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Presentation of Content

In the first article we present, *Energy poverty from a Oaxacan context: Towards an inclusive, pertinent and resilient characterization seen from the solidarity economy and the capabilities approach*, by MATUS-ENRÍQUEZ, Itzel Omara, MORALES-LÓPEZ, Julio Ulises, CHÁVEZ-RUÍZ, Tonatiuh Javier and MARTÍNEZ-LUNA, Edgar Salvador, with adscription in the Universidad Tecnológica de los Valles Centrales de Oaxaca, as next article we present, *Analysis of the thermal sensation in cold period outdoor spaces, in the dry climate of the metropolitan area of Tijuana, Baja California, Mexico*, by SAHAGUN-VALENZUELA, Miguel Isaac, ZARATE-LOPEZ, María de los Ángeles, PITONES-RUBIO, Juan Antonio and ALMEJO-ORNELAS, Alberto, with adscription in the Universidad Autónoma de Baja California, as next article we present, *Design of a digital communication platform to food donations*, by RAMOS-GONZÁLEZ, Luz María, GÓMEZ-MÉNDEZ, Elisa Itzel, CUENCA-LERMA, José Manuel and LAGUNA-CAMACHO, Juan Rodrigo, with adscription in the Universidad Veracruzana, as next article we present, *Water distribution system coupled to a sustainable purification plant for low-income communities in México*, by TORRES-LÓPEZ, José Manuel, CRUZ GÓMEZ, Marco Antonio, MEJÍA PÉREZ, José Alfredo, LÓPEZ AGUILAR, Genaro Roberto, with adscription in the Benemérita Universidad Autónoma de Puebla.

Content

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Energy poverty from a Oaxacan context: Towards an inclusive, pertinent and resilient characterization seen from the solidarity economy and the capabilities approach

La pobreza energética desde el contexto oaxaqueño: Hacia una caracterización incluyente, pertinente y resiliente vista desde la economía solidaria y el enfoque de capacidades

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Abstract

This article aims to redesign the concept of energy poverty through an inclusive and relevant characterization of the biosocial context of the state of Oaxaca, Mexico, since none of the existing concepts in the literature understand its particularities. Based on solidarity economy and the capabilities approach, we discuss the relevance of reflecting on the areas of energy needs and their satisfiers by integrating quantitative and qualitative aspects, as well as the desired outcomes of the communities who suffer from this type of poverty. In addition, this article highlights the cultural methods and capacities that people have to intervene favorably in their energy satisfaction. The methodology for the research relies on a work breakdown structure, where students searched, selected and analyzed the so-called areas of energy needs in Oaxaca. In the final reflections, we define the concept of energy poverty as: lack self-management, access, and affordability of energetic resources impacting social development, collective growth, and health without compromising cultural values and worldview informing the right to personal decision making on what type of energy source is chosen to satisfy essential services in a household.

Energy poverty, Energy development, Sustainability

Resumen

El presente artículo busca rediseñar el concepto de pobreza energética mediante una caracterización incluyente y pertinente al contexto biosocial del estado de Oaxaca, México, debido a que ninguno de los conceptos existentes en la literatura comprende sus particularidades. Basados en la economía solidaria y el enfoque de las capacidades, discutimos la pertinencia de reflexionar sobre las áreas de necesidades energéticas y sus satisfactores desde una mirada que permita integrar aspectos cuantitativos y cualitativos, así como, la visión de las personas que padecen este tipo de pobreza, destacando las formas culturales y las capacidades que tienen las personas para intervenir favorablemente en su satisfacción energética. La metodología para la revisión de literatura fue la estructura de desglose de trabajo, donde acopiamos recursos humanos de estudiantes para buscar, seleccionar y analizar las denominadas áreas de necesidades energéticas de Oaxaca. En las reflexiones finales, exponemos el concepto de pobreza energética como: la incapacidad de autogestión, acceso y asequibilidad a los recursos energéticos, que repercuten en el desarrollo social, superación colectiva y salud de las personas, sin comprometer los parámetros de cultura y cosmovisión en el derecho de decisión-elección de la fuente de energía, así como, en la satisfacción de servicios esenciales del hogar.

Pobreza energética, Desarrollo energético, Sostenibilidad

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1. Introduction

The Energy poverty and its transversal dimensions

In Mexico, 36.7% of the population live under energy poverty (from this point forward named as EP). The main appliances that this portion of the population lacks are "thermal comfort, efficient refrigerators, and gas or electric stoves" (García-Ochoa and Boris-Graizbord, 2016, p. 304). In addition, in 2019, Mexico was ranked eleventh place out of nineteen countries in Latin America with multidimensional poverty (Lagner, 2019).

The State of Oaxaca has a rich culture and many natural resources, but many of its communities live in poverty. In contrast to its wealth, Oaxaca is considered the state with the fourth largest amount of people living in poverty in Mexico. Poverty is defined as "when a person lacks at least one essential social need and not enough income to cover it" (CONEVAL, 2020: p.13) and under extreme poverty…. When a person lacks two or more essential social and has not enough income to cover basic groceries" (Ibid).

In reference to the previous paragraph, the concept used in Mexico to understand and measure the poverty levels and its effects is multidimensional poverty. This is not just a definition or a measure of poverty, but rather understood as an infringement on human rights through the goods and services that promote wellbeing and quality of life. There are eight indicators for this measure method, which are: Income, education level, access to health services, access to social security, access to nutrition, housing quality and size, access to housing utilities, and lastly, social cohesion (CONEVAL, 2015).

When analyzing the multidimensional poverty of Mexico/Oaxaca, it is important to consider the derivation of concept that allows one to go more in depth on EP, showing that it has a direct correlation with at least two of multidimensional poverty's indicators: quality and size of housing and access to housing utilities. EP is a social injustice issue (Sovacool and Dworkin, 2015) that exposes several inequalities and complex challenges for the human development.

Addressing the disparities of EP is a planned objective that will be discussed at the United Nations Organization's meeting in 2030. (Objective 7, Affordable and Non-Polluting Energy).

It could be said that it is excessive to develop another definition of EP given the fact that there are several publications that have defined and indicated the effects of EP. Nevertheless, the existence of various other indicators reflects a need to develop the concept of EP at a local level. The exiting definitions and indicators that tend to omit the cultural characteristics and idiosyncrasies of a community in their analysis generally have strong economic (based primarily in the income) or technological (based on the energy latter) components that do not consider the cultural practices of obtaining and consuming energy, communities' opinions on their own energy scarcity and needs, and the unique meanings ascribed to the concept of "energy" by each region. (Calvo, et al., 2019).

It is important to mention that the definitions of the traditional EP concept are based on an observer's perspective, whom has no direct experience in the mentioned living circumstances. Most of these publications focus on the economic aspects without considering the entire environment and its factors; consequently, this makes the definitions only an informative concept without giving the opportunity to its application to develop a better quality of life and consequently a better energy system.

Research conducted by Pellicer (2018) and Calvo, et al. (2019) considers that the applied EP concepts, used by researchers internationally, are inadequate and rely too heavily on quantitative indicators (economic and technological), while overlooking qualitative indicators such as sociocultural elements, structural and survival practices, and community abilities and skills.

A qualitative and multidimensional solution to counteract energy poverty is energy autonomy. Energy autonomy can be achieved if productive and economic approaches are developed that do not base their existence on individualism and resource utilitarianism.

The practice of solidarity economy[1] contributes to a better understanding and distribution of energy resources, incorporating perspectives that consider the production, management, and common consumption of energy resources from the perspective of justice, cooperation, reciprocity, and mutual aid (Borge, 2015 quoting Pérez et al, 2008 p. 8). With an emphasis on solidarity economy, the definitions and implications of poverty and energy will be discussed from a perspective of collective support reinforcing community ties.

The community lifestyles have been practiced for hundreds of years in rural Oaxaca cannot be ignored. Combining the perspectives of the solidarity economy with the capabilities approach of the community and their ability to develop their own processes and goals will help to develop a better understanding of the relevant indicators of EP, including political, socio-cultural, environmental, technological and economic factors, creating the opportunity to create a more environmentally sustainable system.

Additionally, the current energy model for the economy of natural resources is having significant impacts in three different ways: energetic (consumption of fossils and non-renewable fuels), economic (based on accessibility and cost since most of the community live in poverty), and environmental (negative impact in the environment and community's health). These three factors contribute to a further widening of the gaps and impact of a global crisis (Regueiro and Doldán, 2014).

The relevance between poverty, energy, society, technology, and the environment should become more important lines of research (García, 2014), giving way to inclusive energy systems adapted to the situations of communities and people. The reconceptualization of EP based on qualitative information will create opportunities for possible intervention approaches that could improve the lives of communities.

The main goal of this research is to provide a new concept that will redesign the definition of EP from the perspective of the solidarity economy merged with the capabilities approach.

In this research, thermal comfort, water heating, food cooking, lighting, cooling, and water purification are key uses of energy used in the characterization of EP. In other words, since these components function with a specific purpose linked to a basic human need, they should be key aspects in redefining the EP.

Before redefining EP, the ways in which Oaxacans have satisfied their own energy needs must be identified. That way, we can characterize the needs of those living in EP in a multidimensional, inclusive and pertinent way.

2. Background

EP metrics publications have identified four conceptual perspectives: Multidimensional Energy Poverty Index (MEIP), Multi-tier Framework for Energy Access (MFEA), Three-Dimensional Territorialized Indicator of Energy Poverty (ITTPE), and the energy and human necessities approach. The first two approaches (MEPI and MFEA) are commonly used in less developed countries (Bhatia and Angelou, 2015, p.4), since they are based on an energetic hierarchy that correlates a residences' consumption of energy to its economic status. The other two approaches (ITTPE and energy and human necessities) are based on a Latin American context, specifically Chile and Mexico (Kroon, Brouwer and Beukering, 2011).

Although the criteria used in these approaches can be useful in the context of Oaxacan communities, the methodological approaches do not fully correspond with the context in which they are living in. The information they lack includes:

2.1 Difficulty obtaining data

The methods on which MFEA and ITTPE base their technical criteria are highly specific. This results in data being difficult and costly to obtain in a field study. For example, to measure the carbon monoxide levels in a house, specialized equipment and corresponding usage training is required.

[1] This publication will be based on the solidarity economy approach to better explain the social processes of the region of interest. This approach will unify the focuses of the social economy and the solidarity economy that can be applies depending on the region.

Additionally, ITTPE proposes a national standard of electric installations that corresponds with quality and security of access to energy (Calvo et al., 2019, p. 19).

In Mexico, compliance with this standard (NOM-001-SEDE-2018) can only be determined by the Unidad de Verificación de Instalaciones Eléctricas (UVIE), which is expensive and impractical to perform in a field study.

2.2 Energy Hierarchy

MEPI methodology is composed of five fundamental elements for essential energetic services that are then subcategorized into six criteria (electricity access, access to modern cooking fuel, indoor air pollution, ownership of household appliances, ownership of an entertainment and education and communication media) (Nussbaumer, Bazilian & Modi, 2012, as cited in Lin & Okyere, 2020). The focus on these criteria results in an inadequate analysis at a sub national level, classifying a family or residence as living in EP if the combination of deprivations they face exceeds a predefined limit (Mendoza & others, 2019).

Both the MEPI and the energy and human needs approach refers to the idea that the selection of certain fuels (particularly, firewood for heating and cooking food) implies a low economic status. The correlation between the use of certain fuels and income status has been criticized by authors such as Kroon, Brouwer, and Beukering (2011, p. 7) asserting that the correlation is not as significant as it was thought to be, especially in Latin America.

2.3 Underestimation of renewable and passive technologies

When variables such as thermal comfort are analyzed, the use of specific technologies such as fans and air conditioners are considered. However, this leaves out passive solar technologies such as housing designs. MEPI and the energy and human needs approach do not take into account technologies such as solar sanitary water heaters or solar stoves. According to MEPI and the energy and human needs approach, a home using a solar heating system or kitchen would be considered to be living in EP.

2.4 Cost of living and income level

ITTPE and MFEA utilize a scale of energy costs and income to determine EP. ITTPE utilizes the Low-Income High Cost to define its indicator (Calvo et al., 2019, p. 12) which has been criticized by Middleniss (2016) as well as Linares and Romero (2016). They argue that the method of the Low-Income High-Cost indicator is inefficient and tends to yield false positives and negatives when assessing the energetic efficiency of a residency.

On the other hand, MFEA establishes a spending limit of 10% of a families income for a 36.5 Kwh/year consumption package. Even though the limits are adaptable, the MFEA does not consider the varying rates based on consumption and how it is affected depending on the region's climate. Furthermore, it considers the expenses in an autonomous system as excessive and consequently part of the EP spectrum.

2.4 Discrepancies between the concept and its metrics

Garcia's (2020) energy and human needs approach based on Garcia (2014) and Garcia and Graizbord (2016) focuses its EP analysis on three categories: 1) basic human needs required to live, 2) benefits and state of well-being as a result of consuming energy though specific equipment and appliances, and 3) a residence, which is categorized by one or more people living in the same place. While the energy and human needs approach uses a quantitative-qualitative approach, it does not measure or evaluate poverty itself. Rather, it gives an general overview of the deprivation of technological resources by providing a conceptual relevance of the different facets of EP, but not in terms of its metrics.

This approach focuses on Mexico, but there are discrepancies on its praxis and episteme since the EP concept cannot be removed from the local and economic systems that are important according to Townsend (1962) and Sen (2000), who focus on people's needs and their satisfaction factors from a relative perspective (Townsend) and an absolute perspective (Sen).

In conclusion, it is essential to present pertinent criteria that reflect both the absolute and relative scopes of EP. It is important to identify the needs of a community versus what their cultural practices are (the use of firewood does not necessarily indicate poverty, but rather the reflection of cultural traditions). Oaxaca has great potential in utilizing renewable energies and passive solar technologies.

3. Conceptual framework

3.1 Energy Poverty

When referring to energy poverty, there needs to be an understanding of the duality of the phrase derived from its metrics (indicators) and conceptualization (definition). Within the established definitions, one can find quantitative and qualitative approaches from only a third-person perspective. The characteristics of energy poverty depend on the region, income level, society, and technology available specifically to the region itself. Energy poverty should be defined by interconnected variables that determine what the root issue is. Next, the various definitions of EP that have been established in prior studies will be analyzed and serve as a reference to guide this study.

3.1.1 Predominant Quantitative Concept

The quantitative conceptualization of energy poverty occurs when its components are more orientated to income level and when the acquisition of goods satisfies the common areas of the energetic workforce. According to Bordman (1991), a home under energy poverty is the one using more than 10% of its income on energy consumption costs, including any appliances needs to have a certain level of comfort. In a more recent study, Bordman and Culver (2017) concentrate on the scarcity and incapacity to obtain home energy services, making homes unsafe and inhabitable.

Mires (2014), Bhatia and Angeleon (2014) define energy poverty as experiencing energy inefficiency due to a lack of resources and energy services that would satisfy basic human needs in a healthy, convenient and efficient way. In this definition, there is a direct correlation between human needs and energy resources.

In the transition of conceptualizing EP with material and economic predominance to a concept focused on human needs, Middlemiss and Gillard (2015) propose to define EP by focusing on the lack of capacity in acquiring energy resources used to sustain a healthy life. The capacity or lack there of highlights the importance of managing energetic resources based on the communities that need them.

Masaud (2007) continues with the capabilities approach from Sen to confirm that EP is the lack of options and access to proper, reliable, and safe energy that is environmentally friendly and favors economic and human development.

The definition from Garcia (2014) and Garcia & Graizbord (2016) is foundational for this research since it was developed using a Mexican context and defines a home under energy poverty as:

“The people who live there and do not satisfy their absolute energy needs, which are related to factors of satisfaction and essential economic goods based on their social and cultural values for a specific time and place” (García, 2014:17).

Garcia (2014) asserts that his definition includes the absolute and relative needs described by Sen (1981) and Max-Neeh et al (1991). His definition titled “Necesidades Absolutas de Energía” (NAEs) presents a model based on needs and satisfaction factors in relation to the cultural and social practices that manifest a dimension of relative deprivation.

It’s important to note that although EP is a phenomenon that is generalized to a group of severe social and historical inequalities, the impacts are disproportionate, causing bigger harm to disadvantaged groups. According to Castelao y Mendez (2019), EP has a bigger impact on poor women’s health since it increases the time it takes to perform normal household activities, which are not compensated monetarily and therefore uphold the feminization of poverty.

Garcia’s (2014) concept of EP, while a strong concept, also has its weaknesses.

"His definition has conceptual and methodological flaws, scarcely articulating concepts of poverty, survival strategies, vulnerability, and social exclusion. In addition, the existing bibliography does not explain how EP's distinct factors interact and how this phenomenon factors into compensated and non-compensated labor, and the wellbeing of the people in a home" (Castlao y Mendez, 2019:148).

After the analysis of the information, we can conclude that the capabilities to access energy resources of any kind is not necessarily related to its economic power. The real difficulty lies in the person's ability to access and adopt practices and strategies.

3.2 Solidarity economy

For many decades, the management and distribution of energy resources has been conceptualized by the dominant economy; as Razeto (2001) says in his book "Los caminos de la economía de solidadidad", when people talk about economy, they spontaneously refer to scarcity, competition, profits and interests, among others, and although the concept often includes values, ethics and freedom of initiative, it does not give the value it deserves to gratitude, camaraderie or solidarity.

The main purpose of the economy should be a person's well-being. The concept of EP results in many inequalities due to the close relationship between the economy and the energy sector, which it why it is necessary to approach this issue from the perspective of someone who is living this experience and has the ability to make personal and collective decisions for a better future.

According to Reas (2011, pág. 1), "Solidarity economy is the approach in which economic activity prioritizes the community, environment, and sustainable development. In other words, it is a way of living that encompasses the integrity of people and designates the economy to provide the material bases for the personal, social, and environmental development of the human being in a sustainable way."

Solidarity economy is a post neoliberal alternative based on values such equity, ethical consumption, and labor instead of wealth (Coraggio, 2011) and tries to converge autonomy with self-management (reas, 2011), in order to provide sufficiency over subsistence in relation to production and exchanges sustained by solidarity communities.

One of the most important arguments that outlines EP relates to solidarity economy sociocultural systems coexisting under capitalism. These systems operate under a collective use of resources and factors of satisfaction compared with other systems that operate from a private and utilitarian perspective.

Some countries have established a solidarity economy to reduce EP. In 2018, Greece implemented "Energetic Communities" through the adoption of judicial cooperatives that promote innovation in the energy sector, advocate against EP, and promote sustainable energy through various levels such as production, storage, self-consumption, and distribution (García y Frantzeskaki, 2021: 2).

Greece's law 4450/2016 article 2.1 defines social economy as the economic activities that present different alternatives for production, distribution, consumption, and reinvestment mainly based on principles such democracy, equity, solidarity, cooperation, and respect for the human beings and the environment (García y Frantzeskaki, 2021: 2).

Considering the fact that the cost of energy was very high and many of the islands lack infrastructure and rely heavily on fossil fuels, Greece's government was able to reduce territorial inequalities through their "Energetic Communities" by implementing solidarity economy principles.

By integrating this system into their economy, Greece is reducing the existing inequalities at a faster pace. In conjunction with politics, production and fiscal incentives, communities now can generate, manage, and even sell renewable energies at a local level (García y Frantzeskaki, 2021: 2).

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Implementing the solidarity economy as an alternative economy allows for holistic development both individually and collectively by promoting self-management, autonomy, cultural liberty, development of people's capabilities, environmental awareness, and community and economy solidarity based on local, national, and international relationships (Reas, 2011).

These intersections explain that multidimensionally improving one's quality of life requires the consideration of their liberty and capabilities as mentioned by Sen (1980). In other words, it should be considered that people will face a situation based on their personal knowledge and environments such as culture, technology, society, economy, and environment.

3.3 Capabilities Approach

The capabilities approach is based on the liberties and capabilities needed to obtain a desired living status (Sen, 2003). This approach is used when there are absolute provisions, thus poverty is discussed through the capabilities approach, focusing on its characteristics and utility.

The capabilities discussed are the liberties to choose a valued lifestyle. Therefore, not only goods and their benefits can be taken into account but characteristics take an important role when pursuing a desired lifestyle. The capability of a person is defined through the real-life applications of the various combinations of functions that can be achieved (Sen, 2000).

Capabilities are defined as one's ability to be effective/one's ability to achieve effectiveness (Colmenarejo, 2016, p. 123) in terms of functionality and capability through specific evaluations (León, 2018), by the real or effective opportunities available to the person to realize such functionalities (Colmenarejo citing Robeyns, 2005, p. 192), being a term of importance, the freedoms or opportunities that a person enjoys achieving such functionalities (León, 2018).

According to Pellicer (2018), the capabilities approach can be used to analyze the concept of EP from the perspective of the people who suffer this inequality by asking: what energetic capabilities are valued and undervalued and what are the problems that arise as a result of experiencing energy poverty? By asking these questions, the capabilities approach gives people the agency to analyze their own situation and can be applied to EP.

4. Methodology

In order to redefine EP, one must analyze the bibliographic context that identifies how Oaxaca's communities satisfy their energy needs based on their social and cultural values and the region's environment.

The research began by developing a focus group of 24 students within the Engineering in Renewable Energies program, specifically with the ER-1001 group of the Universidad Tecnológica de los Valles Centrales de Oaxaca, during the September-December 2020 term.

As part of its methodology, the study applied an EDT structure which made it more manageable to break down its phases or steps in order to achieve the desired result. The hierarchical breakdown is based on the work done within the team (Granillo, 2009). The EDT structure looks for the increase of detail and information as it moves through each phase (Díaz, 2006).

The students divided into subgroups and assigned deliverables and goals for the project. The first selection of sources included subjects related to energy and its interests from different fields of study such as Technology, Engineering, and Social Sciences.

The following stage consisted of reviewing the literature based on the development of analytic categories of energetic needs. This was followed by a group discussion on the categories pertaining to the energetic needs. The final phase consisted of the group synthesizing the information collected in the previous phases to focus on the factors of satisfaction related to energetic needs. The results and outcomes of these phases will be presented in the results section.

5. Results

5.1 Areas of energetic satisfaction as per Oaxaca's communities needs

After extensive analysis of research and previous studies, the following information of energetic needs were found:

5.1.1 Thermal Comfort

Oaxaca is one of the states in Mexico with the highest indices for social underdevelopment (CONEVAL, 201) along with Chiapas and Guerrero, having a 73.4% deprivation rate in relation to living thermic comfort (García y Graizbord, 2016).

Although these communities seem to have precarious living situations based on the percentage of the population living without thermal comforts, it is important to mention that the climate of each region varies, thus and in-depth analysis is required to access if sustainable alternatives could meet the needs of each region.

According to CONCANACO SERV Y TUR (2018), the climate is warm sub humid and warm humid with 22 C median temperature and median precipitation of 1,550 mm, which is the reason why the population, do not have the need for a heating system in their homes, with the exception of those living in the highest areas of Sierra Norte, Sierra Sur, and Mixteca due to their colder temperatures.

The construction of a home should be an integral part of research considerations in addition to the environment and regional climate (Haramoto, 2002, citado por Ruiz, 2014).

The state of Oaxaca uses a variety of construction materials; approximately 60% of houses and buildings in Oaxaca's rural areas are built out of adobe or other mud-based materials. Just like many buildings in the different regions of Oaxaca, the buildings in the downtown historic center of Oaxaca were constructed based on the climate of the region (Instituto Politécnico Nacional, 2011).

The areas of Oaxaca with a semi-warm and mild sub-humid climate record an annual temperature between 12C to 18C (Barbosa, 2004). Taking this information into account, the evaluation of thermal comfort needs to take into account the materials used to build house.

For example, according to Sánchez (S.f.) Adobe as part of construction system preserves the cultural identity and authenticity of the person and contributes to environmental preservation. Because of its thermal mass, adobe is able to maintain warm temperatures during winter and consequently provide a comfortable temperature inside houses. Furthermore, adobe's composition and density makes it an ideal material for mild temperatures. It is also nontoxic, 100% environmentally friendly, recyclable and has acoustic properties. (Sánchez s.f.). Another optimal building material is wood because of its abundance throughout Oaxaca.

The burning of wood or charcoal is a great source of heat used in rural areas of Oaxaca. This energy source is also used to heat water, cook, and warm the living space. For example, a citizen, Toribia form Magdalena Jaltepc, stated using firewood to warm the house was enough because of the low temperatures of the area, "I used firewood regularly during the winter to keep warm the kitchen and the room" (Montes, 2020).

In summary, the material used as a heat source or to construct buildings depends on the climate of a specific region. The most common materials used are adobe, wood, and cantera.

5.1.2 Water Heating

The characteristics and conditions of the climate in which one lives determines the necessity of the use of the water at boiling or room temperature. Access to clean water is unequal and limited. In 2015, only 45.3% of homes in Oaxaca had water (INEGI, 2015). More than half of the population does not have water in their houses and if they do have water, they do not have the resources to heat the water for their own use. There are different methods for water heating such microwaves, coffeemakers, electric or gas ranges. The heating methods that tend to be underestimated are ones based on natural resources such solar energy, charcoal, and wood.

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63% of a families total expenses is spent on the consumption of gas, with 54% being used to heat water. However, close to half of households used another source of energy other than gas to heat their water (SIE, 2018). It is important to understand the factors that determine the key impacts of energy consumption in regard to water heating.

The geo-climate factor: Oaxaca has a very bio-diverse climate because of its geographic location. This has a direct impact on the energy consumption, infrastructure and related services, throughout the year (CEPAL, 2018). With seven different climates, Oaxaca is ranked as having the most varying climates of any state in Mexico. It is important to consider the varying climates, regional differences, and how alternate heating methods used by the communities to meet their needs indicate how to obtain a more accurate analysis of energy consumption in Oaxaca. Geography and the climate indicate the needs of communities living in warm climate versus cold climate. Culture, gender, age, and purpose of a resource also play a big role when determining the needs of an individual or community (Garnica, 2020).

According to data from INEGI (2018), mild climate regions have the highest concentration of gas water heaters, about 11millions units, reflecting 70% of the population. Compare this to tropical climate regions such as Campeche, Chiapas, Guerrero, Oaxaca, Tabasco, and Yucatan using 510 thousand units. The data reflect that the methods used to heat water in the mild climate regions, including Oaxaca, are 81% gas, 6% solar energy, 12% electricity, and 1% wood. Rural areas in mild climate regions are more likely to use wood as a source of energy to heat water and cook (Contreras et al, 2003).

Solar energy is another method used in Oaxaca for water heating. The market from 2000 to 2015 reflected an increase from 0.7% to 3.7% for households showing interest in solar energy technology (CEPAL, 2018), but the cost of the equipment is high and the knowledge of its purpose and functionality is limited. Thus, the growth in demand in the market has been affected. Furthermore, the access to this technology is limited to certain populations because of its location. The goal of adopting this technology is to reduce the households' consumption of gas LP and and save energy.

In conclusion, urban areas in Oaxaca are more likely to use gas LP, solar energy, and occasionally electricity for water heating purposes.

5.1.3 Food Preparation

Oaxaca has a wide variety of traditional tools used to prepare food. According to Hinojosa (2003), wood is the main fuel used because of the availability of trees, mainly Mesquite and Encino. The use of wood also has a favorable economic impact on the food industry and can be used to produce other biofuels such a vegetable charcoal.

Wood has been used as a resource in Oaxaca for generations; although various types, sizes and byproduct are utilized, they all serve the purpose of preparing home cooked meals that communities need.

A Lorena stove is a type of technology that optimizes dendroenergy (wood energy) while preserving customs of rural families who use wood as a main source of food preparation (Vazquez et al, 2016). According to FAO-SAGARPA (2007), this type of stove lowers the risk of illnesses that can develop from inhaling smoke that show up mostly in women and children under 5 years old. Additionally, open ranges represent 80% of waste (FAO-SAGARPA, 2007). On the other hand, Mayorga (2017) shows that an earth oven is commonly utilized in the Isthmus region.

5.1.4 Lighting

Good lighting in a home extends the activities that one is able to accomplish in comparison to only using natural daylight. According to INEGI (2015) 3.2% of the population of Oaxaca has no access to electricity and instead uses fire, candles and fossil fuels as an alternate source of light, consequently having a negative impact on the environment and health. (SIFRA, 2018).

Mexico has a high presence of solar energy throughout most of the country. Half of the country has an average insolation of 5.5KWh/m2 a day, which is enough to cover 24 hours of the energy needed to illuminate the average household (SENER, 2012).

Throughout the year, Oaxaca experiences significant solar irradiation between 4.7 KWH/m2 and 5.8kwh/m2 per day, which facilitates the operation of photothermic systems used to generate electricity by heating fluids and photovoltaics (UNAM, 2011).

Due to the lack of electric services provided by the the federal commission of electricity, solar energy can be a viable alternate source of energy. Solar energy is a renewable energy that is free and, more importantly, there is plenty in Oaxaca as shown by the irradiation data previously mentioned. Unfortunately, there is little interest in transitioning to this technology because of the lack of understanding and political support, presence of myths, and the high cost due to low demand.

5.1.5 Refrigeration

The majority of food can quickly go bad according to Diaz (2005). The best way to conserve food is refrigeration to slow down food's decomposition. It contributes to factors like reducing biological activity (growth of bacteria) and water loss, and conserving nutrients (Inestroza, et al 2016). According to data from INEGI (2015), 64% of households have access to a refrigerator and freezer ((DIGEPO,2017). Those without access to refrigeration have to use alternative methods to preserve their food.

An example of an unconventional food preservation method is making brines using salt and vinegar, which limits the loss of water and therefore reduces decomposition and the growth of bacteria (Brito, 2019). Another method is the drying of the food outside to preserve its natural state for a longer period of time (UNESCO,2008). How food is packaged and stored also plays a critical role in food preservation by controlling content of humidity (Guevara y Cancino, 2008).

Another method is the adding of solutes such as salt or sugar. This method preserves food, although for a minimal period of time, since the bacteria's growth is restricted to the water availability (Guevara y Cancino, 2008).

Fermentation preserves food through the growth of microorganisms such as mold, fungus, or yeast (Infoalimentos, s.f.). Lastly, evaporation is used to conserve food by reducing the amount of water and augmenting the concentration of total solids (Guevara y Cancino, 2008). Similar to the drying method, the evaporation method of preserving food heats the food to reduce the amount of water. Rather than using natural heat outside, evaporation requires direct heat.

In conclusion, homes without access to refrigeration have implemented simple conservation methods that are as efficient as refrigeration (Langle y Jimenez, 2018).

5.1.6 Water Purification

The most common methods of water purification involve the following stages: capitation, filtration, sedimentation, decantation, coagulation, coloration, alkalization, and distribution (Samsa, 2008). These stages are processed and completed through specialized equipment that require electric energy to operate.

In 2015, according to CONAGUA 92018:103), 932 purification factories had a flow of 93.6 m3/s, and demonstrated the most significant lags in Oaxaca, Chiapas, and Guerrero.

The purification system in Oaxaca City consists of 58 water wells, with 23 of them being inactive because the equipment is broken (SENER, 2016). The estimated annual consumption of energy for these factories is 13,472,300kwh for an average consumption of 1.19 kwh/m3 of water extraction and 2.27 kwh/m3 for water admitted (SENER,2016). The lack of potable drinking water in Oaxaca is due to the energy poverty situation that the state is currently in.

The technology of social implementation to meet the vital need of potabilization fits perfectly within the type of projects described by Collin (2008). These types of projects emphasize autonomy and the need to diminish the dependency on the market by constructing networks that will guarantee safe drinking water.

Within this classification is ecotechnics, which guarantees safe drinking water for the household through solar disinfection.

From the viewpoint of the solidarity economy, the human right of access to clean drinking water is solidified, since its goal is to guarantee access to necessary resources used promote human development without dependence on current economic situations.

Final Reflection

In order to redesign the concept of EP, it was necessary to identity the concepts and approaches that guarantee a more inclusive and relevant definition. Solidarity economy's areas and dimensions were identified along with capability approaches pertinent to the aims of the study.

The following areas were most important to the comprehensive redesign of EP:

- Human rights
- Sustainable Development agenda 2030
- Decision Making Capabilities
- Quality of Life
- Ensuring health
- Energetic needs as per geolocation
- Culture
- Worldview
- Holistic analysis
- Energetic Natural Resources
- Affordability of current energy sources
- Access to existing energy sources
- Technological resources
- Knowledge of energy-providing technology
- Capacity for Individual development and achievement of goals

According to the information found, the cultural dimension plays an important role for the new redesign concept. By linking Oaxaca's biodiversity with the culture and traditions, the community will have more relevant alternatives to satisfy their energy needs than the ones offered by most economic systems.

Although not all people have access to electric networks or sufficient resources to support continuous consumption of gas, they can opt to use renewable fuels as an alternative to satisfy their needs.

Moreover, similar to the cultural dimension, environmental and technological dimensions are key in achieving autonomy and energy self-management in the regions. One benefit of renewable energies in any of the energetic areas discussed is that the use of ecotechnics and social technologies permits the attainment of energy resources in an accessible, affordable and inclusive way.

In contrast to Garcia's (2014) territorial characterization of EP, underlined by defining thermal comfort, refrigeration, lighting and water heating as "economic goods", we find that rather than possessing economic value, these energetic areas guarantee the realization of human rights. Therefore, they are more than a means to purchase and rather an end that should be guaranteed.

In conclusion, using the works of various authors, above all Garcia and Graizbold (2014), we have redefined the concept of EP as:

The lack self-management, access, and affordability of energetic resources impacting social development, collective growth, and health without compromising cultural values and worldview informing the right to personal decision making on what type of energy source is chosen to satisfy essential services in a household.

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Analysis of the thermal sensation in cold period outdoor spaces, in the dry climate of the metropolitan area of Tijuana, Baja California, Mexico

Análisis de la sensación térmica en espacios exteriores periodo frío, en el clima seco de la zona metropolitana de Tijuana, Baja California, México

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Abstract

Weather variables affect the permanence of a user at an outdoor public space, the diverse aspects of these variables can affect the user's thermal sensation. Thus, by knowing the outdoor comfort temperatures or neutrality temperatures values, users can extend their stay in the areas that are exposed to outdoor weather conditions, a reason why we intend to find the values for those neutral temperatures on the outdoor spaces at the Valle de las Palmas area, in Tijuana, Baja California, because by knowing these values, there can be improved outdoor spaces designed in accordance to the city's climate variables. In order to find these temperature values, a case study was selected, in which an instrument or survey was applied, designed to inquire what the perceived thermal sensation of the user at the open space is, while thermal monitoring was carried out at the same time with the use of automated measurement tools and, once the data was gathered, diverse variables were collected based on the ISO 7730-2005 standard, while Microsoft Excel software was used to analyze the field data and, as a result, the appropriate neutrality temperature was obtained to be able to design future outdoor spaces or redesign and improve the existing ones.

Thermal Sensation, Neutral Temperature, Outdoor Spaces

Resumen

Las variables climatológicas afectan la permanencia de un usuario en un espacio público exterior, los diversos aspectos de estas pueden alterar la sensación térmica del usuario, por lo que al saber cuáles son las temperaturas de confort exteriores o temperaturas de neutralidad el usuario puede alargar su estadía en las áreas expuestas a las condiciones exteriores, es por lo anterior que se busca conocer cuáles son esas temperaturas neutras en los espacios exteriores para la zona de Valle de las Palmas, Tijuana, Baja California, ya que al conocer cuáles son, se pueden diseñar espacios exteriores acordes al tipo de clima de la ciudad. Para conocer dichas temperaturas se seleccionó un caso de estudio, en el cual se aplicó un instrumento o encuesta, diseñado para conocer cuál es la sensación térmica percibida del usuario del espacio abierto, a la vez se realizó un monitoreo térmico con instrumentos de medición automática, y se recopilaron diversas variables basado en la norma ISO 7730-2005, una vez recopilados los datos se utilizó el software de Microsoft Excel para hacer el análisis de los datos de campo y, como resultado, se obtuvo la temperatura de neutralidad adecuada para poder diseñar futuros espacios exteriores o rediseñar y mejorar espacio ya existentes.

Sensación Térmica, Temperatura Neutra, Espacio Exterior

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Introduction

When using an outdoor space, the amount of time in which this space can be used depends on the existing level of comfort in said place. Since it depends on several aspects, including thermal comfort and, unlike indoor spaces where an artificial climate system such as air conditioning or heating ventilation can manage to control temperature to stay within the thermal comfort range, outdoor spaces lack this type of climate control, which however can be improved by means of an adequate architectural design of such spaces and the use of techniques that could improve the direct incidence of the meteorological variables, which would help to induce users to stay longer at the outdoor space. However, in order to achieve this, it is necessary to find out the temperature value of the appropriate neutrality for the place.

In order to search for the thermal comfort temperature at an outdoor public space in the semi-desert climate of Tijuana, a survey was applied on a case study which was chosen for its analysis, where the thermal sensation of the surveyed users was evaluated. The data was collected during the winter season of 2020, the instrument included variables such as: user satisfaction within the temperatura range of the place, the type of clothing the users wore at the time, what were their temperature preferences compared at that moment or how they felt that there was humidity in the environment. Meanwhile, at the same time the temperature and relative humidity readings were recorded by means of data loggers. The design of the instrument is based on ISO 7730-2005 standard, while the survey has a scale of values that goes from one to seven, which ranges from very cold to very hot.

When analyzing the results of the data collected from the applied survey and the data logger, it is possible to find that the neutrality temperature (Tn), or thermal comfort temperature, is the result of the rating given by the user according to the scale of seven that grades the outdoor open space, thus the data can be applied at cities with a weather condition similar to that of Tijuana. To improve coexistence within the designed spaces which take into account the appropriate temperature, to achieve definition of the (Tn), a total of 145 surveys were conducted during 2020's winter season.

To obtain the diagnosis of a space in which it is shown that an area is within the range of its comfort zones, as well as the intervention about design strategies for parks or other open spaces, it is necessary to use strategies of inductive methods along with field research and climatic variables, all of this necessary to improve the length of used time of the spaces by the users. (Guzmán, F., & Ochoa, J., 2014)

Thermal comfort

Since the start of human evolution, mankind has tried to change the environment in order to feel comfortable in its living space. This can be noted on the oldest houses from various civilizations on Earth, which date from ancient times through the modern era were it can be observed that, according to the type of weather, man seeks to adapt spaces to the local climate to feel comfortable. Nowadays, feeling comfortable at home or at the working space is still one of the most important aspects to consider when designing an architectural space whether indoor or at outdoors.

Thermal comfort, which is defined by the ISO 7730 (2005) standard as "That state of mind in which satisfaction within the thermal environment is expressed". The former is a definition which is adequate for most people and therefore is accepted, yet it is a term that has its own difficulty since it is based on the individual's subjectivity as he expresses it. Figure 1 shows the complexity of the evaluation of thermal comfort, in which there are two groups of people in the same city and at the same area, but in very different situations, however both cases demonstrate that they can be within thermal comfort despite the difference of conditions. (Chávez, F.J., 2002)El

Figure 1 People in different conditions and enviroments, both cases in termal comfort
Source: Author's archive

Methodology

Study research of comfort in exterior spaces methodology has been developed recently, since there are different variables from those that affect thermal confort at indoor spaces. Thus, there is limited control of the aspects that affect outdoor spaces, that is why there is a greater complexity between the relationships of the studied parameters, being the reason that a greater variance occurs, due to the little control of the meteorological variables and the adaptation period for the user at the time of being outdoors (Gómez, et al., 2010).

Yanavilca, O., (2021), says in his research that, in order to estimate the thermal sensation of people in outdoor public spaces, relationships must be established among the measured values of the climatological data, and the sensation of thermal comfort of the users when using the analyzed space, thus, external factors such as air temperature or humidity must be considered, collecting data at different times of the day, which entails greater difficulty since the outdoor climatic conditions are variable and very different from those that occur within indoor spaces.

To collect the data, a survey was applied where the users subjectively express their thermal sensation at that moment. Weight and height data of the surveyed users were taken, as well as the dry bulb temperature and RH data. The surveys designed by Bojórquez, G., (2010), by Nikolopolou (2002) and by Guzmán, F., (2014) were taken as a basis for the development of the applied instrument.

The survey is divided into several sections, the first for space location data, the second for the type of activity that was carried out during the survey, the third for user data, the fourth section of the instrument is the most important since it is the one that collects the various aspects of the users' physical adaptation to the space, either due to their thermal sensation or humidity as well as their thermal preferences. In accordance with the ISO 7730-2005 classification, during the fifth section the weather data taken with the portable data loggers used were recorded after the event of the survey.

To make the selection of the measuring instruments for the survey, the reliability of use of the equipment, availability, ease of use to not require extensive training, were taken into account. The search resulted in the selected equipment with a reliability of ± 0.1ºC and with a range of measurements that goes from -20ºC to 70ºC, and with a battery life of up to one year and more than fifty two thousand measurements (see figure 2).

Figure 2 Measuring equipment used during research.
Source: Author's archive

To carry out the analysis of the surveys, all responses were transferred into Excel spreadsheets, where the information collected from the surveys carried out on paper was captured. Once the database from the surveys and the data captured by the data loggers was created, the analysis of the forty three captured variables was continued, including the vote of the thermal sensation by users of the outdoor space.

Location

The survey application site was located within the Tijuana metropolitan area in the Valle de las Palmas academic unit which is located at coordinates 32 ° 25 ′ 59 ″ N, 116 ° 40 ′ 31 ″ W (see Figure 3). The Metropolitan Area of Tijuana includes the Municipalities of Tijuana, Tecate and Playas de Rosarito, the area is adjacent to the East with the Municipality of Mexicali, to the West with the Pacific Ocean, to the South with the Municipality of Ensenada and to the North with the San Diego County while to the Northeast is adjacent to Imperial County, both in the neighbouring state of California.

Figure 3. Map of Valle de las Palmas location
Source: Google Earth application

The research is focused on the thermal comfort of the users of outdoor space, in which field information was collected during February 2020 through the survey developed for the study and with the use of the appropriate instruments to measure temperature and RH. All of the above conducted to evaluate thermal comfort in the analyzed outdoor public space.

The place selected to carry out the survey is located on the grounds of the Autonomous University of Baja California (UABC for short), which is located in Valle de las Palmas, Tijuana, Mexico. These are common public spaces, open to be visited by both the community from the UABC and by users who can reach the visiting campus (see Figure 4).

Figure 4. Aerial view of Valle de las Palmas campus
Source: Google Earth

UABC's Valle de las Palmas campus is located within Tijuana's metropolitan area, to the southwest of the bordering area between the municipalities of Tijuana and Tecate. The Valle de las Palmas academic unit has an area of 240,668 m² (about 59 acres).

It has large esplanades paved with concrete as well as some sports areas (see Figure 05).

Figura 5 Common outdoor areas at Valle de las Palmas
Source: Author's archive

Data and results analysis

While simultaneously monitoring meteorological variables along with the application of the user's subjective evaluation instrument, the maximum value of the ambient temperature or Temp. Amb. Max, registered a value of 17° C. Likewise, a minimum value was registered for the ambient temperature or Temp. Amb. Min. which was 8° C. Within the same record it was possible to obtain values for maximum relative humidity or R.H. Max, with a value of 26% and also the minimum value of relative humidity R.H. Min. which registered 20% (see Table 1).

Valle de las Palmas unit			
Temp. Amb. Max °C	Temp. Amb. Min °C	R.H. Max %	R.H. Min %
17	8	26	20
Average: 12.5		Average: 23	

Table 1 Variable maximum, minimum and average temperaturas recorded at Valle de las Palmas
Source: Author's archive

The data obtained in the field were analyzed and processed separately, grouping them according to ISO 7730 standard categories as can be seen in Table 2. For each of the groups, the mean temperatures were determined, as well as the standard derivation and, when any of the groups did not have enough reliable data, it was eliminated. By having the data analyzed, there were established ranges for each response, starting from the mean temperature or *Tn*.

Finally, a linear regression was made with the resulting values, by which the straight lines corresponding to the extreme limits of the ranges were determined, defined by mean Tn ± 2, the close limits mean Tn ± 1, and those obtained with mean Tn. (Bojórquez, G., et al, 2010).

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	Thermal sensation
7	Very Hot
6	Hot
5	Somewhat Hot
4	Neither Cold nor Hot
3	Somewhat Cold
2	Cold
1	Very Cold

Table 2 Categories for vote of thermal sensation
Source: ISO7730:2005

The survey was applied to a total of 145 people during the winter of 2020, each one giving their vote of perceived thermal sensation distributed as follows: 38% of the responses were for feeling an environment neither cold nor hot, which represents being neutral or comfortable, 36% gave their vote for feeling somewhat cold, which would be to have a slight discomfort to the perceived environment, and 29% of the votes were to be cold in the place, which represents feeling discomfort for the space regarding the thermal environment (see Figure 6).

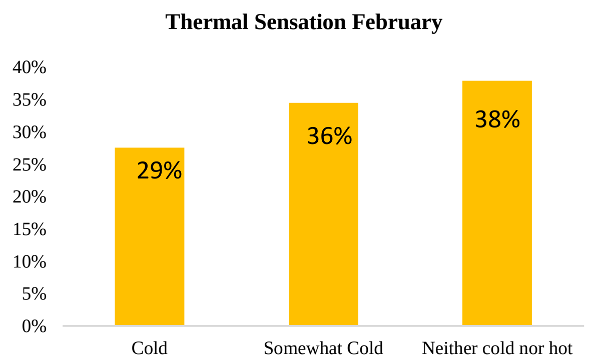

Figure 6 Percentages of the vote of thermal sensation
Source: Author's archive

For data analysis, the Thermal Sensation Interval Measurement Method (MIST for short) was used, in which items were established to calculate the average values and the standard deviation of all the defined groups. With the method, a linear regression was performed, using only the mean values of the sample while not all the values were used, thus, each range is established by adding and subtracting the standard deviation of the sample once and twice (Bojórquez, G. , et al, 2010).

Once the MIST method was applied, the data that can be seen in Table 3 was obtained, where the Tn or Neutral Temperature can be appreciated, as well as the thermal comfort's reduced and extensive range values, based on the equation of the linear regression straight line applied for the mean values.

DS	Thermal Sensation	Scale	TN-2DS	TN-1DS	TN	TN+1DS	TN+2DS
2.99	Neither cold nor hot	4	8.15	11.13	14.12	17.11	20.09

Table 3 Tn and narrow and long range
Source: Author's archive

The neutrality temperature (or Tn) for the measured and analyzed space has a value of 14.12° C, with a reduced range of thermal comfort of 5.98° C, or ± 2.99° C from the neutrality temperature, and an extended range of thermal comfort of 11.96° C, or ± 5.98° C from neutral temperature (see Figure 7).

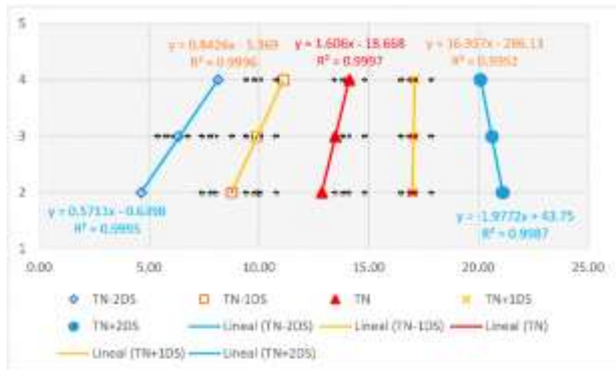

Figure 7 Thermal Sensation vote by ambience temperature
Source: Author's archive

It can be noted in Figure 7 how the users, despite being in the same place and within the same climate conditions, give a different vote of thermal sensation, which is because there are different aspects that can affect the vote of each individual. As the sociocultural physiological or psychological aspects at the moment, these aspects will be reflected in the emission of the vote given by the user during the survey. (Guzmán, F., & Ochoa, J., 2014)

For the data of the results collected in the present investigation, it can be appreciated that 2.99° C resulted as the reduced range of thermal penalty for the analyzed space, and that the neutrality temperature of the space was established at 14.12 ° C (see Table 4).

DS	Thermal Sensation	Scale	TN-2DS	TN-1DS	TN	TN+1DS	TN+2DS
4.11	Cold	2	4.65	8.76	12.88	16.99	21.10
3.58	Somewhat Cold	3	6.33	9.90	13.48	17.06	20.63
2.99	Neither cold nor hot	4	8.15	11.13	14.12	17.11	20.09

Table 4 Neutrality temperature and standard deviation.
Source: Author's archive

Conclusions

During the instrument application used to assess the vote of the respondent's thermal sensation, weather presents an asymmetric behavior with a tendency towards cold temperatures, that is why no votes were given for warm sensations in the questionnaire, which shows a tendency towards adaptation to the cold period of the users.

If the comparison into account of Tn, which was 14.12° C, against the minimum ambient temperature recorded in the three ranges recorded, which was 8 ° C, a difference of -6.2° C can be appreciated and, since the reduced range had a value of ± 2.99° C, it is concluded that this is the reason because the votes of thermal sensation tend to have a value of thermal discomfort. During the instrument application, there were 65% of the casted votes with some degree of discomfort.

Since the straight lines of the linear regression chart are not parallel, it means that the adaptation of the users to the space is not symmetrical as their perception of the temperature changes from hot to cold, since during cold periods sensations tend to be outside the thermal comfort range when using outdoor spaces.

When comparing variables resulting from the surveys applied to each user, along with the climate and vote made during the instrument application, the level of comfort in which the user was at the moment can be noted, resulting in a temperature of comfort, which can be used as a design temperature for planning future spaces which could have a climate similar to that of the case study of semi-desert type.

As it can be appreciated in Table 4, the standard dispersions decrease as the average temperature of each of the ranges increases, which leads to the deduction that the lower the average temperature of the space after scale 4 (or neither cold nor hot), there is a greater consensus of discomfort due to thermal sensation in the place, as well as there is greater dispersion in the votes of thermal sensation due to the differences between the metabolism and activity of each surveyed individual.

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Design of a digital communication platform to food donations

Diseño de una plataforma digital de comunicación para la donación de alimentos

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Abstract

In this paper, a communication strategy between the individuals involved in the donation and collection of food is presented and thus, in this way, reduce the loss or waste of the same, which is one of the causes of food insecurity in Mexico and in the world. The platform is implemented as a distributed computing system. The system is accessed through a mobile application that operates on Android. The server implements the PHP language and stores the information in a relational model using the MySQL manager. In addition, the communication between the client and the server is done through the REST protocol encapsulating the data in JSON In this system, donors can see the location of nearby altruistic organizations, consult information and contact them through social networks. (WhatsApp, Facebook, and Twitter). It also publishes donation offers for organizations to contact them and view reports of donations made. Organizations visualize the offer of users and contact them through social networks. Likewise, they must record the follow-up of each donation received in order to ensure the delivery of the food.

Food insecurity, Communication platform, Food waste or loss

Resumen

En el presente trabajo se presenta una estrategia de comunicación entre los individuos involucrados en la donación y recolección de alimentos y así, de esta forma reducir la pérdida o desperdicio de estos que es una de las causas de la inseguridad alimentaria en México y en el mundo. La plataforma se implementa como un sistema computacional distribuido. Se tiene acceso al sistema a través de una aplicación móvil que opera en Android El servidor se implementa mediante el lenguaje PHP y almacena la información en un modelo relacional utilizando el gestor de MySQL. Además, la comunicación entre el cliente y el servidor se realiza mediante el protocolo REST encapsulando los datos en JSON. En este sistema, los donadores pueden ver la ubicación de las organizaciones altruistas cercanas, consultar información y contactarlos a través de redes sociales. (WhatsApp, Facebook y Twitter). También publica ofertas de donativos para que las organizaciones los contacten y visualizan reportes de los donativos realizados. Las organizaciones visualizan la oferta de los usuarios y los contactan a través de las redes sociales. Asimismo, deben de registrar el seguimiento de cada donativo recibido con la finalidad de asegurar la entrega del alimento.

Inseguridad alimentaria, Plataforma de comunicación, Desperdicio o pérdida de alimentos

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Introduction

Food insecurity is one of the main worldwide problems, due to the inability of families to acquire nutritious food, which is reflected in the hunger and malnutrition of their members. One of the main causes of this issue, in addition to poverty, is the waste or loss of food at all levels and phases of the food chain. Some of the actions that are being carried out is the creation of food banks that are non- lucrative which dedicate to the collection of food that later donate to the people who need it most, for them they establish alliances with medium and large companies, as well as individuals who intend to support by making financial or in-kind donations.

Consequently, it is proposed a project where the objective is to design a communication platform between people who can donate food with the organizations that are dedicated to providing it to population sectors with food security problems, reducing the levels of waste of food in Mexico.

The first section describes what food insecurity is, as well as the loss and waste of food, later it is explained about the realization of the design and architecture of the system to finally expose by means of an example the operation of the application.

It is important to mention that this platform is intended to support the reduction of food waste and therefore support families with food insecurity problems through communication between the parties involved.

Food Insecurity

One of the most difficult problems for humanity to combat is food shortages and malnutrition. Although food production in some countries has increased, the number of hungry people has also grown, this is due to rapid population growth, coupled with inadequate food distribution.

The Food and Agriculture Organization of the United Nations (FAO) has defined that: “food security exists when all people have physical and economic access at all times to sufficient safe and nutritious food to satisfy their dietary needs and preferences in regarding food in order to lead an active and healthy life" (FAO, 1996).

On the contrary, food insecurity is defined as “the limited or uncertain availability of nutritionally adequate and safe food; or the limited and uncertain ability to acquire adequate food in socially acceptable ways” (Shamah-Levy, Mundo-Rosas, & Rivera-Dommarco, 2014).

Poverty is the root cause of food insecurity since it can be the cause of unemployment or insufficient income that does not allow us to buy food. To guarantee household food security, it is necessary to improve nutritional status at the family level (Figueroa-Pedraza, 2003).

Food Wasting

Eradicating hunger and malnutrition are one of the great challenges that are currently faced worldwide, its consequences not only manifest in poor health, but also in other areas such as education and employment. To combat this situation, in 2015 the world community adopted the 17 Sustainable Development Goals in order to improve wellness by 2030. In this paper we focus on the Second Goal (Zero Hunger). In that sense, the intention of that goal is to end hunger, achieve food security, improve nutrition and promote sustainable agriculture. (Programa Mundial de Alimentos (WFP), 2021) Food loss and waste can occur at all levels and in every phase of the food chain from production to consumption.

This phenomenon can be analyzed from 2 points of view: the nutritional and environmental approach. The former is lost before it fulfills its function of nourishing humans and the latter is about some food that can be seen as waste. FAO takes the first approach by distinguishing between food loss and waste. “If food is discarded at any stage prior to consumption, it is loss; if the reduction occurs in the final phase of consumption, it is about waste”.

The loss and waste of food not only represents a loss of the opportunity to feed the population, but its reduction is an important step to combat hunger and improve the level of nutrition of the most disadvantaged populations. Every year, more than 1.3 billion tons of food are wasted around the world, which is one third of global production.

This, in monetary terms, represents close to 1 trillion euros in economic costs, 700,000 million euros in environmental costs and around 900,000 million euros in social costs. (Hidalgo & Martín-Marroquín, 2020) The total amount of food wasted reaches 20 million tons per year in Mexico. That amount, according to the Bank of Mexico, could cover the food demand of at least 7.3 million Mexicans living in poverty and generate income of 400 billion pesos. (NOTIMEX, 2018)

Nowadays, various actions are being carried out, among which the food banks stand out. The Food Bank of Mexico is one of the most recognized organizations in charge of promoting the creation of food banks in entities with an incidence of poverty. In addition, it rescues products from the field, supply centers, self-service stores, packing houses, etc. The purpose is to distribute them in the associated food banks. (Banco de Alimentos de México, 2014).

Food banks have alliances with big companies and startups that donate food (Nestlé, Alpura, Femsa, Bimbo, Gamesa, among others) (Banco de Alimentos de México, 2021) to later distribute it to those who need it most. However, it is reported that the greatest food waste occurs among consumers who are often unaware of the location of these organizations or the way to communicate with them. They also do not know the people who may have or need these foods.

Therefore, the purpose of this paper is to build a digital communication platform between people who can donate food with organizations that are dedicated to providing it to sectors of the population with food insecurity problems. In this way it will reduce the levels of food waste in Mexico.

Methodology

Based on the fact that reducing food loss and waste helps reduce the problem of Food Insecurity. Consequently, this project aims to contribute to the strengthening of food security through the reduction of food waste in the country by connecting people in situations of food insecurity with whom they can donate food to reduce food waste in Mexico.

The controlled variables correspond to characteristics of the community donation platform. Moreover, the variables to be observed measure the experience of using the platform and the amount of food wasted by users.

Controlled Variables

- Platform Access: refers to the strategy by which participants offer their food donations.
- Identification of Organizations: refers to the strategy used to find out the organizations with which the donation can be made.
- Identification of Risk Zones: refers to the strategy used to know the areas in which donations are delivered.
- Communication mediums: corresponds to the strategy used to establish communication between donors and specialized organizations.

Variables to be Observed

- User experience: corresponds to the perception that users of the platform have about its use. Its purpose is to determine the strategy with greater acceptance by the users of the controlled variables.
- Food Wasting: refers to the monthly amount of food that participants who use the platform waste.

Platform Design

The automation of the community food donation process is developed as a distributed computer system which is called "¿Usted Gusta?". The architecture of this system is client-server (Figure 1).

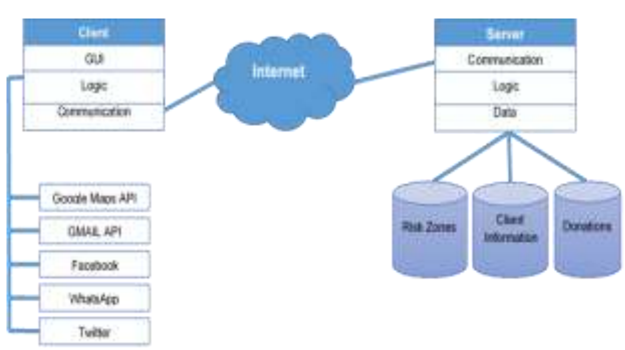

Figure 1 System Architecture
Own Elaboration

The client is a mobile application for users and organizations that receive donations. Likewise, it is a web application for the system administrator. All the information is stored in a central server which is a computational device where all the information of the system is stored and is retrieved by the client using web communication protocols.

The system includes three actors: users, organizations and the administrator. Each of them interacts with the system in a different way, their respective use cases are shown in figure 2, 3 and 4. It is important to mention that WhatsApp, Facebook and Twitter were chosen as means of communication among customers for the reason that these systems are already consolidated in this area.

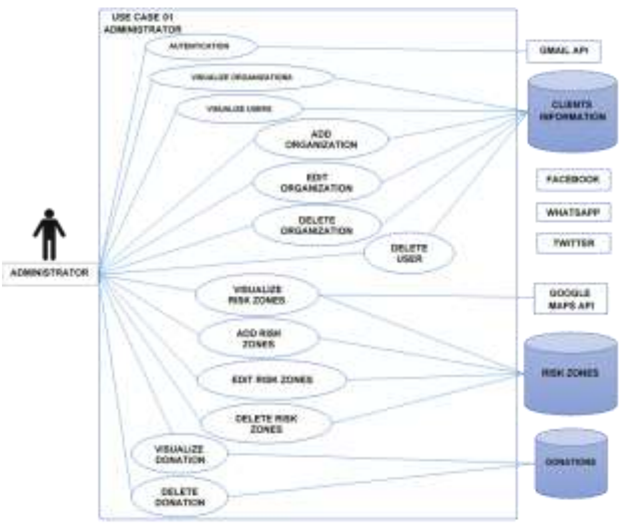

Figure 2 Use Case of Administrator Role
Own Elaboration

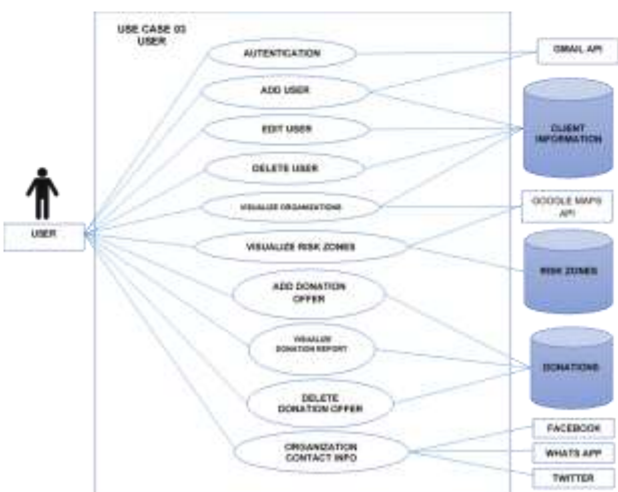

Figure 3 Use Case of Organization Role
Own Elaboration

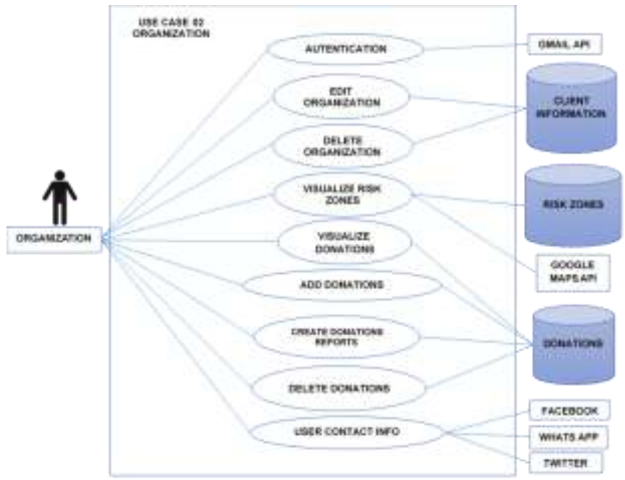

Figure 4 Use Case of User Role
Own Elaboration.

Platform Implementation

The technology to develop the system is described in table 1.

	Android App	Web App	Server
Backend	Java	JavaScript	PHP
Frontend	XML	HTML5, CSS3	-
Communication Protocols	POST	GET y POST	GET y POST
Data Encapsulation			
APIs	Google Maps API, GMAIL API	Google Maps API, GMAIL API	CURL
External Services	Facebook, WhatsApp, Twitter	-	-
Data Storage	SQLite	-	MySQL
Platform Publication	Google Play	Hosting Web	Hosting Web

Table 1 Technology to Implement the System

For the first prototype, the mobile application (Client) runs on the Android operating system. The supported versions are from 4.4 onwards. Therefore all 3 layers were developed with Kotlin using the Android Studio IDE. In addition, for users who do not have this operating system, a multiplatform web interface is developed using HTML5, CSS3 and JavaScript.

The server is implemented using the PHP language and stores the information in a relational model using MySQL. In addition, the communication between client and server is carried out through the REST protocol encapsulating data in JSON and through SHA 256 encryption.

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Results

It is implemented a distributed computer system which operates everywhere and every time.

System Use Scenarios

To understand the system functioning, we will assume that Manuel uses the software to donate food and Elisa uses it to manage the donations received in her organization. In the role of Manuel, he represents both a citizen and a company.

Organizations Location: Manuel has roast chicken that he wants to donate to help those most in need. He enters the system and locates on a digital map the closest organizations that receive donations. Likewise, the system gives him the option of contacting them through social networks to prepare the details of his donation. (Fig. 5)

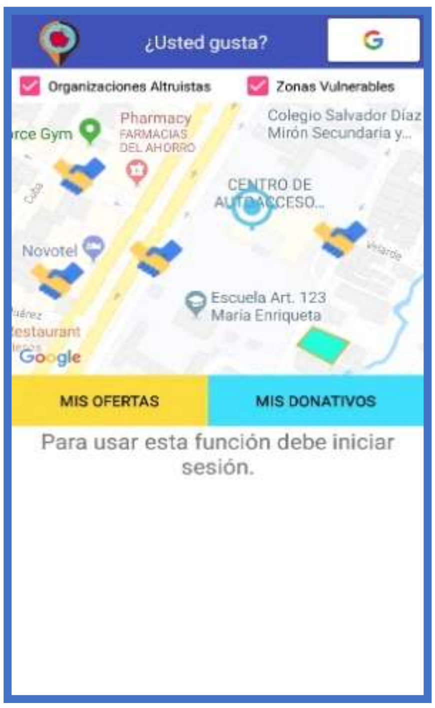

Figure 2 Organizations and Risk Zones Location
Own Elaboration

Figure 3 Registration of Donation Offer

Risk Zones Location: Manuel intends to donate the fruit that the trees in his yard give for the reason that he is not able to consume all of them. Also, he wants to go directly to the areas with food security problems, for this he enters the system and locates on a map the vulnerable areas. (Fig. 5)

Donations offer: Manual published in the system that he has 5 Kg of orange to donate. Elisa reads the publication and contacts Manuel to offer the services of her organization regarding the donation. (Fig 6)

Figure 7 Viewing donations
Own Elaboration

Donation Tracking: When Elisa receives the donation. She records it in the system. In this way, Manuel can see the follow-up that she is giving to the donation. Therefore, Elisa agrees to register the place where the donation was delivered and back it up with photographic evidence. Also, Manuel can share his donation on social networks to invite more people to use the system. (Fig. 7)

Finally, in figure 8 we can see how an organization that is dedicated to collecting food can register donations.

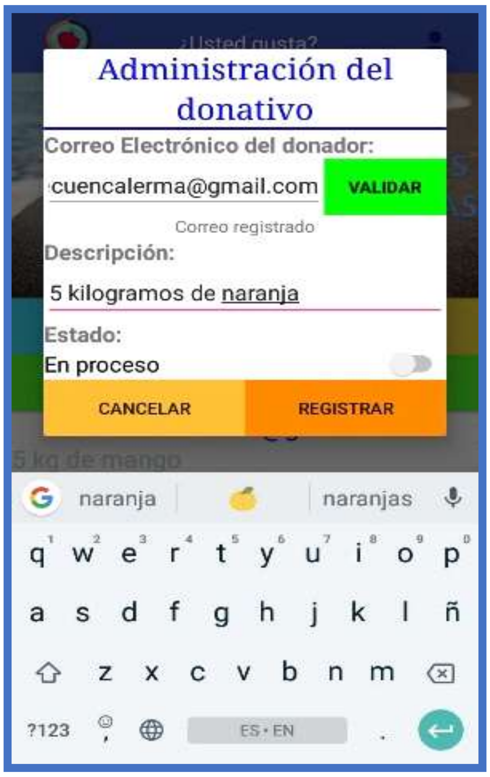

Figure 4 Register of an Organization Donations

Conclusions

Computer Technologies are used to develop "¿Usted Gusta?". This allows digitalization and automated processes obtaining information and communication as quickly as possible and making the food donation process as efficient as possible.

With the design of this platform, it is expected to obtain greater and better communication between the people who can donate food with the organizations that are dedicated to providing it to sectors of the population with food insecurity problems.

It is important to mention that this proposal is inviting the entire country to contribute to the task of achieving food security through the reduction of food waste, consequently, a collective synergy among citizens would be developing.

Therefore, the research contributes to the 2030 agenda of the SDGs, the development and implementation of this platform allows it to be a means of communication that speeds up the collection and distribution of food. In the same way that its projection and disclosure allow to transcend a greater number of the population, and which leads to an increase in the donation of food in an organized way since it would take control of the people who donate and those who benefit from this donation, as well as a decrease in the number of people who need food resources.

It is worth mentioning that at the beginning the approach of the platform "¿Usted Gusta?" was based mainly on reducing waste and promoting a culture of food donation, currently it is intended that. For the second phase of development and updating, this approach changes and allows donation in a general way, that is, all kinds of donations (food, clothing, money, blood, etc.), as well as continuing to work towards achieving the SDGs of the 2030 agenda.

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Water distribution system coupled to a sustainable purification plant for low-income communities in México

Red de distribución de agua acoplada a una purificadora sustentable para comunidades de bajos recursos en México

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Abstract

The National Water Commission (CONAGUA), determined that in Mexico approximately 10% of the population does not have water in their homes. In addition, Mexico is the country that consumes the most bottled water in the world, although there are communities that do not have water for their consumption. This research proposed a drinking water distribution network coupled to a disinfection plant for low-income communities in Mexico. It was carried out using a mixed methodology, applying quantitative techniques to find out the number of people without drinking water service in Mexico and qualitative ones to determine the best option of materials, purification method and type of supply. However, certain parameters must be met in the communities such as the maximum number of 1200 inhabitants for this option to be viable. This research served as a base project for implementation in remote communities and that will be proposed to government agencies and projects.

Drinking wáter, Distribution, Nanofiltration

Resumen

La Comisión Nacional del Agua (CONAGUA), determinó que en México aproximadamente el 10% de la población no tiene agua entubada en sus hogares. Además, México es el país que más consume agua embotellada en el mundo, no obstante, existen comunidades que no cuentan con agua para su consumo. Esta investigación propuso una red de distribución de agua potable acoplada a una planta de desinfección para comunidades de bajos recursos en México. Se realizó mediante una metodología mixta, aplicando técnicas cuantitativas para saber el número de personas sin servicio de agua potable en México y cualitativas para determinar la mejor opción de materiales, método de purificación y tipo de suministro. Sin embargo, se deben cumplir ciertos parámetros en las comunidades como el número máximo de 1200 habitantes para que esta opción sea viable. Esta investigación sirvió como proyecto base para implementación en comunidades apartadas y que se buscará proponer a dependencias y proyectos de gobierno.

Agua potable, Distribución, Nanofiltración

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1. Introduction

Water is an essential liquid for life and the development of society, it is used for industrial, domestic, and human consumption purposes. *World Health Organization [WHO]. (2013) and Boadi, N. et al. (2020).* More than 7,000 million people live in the world today. *United Nations [UN]. (2016).* However, 2 billion people (approximately 28% of the world population) lack access to drinking water services since population growth has accelerated and the technical difficulties to carry out this work have increased. *United Nations [UN]. (2020).* Furthermore, the sources of drinking water have diminished due to anthropogenic effects such as deforestation, human settlements and agriculture. *Boadi, N. et al. (2020).* Therefore, one of the challenges facing the world today is providing drinking water services to the population. *United Nations [UN]. (2020).*

In Mexico the population that has this service has increased since 1990, where 75% of the population had piped water, until 2015 where more than 90% have this service. *Comisión Nacional del Agua [CONAGUA]. (2018).* However, as coverage increases, the water supply becomes more complex. *Comisión Nacional del Agua [CONAGUA]. (2019) and López, P. (2019).*

Additionally, Mexico is the country that consumes the most bottled water in the world. *Paullier, J. (2015).* This is because the water travels long distances to reach its destination, which means that it passes through several sections of pipes, which can contaminate the water, carrying impurities in its path. Added to this, many families store water for their homes in places that are not properly cleaned. Therefore, the population in Mexico prefers to consume bottled water before that supplied in their homes, however some communities do not have water to drink.

The objective of this research is to propose a drinking water distribution network coupled with a sustainable disinfection system to supply water for homes and human consumption in communities with a population of maximum 1,200 inhabitants.

It seeks to improve the quality of life of its population with a safe and sustainable water service, for which a disinfection system was proposed that used renewable energy sources for its operation. *El Ghzizel, S. et al. (2020).* However, to adequately achieve the supply, different factors such as water chemistry, choice of materials for the network and the location of the distribution tank must be taken into account, because by omitting the importance of these factors, the population is exposed to problems of Health. *Alvarez, C. et al. (2013) and Moskvicheva, E. et al. (2016).* In this way, it is possible to supply drinking water to communities in need of this service in Mexico.

2. Methodology

This article uses a mixed investigation, applying quantitative and qualitative methods in systematic processes, using books, manuals, articles, and web pages as sources of information. Due to the lack of potable water distribution in low-income areas in Mexico, this research proposed a potable water distribution network coupled with a disinfection system for these communities. The quantitative approach is necessary to obtain the maximum number of inhabitants of the population to supply.

However, the qualitative approach was used to select the type of network distribution, examine the health damage caused by water with inappropriate chemistry for consumption, and determine the advantages of the proposed purification system. In this way, it was possible to propose a water distribution network coupled with a disinfection system for communities with a population of fewer than 1200 inhabitants in Mexico, to improve the quality of life of its population and the development of said communities. *Hernández, R. et al. (2010).*

3. Distribution of wáter

Water for domestic use is transported through a distribution network, which is the union of pipes, special components, and accessories. Its objective is to lead the water from the service tanks to a household outlet or public hydrants. This network must supply drinking water all the time at the pressure, quantity, and quality necessary to satisfy the daily needs of the population.

The specifications of the water to be considered potable are in the Norma Oficial Mexicana NOM-127-SSA1 current. *Comisión Nacional del Agua [CONAGUA]. (2019).* Figure 1 shows a diagram of a water supply system.

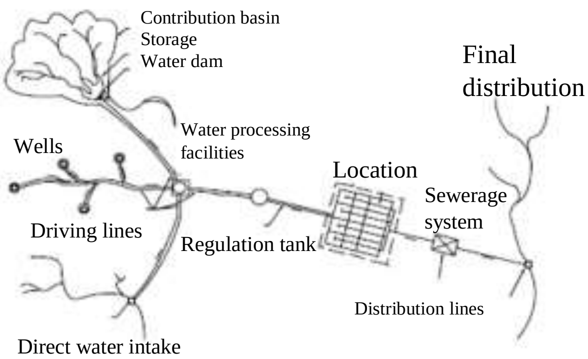

Figure 1 Water distribution network
Comisión Nacional del Agua [CONAGUA]. (2019)

One of the main factors for the design of the distribution network is the choice of pipe material, for this, factors such as durability, corrosion, economy, ease of connection and repair, but especially, the conservation of the water quality. The World Health Organization generated guidelines for the quality of drinking water, where the risks associated with the microbial hazards present in the water are evaluated and the requirements to guarantee the safety of the water are explained, including the minimum procedures and specific reference values, and how those requirements should be applied. *World Health Organization [WHO]. (2006).* Table 1 shows the advantages and disadvantages of the materials most used in the manufacture of pipes.

Material	Advantage	Disadvantages
Steel	High strength, lighter than the iron pipe, easy to transport and install.	It is susceptible to crushing and presents corrosion since it is a metallic material.
Iron Ductile	High service life, it's the way of welding is economical, mechanical resistant, and requires relatively little maintenance.	It can suffer electrical or chemical corrosion, their weight creates difficulties in handling and they are not manufactured in Mexico, therefore they imply costs and import procedures.
PVC	High resistance to corrosion, it is a light and flexible material, it has good tensile strength, it is easy to install and it does not affect the quality of the water.	It can be easily damaged during transport, it reduces its resistance if it is at 0 ° C and the working pressure must be reduced if it is at a temperature higher than 25 ° C.

Table 1 Advantages and disadvantages of pipe materials.
Comisión Nacional del Agua [CONAGUA]. (2019)

Therefore, considering the advantages and disadvantages, the material that offers the best conditions according to its advantages and disadvantages is PVC. On the other hand, there are different ways of supplying water to users depending on local conditions, the two main ones are by gravity and by pumping, however, in some cases, a mixed-method can be used. *Comisión Nacional del Agua [CONAGUA]. (2019).* Currently, most of the works of distribution networks in urban areas are done to improve or expand existing networks. The generation of new works to supply the service to new or isolated places is minimal. *Comisión Nacional del Agua [CONAGUA]. (2019).*

4. Distribution network design

The first factor to consider when designing a distribution network is the source of water to supply the network. Communities may have surface or underground sources of water, therefore a geophysical study is necessary to determine the source of water to supply the distribution network. For underground sources, the water intake from the network must be through a well. On the other hand, for surface sources, the water can be obtained through rivers or springs. On the other hand, it is necessary to identify if the terrain in the area is flat or has irregular heights, which will determine whether the type of distribution of the network will be by gravity or mixed (by gravity and pumping). Therefore, the idea is to locate the distribution tank in a high area, in this way the water can be conducted by gravity to the population. However, a mixed distribution can be used, since the conduction to the tank can be carried out by pumping, subsequently, the water is supplied from the tank to the users using gravity. *Comisión Nacional del Agua [CONAGUA]. (2019).* Figure 2 shows a diagram of a mixed-type water distribution system.

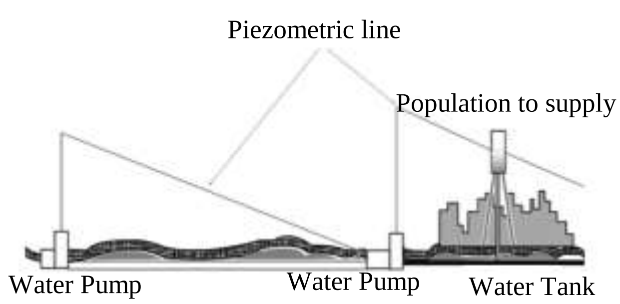

Figure 2 Diagram of a mixed-type water distribution system
Comisión Nacional del Agua [CONAGUA]. (2019)

The capacity of the tank is based on the maximum daily expenditure and the demands of the area, it can be obtained by graphical or analytical methods. It is important to consider the feeding time of the supply sources to the tank, storing the water in the hours of low demand to distribute it in the hours of high demand.

In addition, a volume of water reserved for emergencies such as network failures or repairs must be taken into account. *Comisión Nacional del Agua [CONAGUA]. (2019).* To determine the location and layout of the pipe network for the distribution system, a field survey is required.

The design of the conduction and distribution lines must be defined taking into account the existing roads of the community and avoiding crossing private properties. For what is shown in Table 1, a PVC pipe is recommended over the other materials for the distribution network, since this material is light and flexible, resistant to corrosion and stress, presents low friction losses since the inner wall is smooth and does not affect the quality of the water. *Comisión Nacional del Agua [CONAGUA]. (2019).*

On the other hand, for remote communities, this material is feasible because it is inexpensive, easy to install, and requires less maintenance than other materials. The quality of drinking water is necessary for good health.

The guarantee of the microbial safety of the drinking water supply is based on the application of multiple barriers to avoid or reduce the contamination present in the water to levels that are not harmful to health, for example, nitrate content less than 50 mg / L, chlorine less than 5 mg / L, in addition to the removal of sludge, animal feces, and solid particles. *World Health Organization [WHO]. (2006).*

To provide safe drinking water service, factors such as water chemistry and corrosion must be taken into account. *Kutz, M. (2018), Alvarez, C. et al. (2013) and Moskvicheva, E. et al. (2016).*

5.1 Water chemistry

Drinking water contains complex chemistry, which has an impact on both plumbing, human ingestion, and environmental implications. Factors such as pH, alkalinity, dissolved inorganic carbon, hardness, chloride, sulfate, inhibitors, disinfectants, bacteria, dissolved oxygen, solids, and turbidity are essential to determine the reactions caused by water chemistry such as corrosion and precipitation. *Kutz, M. (2018).*

On the other hand, the mentioned factors can interact with each other, which demonstrates the complexity of the processes that can occur in drinking water. Therefore, it is very important to calculate the chemical characteristics of the water before choosing the materials used in the distribution networks. *Álvarez, C. et al. (2013).*

5.2. Corrosion

Water has a corrosive nature, it frequently contains nitrate (NO_3), which can cause damage to the health of the inhabitants of a population. On the other hand, water carries corrosion particles in the pipes, especially in metal pipes, which corrode and release solid particles carried by the water. In the case of plastic pipes, this phenomenon decreases drastically, but particles of the pipe material are still dragging along. *Alvarez, C. et al. (2013).*

Effectively protecting the pipeline against corrosion is necessary for a long and safe service life of pipeline systems, since in addition to being harmful to humans, corrosion in pipes causes large-scale contamination in the lithosphere and the hydrosphere. Corrosion of materials depends on different factors such as water chemistry, temperature, and building materials. On the other hand, materials can develop thin films, which can reduce the internal diameter of the pipe, causing blockages and blockages. *Moskvicheva, E. et al. (2016).*

5.3. Water for human consumption

The inadequate distribution of drinking water throughout the world causes millions of people to be frequently exposed to dangerous microbiological contaminants such as sludge and solid particles, and chemicals, for example, nitrate concentrations greater than 50 mg / L in water.

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Which does not comply with what is recommended by the WHO in the guidelines for the quality of drinking water. *World Health Organization [WHO]. (2006).* For this reason, chemical and physical methods have been developed for water purification. In chemical methods, substances capable of disinfecting are added, such as chlorine and ozone. However, these substances can generate secondary reactions, which can be dangerous to health. Existing physical methods such as ultraviolet radiation, membrane separation, and thermal disinfection are often expensive and generally do not meet the desired level of disinfection. *El Ghzizel, S. et al. (2020).*

Well-drawn groundwater is commonly considered safe to drink. However, its quality depends on different factors such as climatic changes, types of soil, surfaces, and nature of the rocks through which the water moves, therefore it is recommended that the well water be treated before drinking it. *Boadi, N. et al. (2020).*

6. Drinking water purifier

A study carried out at the Al Annouar institute in Sidi Taibi in Morocco showed the first water purification plant, where nanofiltration is used coupled with an electrochemical disinfection system that is powered by photovoltaic and wind energy. This plant was designed to supply drinking water to the 1,200 students of the Al Annouar institute. *El Ghzizel, S. et al. (2020).* Figure 3 shows the schematic of the Sidi Taibi plant.

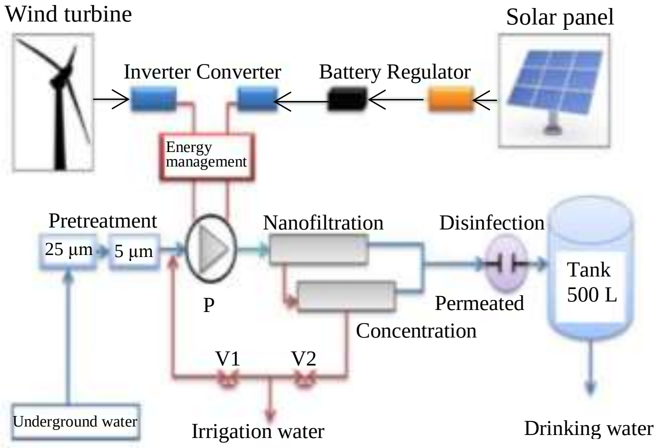

Figure 3 Scheme of the Sidi Taibi purification plant
El Ghzizel, S. et al. (2020).

The process is carried out using groundwater, which is pumped to the plant through inlet pipes. At the beginning of the process, the water is transported to the pretreatment behavior, which is made up of 2 filters, the first 25 μm and the second 5 μm, these are connected in series and allow the removal of sludge and fine particles from the water. *El Ghzizel, S. et al. (2020).* These filters are made of polypropylene microfibers bonded by thermal action.

Subsequently, the pretreated water is transported to the nanofiltration compartment, which consists of two spiral membranes of the type: polyamide thin-film compound, its operating characteristics are shown in table 2. *El Ghzizel, S. et al. (2020).*

Parameter	Value
Maximum operating temperature (˚C)	45
Maximum operating pressure (bar)	41
PH range, continuous operation	3-10
Maximum feed flow (m^3/h)	15.9
Maximum feed sediment density index (SDI)	5

Table 2 Characteristics of the membranes used for nanofiltration
El Ghzizel, S. et al. (2020)

At the end of the nanofiltration, the water is disinfected through an electrochemical process without the need for additives. *El Ghzizel, S. et al. (2020).* Electrochemical disinfection is a process in which electrons supplied by direct electrical current react with ions and molecules in the water. *Global Aquaculture Alliance. (2020).* In addition, this process oxidizes chloride, which generally occurs in water, to free chlorine. *El Ghzizel, S. et al. (2020).* The characteristics of the electrochemical disinfection system are shown in Table 3.

Parameter	Value
Power input (V)	220
Raw Water Required Chloride Range (mg/L)	10-250
Maximum operating flow (L/h)	400
Minimum operating flow (L/h)	Depends on the current supply
Power Consumption Range (W)	100-700
Water temperature range (˚C)	4-25
Minimum conductivity of raw wáter ($\mu s/cm$)	300
Maximum ambient temperatura (˚C)	50

Table 3 Characteristics of the electrochemical disinfection process
El Ghzizel, S. et al. (2020)

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Finally, the purified water is led to a storage tank and distribution begins. *El Ghzizel, S. et al. (2020).*

7. Results

Table 4 presents the characteristics of the groundwater sample and water after the permeate.

	Underground water	Permeated	Ion rejection (%)
$K^+ (mg/L)$	7.04	1.5	78.6
Na^+ (mg/L)	4.95	0.77	84.4
Mg^{2+} (mg/L)	36.01	1.3	96.3
Ca^{2+} (mg/L)	112.9	8	92.9
HCO_3^- (mg/L)	377.3	29	92.3
NO_3^- (mg/L)	68.7	14	79.6
Cl^- (mg/L)	25	2	96
SO_4^- (mg/L)	35.01	1.2	96.5
Conductivity (µs/cm)	856	90	89

Table 4 Characteristics of the feed water, permeate, and ion rejection
El Ghzizel, S. et al. (2020)

Its great efficiency is because the nanofiltration membrane rejects the charged particles, in this way it can extract a large number of components from the water. On the other hand, electrochemical disinfection has advantages compared to other methods; since it does not require storage, maintenance and transport, in addition, its effect can be adjusted to the required demand. *El Ghzizel, S. et al. (2020).*

The Sidi Taibi plant works through a permeate flow rate of up to 400 L / h, with a pressure of 5 bar and a recovery percentage of 75%; the energy it consumes is 0.2 KWh/m^3. On the other hand, the quality of the permeate meets the required standards due to the low concentration of nitrate (14 mg / L), and the WHO recommends a standard of (50 mg / L). *El Ghzizel, S. et al. (2020).*

In addition, using alternative energies allows satisfying the electricity demand for this process, which ensures the disinfection of the water, regardless of the weather conditions. *El Ghzizel, S. et al. (2020).*

8. Discussion of results

The proposed distribution network recommends the use of PVC as the material of the pipes since this material is light, flexible, easy to install, and does not affect the quality of the water, however, other materials can be used in communities where PVC is not feasible either because of the type of soil, water chemistry or environmental conditions.

On the other hand, the type of distribution recommended is by gravity, this is the most reliable distribution method because the pressure remains sufficient and constant in the network, however, if the terrain does not present great heights, a distribution by pumping or pumping can be applied. mixed. *Comisión Nacional del Agua [CONAGUA]. (2019).*

The water purification process used at the Sidi Taibi plant can be coupled to supply communities with a lack of purified water, as the production of water would be sufficient to meet the needs of a population of fewer than 1,200 inhabitants. The purification plant works through a permeate flow rate of up to 400 L / h, with a pressure of 5 bar and a recovery percentage of 75%; the energy it consumes is 0.2 KWh/m^3. *El Ghzizel, S. et al. (2020).*

The amount of water produced is adequate since men and women over 14 years of age should consume 2.5 and 2 liters of water a day, respectively (including beverages of all kinds and water present in food). *Instituto Mexicano del Seguro Social [IMSS]. (2013).* Therefore, for a population of 1,200 inhabitants, this plant can produce up to 8 liters of water per day per inhabitant, enough for drinking and cooking.

In addition, in the area of sustainable development, the proposed network seeks to conserve natural resources and the environment; using renewable energy for its operation, thinking about the natural environment. On the other hand, in the area of sustainable development, it seeks to satisfy the need for drinking water in the communities of Mexico, taking into account the social, economic, and environmental spheres. In the social sphere, it seeks to improve the quality of life of the population of low-income communities.

In addition, government investment is sought so that the economy of the needy population is not affected. Finally, by using renewable energies such as solar and wind, it allows the purification process to be carried out far from the electricity supply network, which is extremely favorable for the production of drinking water in rural areas. *El Ghzizel, S. et al. (2020).*

9. Conclusions

In Mexico, 10% of the population does not have drinking water services in their homes. Therefore, a distribution network coupled with a sustainable water purification plant was proposed for communities with less than 1200 inhabitants.

For the design of the network, the proposal is recommended to use PVC as a material for the pipes, however other materials can be used in communities where PVC is not feasible. In addition, it is necessary to identify the source of water, whether surface or underground, later the water is transported to a regulation tank that supplies the water to the houses using gravity or pumping. The design of the water conduction lines must be carried out taking into account the existing roads within the locality. *Comisión Nacional del Agua [CONAGUA]. (2019).*

The purifier attached to the network uses the process of nanofiltration and electrochemical disinfection. *El Ghzizel, S. et al. (2020).* This process can be implemented for communities in Mexico with a population of fewer than 1200 inhabitants that need water for their consumption. However, as it is a proposal that uses innovative technologies for its process, government investment is required to be able to implement it in the future.

On the other hand, the cost of the distribution network may vary according to different factors such as; the community topography, number of inhabitants, number of dwellings to be supplied, materials to be used, and type of distribution source, however, the study of the proposed water disinfection system does not stipulate a cost estimate.

However, considering that the distribution network was proposed for a maximum of 1,200 inhabitants and that CONAGUA invests approximately 750 dollars per inhabitant for the realization of water distribution networks, we can estimate an approximate maximum cost of 900,000 dollars with a variation of 20 %, indirect costs of the concession to exploit, use or take advantage of national waters, in addition to topographic and geotechnical studies, must be attached to this approximation. On the other hand, to estimate the costs of the water disinfection system, the price of similar equipment is between 5,000 and 8,000 dollars.

However, the objective of this study is to carry out the analysis and development of technology to support sectors that need drinking water, therefore, this project is non-profit, therefore, the economic study for a specific region will be a reason for subsequent studies by the approach to government agencies such as CONAGUA.

In this way, it is intended that this system be applied in low-income communities in Mexico that require water for their homes and consumption, improving their quality of life and the development of low-income communities, in addition to using renewable energies for their process, is sustainable with the environment.

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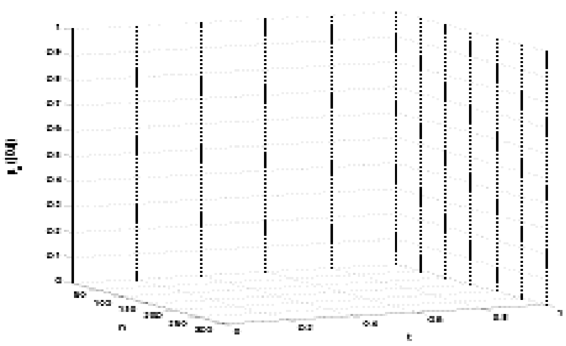

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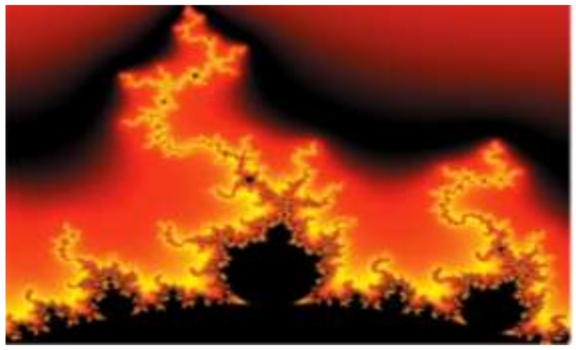

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