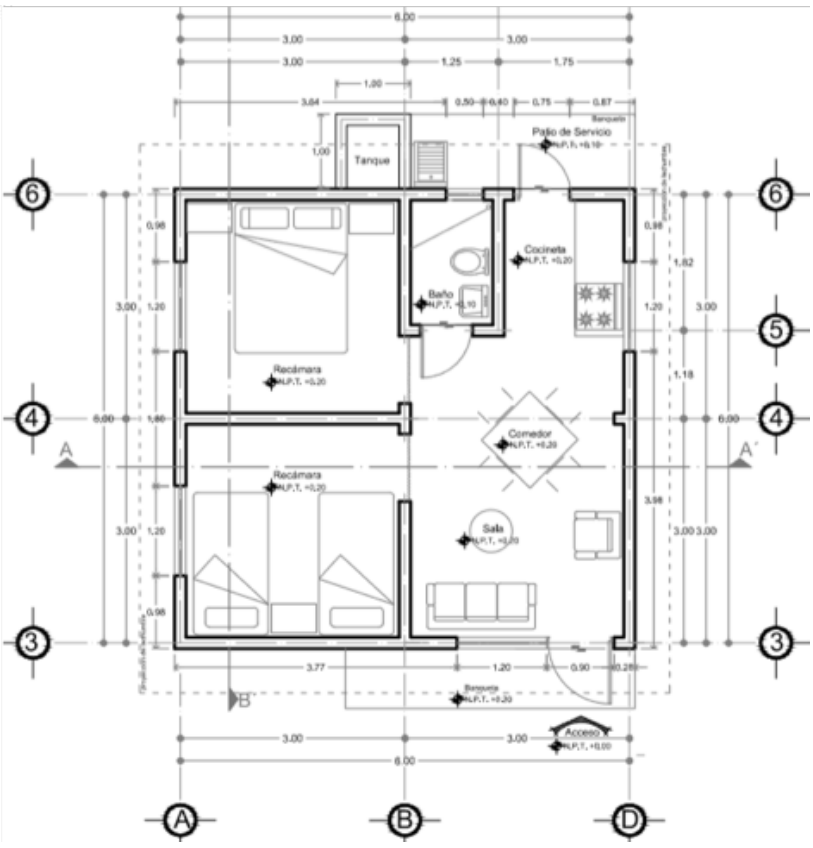
Both housing proposals contemplate the rescue of vernacular elements, such as the gabled roof with clay tiles on roof and portico that will give access to the house, but with masonry walls with pieces of hollow mortar block. On the other hand, use of materials from the region is very important in the proposals: use of sand and stone from the place for the construction of the foundation, walls and other concrete elements; also, wood from the place in the structure of the roof, or in doors and windows. Constructive elements proposed for both models are: foundation of stone masonry of the place, walls of three-cell hollow mortar blocks (modular), roof with wood structure and tile of colonial mud, floors with firm of concrete, doors and windows of metallic frames or, in its case, of wood, to the taste and economic possibility of the user.

Type "A" housing model (progressive single-store house).

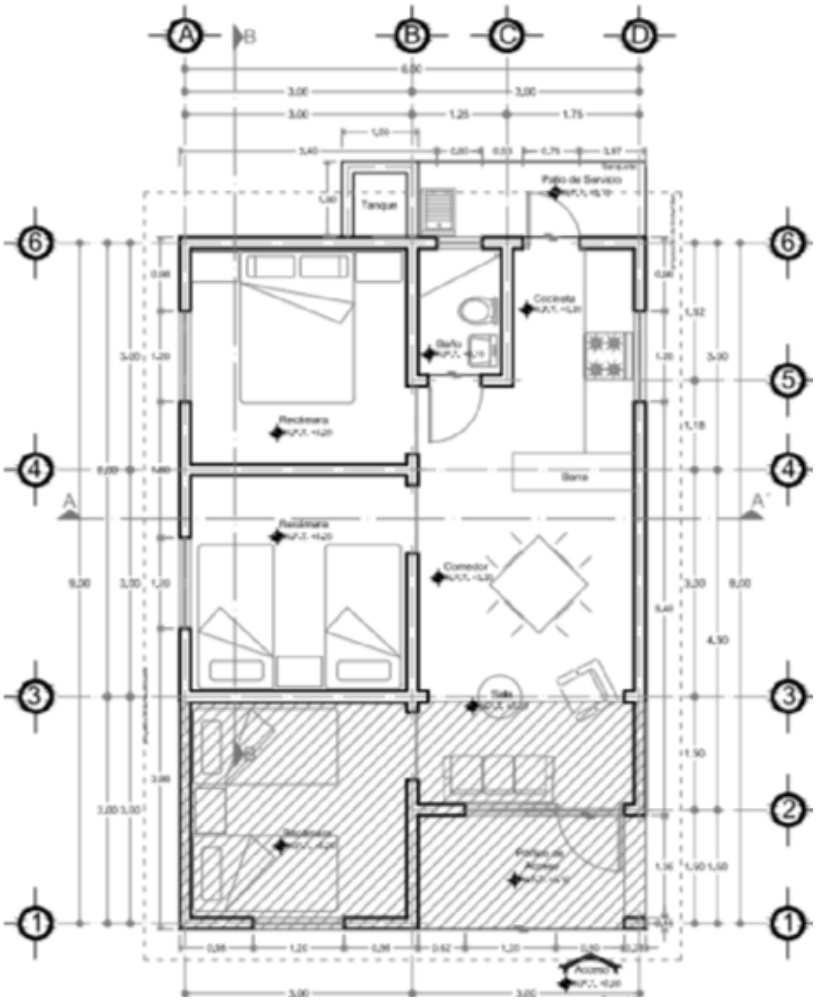
This housing, is proposed for families of 2 up to 5 members, from a compact model with a surface of 36 m2, and it is developed in a plant, organized by two bedrooms, stay, dining room, kitchen and bath; later, the option to extend housing is available, in agreement with the family's economic possibilities. Extension in a future growth is given in the front part of this one, where it is considered the access porch that distributes towards the housing interior. Future growth consists of a bedroom and the extension of spaces in the living and dining room (Plans 1 and 2; Images 20 and 21).

Housing model "B" (progressive double height housing).

The second proposal is similar to the previous one, in terms of space and distribution of the starting house. For future growth, a double height (mezzanine) is considered. In the access there is a staircase that leads to the mezzanine that considers the space for two more rooms. Ground floor is distributed with a living-dining room and kitchen, with open spaces and two bedrooms. The bathroom module is the only one that is closed. The proposed construction elements are the same as model "A". However, in this model, a higher height in the walls for wall covering and with the roof sloping to two waters is considered (Plans 3 and 4 and Image 22).



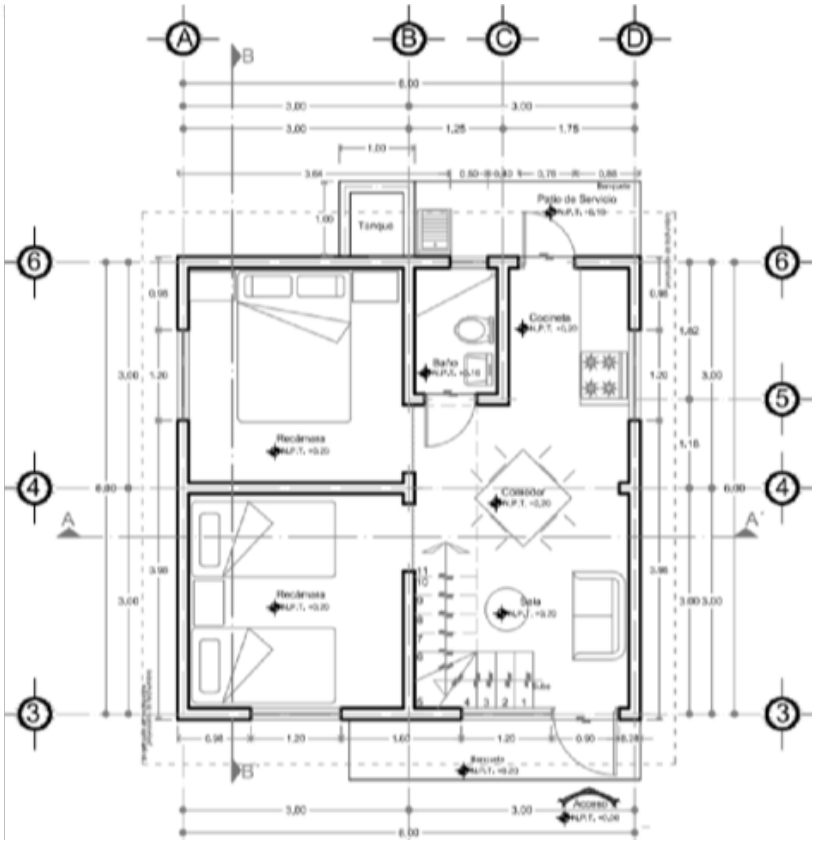
Plan 3. Architectural Floor Model "A" (Starting house). Source: Own elaboration



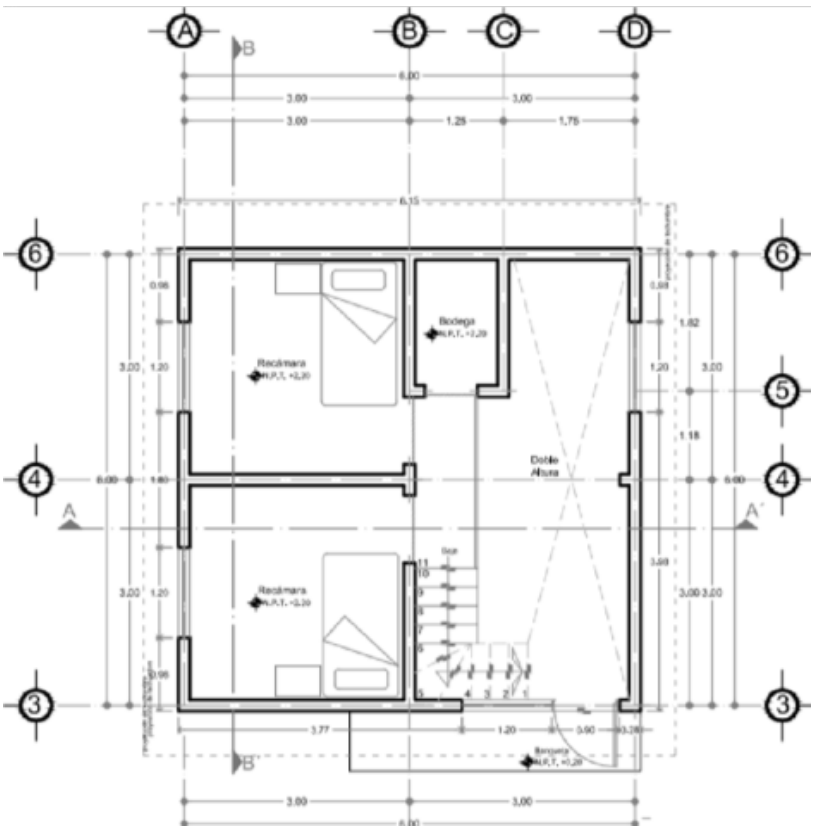
Plan 4. Architectural Floor Model "A" (Future horizontal growth). Source: Own elaboration

Image 20. Model "A" perspective (Starting house). Source: Own elaboration

Image 21. Model "A" perspective. (Future growth) Source: Own elaboration



Plan 1. Architectural Floor Model "B" (Starting house) Source: Own elaboration



Plan 2. Architectural Floor Model "B" (Future horizontal growth) Source: Own elaboration

Image 22. Model "B" perspective (two floors) Source: Own elaboration

The following technical recommendations are proposed, with the aim of facilitating construction process and supporting low-income families in building their homes, in accordance with the standards (NTC, 2017)

- Foundations: Masonry with local stone, seated with cement-sand mortar; ratio 1:3.5 (1 bag of cement, 7 cans of local sand and 1½ of water) The base will be 40 cm wide and 60 cm deep, with a trowel chain reinforced with ARMEX (10x15x10 cm) and concrete f'c = 150 kg/cm² (1:3:4 = 1 bag of cement, 6 cans of screened sand from site, 8 cans of gravel from ¾" and 2 cans of water) (diagram 1 and plan 5).
- Structure: The walls will be made of three-cell hollow mortar blocks, confined with castles and reinforced concrete chains of f'c=150 kg/cm², in intersections and in openings of doors and windows; additionally, vertical and horizontal elements of reinforced concrete will be placed inside the cells, with characteristics indicated in diagrams 2 and 3, and in model 5. Mortar with a 1:4 proportion will be used to join the pieces (1 cement lump, 8 cans with local sand, 1¾ water).
- Roof: The roof is proposed to be gabled, with a wooden structure that will support a local clay tile roof, with 16x18x46 cm dimensions. The wooden structure is installed starting from the center of the house and supporting the ends of it, on the side walls; the wood, on the other hand, is made of pine from the municipality of Coapilla, located 35 km from Copainala, where there are legal sawmills to acquire and transport the wood. Dimensions used in the sections of the elements, are those of common use; rulers of 2.5x10 cm, bars of 5x10 cm and 5x15 cm, pollen of 10x10 cm, and according to the specifications of the norm (plane 6).
- Floors: On the foundation base, 12 cm of improved and compacted material are placed, which will receive the 8 cm thick concrete pavement, reinforced with 6-6/10-10 electro-welded mesh and f'c concrete = 150 kg/cm².
- Service installations: In cases where there is no sanitary sewage network, a bio-digester or septic tank will be used in the house. Regarding the supply of electricity, colonies have this service; they also have water service, which reaches the houses through the municipal network. Both housing models consider construction of a tank for water storage.

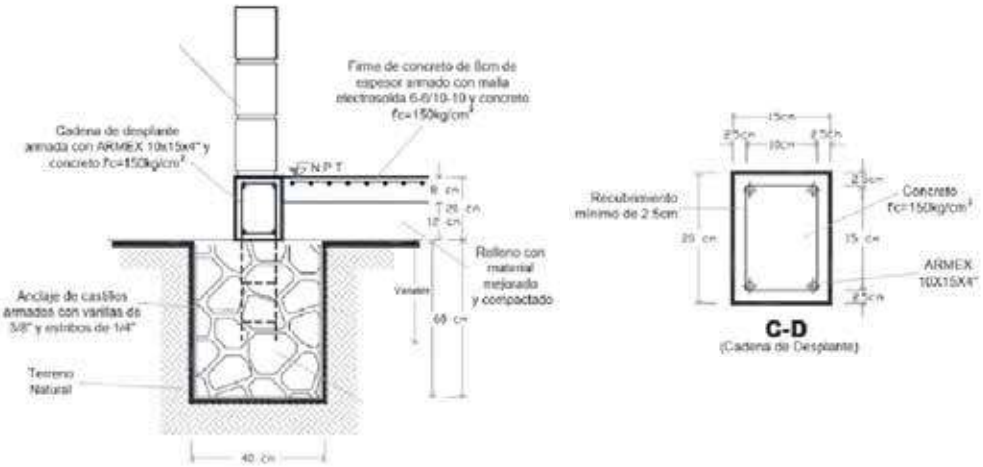


Diagram 1. Proposal for the foundations of the houses. Source: Own elaboration

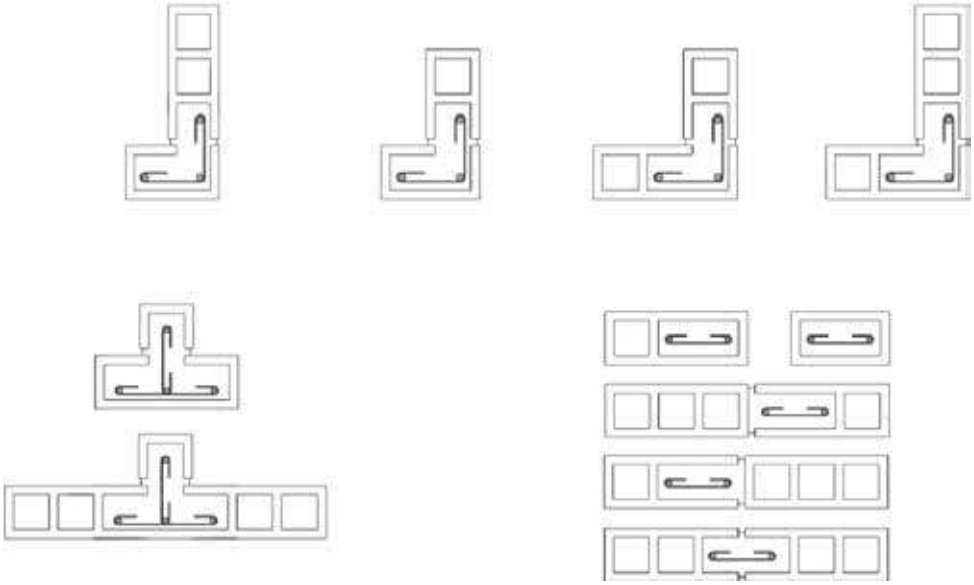
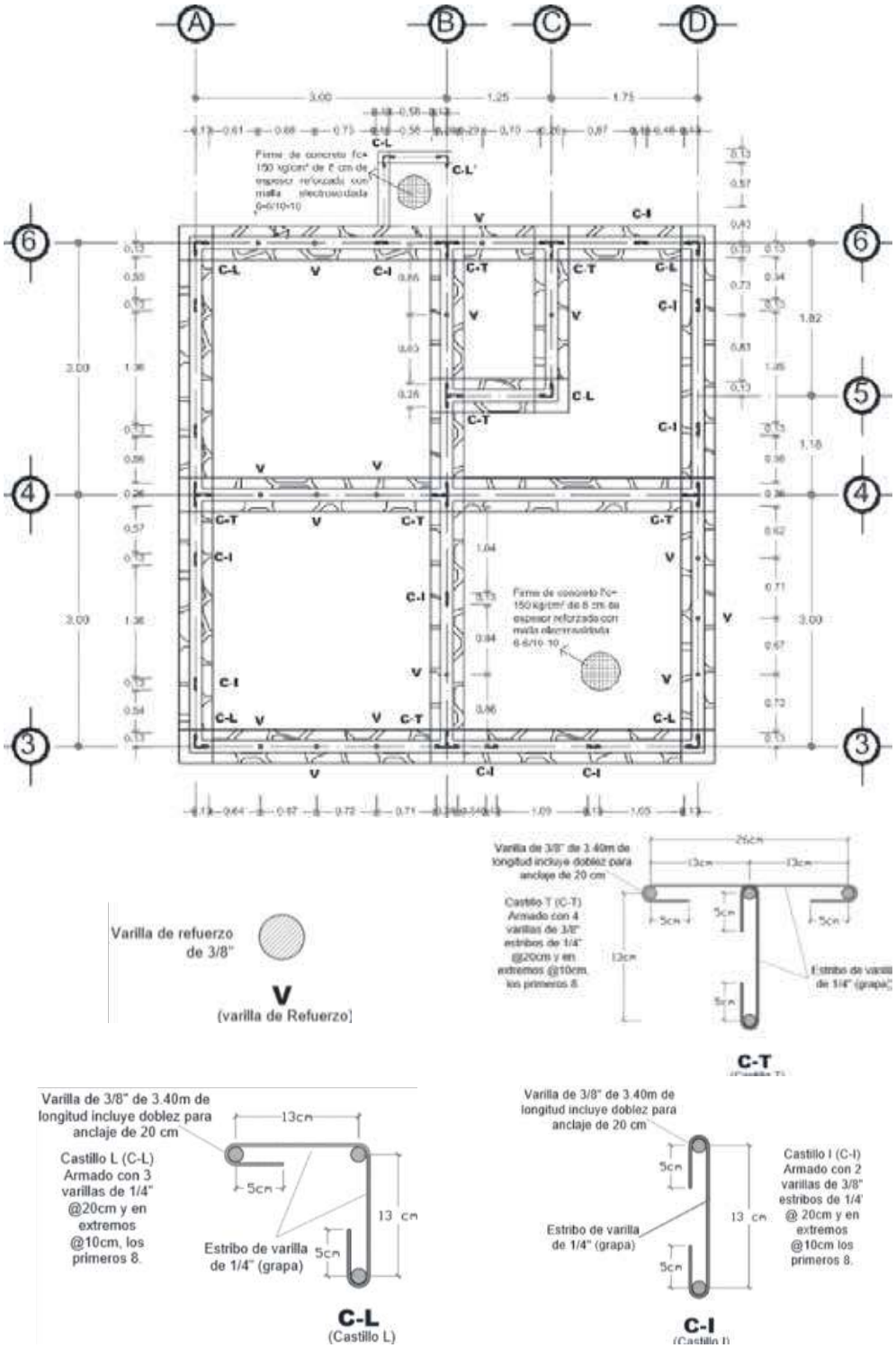


Diagram 2. Placement of hollow block pieces to build castles on the walls. Source: Own elaboration



Plan 5. Proposed type of foundation for housing. Source: Own elaboration

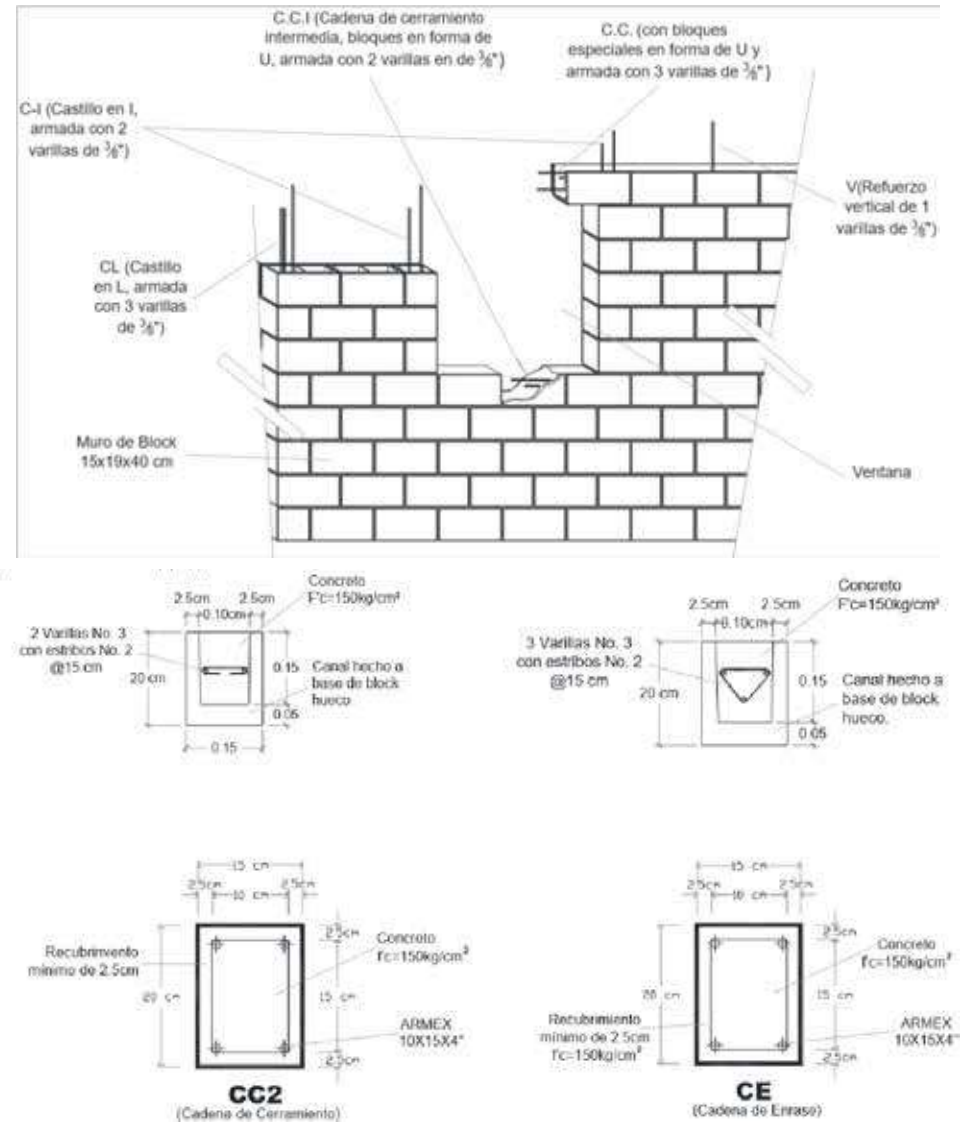
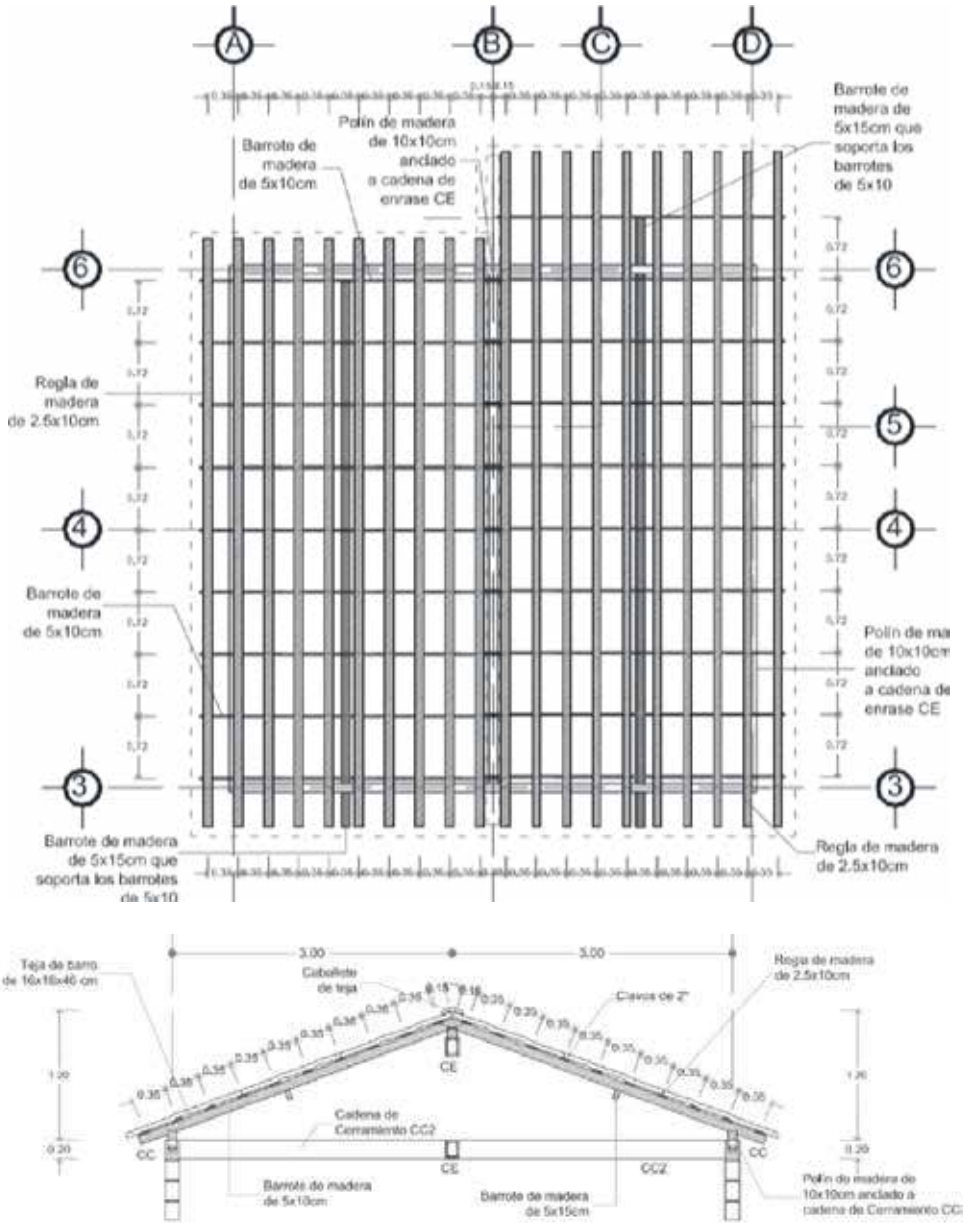


Diagram 3. Steel reinforcement inside wall, both directions. Source: Own elaboration



Plan 6. Proposed type of roof for housing. Source: Own elaboration

CONCLUSIONS

The study conducted in the homes of low-income families in El Triunfo, Vicente Fox and Siglo XXI colonies in Copainalá, Chiapas, identified the presence of cracks in masonry walls built with hollow mortar blocks located at the intersection of these and in the vicinity of door and window openings, which are the result of insufficient structural confinement. In this regard, and in order to take advantage of the experience of local labor force and

the inhabitants preference for two-cell hollow mortar blocks and a section of 12x19x40 cm, for the construction of their homes, it is proposed to use new pieces of hollow blocks, with three cells and a section of 15x19x40 cm, made with the same amount of materials used on site by inhabitants, but with better compaction and curing of concrete. Obtained results in the laboratory tests, show that the average resistance to the three-cells pieces compression, increased 14.73%.

On the other hand, the characteristics of the houses, uses and customs, typology and materials of the place used, guided the formulation of two models of alternative housing: "A" and "B", that were designed based on the norms and low income families spatial needs. Application of a construction technique known and preferred by inhabitants, based on masonry walls with new pieces of hollow blocks, with three cells and a section of 15x19x40 cm, will facilitate house constructions, and in particular, of castles steel reinforcement placement at walls and the chains intersection; as well as reinforcement inside the cells, in both directions, distributed along the length and height of walls, as indicated in the standard for masonry walls in the Mexico City building regulations (NTC, 2017). It is also proposed to start construction with a minimum surface (starting house), of 6 x 6 m, with possibilities of growth in the future, from a modular structure of 3 x 3 m. Model "A" considers a frontal progression, and model "B" proposes a vertical progression (double height), so that families will have the possibility of choosing the housing model most favorable to their needs, according to the availability of their economic resources. In addition, housing proposals aim to reduce construction costs, both in the use of materials and labor, since the placement of steel reinforcement inside the cells of the pieces, eliminates the use of formwork (wooden formwork).

The work presented here is intended to contribute to the improvement of housing and reduction of vulnerability to seismic events, for the benefit of low-income families in Copainala. The characteristics of the models proposed facilitate construction process and support families in the construction of their homes. However, in order to avoid bad construction practices, participation of authorities with technical advice and construction follow-up should be considered. Likewise, in self-construction of housing, technical assistance of a facilitator is recommended: a student or technical professional from the University, who guides the construction processes established in the information. *"Fulfilling this purpose is a great aspiration for the University, the linkage of its work with social reality. Although it is true that proposals made for housing and sanitation are at project level, we believe that this is a good start for the management and search for financing to materialize the proposed housing"* (Escamirosa, 2001).

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CORROSION AND STRUCTURAL INSPECTION OF AN INTERNAL REINFORCED CONCRETE ELEMENT LOCATED AT CHAINAGE 0+145 IN THE SAN ROQUE UNDERGROUND CULVERTS-ARCH, IN TUXTLA GUTIERREZ, CHIAPAS

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— *Abstract*—

Sabinal River crosses the city of Tuxtla Gutiérrez, Chiapas, from west to east, with an approximated longitude of 12 km. This river has 21 tributaries, which over the years and the population growth, the river federal zone and its effluent's have been invaded by the urban spot. Currently, four of these tributaries have been constructed as underground culverts-arch and represent a high risk to the population located close or over this infrastructure, because some sections have more than 50 years without maintenance and have been submitted, internally, to aggressive environment, product of the gases generated by sewage, such as: hydrogen sulfides, methane and ammonium, mainly. Besides carbon dioxide, oxygen and nitrogen, which are common, together with humidity and high temperature which contribute to the accelerated deterioration. This paper presents the analysis of a visual inspection, integrating materials deterioration associated to the structural damage found, in addition to obtained results from electrochemical and chemical test to evaluate the degree of corrosion in a structural element of reinforced concrete that crosses the underground culverts-arch. It is possible to conclude that structure presents different pathologies, classified as common damages such as efflorescence, softened zones, and fungi on bricks and natural rocks, on areas with reinforced concrete, cracking, leaks, efflorescence, lixiviation, infiltration and concrete runoff. Severe damages were observed, such as blowups, partial detachments, generalized corrosion and total loss of steel reinforcement, at some locations, in the main structure. This degradation is active and constant, according to the evaluated electrochemical parameters, which affects the efficiency and durability of evaluated elements in the San Roque underground culverts-arch.

Keywords

Inspection; corrosion; underground culverts-arch; corrosion potential; carbonation; structural pathologies.

Despite his knowledge of construction, man has not been able, until today, to carry out civil infrastructure that does not need to be conserved. Worldwide, structures (buildings, roads, ports, bridges, docks, tunnels, underground culverts-arch, drainage works, etc.), throughout the years, have been observed to suffer environmental impact where they have been built. Corrosion problems and degradation of materials are due to a natural phenomenon, through which chemical systems express their tendency towards a state of stable equilibrium (González, 1989). For this reason, timely inspection and evaluation serve to plan a proper conservation program which can result in a long and efficient service life under extreme environmental and structural loads to which the infrastructure is exposed.

Therefore, this paper presents the analysis of visual inspection and specific chemical carbonation tests, as well as electrochemical measurements of corrosion potentials (ASTM C876-91) performed on an internal reinforced concrete element, which crosses the San Roque underground culverts-arch at chainage 0+145. This investigation was derived from two incursions inside the San Roque underground culverts-arch by a group of specialists in materials science, structures, hydraulics, hydrology, topography and social communication (see the following link on youtube: https://www.youtube.com/watch?v=MkXuOTc_VkI). The main results associated with materials science (corrosion) and structures are presented in this paper.

Civil infrastructure of the underground culverts-arch, with an approximate length of 1,248 m (Figure 1), is composed of various materials, such as masonry (non-industrialized clay bricks and natural stones) and reinforced concrete. Such structures fulfill the function of support (against gravitational and seismic loads) and structural lining. All underground culverts-arch components are constantly subjected to environmental corrosion and to structural loads as well (earthquakes, for example). Mechanisms of degradation of materials are diverse, however, the main source comes from aggressive agents, that is, from gases that emanate from the sewage, such as: hydrogen sulphide, methane and ammonia (Figure 2), associated with oxygen, relative humidity and internal temperature from the sewage system. The evaluated structure has diverse pathologies, classified from common to severe damages which keep it in constant degradation, compromising both its efficiency and durability.

Figure 1. Location and layout of "San Roque Underground culverts-arch" (Mundo, 2019)

It is evident that the lack of inspection and conservation of urban civil infrastructure have provided unfortunate experiences in several structures worldwide, with diverse consequences, for example, undesirable aspects in its structural behavior, and decrease of its service life generated by static or dynamic loads and deterioration by weathering effects; these circumstances have caused the collapse of many civil structures, among others to the underground culverts-arch located in several States of México, some of them have collapsed. For example, in Mexicali, 2004, a section of the underground culverts-arch located at the Nuevo river collapsed due to a structural failure, and in the city of Toluca, the underground culverts-arch located at the Verdiguel River collapsed in 2015 (Mundo *et al*, 2019).

The following are the results of the first exploration carried out in October 2018 by a multidisciplinary group of specialists to determine the current state of deterioration of the structure.

Figure 2. Black water flowing through the "San Roque Underground culverts-arch"

2. VISUAL INSPECTION AND THEORETICAL QUALITATIVE ELEMENTS

The infiltration through cracks, crevices and voids in the underground culverts-arch internal protection (reinforced concrete lining) were observed, causing staining, efflorescence and leaching of calcium hydroxide and other components, which are dispersed over the sides of the concrete surface (Figure 3a). The steel reinforcement of the concrete, both longitudinal and transversal, shows visible corrosion, clearly exposed, with detachment of materials typical of the lining zone and crystallized alkaline leachates, as can be seen on the chainage 0+568 (Figure 3b).

a) b)

Figure 3. Material degradation of the "San Roque underground culverts-arch" structure (Mundo, 2019)

In the reinforced concrete (RC) system, beams and slabs, located at the chainage 0+145, various undesirable structural aspects were observed, such as: a) exposure of longitudinal and transverse steel reinforcement, b) partial longitudinal cracking (Figures 4a) and bursting shown in Figure 4b, highlighted in a blue box. It was observed that, in this last damage zone located in the slab structure, maintenance work had already been carried out (unknown dates of execution). However, it was noted that the construction process used in such maintenance is of low quality, as shown in Figure 4b. Lack of adequate maintenance is evident and therefore, there are notorious material failures such as cracking and detachments in several sections of the RC slab.

a) b)

Figure 4. Material failures: (a). Cracking and (b). Slab bursting

A relevant aspect of the inspection was the identification of a collapsed area of the reinforced concrete structure, located at chainage 0+145, as shown in Figure 5a. In this collapsed section, the severe deterioration due to corrosion of the steel reinforcement and the concrete degradation can be observed. In addition, problems were observed in reinforced concrete beams that have never received maintenance, presenting areas without concrete cover on the bottom side of the element, exposing the steel reinforcement and, therefore, with an active process of generalized corrosion. Moreover, concrete segregation was observed in beams, because the material used as coarse aggregate in the construction process is either from boulder or from river (Figure 5b).

a) b)

Figure 5. a). Slab collapse and b). Areas without concrete cover and with visible concrete segregation in beams of the RC structure

In general, this section of the structure has no conservation and a serious material deterioration process. Various pathologies were observed, both in longitudinal beams, as well as in the reinforced concrete slab (Figure 6), where there are problems of spalling, delamination, segregation, bursting, efflorescence, filtration, humidity, leaching, little or complete lack of the concrete covering for the steel reinforcement and, with light to severe electrochemical corrosion. The latter, is a phenomenon that is due to the action of electrochemical batteries, where metal (steel reinforcement) suffers dissolution in anodic regions, without attacking the cathodic regions, not affecting equally all the metallic surface that are in contact with electrolytic conductivity systems, where the presence of water molecules on the material surface is necessary for this deterioration to occur (Otero, 2001), producing in visible anodic areas, partial or total loss of the bottom longitudinal steel reinforcement (Figure 6, 7a and 7b). In this area, the use of inadequate construction process techniques, lack of quality control of materials and little or no supervision provided is also visible.

Figure 6. General view of slabs and beams with various pathologies

a) b)

Figure 7. a). Severe corrosion with total loss of main steel reinforcement and b). Light corrosion of concrete slab reinforcement

Materials such as brick and stone, joined using mortar, show slight deterioration mainly due to environmental exposure, humidity and internal temperature. The structure built with these materials was observed to be stable and some areas were detected to have stains, eroded areas, soft areas or flabby areas due to excess of humidity in bricks, with efflorescence in the form of crystallized salts (Figure 8). Stains were also visualized by the

chemical reaction with water and by bacteria or fungi, including mosses on stones as a result of biological degradation (Figure 9).

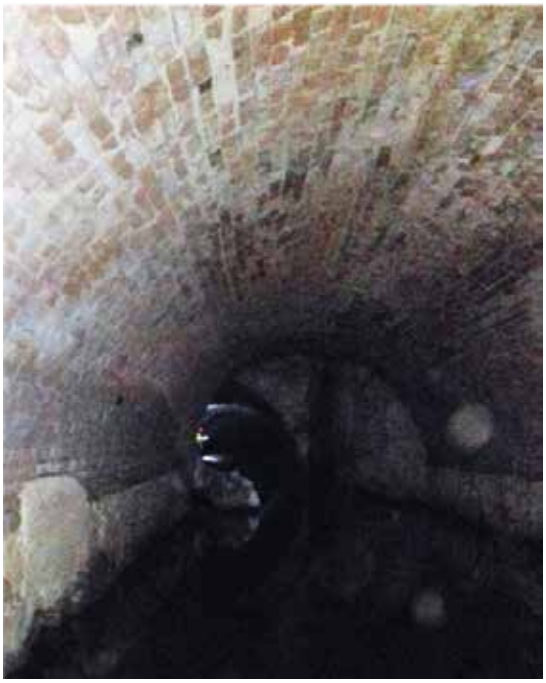

Figure 8. Brick underground culverts-arch´s general view with efflorescence presence (Mundo, 2019)

Figure 9. General view section of the stone underground culverts-arch´s (Tavera, 2018)

Corrosion products exert pressure on the surrounding concrete, causing cracking and detachment of the reinforcing steel cover (spalling), which compromises structural integrity (Castorena *et al*., 2007). This effect

obviously has a negative influence on both the structure's durability (steel reinforcement without protection from corrosive atmospheric agents) and its structural behavior.

As commented, all points illustrated above (Figures 3 to 7), could represent important structural risks, as it is known and it has been illustrated (Figures 6 and 7), corrosion can deteriorate steel reinforcement to such a degree that it practically disappears. In such cases, there may be a significant reduction of the flexure and shear strength of individual structural elements. This is due to the fact that when stirrups (and longitudinal steel) corrode, they are no longer useful and the elements' failure mechanism can be modified, instead of having a behavior governed by flexure (assumed at the design stage), as is desirable, premature and sudden shear failures can occur, which is totally undesirable. In addition, in some cases, longitudinal steel rods are much more prone to buckling and the concrete effective area is reduced (Figure 6), affecting its strength. The deformation capacity of the RC members can also be seriously affected by the transverse steel reinforcement degradation, since, in the absence of adequate confinement of the concrete core, deformation capacity (curvature ductility) of transverse sections that make it up can vary significantly from what was originally considered in the design.

Associated to the longitudinal steel reinforcement deterioration, in some cases, rods' corrugations tend to disappear (Figures 5, 6 and 7), so there is also a deterioration in the bond capacity with surrounding concrete (debonding), which could lead to considerable cracking in the presence of extreme actions or even under normal service conditions, as commented by Vidal *et al*. (2007). Bond strength degradation could increase in those sections where, due to the corrosion effects, a lack of effective transverse steel reinforcement for confinement is developed (Fang *et al*., 2004). As indicated in this section, the structural properties of the elements, such as flexural stiffness, shear and flexural strength, can be degraded with the increase of the corrosion levels, due to the steel reinforcement deterioration (caused by the respective induced concrete spalling), since such properties are in function of the amount of longitudinal (the tensile reinforcement ratio, relationship between the tensile and compression reinforcement ratio) and transverse steel reinforcement (stirrups), the resisting effective concrete cross-section area, as well as bond strength between steel and concrete (e.g. Vidal *et al*, 2007, Xia *et al*., 2011, Godínez *et al*., 2019).

3. ELECTROCHEMICAL AND CHEMICAL TESTS *IN SITU*

The selection of the technique to evaluate the corrosion levels was based on both the characteristics of the structure under study and the conditions of

the environment where it is located. Therefore, given its speed of application and a very important parameter such as measuring the system's energy from the thermodynamic point of view, the electrochemical technique of corrosion potentials (Ecorr) was used. In this case, a non-destructive test method was used, employing a Copper/Copper Sulphate ($Cu/CuSO_4$) corrosion sensor and a high impedance multimeter with necessary attachments (Figure 10a).

A total of 60 electrochemical readings were taken, one measurement every 50 cm, measured longitudinally on the surface of a 180 cm wide and 700 cm long slab section, as well as on a 75 cm depth and 700 cm long beam (Figure 10b and 10c) with corrosion problems. Measurements of the carbonation front were made on several samples of the collapsed concrete slab, using material remains for the carbonation test, in which an acid-base indicator (phenolphthalein) and a transparent millimetric ruler were used (Figure 11).

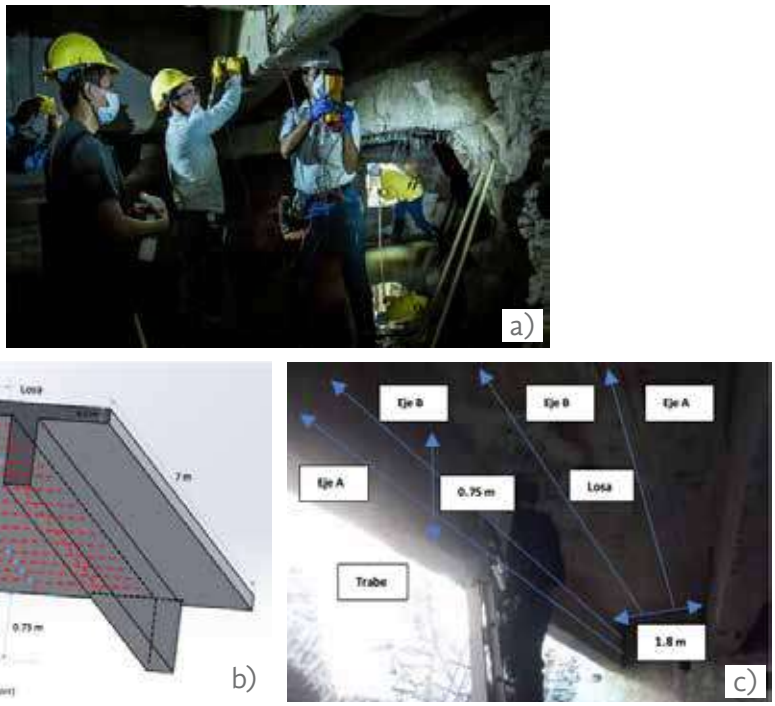

Figure 10. a). In-situ measurements of corrosion potentials (Tavera, 2018), b). Detail of the structure's reading points and c). Measurement axes in slab and beam

Figure 11. In-situ carbonation front measurement in a concrete sample of the slab, using an acid-base indicator solution: phenolphthalein (Tavera, 2018)

4. ANALYSIS AND DISCUSSION

Generally, steel reinforcement embedded in concrete is protected from corrosion due to a two protection characteristics: a concrete cover thickness as a physical barrier and the iron oxide layer (of the order of a couple of nanometers) that forms on its surface, due to high alkalinity of the surrounding concrete, with values higher than 12.6 pH (Peguin *et al*., 1972). This phenomenon is known as passivation (Fontana, 1986) and prevents steel reinforcement corrosion from spreading further. However, the structure, when acting in its environment, begins to degrade due to various mechanisms that are a function of corrosive elements aggressiveness in the internal environment, soil and water, in which they are in permanent contact (Figure 12).

Figure 12. Underground culverts-arch's internal lining with strong steel corrosion problems and crystallized salts from concrete leaching (Mundo, 2019)

During the inspection, assessment and interpretation criteria for corrosion potentials were applied, from which the in-situ energy flow of the system is measured, as recommended in the *Manual de Inspección, Evaluación y Diagnostico de Corrosión en Estructuras de Hormigón Armado* (Trocónis de Rincón *et al*., 1997) and according to the interpretation of the ASTM C876-91 standard results, as indicated in Table 1.

Table 1
Results' interpretation according to ASTM C876-91

Corrosion potential (Ecorr)	Risk of damage (%)
< -200	10% probability of corrosion
-200 a -350	Certain uncertainty
> -350	90% probability of corrosion

Corrosion potential measurements carried out on the slab and beam that make up the superstructure of the section under evaluation reveal that reinforcement is in active condition. The graph in Figure 13, axis B, corresponding to the slab, shows corrosion potential values that vary from -35 mV to -140 mV, with values ranging from -300 mV to -400 mV detected at the center of the axis. The graph in Figure 13, axis A, of the slab, showed potential values between -20 mV and -140 mV. These values, according to Table 1, indicate that for non-visible reinforcing steel, in general, there is a 10% probability of corrosion for both axes. It should be noted that the most critical values observed in Figure 13 for axes A and B were in the range of some uncertainty and 90% probability of corrosion according to the ASTM C876-91 standard. Therefore, it can be pointed out that the area with high structural problem, where the most negative potentials were computed, is at the center of slab, at 300 cm and 350 cm from its total length. These values coincide with the visible damage observed in the area showing segregations with openings of 10 cm and depths of 1 to 5 cm on average, with corroded exposed steel (Figure 14a).

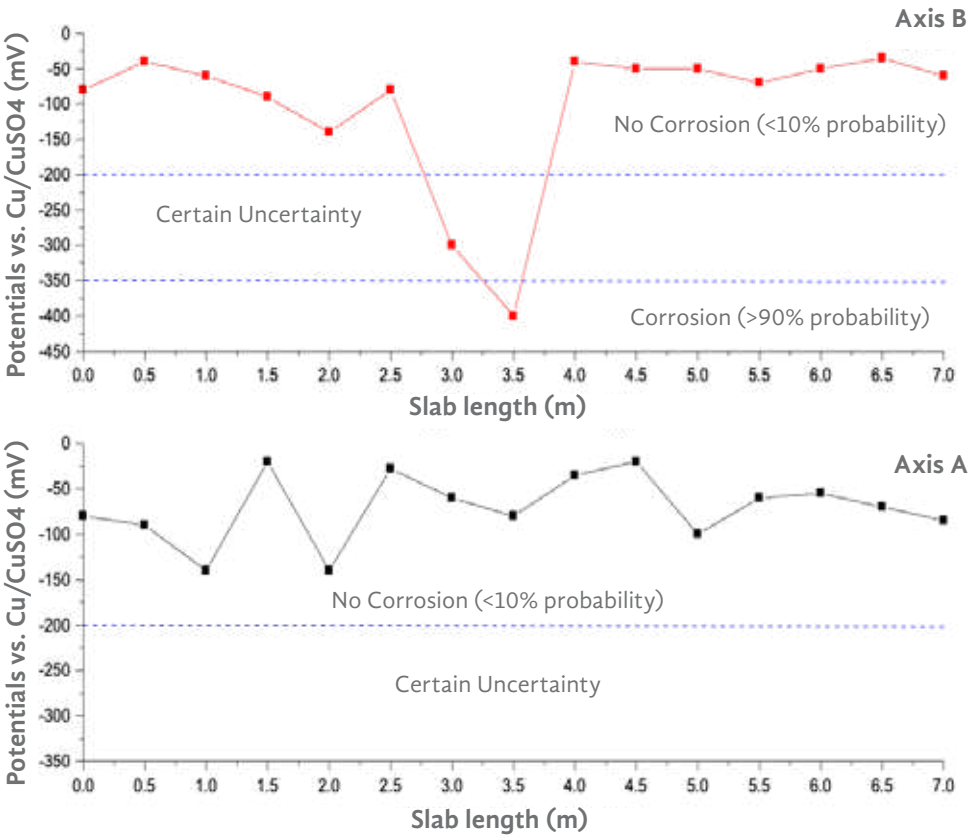

Figure 13. Corrosion potentials (Ecorr) in reinforced concrete slab

a) b)

Figure 14. a). Measurement of deterioration (segregations) in slab and b). Measurement of beam's segregations with digital vernier "Mitutoyo" and transparent millimetric ruler

From the A axis of Figure 15, corresponding to the beam, potential values that vary from -45 mV to -336 mV were observed. In graphic 15, in axis B of the beam, values between -75 mV and -330 mV were observed. These values, according to Table 1, indicate for non-visible steel reinforcement have a 10% risk of corrosion damage and some uncertainty for both axes. It

should be noted that the most negative potentials were in the range of some uncertainty according to the standard. Therefore, it can be pointed out that the higher structural problem, which presents the most negative potentials, is located at 450 and 600 cm from its total length. These values match with the visible damage observed in the beam area, which shows segregations with openings of 15 cm and depths of 2.3 to 5 cm, with exposed corroded steel (Figure 14b).

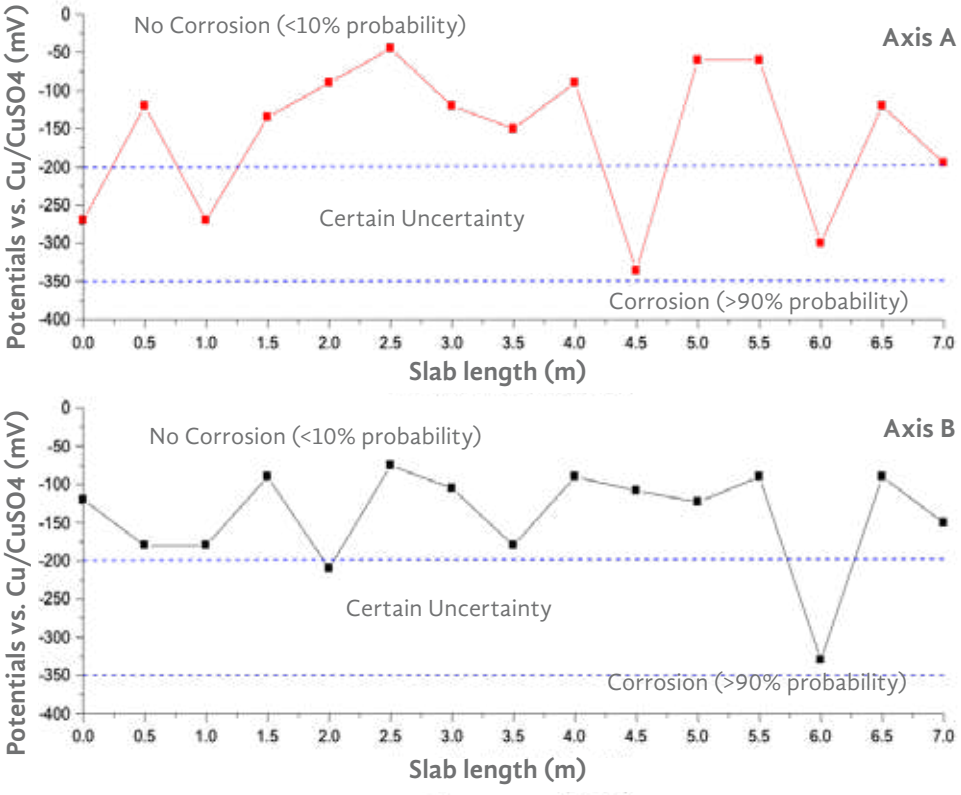

Figure 15. Corrosion potentials (Ecorr) in reinforced concrete beam

It is important to mention that remains of totally corroded steel were found inside concrete segregation voids, in the form of pores and voids, detecting punctual signs even <-500 mV vs Cu/CuSO4 for adjacent areas, detected with severe corrosion, not recorded in previous graphs. This active tendency of reinforcing steel in the steel-concrete system, once the corrosion driving force starts, this material will have a tendency towards stable equilibrium, until this parameter has reached a minimum value in the system (González, 1989), in other words, total steel degradation.

On the other hand, carbonation is a process in which carbon dioxide (CO2) from the atmosphere reacts with the alkaline components of the concrete's aqueous phase, lowering its pH and resulting in neutralization of

all material. From data obtained through the concrete's phenolphthalein test, an advanced depth of carbonate front was found (2 cm), this value, even in certain degraded parts, is greater than the coating's free zone. Concrete's pathology, together with alkalinity loss, promotes the appearance of damage such as fine cracks and flabby areas, which end up in delamination near the reinforcement steel level with light, medium, strong and severe category (Carmona, 2003). This was corroborated by material detachment over 25% of the slab and beams surface analyzed *in situ*. Another consequence is the generalized reinforcing steel's depassivation, forming electrochemical cells due to chloride diffusion and sulfate ions, which increase their mobility in carbonated concrete. Sewage aggressive agents and its vapors, as well as the atmosphere of the drainage system, in addition to the alkaline reserve leaching, are the accelerating factors that keep the structure in constant degradation.

There are other parameters that promote steel-concrete system pathologies, such as temperature, which plays a double role in deterioration processes. Its increase helps molecules' mobility, facilitating transport of substances, among them aggressive ones, and its decrease in condensation of local humidity in materials that favor their deterioration. Environmental humidity promotes corrosion in neutral and alkaline environments, intervening in cathodic processes of oxygen reduction, as well as favoring ions mobility through electrolyte (concrete). Differences in oxygen concentration in different areas around reinforcing steel due to cracks presence, porosity and surface damage, accelerate differential aeration piles formation, triggering steel corrosion. This mechanism is common in carbonated concrete.

The concrete patch observed in Figure 4b (blue square) corresponds to blowout damage, generally caused by reactive aggregates and cement that are high in alkalis, or in its case, by aggregates that expands when is in constant contact with water or humidity. In this case, it is a severe burst that has been repaired, since the damage diameter is greater than 5 cm and depth greater than 2.5 cm (Carmona, 2003).

Cracks located on the analyzed slab lower surface, in chainage 0+145, are structural damage caused by dead and live loads, ranging from strong to severe cracking, with cracks from 0.6 mm and larger than 1 mm wide.

It should be clarified that during the development of this research, the City Council of Tuxtla Gutierrez has undertaken some maintenance work on the underground culverts-arch, focusing exclusively on repairing sinkholes; however, procedures and techniques used are not the most desirable (Mundo *et al*., 2019a), from a technical point of view.

It is important to emphasize that it is indispensable to obtain data of the temperature, relative humidity, gas emissions, aggressive ions, as well as mechanical tests for concrete, stone and brick materials in order to achieve a more thorough inspection. It is also important to carry out a study of the

contaminants in the sewage. Finally, it would be highly recommendable, in the reinforced concrete structure case, located at chainage 0+145, to perform reinforcing steel corrosion kinetics by means of electrochemical techniques, as well as to perform chemical tests on concrete, to analyze the penetration of aggressive agents such as chloride and sulfate ions.

CONCLUSIONS

It has been shown and discussed the impact of the material degradation in the sewage infrastructure, mainly of an internal reinforced concrete (RC) element, which crosses the San Roque underground culverts-arch in chainage 0+145. Based on visual inspection and results from carried out tests, the following conclusions are made:

The San Roque underground culverts-arch structure lacks of constant and preventive maintenance. For the RC slabs and beams that transversely cross the underground culverts-arch in chainage 0+145, physicochemical damages are strong and severe and, visible in its diverse pathologies.

The corrosion of the steel reinforcement in the structure is from electrochemical nature and is due to constant action of humidity and advanced carbonation, together with aggressive agents emanating from the sewage.

Based on measurement of potentials in the evaluated reinforced concrete slab and beam, it was observed that the most negative voltage recorded coincide with the most deteriorated areas and the risk of damage to the reinforcing steel, according to Table 1, corresponds to a 10% to 90% probability of very high corrosion in the adjacent anodic areas with voltages below -350 mV.

Concrete's *in-situ* carbonation test, using phenolphthalein, shows advanced depth of the front of carbonation, 2 cm in average, enough to reach the main steel of the beams and slab. This degradation by carbonation in the elements is accentuated by the small or total lack of concrete cover observed, which was measured in areas showing segregations for both elements that range from 1 to 5 cm deep and openings between 10 and 15 cm in average, presenting exposed steels rods without concrete cover. These damages are mainly due to the low material quality control and lack of supervision during its construction.

Brick and natural stone masonry sections are stable, with samples of saltpeter and stains due to fungi, so the risk of damage is low.

Among the most evident structural consequences that may occur (or already exist) in the analyzed structure (chainage 0+145): local and global load capacity problems, significant bond strength losses between steel and surrounded concrete, modification of failure mechanism (from ductile to brittle), loss of deformation capacity (local and global) and susceptibility to buckling of longitudinal steel reinforcement.

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USED FORMULAS, ABBREVIATIONS, ACRONYMS

Cu/CuSO4	Copper/Copper Sulphate
CO2	Carbon dioxide
Ecorr	Corrosion Potentials
mV	Millivolt
pH	Unit of measure which describes the degree of acidity or alkalinity of a solution
in-situ	On-site
cm	Centimeters

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

BOOK REVIEW

PLANNING FOR DEVELOPMENT IN LATIN AMERICA AND THE CARIBBEAN. FOCUS, EXPERIENCES AND PERSPECTIVES

—

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Fraga R. Evelyn L. (2020). [Reseña del libro Planificación para el desarrollo en América Latina y el Caribe. Enfoque, experiencias y perspectivas, de Máttar, J., & Cuervo, L. M.]. *Espacio I+D, Innovación más Desarrollo. IX*(22), 172-177. Recuperado de https://espacioimasd.unach.mx/docs/Resena_libro_Planificacion_para_el_Desarrollo.php

Keywords

Planning, development, multi-temporality, multi-scale, intersectional, evaluation.

The book Planning for development in Latin America and the Caribbean. Focus, experiences and perspectives was written by authors from the Economic Commission for Latin America and the Caribbean (ECLAC), an institution that is part of the United Nations regional commissions and whose objective is to collaborate mainly in a technical manner for the development of said region. Jorge Máttar, former director of the Latin American and Caribbean Institute for Economic and Social Planning (ILPES), an organization that is part of ECLAC and whose vision is to generate knowledge, present research and technical proposals related to the State's role, planning and public management in development processes. Luis Mauricio Cuervo is currently an Economic Affairs Officer at ILPES and his research focus on the analysis of development theories and practices, as well as on the investigation of prospective tools applied in construction of futures as a means for long-term planning.

Modern planning paradigm has been strongly analyzed by ECLAC. Within this framework, ILPES is compiling a compilation of experiences of nine countries in the region in the 21st century, based on current challenges it faces, identifying the following: (i) Multi-temporality; (ii) Multi-scale; (iii) Intersectional; (iv) Evaluation and monitoring. In this way, the present document establishes a synthesis of the main research results generated on planning challenges outlined above.

The first chapter studies "Planning for Latin America and the Caribbean development", beginning with a historical analysis of the concept of development planning in Latin America, whose origin dates back to the 1970's and in which it is considered to be a central part of the State and industrialization is assumed to be an important part of it. During the 80's and 90's, planning was distorted and therefore its conceptualization did not have great advances. Development greatest challenges had as a means of operation public

management, which sought to resolve critical knots related to "development of plan, budget and results" (p.20).

Later, conceptualization of development planning from a modern paradigm has its origin in the 20th century, and starts from the "proclamation of the International Charter of Human Rights, the birth of the United Nations and the geopolitical disputes (...)" (p.19). Planning for development has as its main ingredients public management linked to management by results, public value chain creation, development of new political leadership, importance of citizen participation framed in the need to achieve sustainable and egalitarian development, economic slowdown which is one of the main challenges linked to the creation of own development models and finally it considers international agreements, an example of this is the 2030 Agenda, which through its Sustainable Development Goals aims to build a desired world in the long term in a collaborative way.

Thus, the chapter ends with the conceptualization of planning as "a political act, a theory and a discipline for the creation of a sense of belonging and future and multi-secular, intersectional, and multi-temporal governance of development" (p.35), and development planning is further understood as:

> [...] a means and not an end. Its purpose is to contribute to the construction of development, understood as a collective idea of the social duty to be, of what humanity in general and different groups in which it is organized intend for themselves as an ideal and as a vision of the future (p.36).

Multi-temporality challenge is addressed in chapter III, which analyses the way in which public policy has different time frames for its implementation. In this regard, it focuses on how countries of the region present solutions for articulating instruments and means of planning in short, medium and long term. Experiences of Guatemala, the Dominican Republic and Cuba have been considered in the analysis and show as a result the importance of having a long-term vision in planning processes that allows for the definition of State policies based on participatory processes that guide short and medium-term actions, medium-term planning that is aligned with periods of government and is articulated with the vision, and short-term planning that links management and budget with medium-term planning.

Chapter IV analyses multi-scale, which is based on the existence of various levels of planning; national, intermediate and local, and on these levels the existence of a variety of competencies and actors, making it necessary to articulate various scales and generate convergences in order to manage development within the framework of the national territory. Argentina, Mexico, Dominican Republic and Ecuador are analyzed, and as a result of their management, it is considered important in this challenge

to define the territorial problems and potentialities in the public policy framework, to build suitable regulatory mechanisms to guide the articulation of national and subnational planning, to generate dialogues for intergovernmental agreement, to develop mechanisms for follow-up and evaluation, and to improve institutional capacities.

Intersectional challenge is analyzed in chapter V. This challenge seeks to examine how countries propose to resolve coordination of specialized planning within a sector with more comprehensive and cross-cutting planning, recognized as intersectional and national planning. Brazil, Dominican Republic, Chile, Argentina and Mexico were analyzed in this chapter, the analysis of their experiences shows that one of the mechanisms used for section coordination is management by results. On the other hand, it is necessary at this level to convene non-governmental actors as well as the articulation and strengthening of institutional capacities. However, generation of budgets by section programs still presents challenges.

The chapter concludes by mentioning that the challenge of intersection analysis through experiences in the region has been complex and recommends the following to improve national and sectional coordination: (i) Generate mechanisms for coordinating national and sectional goals; (ii) Articulate national and sectional objectives; (iii) Link public investment with sectional investment; (iv) Strengthen institutional capacities and follow-up and evaluation mechanisms.

Chapter VI discusses the challenge of evaluation, plans and programs monitoring, which analyses the monitoring and evaluation measures that allow for improvement in the processes of public policy implementation and lifelong learning, as well as verification of planning processes developed in order to achieve desired results. Monitoring and evaluation applies to public policies, plans, programs and institutions. This chapter analyzes the experiences of Colombia, Chile and Brazil, identifying that currently in the region there are great advances in the implementation of monitoring and evaluation systems that have regulatory support, as well as responsible entities. However, it is still necessary to strengthen the monitoring processes at the local level, as well as the monitoring of international commitments such as the 2030 Agenda, on the other hand, it is necessary to strengthen impact evaluations mainly at program level.

The document ends with conclusions, which the following can be highlighted: (i) Planning must be understood as a system, i.e., coordination processes that must exist in its components must be identified; (ii) Challenge of participation cuts across all planning challenges identified in the document and must therefore be analyzed in the planning processes; (iii) Tools that allow progress to be made on each of the challenges are, in general, strategic planning, foresight, management by results, multi-year

budgets and monitoring; (v) Planning is a political act which must contribute to the achievement of society's wishes and desires. In this regard, it is necessary to have long-term national agreements which guide action in the medium and short term.

It is important to mention that planning system is not static, therefore tools used are various, complementary and evolve over time, since they respond to specific moments and problems; this is why institutions such as ECLAC and ILPES share tools, methodologies and in general, knowledge generated in the region regarding planning as a development tool and a shared learning mechanism.

Finally, in the book analysis framework, I consider that it is of great relevance in learning from the region's experiences regarding the challenges of modern planning; however, research could deepen in an analysis of articulation mechanisms of regional planning and how this would support the hegemonic development of Latin America and the Caribbean.

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ABBREVIATIONS

ECLAC: Economic Commission for Latin America and the Caribbean
ILPES: Latin American and Caribbean Institute for Economic and Social Planning

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FIRST PLACE IN THE POSTER CONTEST "CARLOS GRAEF FERNÁNDEZ" DEL LXII CONGRESO NACIONAL DE FÍSICA 2019

BLACK HOLE DISPERSION: HAYWARD

—

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RESUMEN

The current work analyses flat wave scattering problems that impact on a black hole. In this case, a Hayward black hole is worked on, using the Klein-Gordon equation for a massless scalar field, and the differential equation obtained is solved numerically to find the differential effective section.

Black holes are objects so compact that not even light can escape their gravitational pull. Nowadays, existence of supermassive black holes (millions of times the mass of the sun) in the center of many galaxies, and smaller black holes (5-10 times the mass of the sun) in binary X-ray systems is generally accepted [1].

The Schwarzchild black hole, the simplest, has spherical symmetry and is described by the line element

$$ds^2 = -\left(1-\frac{2M}{r}\right)dt^2 + \frac{1}{\left(1-\frac{2M}{r}\right)}dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\varphi^2, \quad (1)$$

here, M is the mass of the black hole (in natural units).

In this paper, we will study scattering problems involving black holes. This problem is similar to a scattering problem, where the refractive index of the medium is not constant. In black holes case, curvature of space-time produces the scattering effect of the incident waves.

Let us consider a plane wave $\psi(z)=e^{i\omega z}$ that strikes the black hole. Information from the black hole is encoded in an effective long-range potential. Effective potential on the incident plane wave modifies standard expressions (plane space) for the scattering amplitude.

The scattered wave (see Image 1) can be expressed as

$$\psi(r,\theta) \approx Ae^{i\omega z} + f(\theta)\frac{e^{i\omega r}}{r};$$

$$f(\theta) = \frac{1}{2i\omega}\sum_{l=0}^{\infty}(2l+1)(S_l - 1)P_l(\cos\theta), \quad (2)$$

where $\mathbf{f}(\theta)$ is the amplitude of dispersion, S_l is the S matrix and $P_l(\cos\theta)$ are the Legendre polynomials of order l.

From the scattering amplitude, the differential effective cross section [2] is obtained, given by

$$\frac{d\sigma}{d\Omega} = |f(\theta)|^2. \quad (3)$$

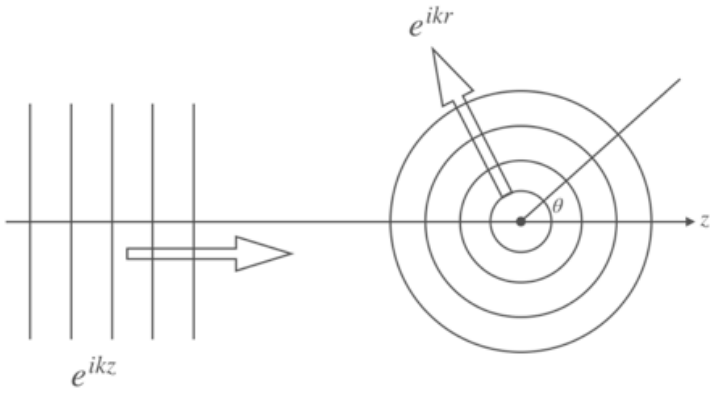

Image 1. Incident plane wave traveling in the z-axis and the scattered spherical wave

SCALAR FIELD EQUATION AND EFFECTIVE POTENTIAL

Reference [3] describes a regular black hole, this model has spherical symmetry, is asymptotically flat and has no singularities in $r = 0$.

Space-time of the Hayward regular black hole line element is

$$ds^2 = -F(r)dt^2 + \frac{dr^2}{F(r)} + r^2 d\Omega^2, \quad F(r) = 1 - \frac{2Mr^2}{r^3+2M\epsilon^2}, \tag{4}$$

where M represents the mass of the black hole, the parameter $\boldsymbol{\varepsilon}$ is associated with a cosmological constant. For $\boldsymbol{\varepsilon} = 0$, the Hayward metric is reduced to the Schwarzschild metric.

Regular Hayward black hole describes the behavior of a collapsing or evaporating black hole and may have one or two event horizons, depending on the relationship between mass and parameter $\boldsymbol{\varepsilon}$.

Consider a massless scalar field $\boldsymbol{\psi}$ that propagates in Hayward space-time. The equation governing the evolution of the scalar field is

$$\frac{1}{\sqrt{g}}\partial_\mu\left(\sqrt{g}g^{\mu\nu}\partial_\mu\psi\right) = 0. \tag{5}$$

For monochromatic plane waves, we have

$$\psi_\omega = \sum_{l,m} \frac{\phi_l(r)}{r} Y_l^m(\theta,\varphi)e^{-i\omega t}. \tag{6}$$

with $\psi_\omega = Y_l^m(\boldsymbol{\theta},\boldsymbol{\varphi})$ the spherical harmonics. Substituting (6) for (5), the following equation is obtained

$$F(r)\frac{d}{dr}\left[F(r)\frac{d}{dr}R_l(r)\right] + [\omega^2 - V(r)]R_l(r) = 0\,, \tag{7}$$

where we have considered that **φ=0**. The effective potential *V(r)* is given by

$$V(r) = F(r)\left[\frac{1}{r}\frac{dF(r)}{dr} + \frac{l(l+1)}{r^2}\right]. \tag{8}$$

The effective potential is plotted in Image 2.

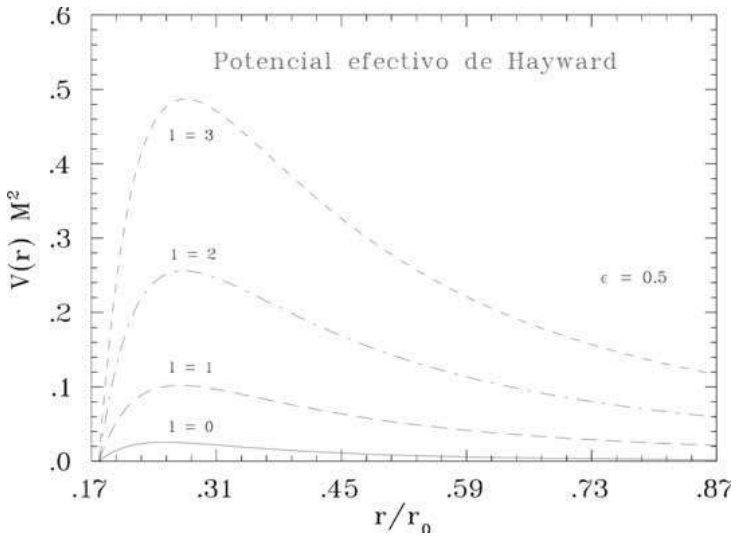

Image 2. Effective potential (8) for a scalar wave in a Hayward black hole, with *l = 0, 1, 2, 3* for *M* = 1 and **ε** = 0.5

NUMERICAL SOLUTION

Solution to equation (7) is possible by using a numerical method, defining the function's values in discrete quantities on a uniform nodal spacing grid. The differential equation becomes a finite difference equation and can be solved along a grid by calculating new values of the function from previously known values.

Using Taylor's second order expansion for a *u(r)* function. Solving the first and second derivatives of *u(r)* (equations (3.5) and (3.26) of [4]) gives

$$u_i' \approx \frac{u_{i+1}-u_{i-1}}{2h}; \qquad u_i'' \approx \frac{u_{i+1}-2u_i+u_{i-1}}{h^2}; \tag{9}$$

where h is the interval between the nodes and the subscript in u label the nodal point. Substituting in equation (7) and clearing *ui+1*

$$u_{i+1} = \frac{2F(r)h^2}{2F(r)+\frac{dF(r)}{dr}}\left[\frac{2u_i - u_{i-1}}{h^2} + \frac{\frac{dF(r)}{dr}}{F(r)}\frac{u_{i-1}}{2h} + \frac{1}{F(r)}[\omega^2 - V(r)]u_i\right] \quad (10)$$

Amplitude of dispersion $f(\boldsymbol{\theta})$ can be rewritten as follows [4]

$$f(\theta) = \frac{1}{2i\omega}\sum_{l=0}^{\infty}(2l+1)(S_l - 1)P_l(\cos\theta) \quad (11)$$

where S_l is called the **S-matrix**. Which is written as

$$S_l = \frac{u_l(r_{n-1})r_n h_l^{(-)}(\omega r_n) - u_l(r_n)r_{n-1}h_l^{(-)}(\omega r_{n-1})}{u_l(r_n)r_{n-1}h_l^{(+)}(\omega r_{n-1}) - u_l(r_{n-1})r_n h_l^{(+)}(\omega r_n)} \quad (12)$$

here $\mathbf{h}_l^{(\pm)}(\omega r_n)$ are the spherical Hankel functions and $u_l(r_n)$ sare the solutions of equation (10).

RESULTS

The following figure shows the numerically calculated differential effective dispersion section and the Glory approximation.

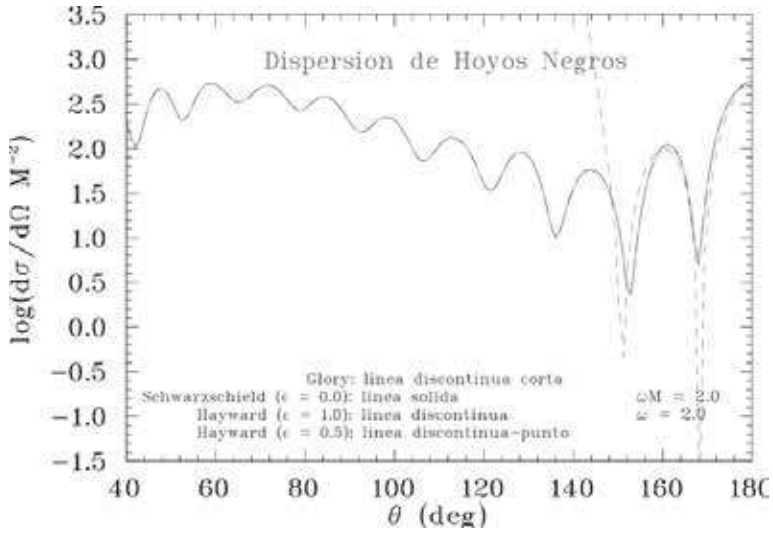

Image 3. Differential RMS section for Hayward metric

CONCLUSIONS AND STANDPOINT

- Results obtained coincide with the Glory dispersion formula.
- Analyze black hole scattering problem considering electromagnetic and gravitational fields.
- Other black hole scenarios can also be analyzed.

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ANNEX


La Sociedad Mexicana de Física

Otorga el presente

RECONOCIMIENTO

A

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Pedro Josué Hernández Penagos, Universidad Autónoma de Chiapas;
Omar Pedraza Ortega, Universidad Autónoma del Estado de Hidalgo

Por ser uno de los ganadores en el Concurso de Carteles
"CARLOS GRAEF FERNÁNDEZ",
MB-522. "Dispersión de hoyos negros: Hayward"
8 de octubre de 2019

LXII Congreso Nacional de Física 2019

Dr. Tonatiuh Matos Chassin
Presidente de la
Sociedad Mexicana de Física