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Journal-Urban-Rural and Regional Economy

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Support the international scientific community in its written production Science, Technology and Innovation in the Field of Humanities and Behavioral Sciences, in Subdisciplines of General regional economy: Analysis of growth, Development, and Changes, Size and spatial distributions of regional economic activity, General equilibrium and welfare economic analysis of regional economies, Land use patterns, Econometric and Input-Output models; Household analysis: Housing demand, Other Demand, Regional migration, Regional labor markets, Population; Production analysis and firm location: Housing supply and markets, Other production and pricing analysis, Nonagricultural and nonresidential real estate markets, Input demand analysis, Government policies; Transportation systems: Transportation, Government and private investment analysis, Government pricing; Regional government analysis: Finance in urban and rural economies, Land use and other regulations, Public facility location analysis, Public investment and capital stock, Regional development policy.

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Presentation of the Content

In the first chapter we present, *Acquisition of electrical power using synchronous generators at the Universidad Politécnica De Victoria*, by ENRÍQUEZ-SIFUENTES, José Antonio, LÓPEZ-HERNÁNDEZ, Juan and BORTONI-ANZURES, Liborio Jesús, with adscription in the Universidad Politécnica de Victoria, as the following article we present, *Long-term supportable development programs for railway systems*, by VALLADARES-ESTRADA, Gustavo Gabriel, CRUZ-GÓMEZ, Marco Antonio, LÓPEZ-AGUILAR, Genaro Roberto and ESPINOSA-CARRASCO, María del Rosario, with adscription in the Benemérita Universidad Autónoma de Puebla, as the following article we present, *Impact of the sowing life program in the forms of social organization, from the Good Living approach in San Blas Atempa, Oax.*, by CRUZ-CARRASCO, Cynthia & LOPEZ-CRUZ, Juana Yolanda, with adscription in the , as the following article we present, *Study of the dynamics of urban solid waste management considering the characterization of the collection routes in the municipality of Huatusco, Veracruz*, by ESPINOZA-CORTES, Claudia Sofía, SOLIS-JIMENEZ, Miguel Ángel, CALDERÓN-PALOMARES, Luis Antonio and TEJEDA GARCIA, Rafael, with adscription in the Tecnológico Nacional de México - Instituto Tecnológico Superior de Huatusco.

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Acquisition of electrical power using synchronous generators at the Universidad Politécnica De Victoria

Obtención de potencia eléctrica a través de generadores síncronos en la Universidad Politécnica De Victoria

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Abstract

The lack of use of renewable resources, in terms of wind energy, at the Polytechnic University of Victoria has been unnoticed. Specifically, the implementation of wind power systems leads to the formulation of a hypothesis that proposes the use of wind currents at levels lower than 5 meters above ground level between the buildings of the university to provide electrical power through 400 Watts wind generators. The methodology includes the acquisition of official plans of the university, delimitation of the study areas, collection of wind speed data, the analysis of the information obtained and installation of the wind generator that allows carrying out its operation in practice. The main result will be the use of available renewable resources to generate clean energy, reduce dependence on hydrocarbons, thus contributing to energy sustainability.

Resumen

El poco aprovechamiento de los recursos renovables, en materia de energía eólica en la Universidad Politécnica de Victoria ha pasado desapercibido. Específicamente la implementación de sistemas eólicos, ha dado paso a la formulación de una hipótesis que plantea el aprovechamiento de las corrientes eólicas a niveles inferiores a 5 metros de altura sobre el nivel del suelo entre las edificaciones de la universidad para proporcionar potencia eléctrica mediante generadores eólicos de 400 Watts. La metodología comprende la adquisición de planos oficiales de la universidad, delimitación de las áreas de estudio, recopilación de datos de velocidad de viento, el análisis de la información obtenida e instalación del generador eólico que permita llevar a la práctica su funcionamiento. El principal resultado será el aprovechamiento de los recursos renovables disponibles para generar energía limpia, reduciendo la dependencia de los hidrocarburos contribuyendo así a la sostenibilidad energética.

Sustainability, Wind Generator, Renewable Energy

Sostenibilidad, Generador Eólico, Energía Renovable

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Introduction

Population growth and the increase in the consumption of inputs per individual has driven an accelerated increase in the demand for natural resources, both renewable and non-renewable, attributable to technological development, causing global climatic changes such as the unusual warming generated in the last 150 years due to greenhouse gases, and this process will certainly accelerate in the coming decades. In the current scenario, it is necessary to initiate actions to adapt to the new climatic conditions, given the high vulnerability of various sectors such as forests, agriculture and mainly water, which will be the most affected by temperature increases of between 2°C and 4°C at the end of the century, with a predominance in the northern part of the country (Mexico). The best way to prevent a climate disaster is to resort to preventive, adaptive and mainly participatory strategies (Magaña, 2007).

Currently, the accelerated rate of consumption of fossil fuels and depletion of natural resources for energy production have generated negative consequences not only for a nation but for the whole world, where the signs of deterioration are already visible due to the high levels of environmental pollution resulting from the high concentration of $[\text{CO}]_2$ (Santaló, 2009). It follows that the use of smaller-scale generators can be considered ideal for supplying electricity to low-demand systems. Generation can be increased by including more devices in the collection network. Therefore, the use of wind currents at levels below 5 meters between the buildings of the Polytechnic University of Victoria that have sufficient speed to provide power according to the prevailing wind currents by means of a 400 Watts wind generator is analysed in the present work.

Based on these considerations, wind energy is prioritised because of its abundance at the Victoria Polytechnic University. The university can take advantage of its large surface area and use one of the least environmentally degrading technologies by employing a synchronous generator. Although these generators do not compete with those used by large industries, they may well represent a contribution for those places where it is easy to install and adapt to local needs due to their tiny dimensions.

Methodology to be developed

The study area is located within the Tecnotam Park in Ciudad Victoria Tamaulipas in the area corresponding to the Polytechnic University of Victoria, which has seven irregular hectares of land within which there are already existing buildings and future construction projections. However, there are still available spaces and/or the roofs of the built structures for the implementation of small wind farms. On the other hand, a 400W 12/24V permanent magnet synchronous generator was used, of which there is a prototype for installation and wind speed sensors.

In the elaboration of the research project, quantitative methods are used, derived from the quality that the methodology demands in terms of reliability and veracity of the data, especially those that were recorded at the site where the experiment was carried out. Tests were carried out in the different areas of a structure consisting of a tripeé reinforced with a 2" tubular base with the capacity to house in its interior 2 extensions of smaller diameters respectively one of the other in order to have a structural element that allows easy transfer and installation in different areas without affecting the infrastructure of the university as shown in image 2.



Figure 1 Selection of possible data collection and experimentation areas in yellow circles



Figure 2 Design in Solidworks and prototype developed

Wind Generator	
Model: 400W	Rated power: 400W
Blade number: 3	Rated voltage: 12V
Start-up wind speed: 2.0m/s	Rated wind speed: 13m/s
Wheel diameter: 1.4m	Net weight: 6.8kg
CE production date: 04.01.2019	

Figure 3 Generator data sheet

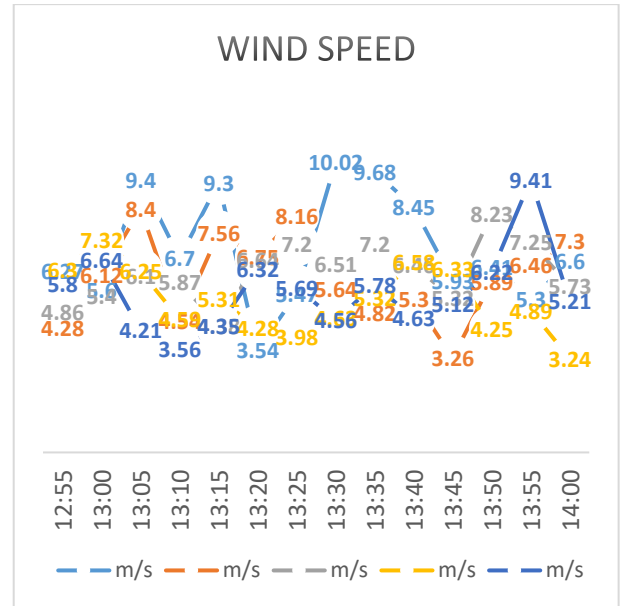
Results

The generator manufacturer states a nominal working wind speed of 13m/s (Figure 3) equivalent to 46.8km/h, and the excess effort was characterised by a speed of 60km/h or 16.6m/s, giving a difference of 3.6m/s.

Wind speed data was collected taking into consideration the maximum value captured by the instrument during a sample period of one minute reading for every five minutes of sampling. Table 1 shows the data collected from various samples taken on different days within an approximate time span of one hour during daylight hours. Graph 1 shows a trend in the fluctuations of the velocities oscillating between values between 3m/s and 10m/s, so that the intermediate gusts have the necessary values to maintain the operation of the device in optimal conditions.

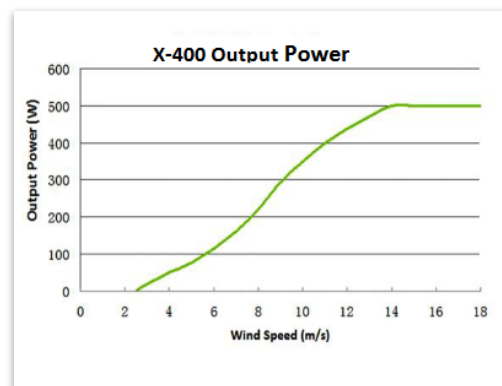
Time	m/s	m/s	m/s	m/s	m/s
12:55	6.27	4.28	4.86	6.3	5.8
13:00	5.6	6.12	5.4	7.32	6.64
13:05	9.4	8.4	6.1	6.25	4.21
13:10	6.7	4.54	5.87	4.59	3.56
13:15	9.3	7.56	4.38	5.31	4.35
13:20	3.54	6.75	6.64	4.28	6.32
13:25	5.47	8.16	7.2	3.98	5.69
13:30	10.02	5.64	6.51	4.63	4.56
13:35	9.68	4.82	7.2	5.32	5.78
13:40	8.45	5.3	6.46	6.58	4.63
13:45	5.93	3.26	5.32	6.33	5.12
13:50	6.41	5.89	8.23	4.25	6.22
13:55	5.3	6.46	7.25	4.89	9.41
14:00	6.6	7.3	5.73	3.24	5.21
Promedio	7.05	6.03	6.23	5.23	5.54

Table 1 Random sampling of velocities at one-hour intervals



Graphic 1 Cumulative values of maximum speed ranges from 3m/s to 10m/s.

It is estimated that a 400W generator will be able to operate and supply an electrical load, as its technical data sheet has a start-up speed of 2m/s. Comparing the risk speeds of the device and the maximum speeds in optimal climate conditions, it is determined that the generator is within the acceptable operating ranges.



Graphic 2 Power output by speed range



Figure 5 Location of wind direction mostly predominantly northeasterly

The average speed is around a maximum of 7m/s and the maximum bursts up to 10m/s, so the available power is between 150W to 350W as shown in Graphic 2. From the tests carried out we can see that from 13m/s onwards the operation is risky, as the maximum power (400W) is at 11m/s, which is a higher value than the readings captured in the area under study.

Acknowledgement

Thanks are due to the Polytechnic University of Victoria for the support provided to carry out the measurements, installation and testing of the generator in the different work areas.

Conclusions

In situ tests were carried out taking into consideration wind speed parameters, which made it possible to determine the speeds of the currents that predominate mainly in a north-easterly direction during different periods of the year. From the tests, a constant wind speed of over 60km/s was determined, which means that both the structure and the generator itself are at risk of fracturing the rotor blades. However, these must be sustained gusts, which is unlikely to occur for a prolonged period of time, except in the case of larger natural phenomena.

The wind generator by itself and with the existing average wind values has the capacity to start its operation without inconvenience, which makes it feasible to feed a battery bank and to be isolated or interconnected to the electrical grid. This type of alternative energy adaptations are of utmost importance both for the region and globally, so it should be considered appropriate to take advantage of local conditions, and thus make contributions to mitigate climate change, which has been an important factor to consider in the near future.

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Long-term supportable development programs for railway systems

Programas de desarrollo sostenible a largo plazo de los sistemas ferroviarios

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Abstract

Supportable programs were embodied in 17 Supportable Development Goals and approved in the 2030 agenda of the United Nations Organization, to avoid environmental degradation and establish a more prosperous world, with peace and justice in the eradication of poverty. The objective of this research was to characterize the different stages of supportable programs for railway systems in the long term, considering the useful life of the railway infrastructure and the dependence on subsidies. However, the long-term supportable programs of rail systems supported by subsidies have the possibility of reaching a stage of maturity at the same time as the economic explosion of the environment, on the other hand, the long-term supportable programs of rail systems that do not have subsidies are intended for inoperability and lack of reinvestment. A mixed methodological analysis was carried out to identify the subsidy parameters used by the supportable development programs in railway systems in their different stages of the project. Sources of formal and informal scientific, technical, and empirical information were the basis for identifying the strategic sources of subsidies that generate stability and quality of service.

Supportable development, useful life of the railway, long-term project

Resumen

Los programas de sostenibilidad fueron plasmados en 17 Objetivos de Desarrollo Sostenible y aprobados en la agenda 2030 de la Organización de las Naciones Unidas, con el fin de evitar la degradación ambiental y establecer un mundo más próspero, con paz y justicia en la erradicación de la pobreza. El objetivo de esta investigación fue caracterizar las diferentes etapas de programas de sostenibilidad de sistemas ferroviarios a largo plazo considerando la vida útil de la infraestructura ferroviaria y la dependencia de los subsidios. Sin embargo, Los programas de sostenibilidad a largo plazo de sistemas ferroviarios apoyados por subsidios tienen posibilidad de alcanzar una etapa de madurez a la par de la explosión económica del entorno, por otro lado, los programas sostenibles a largo plazo de sistemas ferroviarios que no cuentan con subsidios están destinados a la inoperatividad y a la falta de reinversión. Un análisis metodológico mixto fue llevado a cabo para identificar los parámetros de subsidio que emplean los programas de desarrollo sostenible en sistemas férreos en sus diferentes etapas del proyecto. Fuentes de información científica, técnica y empírica, formal e informal fueron la base para identificar las fuentes estratégicas de subsidios que generan estabilidad y calidad del servicio.

Desarrollo sostenible, vida útil férrea, proyecto a largo plazo

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Introduction

The world demand for transport is growing logarithmically in the transfer of passengers and cargo, due to social and economic progress, however, this will generate a demand for energy and greater atmospheric polluting emissions in the next century. The railway has the potential to solve to a great extent the problems that growth in urban environments entails. High-speed rail is an alternative to short-distance air travel, and freight rail can complement other modes of transportation by providing efficient mobility (Railway-News, 2023).

Transportation annually consumes around 50% of world oil production, generating approximately 25% of the planet's polluting emissions. Therefore, the implementation of a rail transport in its different energy modalities in trajectories typical of this transport reduces the time of transfers and pollutants, making it an efficient means of transport. Currently, railway systems move around 10% of passengers and goods globally with an energy demand of around 2% of world oil production (Five years into the 2030 Agenda: Time to give a big push to railway transport, s.f.)

Currently, 800 million people in the world are mobilized by rail-electric transport, while a couple of decades ago there were around 320 million people. The railway sector is the system that has the greatest affinity for electrification due to its infrastructure conditions and that will hardly be matched by the automotive, aeronautical, and maritime sectors in the coming decades. Passenger rail systems present 90% greater electrification than freight systems (A Supportable and green rail system, s. f.).

The regions with the greatest activity for high-speed electric trains are Europe, Japan, and Russia, while Latin America depends on hybrid systems or fossil fuels in low-speed rail systems of less than 250 km/h on short, medium, and long distances. Conventional railways represent about 90% of world passenger movements, first India with 39%, China 27%, Japan 11%, and the European Union 9% (Sustainability - UIC - International union of railways, 2023).

The aims of this research were to characterize the different stages of sustainability programs for railway systems in the long term, considering the useful life of the railway infrastructure and the dependence on subsidies. However, long-term sustainability programs for rail systems supported by subsidies have the possibility of reaching a stage of maturity along with the economic explosion of the environment, on the other hand, long-term Supportable programs for rail systems that do not count with subsidies are destined to inoperability and lack of reinvestment.

The identification of strategic sources of subsidies used by Supportable development programs in railway systems in their different stages of the project, it is essential to know them to generate stability and quality of service in the long term. The sustainability programs of transcendent projects of the Nations must comply with the 17 Supportable Development Goals approved in the 2030 agenda of the United Nations Organization.

What is the difference between supportability and sustainability?

Supportable development is ecologically bearable, economically viable and socially equitable. Supportable is what can be maintained for a long time without depleting resources. Satisfy the needs of present generations without compromising the possibilities of those of the future to meet their own needs and aspirations, without consuming their resources indiscriminately sustainable development explains the reasons for defending with reasons the preservation, protect and conserve current natural resources and futures (Supportable Development, s. f. and Sustainability, s. f.).

A better way of understanding sustainability is the 17 Supportable Development Goals approved in the 2030 agenda of the United Nations, see figure 1. These goals are interrelated. a global vision elimination of poverty, inequality, quality education, avoiding environmental degradation, a more prosperous world, with peace and justice, in an environment of equity and globality, they seek the development and equitable well-being of people, taking care of the environment (Five years into the 2030 Agenda: Time to give a big push to railway transport, s.f.).

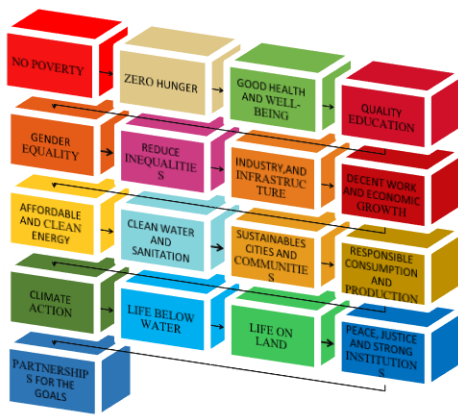


Figure 1 Supportable Development Goals approved in the 2030 agenda; United Nations Organization (Five years into the 2030 Agenda: Time to give a big push to railway transport, s. f.)

Promising means of mobility railway projects; Supportable with long-term subsidies.

The classification of the railway systems is, high-speed trains and metros (which travel long distances operating at a speed greater than 250 km/h), Metrorail (urban services of high frequency and capacity, separated from traffic, underground or elevated), and light trains or trams (lower speed capacity and at street level). High-speed rail, an alternative to aviation, and Metrorail offer a solution to congested and polluted cities.

Freight rail activity in exclusive freight trains is concentrated in China, the United States with a quarter and Russia a fifth of global freight activity. Minerals, agricultural products account for most of the railway activity (Bai & Weng, 2023).

The future of the railway is promising as a green transport means that can meet the demands of exclusive transport and presents great advantages over competing means of transport, however a disadvantage that it will have to face in the coming years will be the high costs of infrastructure and operation required until it becomes a self-sustaining medium.

Population growth in developing and emerging economies in cities is growing exponentially and will require high demand for more efficient, faster, and cleaner transportation, but the need for speed and flexibility tends to favor car ownership and air travel.

However, the railway systems have their field of action together with the other means of transport and none will displace another, they will only present an expansion in the coming years, each one in its field with greater performance according to volumes, masses, and speed of transfer. The railway industry requires strategic investments and Supportable development plans that trigger the subsidy economy of the system and improve commercial competitiveness and technological innovation. (Feng et al., 2023)

The scenario of a future railway system shows growth of around 42% with 4% energy consumption in the next three decades. The advantages of the railway industry over all means of transport are to have a confined lane (which is only used by this means of transport), which generates a second advantage: reduction of transfer times, which implies two more advantages, reduction of energy consumption and generation of pollutants. On the other hand, its disadvantages are compared to other means of transport, it is the railway infrastructure, involvement of other developing sectors such as the generation of electricity to supply the system, long distances, topographic elevations, lack of flexibility of the railway infrastructure, among others.

The railway systems industry in the next three decades will experience a stage of radical changes from oil-based energy systems to hybrid systems and from hybrid systems to electric, until the energy sector in electricity generation can detonate its expansion for the supply of different electric means of transport. The sources of electricity generation at present obey, to generation plants by petroleum-derived energies such as (generation plants based on Diesel motor systems, combined cycle and mineral coal), alternative energy sources in the generation of electricity (hydroelectric, wind, geothermal, solar panels, photovoltaic systems, among others) and the generation of electricity through nuclear power plants, which in a controlled manner represent green energy sources (Zhu et al., 2022).

The stages of evolution of railway systems in the next three decades will not only be limited to energy systems, but they will also experience radical changes in the implementation of railway systems in technology parameters and high speeds (greater than 250 km/h) for trajectories long enough to interconnect remote cities. Some countries like India do not have high-speed trains, however their mobility is carried out mostly through low-speed trains, due to this, a next stage of evolution proposed for India and countries with similarities is to celebrate a collaboration agreement with powers such as Japan for the implementation of high-speed trains with state-of-the-art technologies.

In 2050, it is expected that rail activity will move 15 billion passengers worldwide in urban areas with large populations and this exponential growth in population areas ensures the high demand for rail systems, which is a very important factor for subsidies of the system are reduced and reach a Supportable operation in a Sustainable environment (X. Chen et al., 2023).

Economic, social, and environmental sustainability in rail transport

In order to contribute to the design of models applicable to rail transport systems; The United States has developed the National System of Intermodal Transport, economically efficient, environmentally rational that competes in the energy-efficient global economy, on the other hand the European Commission Supportable Urban Mobility Plan, improves accessibility and social inclusion based on income, social status, quality of life, urban environment, improvement of road safety, public health by reducing factors that impact health caused by the chain of effects of environmental pollutants, help the health sector in the transfer of medicines and greenhouse gas emissions, economic viability, environmental quality. (Wang et al., 2023)

The affordability, accessibility of services and social factors of nodal transport companies in a competitive market with a short-term horizon, raised in government programs, do not tend to expel highway operators, they become trunk nodal means of the main rail transportation system.

The government tends to integrate different modes of transport in a Supportable way, encourage and impose economic challenges and key policies of mobility, accessibility, road safety, traffic and better quality of life, increase in the market share of rail transport, cleaner ports between others. (Zhou et al., 2023)

The dimensions of sustainability, such as expanding knowledge, interactions, implementation, and adaptation of railway project models, simultaneously improve economic, social, and environmental sustainability in transport. Governments pursue sustainability objectives based on previous actions of railway systems with greater experience of transport systems of leading countries with documented strategies of this technology such as implementation of taxes, subsidies, transport study based on market data, fuel tax policies. Fiscal policy could shift 0.8 percent from road transport to rail, causing a reduction in road transport gallons of total fuel consumption per year while tax policy could increase rail. Governments that follow these policies applied to mobility grant as part of their budgets a percentage of subsidies per year to intermodal transport, however, the government aims to gradually reduce subsidies as the maturity and sustainability of the independent mobility.

At some point, can the government become independent from the payment of subsidies without affecting the sustainability of rail transport?

Energy efficiency, environmental factors, side effects. Programs that require initial investment, trucks that increase fuel consumption, lower transportation prices, absorb greater demand. rebound effects competition intermodal transport. optimal government policies. Sensitivity analysis, levels of strategic, tactical, and operational planning do not allow the independence of government subsidies to the means of transport because it is a demanding factor initially, of great absorption in its operation, maintenance and continuous modernization, in addition to the fact that the Transport prices generate a chain of price controls that balance the economy.

Urban railway systems require large amounts of financing that sometimes exceed 80%, which indicates a disconcerting amount in a business plan where economic profitability of the project is required. A railway system presents a project that generates ecological contributions, demographic mobility, savings in transfer times, but this does not mean that in the economic part it can walk in perfect synchrony with these factors and even less so in the initial stages of the project.

A railway system requires large investments for its construction, maintenance, operation, capital equipment renovations, expansion, renovations, and system upgrades among others, so organizations may have difficulties obtaining funds affecting the income of the urban railway in the long run. term. The railway system must have plans and programs from the beginning attached to international regulations and strategies attached to their sustainability.

Government subsidy through taxes, issuance of bonds, stimulation of income from fees, income from property rentals (stores in stations, advertising spaces, loan dependency, subsidies, direct subsidies or cross subsidies, among others, avoid borrowing to finance regular operations, direct grants are used to “fill” any shortfalls in revenue and cover operating costs from tax revenue, less than amount to maintain good condition, include concessional rate support, El Service level is generally measured through train or car-km.

Evaluation of plans and programs of railway systems

The health of a railway system can present a downward spiral, due to the decrease in the number of users and cargo services that reduce the finances generated by the system as a railway company, coupled with this, restricted government financing causes impacts on the system. negatives that sharpened the downward spiral. Given these operating conditions, the quality of service and infrastructure deteriorate, presenting a logarithmic drop behavior of the railway system.

The plans and programs of a railway system must propose both quantitative and qualitative mixed scenarios, based on the performance of railway systems in the region and, in the event that it does not exist, because it represents an innovation system in the region to be implemented, it must be based on results and rail system strategies in different regions of the world that offer higher amounts of similarity. The conjectures of international organizations generated from the conclusions of groups of experts and scientists in the field of railway systems will be essential for making mixed decisions that will strengthen the health of the railway system.

Socioeconomic, political, geographical aspects, use and interpretation of qualitative data from the last decade will strengthen the strategies to be followed in the plans and programs of railway systems that can cover plans of up to 100 years with a vision of supportability and sustainability of the same.

The strategies of the railway systems must establish qualitative objectives of sustainability based on political and government changes in the long term, where the management of projects of a nation involved in an upward spiral at the international level can respond to the paradigms of mobility based on growth in accordance with the geopolitical strengths of the region, since a radical change in uses, customs, and activities in the region by geographic location would undermine the objectives of the plans and programs of the railway system and its sustainability. The irresponsibility of ignoring the variables involved in the development of a railway system can undermine the capital financing that will provide the sustainability of the system in the coming decades and in the process of maintaining the balance of project financing, many strategies could be tried, without However, previous studies put full payment for the service by the user as the primary strategy, which causes the system to be abandoned and displaced by preferences for other means of transport, putting it on the verge of bankruptcy until it becomes inoperable (Wei et al. ., 2022).

Supportability sensitivity

The lack of an index system for the selection of sites in the decision making to solve scenarios with more objectives and goals based on a comparative sensitivity analysis. The selection of sites for the occupation of the railway environment for the creation of infrastructure that allows the Sustainable development of the railway system can be very varied, from power generation plants to service sales centers. In the case of a photovoltaic plant, it has quantitative and qualitative factors, however, experts are more concerned with sustainability than with profit, which in the long term will generate a more solid transportation network.

The rapid population growth coupled with the expansion of the railway system by 2035, demands a greater number of electrical energy sources that will lead to an increase in greenhouse gas emissions. To mitigate this impact, the electrical energy consumed by the electric or hybrid railway systems will be generated by diverse and varied energy sources (ranging from those that use petroleum derivatives, alternative and nuclear energies) whose infrastructures have different requirements that depend on various factors such as sources of transformation, size of the plant, required environmental conditions, dangerousness of the system for an urban environment. All these qualitative and quantitative variables generate a modeling that, based on criteria priority, contributes to model theory decision-making on possible solutions and their feasibility based on sensitivity analysis, placing qualitative criteria above profitability. the systems. Large cities and their tendency in decision-making are more concerned with making sensible decisions for sustainable development with robustness that allows the sustainability of the railway system in the long term than promising short-term solutions whose sustainability does not transcend, because experiences in the railway industry could lead the system to parameters of inoperability due to lack of sustainability. Uncertainty based on mixed information models (quantitative and qualitative) is a challenge for humanity because it cannot be dealt with effectively, the assumption of independence of the decision criteria does not fit reality and the problems do not it can be resolved in scenarios with more changing goals according to interests with future priority (Yin et al., 2022).

The financing of urban passenger trains has become a concern for the economy of a country, due to the problems that influence the fluctuation of passengers, financing, and sustainability of the system in the long term. The sustainability of a railway system is affected by the vulnerability of inflationary effects, political interference, consumer prices that lead to the reduction of income in real terms. To maintain high-quality operations of the railway systems in their construction stages, continuous maintenance and renovations of capital goods, taxes and cross-subsidies are required to improve direct subsidies, which are guaranteed by legislation, reducing their instability in budget allocation. the time established by decree of the project, thus not influencing the changes of government, however the budget assigned to the mobility system in its different modalities can be modified by the governments, because it does not represent a priority factor of a country such as the health, hunger among others.

Previous studies record that all the train systems in the world have presented the requirement of subsidies to be able to operate. The importance of the operability of the urban railway systems seek to generate a point of reference and balance in the costs of private transport and factors that regulate the economy of a country. On the other hand, passenger rail systems do not report large profits in their different stages and require subsidies to maintain it as a quality transportation system (Xuto et al., 2022).

The investment required in its different stages of a railway system is very large and its sustainability is based on long-term subsidies, hence a project of this nature at an international level represents a commitment to an investment policy in favor of the improvements in sustainable development conditions, but not exactly a profitable project in the short, medium, and long term. In the case of a policy system of austerity and limitation of subsidies, marginalization and distortion of public funds, the non-existence of programs for the allocation of lost funds, together with a demographic use limited by geopolitical factors, will cause a downward spiral until its inoperability of the rail system.

The investigation of railway system model approaches will be limited to the practical parameters of the system, however, the experiences of multiple railway systems carried out by multidisciplinary expert teams are the ideal development base for its implementation for the first time in a country with deprivation from experience.

Revenue stream, constant subsidy (public finance, politics, and heterogeneous sources), general sales tax, additional tax rate, employment tax, subsidies (come from government loans or tax revenue), cross-subsidies (tariffs, depending on the price), congestion charge, vehicle fuel taxes, commercial income, funds from a specific source, provide the railway system with sustainability, but without being guaranteed by legislation, they can stop being generated, favoring instability (SUPPORTABLE Development, 2018).

Prices per service of the rail transport system

In the first world countries, wages generally increase faster than consumer prices, growth is less than inflation (wages). This influences an annual adjustment of the rates of the railway systems that increase the price index per trip, generating increases in the income of the railway system that can be used in improvements. If the railway system is geolocated in a country where the price of the trip regulates other economic factors and the increase in salary is nil or minimal for decades inclusive, it represents a factor against the acquisition of economic income to the railway system that they will have to be corrected by a greater injection of subsidies into the system in order to achieve sustainability.

Equity in transportation (refers to justice concerns including economic redistribution to address social inequality) is framed in fare affordability with real-world implementation, subsidies can be useful to help address serious equity issues, particularly during economic crises. However, a tax adjustment may need to be spread over time for capital investments, as the beneficiaries are those who use the system in the future.

The surrounding population must feel that the railway system is part of the growth of its environment that will bring progress with a responsibility to take care of the system's assets, because if this does not happen, the system components are blocked, looted, and maintaining the assets represents a challenge. For the administration of the railway system impacting on the subsidies that will have to be allocated to enable the system.

Methodology

This research used a mixed type of methodology. Quantitative techniques were used to analyze statistics that determined the dependency of the subsidies that the railway systems require for their stability and quality of service throughout the useful life of the project, until reaching their independence and profitability in the long term. On the other hand, qualitative techniques were analyzed to estimate as a predictive means the decision-making that will influence the sustainability of the railway system. The objective of this research was to characterize the different stages of sustainability programs for railway systems in the long term, considering the useful life of the railway infrastructure and the dependence on subsidies. The mixed analysis determines control variables such as sources of subsidies, economy, social equality, and ecology in responsible decision-making for long-term Supportable systems. Projects with infrastructure renovation requirements to reach maturity in total dependence on subsidies must have a broad vision aligned with the 17 Supportable Development Goals so that project profitability can be achieved through synchronized growth, conservation, and modernization of the environment. and demography responsibly.

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Conclusions

The sustainability of a railway project is limited to the continuity of the subsidies in its different stages of the project. The railway infrastructure, similar to all machines, is subject to wear and tear, so the long-term project with a scheduled time of around 100 years should not only cover the initial costs of the infrastructure, maintenance, operating expenses, innovation, etc. It should also be considered that the railway system has a useful life and within the scheduled period at least two to three total substitutions will be made depending on the timely maintenance. Railway systems with high rates of wear have a greater possibility of failure that can directly impact the loss of human lives due to accidents. Investments in railway systems are large investments for a developed country, but they will be even more so for underdeveloped countries whose finances are limited, so a long-term trust is the means of acquisition that in some cases becomes public debt. For the railway systems to reach a stage of maturity and profitability, they must comply with adequate and responsible planning according to the demographics accompanied by several stages with subsidies that strengthen the railway system for its next stage of substitution that makes it the preference of the users as a means of quality mobility, otherwise the railway system will enter an economic crisis until total bankruptcy.

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Impact of the sowing life program in the forms of social organization, from the Good Living approach in San Blas Atempa, Oax.

Impacto del programa sembrando vida en las formas de organización social, desde el enfoque del Buen Vivir en San Blas Atempa, Oax.

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Abstract

The objective of this paper is to identify the relationship between the forms of social organization from the perspective of good living in the indigenous communities that belong to the Sembrando Vida Program in the municipality of San Blas Atempa, Oax. The study is qualitative in nature, and is supported by non-participant observation and semi-structured interviews. The selection of the sample was convenient, in combination with the "snowball" technique. Data collection was carried out in March 2023 and consisted of a sample of 22 planters. The research results indicate that in the operation of the program, the forms of community organization in the interior of the state of Oaxaca have been strengthened, provided that the Sembrando Vida Program has taken advantage of traditional forms of organization and institutions, of an indigenous nature, among which are the mano vuelta, the tequio and the guelaguetza, especially in communities that became more vulnerable after COVID.

Resumen

El presente trabajo tiene por objetivo identificar la relación entre las formas de organización social desde el enfoque del buen vivir en las comunidades indígenas que pertenecen al Programa Sembrando Vida en el municipio de San Blas Atempa, Oax. El estudio es de naturaleza cualitativa, y está respaldado por observación no participante, y entrevistas semiestructuradas. La selección de la muestra fue a conveniencia, en combinación con la técnica de "bola de nieve". La recolección de datos se realizó en marzo del 2023 y consistió en una muestra de 22 sembradores. Los resultados de investigación señalan que en la operación del programa se han fortalecido las formas de organización comunitaria en el interior estado de Oaxaca siempre que el Programa Sembrando Vida, ha aprovechado las formas de organización e instituciones tradicionales, de carácter indígena, dentro de las cuales se encuentran la mano vuelta, el tequio y la guelaguetza sobre todo en comunidades que después del COVID se volvieron más vulnerables.

Communality, Good living, Sowing Life

Comunalidad, Buen vivir, Sembrando Vida

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Introduction

COVID-19 exposed fundamental problems such as the concentration of wealth/social inequality and the ecological catastrophe/destruction of life on the planet, both of which are a consequence of the neoliberal economic-political model that has pushed social and environmental conditions to the limit, a situation that, if it continues and an alternative economic model to capitalism is not implemented, the economic, environmental and social problems will increase. (Boaventura, 2021:373).

Given this situation, it is important to strengthen the forms of social organisation of indigenous communities in our country, and to contribute to the regeneration of the social fabric and the generation of income in the communities, reducing their dependence on the big cities in terms of employment and income. The aim of this research is to determine the impact of the Sembrando Vida programme on the forms of social organisation, from the Good Living approach in San Blas Atempa, in the Isthmus of Tehuantepec.

The first part of the paper describes the concepts of Good Living and communality framed in the sociology of absences in the communities of Oaxaca, based on Bonaventura de Sousa Santos, Esteva, Sulvarán and Tapia to mention the most important ones, as well as the operation of the Sembrando Vida Programme. The second part describes the methodological aspects, the unit of analysis and the method of data collection. The third part describes the forms of organisation of the Peasant Learning Communities of the Sembrando Vida Programme, as well as the forms of social reproduction of the communities, and finally the conclusions of the work are described.

The interest of the present study arises from the need to know the forms of social organisation of our communities, whose main objective is autonomy, food self-sufficiency and the satisfaction of basic needs without giving priority to the search for profit as the ultimate goal. The hypothesis of the study is that the forms of organisation existing in the CACS of the PSV strengthen the forms of social reproduction existing in the communities (Ballina, 2017: 2).

The Peasant Learning Communities (CACs) in the Sembrando Vida Programme have made an effort to rescue the traditional knowledge of the communities through the dialogue of knowledge between the producers and the programme's technicians, improving the management of agroforestry systems and the production of products and crops that allow the planters to guarantee self-consumption and strengthen organisation and cooperation.

The hypothesis of the work is that the existing forms of organisation in the CACS of the PSV, strengthen the forms of social reproduction existing in the communities (Ballina, 2017: 2).

Development

Good living

In the past, it was believed that the economic factor was the only determinant of development; however, in recent years, other dimensions of development have been incorporated, such as economic, social, cultural, environmental, physical-territorial and political-institutional, which maintain a certain relationship. These dimensions condition or determine development, as well as the way in which we should organise ourselves and live together. In this sense, alternative theories of development emerge under the premise of constructing another development, outside of capitalist economic development, which tends to exclude the majority (Franco, 2008:3).

The Epistemologies of the South consider that any process of knowledge construction requires a process of deconstruction of what has been learned, which implies a process of decolonisation, which starts with a process of transformation of Western, Eurocentric scientific knowledge that allows a true liberalisation, which aims to rebuild the foundations of inequality, exclusion and exploitation (Tapia, et al, 2020:10). Buen vivir in this sense is presented as a new way of doing economy through maintaining and building new forms of social reproduction and food production (Amador & Rojas, 2023:23).

(Boaventura de Sousa, 2006:26) points out that capitalist rationality leads to the conception that developed countries are civilised and that countries that do not share the same worldview are backward, unproductive, residual, local, and ignorant. The aim has been to incorporate non-Western knowledge, eliminating the differences that denigrate or demean people, rescuing non-capitalist forms of production with the aim of humanising people who live at the expense of globalisation.

The result of this process of deconstruction-reconstruction will have to be, necessarily, outside of colonial conceptualisation, allowing for the reconstruction of inequalities, exclusion and exploitation in our countries. Therefore, the promise of Good Living is promoted with the aim of working on a proposal that allows us to unlearn the indicators of life that we have constructed (Alaminos, 2012: 172). This proposal should be constructed methodologically, taking up aspects of objective and subjective well-being in order to reach happiness, which depends on each subject and has no firm correlations (Ab-dallah, 2010: 34). The Good Life is presented as an alternative to the androcentric and anthropocentric view, which proposes a separation of human beings from nature based on the control of capital through the market, based on the thinking of logical rationalism that Vandana Shiva called "mental monocultures" (Ab-dallah, 2010: 34).

In the face of the failure of the theories of capitalist modernity and theories of development, it is worth remembering that in the different indigenous cultures there is "a conception of well-being in society or of a good life, which has nothing to do with the possession of material goods or the accumulation of wealth, but with a notion of collective life, harmonious and in balance with all the living beings that populate planet earth" (Amador & Rojas, 2023: 50).

Sulvarán & Sánchez (2017): define the good life as follows:

Living well within and outside the family. Lekil means good and well, kuxlejal life or living. It is tranquillity, harmony, it is the collective work that unites almost all the people in each community, it is fullness, all the good that can exist, that is lekil kuxlejal or good living. If in the community there is no

tranquillity, there are no agreements, there is no lekil kuxlejal (p.210).

Some other indigenous peoples have not found a definition in this regard, nor in their constitutional norms, but in their social organisation and community life, which is confirmed in their original language.

It was in the 1980s that authors such as Boaventura de Santos (2006:13) and Esteva (1996: 11) discovered that there were other forms of development, which coincided with the definition of good living, which aims to honour mother earth and coexist with others. With the aim of rethinking ideas and opening ourselves to the need to learn from and about the South, building a fairer society that sustains that there is life beyond postmodernity. From the above, new epistemologies will be constructed in territories built by peasants and indigenous people, as well as the recovery of values, philosophy, biocultural heritages, linguistic diversity and community practices of organisation and social solidarity economy. To quote Gustavo Esteva (1996).

the problem of underdeveloped countries is not mere growth, but development. Development is growth plus change. Change, in turn, is social and cultural as well as economic, and qualitative as well as quantitative. The key concept must be to improve the quality of people's lives (p.12).

One development proposal is the practice of "buen vivir" (good living), presented by the indigenous communities, in which the forms of decision-making are taken by means of collective assembly through participatory democracy in which women are gradually being incorporated and where the inclusion of all the inhabitants of the community is possible.

The socio-economic indicators of indigenous households, such as education, health, income and social security, are the lowest at the national level; however, social cohesion is what has allowed them to "recreate a solidarity economy that has been reproduced and maintained to the present day" (Sulvaran and Sanchez, 2001). (Sulvaran and Sanchez, 2017:250).

It is therefore important to highlight the forms of organisation of indigenous groups as part of the forms of social reproduction.

In the Tojolabal communities of the 21st century we will thus find a solidarity economy that survives and makes exchanges possible, not so much the material as the possibility of exchanging, of offering reciprocity and seeking *lajan aytik* (to be even and equal), a basic principle of their philosophy, as we have pointed out in other studies (Ávila and Ávila, 2014: 54).

It is important to highlight the exchange and solidarity economy among the Tojolaban communities, among which "the *koltumatel*, *tequio* or *mano vuelta*, which is characterised by the exchange of labour force in the hope that this act will be returned by another person" stands out. This activity is carried out 'usually when the maize is harvested, the family that owns the plot seeks help from another family to carry out this activity and then return the work provided in the plot of the family that provided the support (Ávila and Ávila, 2014:65). "In both cases, at the end of the work, a *convivial* is held, better known as the *chich*, which signifies gratitude for the labour force provided through a meal" (Sulvaran & Sánchez 2017:112).

"Another example is the *b`olmanek* is when a person comes to exchange their product for another in a community and where both parties benefit" (Ávila & Ávila, 2014:65). Bartering is carried out when a person needs help in terms of wages or labour force, through which an agreement is made to benefit both parties either in kind or with labour force. The Tojolabales note in (Sulvaran and Sánchez, 2017)).

We don't care whether we eat meat or not, let alone have fancy cars, new or brand new clothes, the only thing that matters to us is to live in harmony with everyone else, to be at peace with God and with nature, that makes us live well and makes our hearts happy (p.260).

Within the concept of Good Living (*Lekil kuxlejal*), peace, family solidarity, the right to education in traditional knowledge, the right to food, linked to the *slamadil kinal*, for the *Tsetals* this means the sacred and perfect dimension in silence, *slamalil* also means tranquillity. Linked to this is the *chabajel* which is community reintegration and their own rules of justice.

One of the consequences of capitalism is to destroy the community in order to turn its inhabitants into wage labourers, in the logic of the reproduction of capital. Therefore, it is of vital importance that the community becomes an instrument of emancipation that allows it to be self-sustainable and thus to resist (Amador&Rojas,2023:54). In this sense, various authors have taken up the concept of communality as a form of social reproduction of the peoples in the communities in Mexico, specifically in the state of Oaxaca.

Community

The concept of community comes from the Latin *communis* which means, men living together in a space, sharing coexistence, communication, unity, which is defined as a system of social relations as a defined space, integrated by shared interests and needs (Kisnerman, 1986:150). In Oaxaca, rural populations appropriate the concept of community, defined as an entity represented by a group of people who pursue common goals. This characteristic has allowed the communities to have stability, basing their satisfaction of needs on nature and on which they have exercised their traditions and the use of them.

Within the communality, the system of voluntary community work implies for the members the obtaining of common benefits, having a morally legitimised social action such as the system of charges, kinship and relationship with nature. Unlike salaried work, it does not seek to make a profit, but represents a strategy for the reproduction of life and a survival strategy through the management of work for a given community.

Uses and customs in the state of Oaxaca

As strategies of social reproduction, which are still preserved in our communities in Oaxaca, we find the "uses and customs" which, in most cases, "refer to the customs of yesteryear that endure to this day", i.e. the ways of life of the people, which include traditional medicine, festivals, rites, etc." (Avendaño). Likewise, as part of social reproduction are the strategies of citizen participation, identity and collaboration in the provision of services, such as the *tequio*, *mano vuelta*, *gozona* and the *guelaguetza* (Avendaño, 2009) (Cruz, 2014:9).

Within the modes of social, cultural and economic reproduction, there is a reproduction of political social organisation, which refers to the forms of self-government in their systems of governance (Cañedo, et, al 2015:2) (Cruz, 2014:10). Indigenous communities have exercised various forms of communal work with the characteristic of cooperation, voluntary and forced. These strategies aim to ensure the subsistence, social security and harmony of the group (Carrillo, 2011). The following are some examples:

The Guelaguetza

The guelaguetza is defined as:

An act of social solidarity of reciprocal aid in the components of a community, practised by the indigenous Zapotecs, in function of common needs and resulting product of coexistence. It is an institution of mutual aid through which any member of the community receives help from neighbours in work, money or kind, in which the beneficiary is committed to reciprocate the services or help provided in case of need or on the occasion of some transcendent event of the individual such as marriage, death, birth of a child as well as construction or repair of a house through the loan of material and/or executing the labour (Cañedo, 2008:6)

The tequio

The word tequio is defined as follows:

It comes from the Náhuatl which means: "thing that has, or gives work", it consists of the summoning of the whole neighbourhood for the execution of a material work of collective utility (construction of a temple, school, market or town hall building or repair, as well as the opening or conditioning of neighbourhood roads and the work of tilling, sowing and harvesting the lands in common), the services rendered are not subject to any retribution, the neighbours are responsible for providing the necessary materials of the work undertaken, according to their economic possibilities (Bradomin, 1968:250).

The call for the tequio is an example of social solidarity and is convened by the municipal authority, of an obligatory nature, verified by neighbours after a previous call in which the days of work are indicated.

Mano Vuelta

It is a communal way of organising work to give, to share, without money, only with collective work.

The Sembrando Vida Programme

In 2019, the administration of President Andrés Manuel López Obrador, launched the Sembrando Vida Program; deployed in several stages, a strategic project whose purpose was to serve farmers in the national territory, through \$5000.00 per month in arrears, under the fulfillment of a work program, contemplating within its principles social inclusion and gender equity (Secretaria de Bienestar, 2019).

The Program provides economic support to the subjects of right, deposit that is made through the Banco Bienestar. The planters must comply with the work plan agreed between the Productive Technician, the Social Technician and the subject of right and perform at least 80% of the activities set out in the monthly work plan either directly on the plot or through the CAC and in most cases received support for nursery installation, establishment of plants and inputs for their plot and biofabrica (DOF, 2022:5).

The Farmer Learning Communities (CACs) are made up of an average of 25 beneficiaries of the program, whose objective is to generate dialogues for learning and generational encounters. The CACs seek to recover traditional knowledge, crop improvement and local productive systems, to guarantee self-consumption, promote the organization and cooperation of the communities through their specific forms of social reproduction and ancestral ways of living (Arellano, 2020:2).

The importance of the research lies in identifying the forms of knowledge transmission with the objective of identifying problems of the past, since many have started from the lack of knowledge of the ecosystem and disregard for the culture, knowledge and practices of the native peoples from the generation of enterprises that promote the productive conservation of ecosystems and biodiversity as a viable, efficient and sustainable alternative with the objective of promoting inclusive and culturally relevant development in the communities (Álvarez, 2023).

Methodology

The nature of the research is descriptive, with a non-experimental quantitative qualitative design (Hernández, 2014:169). The primary information gathering technique consisted in the application of semi-structured interviews to know the situation with respect to the objective of the program; and participant observation: of the various activities promoted by the Sembrando Vida program with the Peasant Learning Communities with the planters. The unit of analysis was the planters who are beneficiaries of the Sembrando Vida program in the municipality of San Blas Atempa. The techniques of the secondary sources of information were the following: compilation of information in CONEVAL, CONAPO, INEGI, Adata, Secretary of Welfare, as well as bibliographic information that points out the approach, methodological strategies of the uses and customs of the municipalities of Oaxaca.

The sample size by convenience was 22 planters located in the CAC (Comunidad de Aprendizaje Campesino) Bissa Llaga which is located in San Blas Atempa and is formed by 13 men and 9 women and has stood out for its form of social organization in community work.

Sembrando Vida Program in the municipality of San Blas Atempa

In the municipality of San Blas Atempa, the Sembrando Vida program operates with 12 CACS, Comunidades de Aprendizaje Campesino, with a total of 264 beneficiaries, of which 90 are women and 174 are men. The CAC Bissa Llaga is located in San Blas Atempa and is made up of 13 men and 9 women, standing out for its form of social organization in community work.

Nursery plant production

The production of the CAC nursery for the establishment of its agroforestry systems for the month of May to 2022 was as follows: (See Table 1).

Species	Total Amount
Caobilla (<i>Swietenia humilis</i>)	303
Tepeguaje, palo fierro (<i>Lysiloma acapulcense</i>)	2,313
Papaya (<i>Carica papaya</i>)	100
Soursop (<i>Annona muricata</i>)	500
Cocohite, cacahunanche (<i>Gliricidia sepium</i>)	3,526
Pink cedar (<i>Acrocarpus fraxinifolius</i>)	1,384
Chicozapote (<i>Manilkara zapota</i>)	150
Lemon (<i>Citrus spp.</i>)	35
Guaje, guach, leucaena (<i>Leucaena leucocephala</i>)	950
Anona blanca o saramullo (<i>Annona squamosa</i>)	100
Total	9631

Table 1 Nursery plant production

Source: Interview with CAC, 2022

Forest species include cacahuananche, cedar and tepehuaje, and fruit species include guabana anona, chicozapote and lemon. It is important to note that the Tepehuaje colorado is a species used to make cartwheels for the community's field work.

The Sowing Life program promotes a payment per day to the planters for the establishment of their plot, the management of their nursery and the construction of their biofactory. For which it is important to create a committee which is integrated by the Peasant Learning Community (CAC) which is organized with the following commissions and main actors:

Coordinator: To ensure that the decisions and actions of the CAC are in accordance with the program guidelines and internal agreements.
Secretary: Support the central committee in making clear and consensual agreements for the benefit of the CAC, as well as preparing assembly minutes and attendance lists.

Treasurer: Control the CAC's finances, as well as ensure that collections and payments are made in a timely manner (resources related to the management of the CAC, not savings).

Savings Committee. Contribute to generate a savings culture, based on the principles of social and solidarity economy, giving another look at the value of work, the use of money, establishing fairer and more equitable relations for all.

Education Commission. Contribute to generate and organize space for dialogue and learning on important topics such as nutrition, gender equity, reconciliation with nature, teamwork, leadership and healthy cooking.

Sustainability Commission. Contribute to ensure that decisions and processes in the CAC are based on the principles of autonomy, self-sufficiency, solidarity, diversity and respect for the environment, which together strengthen the sustainability of the localities where the VSP works.

Nursery Commission. Plan, supervise and guarantee the sufficient and necessary production of seedlings in the nursery under agroecological and sustainable conditions in agroforestry systems.

Biofarm Commission. Design strategies to maximize the use of organic resources, preserving the natural conditions of the environment and not depending on chemicals, in addition to ensuring that the CAC has sufficient and necessary inputs, such as fertilizers, bioinsecticides, substrates, broths, etc. for use in the nursery and plots.

Work plan committee. To have complete information on the real situation of the plots with respect to the MIAF and SAF agroforestry systems, through the follow-up and verification of the work plans of each planter enrolled in the Sembrando Vida program. This results in a record of progress and difficulties reported each month (De la Rosa, 2021).

Sowers. Subjects of law, who are fulfilling their work program, and who carry out the activities indicated in the rules of operation, such as the establishment of agroforestry systems, work in nursery and biofabrica established by their commission, as well as attendance to the trainings indicated by the social and productive technician, which as a result will receive \$5000.00 as economic support from the Banco de Bienestar (Aguilar, 2022).

Scholarship recipients. Mexican youth residing in the community between 18 and 29 years of age who are not studying and not working, in training in the Sembrando Vida program to develop their skills and strengthen their work experience.

Social technician. Training planters in social skills, elaboration and follow-up of work plan in savings, education and sustainability, as well as administrative activities related to the program.

Productive technician. Training to planters in productive nature, elaboration and follow-up of work plan in biofactories, nursery and plot management, as well as administrative activities related to the program.

Facilitator. Follow-up and validation of work plans of productive technicians, social technicians, planters and scholarship holders (DOF, 2022).

Territorial Coordinator. Validate the work plans prepared by the community facilitators and supervise the activities of the technicians.

Women: The participation of rural and indigenous women in the program is promoted in the rules of operation, which contribute significantly to the work of the CAC, with respect to nursery, biofarm and plot management. Women's participation has been important, as they have stood out as presidents of the CAC, citizen oversight committee, commission representatives and in most cases they have been characterized by their compliance with the activities entrusted to them and the achievement of goals, despite the double workday that characterizes the female gender.

Key Actors

The participation of the economic organizations was mainly with the irrigation units, communal properties and the municipal president, who have provided support in the operation of the program.

Municipal President: The municipal authorities participated in the presentation of the intervention strategy on the objective and requirements of the program to the agrarian authorities, in addition to collaborating with the logistics for the organization of the community information assemblies in which the program was made known to the interested parties (De la Rosa, 2021).

Communal property: The agrarian authorities helped with the management of the beneficiaries' property titles, as well as with the approval of the sharecropping contracts. The sharecropping contracts are agreements signed by the landowner and the sharecropper in which they agree to rent or loan the land to participate in the program.

Irrigation units: This committee has supported the verification of irrigation with the planters in order to follow up on the plants planted.

In the municipality of San Blas Atempa, although it is not a municipality governed by customs and traditions due to its governmental regime, it preserves traditions of customary origin, which are developed within the VSP in coordination with the social and productive technicians, to achieve the program's objective. As part of the sowing life program, the following activities have been carried out:

Tequio or mano vuelta among CAC planters

The program established as a goal for planting 2,750 plants in the 2.5 hectares per planter. The planters who for personal reasons have fallen behind in meeting the goal, are organized with the work plan commission, in groups so that they can carry out tequio or mano vuelta to support the planters to achieve their goals.

Once organized, they plant trees in the benefited plots, in this case the owner of the plot provides the necessary resources, such as the plants and to have the land clean. Several planters have achieved their goal with this strategy. Due to the CAC's regulations, support is given to senior citizens or women who do not have the support of a man.

Tequio in favor of your community

The PSV aims to contribute to the social retribution of the community such as cleaning of roads, schools, rivers, etc. The planters have organized themselves to support their localities with community volunteer work (mainly Tequio) on a monthly basis or when required in order to contribute to the development of their community.

Guelaguetza in community work

The word guelaguetza comes from the Zapotec word meaning "to give or share" (Rentería, 2014). During the work of the CAC in the nursery, plot or biofabrica, it has been implemented that all planters share their food, such as water, tortillas, meat, or stews from the community. The activity has allowed the reconstruction of the social fabric of the CAC with the planters, technicians and scholarship holders.

Sanctions

The program includes warnings, suspensions and cancellation of the planter for non-compliance with the program's activities. The warnings are established as a warning to planters for not complying with 80% of the work program by the technicians, as well as unjustifiably missing a CAC meeting, or unjustifiably missing the production unit when the technician so indicates (Aguilar, 2022).

Suspension of benefits occurs for repeated failure to comply with the work plan, as well as failure to attend CAC training or a plot supervision visit.

The cancellation of benefits is subject to incurring in the behaviors foreseen for the reprimand and/or suspension of program benefits. Although the sanctions are established in the operating rules, the CAC, together with the technical team, has been empowered to resolve internal problems within the CAC, and only resort to the operating rules in the event of problems in which the beneficiary does not show interest in resolving his situation with the board of directors.

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Conclusions

The objective of this work was to know the existing forms of social organization and to see their incidence in the Good Living, specifically in the municipality of San Blas Atempa, Oaxaca in the Sembrando Vida program. Based on the above, the theoretical conceptualization of Good Living, Communitary and Uses and Customs in the communities of Oaxaca was carried out. Likewise, a diagnosis was made of the structure of the PSV and the forms of social reproduction such as the tequio, the mano vuelta and the guelaguetza, which contributed to achieving the objectives of the program. The review of the forms of social organization included the main actors and activities for the operation of the program, as well as the findings that have been found in the study communities.

The results show the positive relationship between the forms of social organization of the indigenous communities and the operation of the program, so it is important to make visible the activities of cultural, political, economic and social reproduction of the indigenous peoples as the ways of life of the people related to forms of social organization, traditional medicine, rites, festivals and government systems.

Social reproduction activities such as stewardship, tequio and guelaguetza allow their citizens to generate certain prestige derived from the fulfillment of responsibilities linked to service capacity, generating cohesion and community identity and mutual collaboration in the communities (Cruz, 2014).

These forms of organization should be encouraged by the different levels of municipal, state and federal government as development strategies through government programs in the localities, since, on many occasions, the intervention of diverse practices or development models external to the community generates conflict in the communities, because it breaks their systems of organization or specific ways of doing for life, hindering the development of the CACs.

The Sembrando Vida program has represented a platform for rescuing the countryside, especially in economic, social and training terms, representing a significant intervention strategy, especially because of its national scope; however, it is important to emphasize that the use of the communities' resources should be privileged, with the objective of motivating the planters to generate their own development.

The PSV contributes to the recovery of the forms of social organization of the communities of the Isthmus of Tehuantepec, as part of the Good Living of the municipality of San Blas Atempa, as well as to the generation of dialogues for learning and intergenerational encounters (Arellano, 2020). It is recommended for future research to make visible forms of social organization of communities in Oaxaca and Mexico that seek to recover traditional knowledge through the exchange of experiences and knowledge to improve crops with the objective of guaranteeing self-consumption and promoting the organization and cooperation of the communities.

However, there were some comments from planters who pointed out that the program's methodology is top-down in some cases, limiting the actions of the farmers. Therefore, it is proposed to strengthen the CACs, migrating from a traditionalist education where the teacher is the owner of the knowledge to a critical school where the aim is to build knowledge with a view of social justice in solidarity and dialogue (Castañeda, 2023).

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Study of the dynamics of urban solid waste management considering the characterization of the collection routes in the municipality of Huatusco, Veracruz

Estudio de la dinámica de la gestión de residuos sólidos urbanos considerando la caracterización de las rutas de recolección en el municipio de Huatusco, Veracruz

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Abstract

This study was conducted in the municipality of Huatusco de Chicuellar, in the state of Veracruz, to characterize the urban solid waste collection system, and to identify the pertinent logistical indicators to propose and analyze possible strategies that contribute to the redesign of the current collection system. For the development of the study, sampling was carried out to identify the micro waste collection routes with the help of technological tools such as the Global Positioning System, known as GPS, and they were represented graphically on the Google Earth platform. Through the evaluation of the collection routes, the main logistical indicators were identified, such as the mileage traveled on the routes, diesel consumption and the cost of final waste disposal. The information obtained in the characterization of the routes, in addition to other data obtained in previous studies of MSW generation and composition, carried out in the city, made it possible to develop a dynamic model with which it is possible to present an improvement scenario that consists of separating waste at the source (in families) and to observe the economic impact that this action can have for the municipality.

Municipal Solid Waste Management, System Dynamics

Resumen

El presente estudio se realizó en el municipio de Huatusco, perteneciente al estado de Veracruz, con el objetivo de caracterizar el sistema de recolección de residuos sólidos urbanos, para identificar los indicadores logísticos pertinentes a fin de plantear y analizar posibles estrategias que contribuyan al rediseño del sistema de recolección actual. Para el desarrollo del estudio, se efectuó un muestreo para identificar las micro rutas de recolección de residuos con la ayuda de herramientas tecnológicas como el Sistema de Posicionamiento Global (GPS) y se representaron de manera gráfica en la plataforma Google Earth. Mediante la evaluación de las rutas de recolección se logró identificar los principales indicadores logísticos como, el kilometraje que se recorre en las rutas, el consumo de diésel y el costo que representa la disposición final de los residuos. La información obtenida en la caracterización de las rutas, además de otros datos obtenidos en estudios previos de generación y composición de RSU realizados en la ciudad, permitieron desarrollar un modelo dinámico con el que es posible presentar escenarios de mejora que consiste en la separación de los residuos desde el origen (en las familias) y observar el impacto económico que dicha acción puede tener para el municipio.

Gestión de Residuos Sólidos Urbanos, Dinámica de Sistemas

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Introduction

Municipal solid waste (MSW) management is a sensitive issue for the authorities in charge of its management, as it represents an indispensable service for the population given its repercussions on public health, the environment and the economy. The complexity of the system stems from the social, economic, technological and environmental implications related to it (ECLAC).

Since the 1990s, the Ministry of Environment and Natural Resources (2009) of the Federal Government has recognised that Mexico faces great challenges in the integrated management of solid waste, due to:

- High costs associated with the operation of public waste management systems.
- Lack of knowledge on the part of waste managers
- Lack of interest on the part of citizens
- Increase in solid waste production rates
- Excessive consumption
- Reduction of the useful life of products, among others.

It has been observed in different research studies that the process with the highest incidence and that presents the greatest complications at the time of implementation is the collection routes, the most neglected factors being the frequency with which the collection truck passes and the scheduling of timetables for each zone, as well as the concern in the municipalities about the insufficient fleet of collection vehicles and high operating costs.

In most of the methodologies related to the analysis of household solid waste collection routes, the concept of costs is emphasised, taking as a reference that the collection process represents between 70% and 85% of the total maintenance costs of the system, highlighting the need to optimise the process in order to reduce costs.

For authors such as Medina (1999):

The issue of solid waste is of great interest and concern for authorities, institutions and the community, due to the threat it represents to human health and the environment, specifically in relation to the aesthetic deterioration of urban centres and the natural landscape, as well as the proliferation of disease transmitting vectors and the effect on biodiversity.

Among the most relevant points found in research dedicated to the optimisation of routes, the following concepts stand out:

- Topography
- Roads
- Type of population
- Number of inhabitants
- Commerce, schools
- Quantity and type of waste

These are directly related to the equipment and conditions available to operate the collection system.

Municipal Solid Waste Management

Currently, "Municipal Solid Waste (MSW) Management" is understood as the set of operations aimed at giving the MSW generated in a given area the most appropriate overall treatment, from the technical, economic, environmental and sanitary points of view, in accordance with its characteristics and available resources (Márquez Benavides, 2011).

Integrated Solid Waste Management System

Solid waste management can be considered a management system based on a sustainable approach that has as its primary objective the reduction of waste sent to final disposal, in order to minimise the negative impact of waste and the costs associated with it. The handling or management of each of the phases from waste disposal to disintegration is observed in four stages:

- Generation
- Collection and transport
- Transfer
- Final disposal and/or treatment

Collection

This is a public service comprising the collection of MSW at the site where it is produced and its transfer to the site where it is treated or disposed of. Collection is differentiated as follows:

- General: without discriminating between different types of waste.
- Differentiated: discriminating by type of waste according to its subsequent treatment and valuation.

Collection routes

In the SEDESOL Technical Manual on the generation, collection and transfer of municipal solid waste, routes are defined as the specific routes that collection vehicles must follow on a daily basis in the areas of the locality where they have been assigned in order to collect the waste generated by the inhabitants of that sector in the best possible way.

Waste collection routes in the municipality of Huatusco, Veracruz have usually been designed in an intuitive way by the people in charge of the public cleaning service, and when the government changes there is confusion on the part of the new people in charge, so they do not evaluate the system and operate it in a conventional way, without taking into consideration important aspects such as route modelling and its optimisation through engineering tools that allow for a more efficient performance.

Basic rules for the design of collection routes

- Increase the productive distance relative to the total distance.
- Routes should not fragment or overlap.
- The start of a route should be close to the place where the collection truck will be stored and the end close to the place of final disposal of solid waste.

- In places with steep slopes or high gradients, try to make the route from the top to the bottom.
- Try to collect simultaneously from both sides of the street.
- Respect the direction of traffic.
- Avoid left turns and U-turns.
- It is necessary to recognise the characteristics of the city very well so that the routes of the collection trucks do not cause different types of problems.

In this paper, entitled "Characterisation of MSW collection routes and proposal for improvement under the Eco-Driving concept in Huatusco, Veracruz", the aim is to analyse the current MSW collection system in the city of Huatusco, Veracruz, based on data from real routes obtained by means of global geopositioning devices (GPS); with the aim of evaluating the MSW collection routes by means of logistical indicators, in order to propose and analyse strategies that contribute to the redesign of the current collection system.

This project is carried out with the aim of implementing the GPS global positioning system in the collection units to control and monitor the collection routes used by the municipality's public cleaning system, as this system provides tools to identify geographically on a map the points travelled by the units, as well as visualising important information for correct decision making.

In addition, the analysis of the information allows the identification of possible areas for improvement in the public cleaning system, optimising processes and contributing to the sustainable development of the city. By analysing this situation, the aim is to understand the operation of the current routes in order to find opportunities for improvement.

Macro routes

The Mexican Ministry of Sustainable Development (SDS), in its manual on integrated solid waste management, calls macro routes the stratification of the city through sectors of operation, for which it establishes the optimal number of trucks, assigning them to fulfil the route according to their operational sector.

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Micro routes

A specific route that collection vehicles must follow daily in the areas of the city where they have been assigned, in order to collect the solid waste generated by the inhabitants of the area in the best possible way (Bravo Figueroa, 2021).

System dynamics

System Dynamics is understood, in the sense of Forrester (1968), as a methodology for understanding change, using finite difference equations or differential equations. Given the representation of these processes, we can study the dynamics of the set of states available to the system, which is the central theme of the modelling (García, 2017).

Methodology to be developed

The Methodology section describes the steps to be followed to carry out the research process, it is divided into three parts: cabinet work, field work and study method.

Desk work

- Elaborate the relevant documents to request permission from the Huatusco City Council to carry out the development of the project in coordination with the Municipal Public Services Department, to finally be channelled to the Coordination of Public Cleaning Services, who are directly in charge of the subject in question.
- Hold a meeting with the person in charge of the Coordination of Public Cleaning Services to draw up the planning of the activities to be carried out and to define the dates on which the sampling will be carried out with the GPS devices duly installed.
- Schedule periodic consultations to review the progress of the project and make recommendations to improve the structure of the research work.

Field work

- Verify the type and quantity of mobile units in charge of waste collection and check the route map (if available) or the records related to the operation and maintenance costs of the system.
- Determine the carrying capacity of the vehicles.
- Configure the GPS correctly for optimum performance during journeys and install them properly in the units.
- Identify collection routes through the digital monitoring platform corresponding to the tracking device.
- Record the collected information in an Excel database.

Survey method

- Locate geographically on a map the GPS tracked points using the Google Earth platform.
- Analyse the fulfilment of the micro routes based on the macro routes established by the system.
- To elaborate a report of the operation indicators obtained in the routes.
- Analyse the data in order to detect inefficiencies in the routing system and propose areas for improvement.
- To elaborate improvement proposals considering the optimisation of the system.

Results

Route monitoring coverage.

- The waste collection process is carried out continuously throughout the week in the neighbourhoods of the municipal capital, from 6:00 a.m. to 15:00 p.m. on average.
- An evening tour of Avenues 1 and 2, which are the main thoroughfares in the city, was observed, especially to cover the commercial area and primarily the Juárez Market, which is one of the areas with the highest waste production.

- Tours are made to cover the service to rural communities, this route is carried out on Wednesdays, Fridays and Saturdays.
- Focal points are taken into account or well known as red points which are the areas that are saturated with waste at any time of the day.

Macro routes currently operating in Huatusco.

Due to the fact that Huatusco is a city with a large number of neighbourhoods and therefore a large number of inhabitants, collection was divided into large zones. These zones were delimited by the person in charge of the Limpia Pública system and their compliance was corroborated based on data obtained from GPS devices. For illustrative purposes, the 2-day macro and micro routes are shown below, which best represent the operation of the current collection system.

Monday

Table 1 shows the sectorisation carried out to define the macro routes. It can be seen that three routes were defined for Monday.

Day	Route 1	Route 2	Route 3
Monday	Avenida 2 Avenida 4 Avenida 6 Avenida 2 Avenida 4 Avenida 6 Avenida 8 Emiliano Zapata Los Encinos Los Manantiales Praderas de Axol Laguna Autozone Villas la vista Setse 1 Setse 2 Maná Restaurante	Avenida 1 Avenida 3 Avenida 5 Avenida 7 Agustín Chicuellar Ejidal Acatepec Miguel Alemán Reserva Territorial	Puntos rojos Reserva Territorial

Table 1 Macro Routes Monday
Source: Own elaboration

Figure 1 shows graphically the macro routes mentioned above, the yellow colour represents route 1, while route 2 is identified with green colour, route 3 is marked with purple colour and finally the red area is the area of influence of the red points.



Figure 1 Monday macro routes
Source Google Earth

Figure 2 shows how the Monday routes operate in detail, showing the streets and avenues along which the collection truck travels. It can be seen that they coincide with the established macro routes.

Friday

Taking into account the information in Table 2, we can consider the execution of three routes, one for the urban area, another covers a large part of the urban area and an educational institution, the Autonomous University of Chapingo, which is located on the outskirts of the urban area approximately six kilometres from the municipal palace, in addition to the route that covers the needs of the rural area.



Figure 2 Micro Routes Monday
Source: Google Earth

Figure 3 shows the three routes that were proposed for the public cleaning service in the municipality; however, there are also four zones (represented in black) that do not correspond to the data shown in the table, but are covered by the service on Fridays. Figures 4 and 5 show the macro routes in the urban area.

Day 1	Route 1	Route 2	Route 3
Monday	Avenida 2	Avenida 1	Puntos rojos
	Avenida 4	Avenida 3	Mesa del rancho
	Avenida 6	Avenida 5	Refugio
	Avenida 8	Avenida 7	
	Morelos	Ejidal Acatepec	
	Húngaros	Villas la Vista	
	Guillermo	Xocotla	
	Lira	Ampliación	
	Las garzas	Constitución	
	Calle 20	2 de Noviembre	
	El molino	Gas Huatusco	
	Cruxtitla	Ferche Gas 2	
	Beneficio	Fraccionamiento	
	Alamos	San Antonio	
	Gasolinera	Olimpo	
	Alamos		
Pepe Coffe			
Las cañadas			
Chapingo			

Table 2 Macro routes Friday
Source: Own elaboration

Figure 3 shows the three routes that were proposed for the public cleaning service in the municipality; however, there are also four zones (represented in black) that do not correspond to the data shown in the table, but are covered by the service on Fridays. Figures 4 and 5 show the macro routes in the urban area.

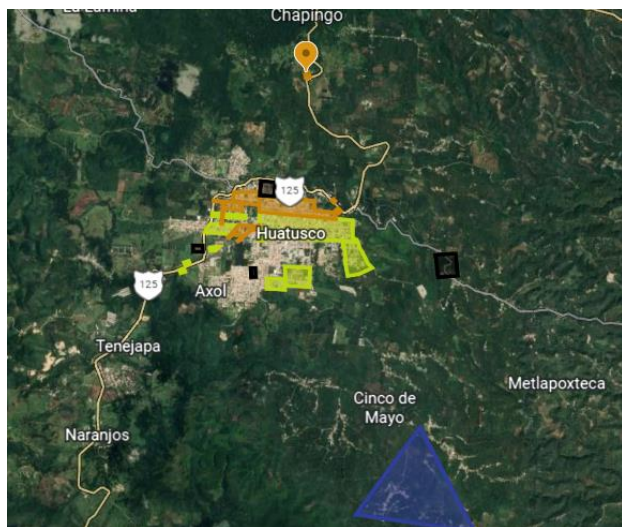


Figure 3 Macro routes, Friday
Source: Google Earth



Figure 4 Macro routes, Friday
Source: Google Earth



Figura 5 Macro routes, Friday
Source: Google Earth

Red Dot Area

The red dots referred to in the routes are based on the commercial area because they are areas that many people use as dumps, Table 3 shows the locations of these dots. Figure 6 shows the location of the dots on the digital map.:

Red dots	Ubication
1	Corner of 6th Street and 7th Ave.
2	Corner of 4th St. and 7th Ave.
3	Corner of 6th St. and 5th Ave.
4	Corner of 4th St. and 5th Ave.
5	Corner of 6th St. and 3rd Ave.
6	Corner of 4th St. and 3rd Ave.
7	Corner of 2nd St. and 3rd Ave.

Table 3 Location of Red Dots in the city



Figure 6 Red Dots
Source: Google Earth

The red box indicates the area of influence of the red dots and clearly shows the points located on the map. This area has such an impact because it is considered a commercial area, the businesses near these points commonly offer organic products, i.e. fruit, vegetables and even flowers. It is known that these types of products are perishable, which is why this area is considered a warning sign because if these sites are neglected, they could become sources of infection, which would have a negative impact on the environment and society. Figure 7 shows the problem mentioned above, these images were taken during the sampling that was carried out.

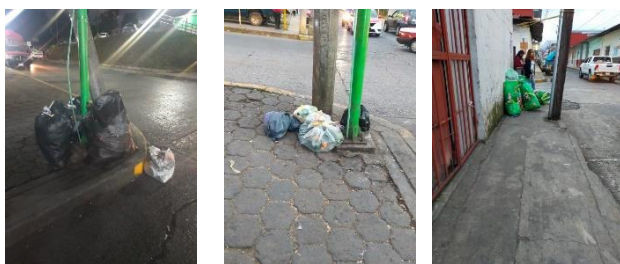


Figure 7 Red Dots Urban Area

Mileage Report

Table 4 shows the kilometres travelled on each route, as well as the fuel consumption data, based on the distance travelled and taking into account the consumption coefficient: for every 100 kilometres travelled, 38.74 litres of diesel are consumed. This data was taken based on the route to the landfill located in the city of Nogales, in which 142.28 kilometres are travelled and a total of 55 litres of diesel are consumed, giving a performance of approximately 2.581 kilometres per litre. (Consumption data obtained from the Technical Report of the Study of Generation and Composition of Urban Solid Waste in the Municipality of Huatusco, Veracruz).

Day	Route	Target Name	Kilometres Travelled	Consumption (L)
Monday	Route 1	TK905-54462	27.43	10.62
	Route 2	TK905-54486	26.38	10.22
	Route 3	TK905-54462	42.69	16.54
Tuesday	Route 1	TK905-54462	23.68	9.174
	Route 2	TK905-54486	39.75	15.40

Table 4 Mileage of MSW collection vehicles
Source: Own elaboration

Day	Route	Target Name	Kilometres Travelled	Consumption (L)
Wednesday	Route 1	TK905-54462	28.83	9.23
	Route 2	TK905-54486	21.44	8.31
	Route 3	TK905-54462	43.02	16.67
Thursday	Route 1	TK905-54462	17.68	6.85
	Route 2	TK905-54486	27.96	10.83
	Route 3	TK905-54462	31.35	12.15
Friday	Route 1	TK905-54462	40.2	15.57
	Route 2	TK905-54486	44.1	17.09
	Route 3	TK905-54462	158.64	61.46
Saturday	Route 1	TK905-54462	24.67	9.56
	Route 2	TK905-54486	27.7	10.73
	Route 3	TK905-54462	130.67	50.63
Sunday	Morning and Evening Route	TK905-54486	22.69	8.79

Table 4 (Continued) Mileage of MSW collection vehicles
Source: Own elaboration

Proposals for improvement

A Forrester model was developed, using the data currently available for the solid waste collection system as input data:

- Kilos collected per kilometre,
- Percentage of recovery,
- Kilometres travelled,
- Tons collected
- Load capacity of the trucks on each trip.

Among the variables to be highlighted is the monthly waste generation in the municipality, which shows a behaviour according to a uniform distribution with a lower limit of 413.05 and an upper limit of 951.81 tonnes, which coincides with the data obtained from the Technical Report of the Study of Generation and Composition of Urban Solid Waste in the Municipality of Huatusco, Veracruz.

The main elements of the model are the generation per capita, a variable that is introduced by a secondary variable to MSW Generation, this data is complemented with the population of the municipality (59,960 INEGI), the days and the production per capita (0.469 kg/person); in turn, the tons collected are related to MSW because the collection process is based on the efficiency of the system (87.26% of the MSW is collected in the municipality).

The proposal for improvement contemplates the separation of waste at source, i.e. it is analysed what would happen if waste is separated into organic and inorganic waste, considering the different types of waste, as well as the percentages that are being generated in the municipality, so that, with this information, the impact that these actions could have can be seen. The model is presented in three parts due to its size. This can be seen in Figures 10, 11 and 12.

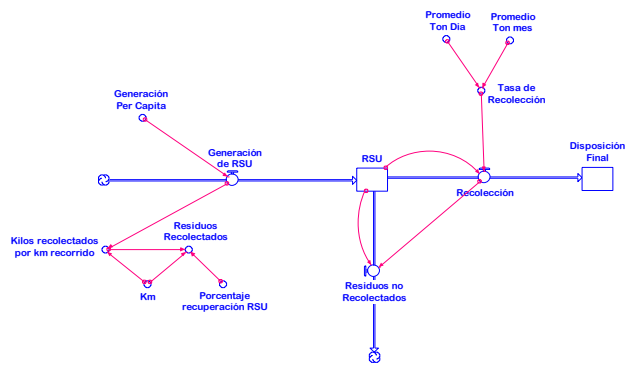


Figure 8 Dynamic model of the current MSW management system

The model in Figure 8 presents the current operation of the MSW management system in the city of Huatusco de Chicuellar.

The public cleaning service system operates on a daily basis by carrying out mixed waste collection, sweeping the main streets of the city and then disposing of the collected waste in a sanitary landfill. Based on these processes, the modelling of the current situation was constructed as shown in Figure 8, and the data obtained show the behaviour of the system over a year.

Figure 9 shows the amount of MSW generated and collected per month. In the Final Disposal column, there is an approximation of the total number of kilograms of waste to be deposited in a landfill in a year. These data were validated against the information provided by the municipality, so that the behaviour of the model can be considered to replicate what happened in reality.

Months	Generación de RSU	Recolección	Residuos no Recolectados	Disposición Final
Jan	742.440.36	664.296.26	72.937.28	665.607.17
Feb	856.746.16	668.477.05	73.963.30	1.129.903.43
Mar	862.461.05	753.382.85	103.363.31	1.799.380.48
Apr	783.796.76	787.425.16	105.035.89	2.551.763.33
May	790.910.27	693.421.59	90.374.17	3.309.188.49
Jun	699.282.77	712.241.12	78.669.16	4.002.610.08
July	822.238.19	614.118.83	85.163.94	4.714.851.20
Aug	690.504.21	737.881.46	84.356.73	5.328.970.03
Sep	707.844.45	620.117.68	70.386.53	6.066.851.48
Oct	889.201.99	617.245.59	90.598.86	6.686.969.16
Nov	547.766.60	782.471.19	96.730.80	7.304.214.75
Dec	905.860.53	488.862.90	58.903.69	8.096.685.94

Figure 9 Results of the current Dynamic Model

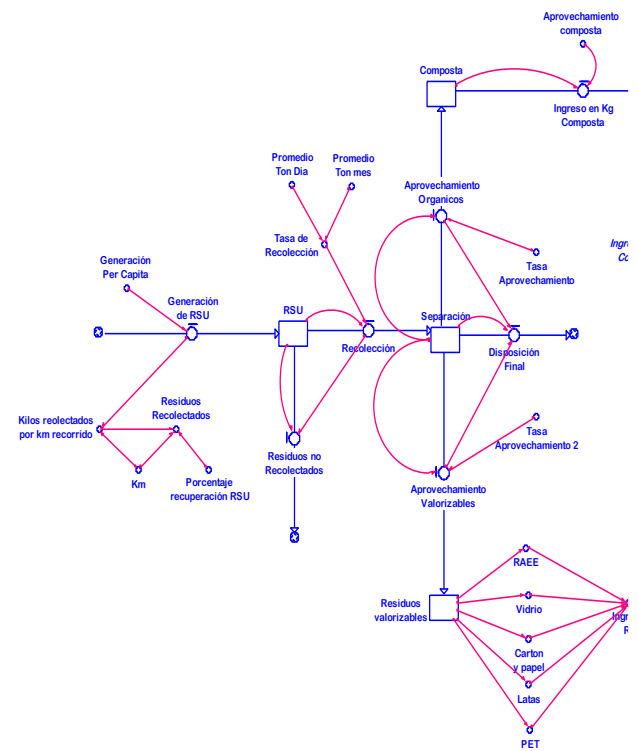


Figure 10 Dynamic model of the improvement proposal (Part 1)

Some of the results obtained from the improvement model are shown in Figure 13. This figure numerically describes the impact on the final disposal process based on the use of organic and recoverable waste, and by carrying out the corresponding calculations, an approximate reduction of between 40% and 50% can be seen. Positive benefits can be obtained from a differentiated collection, such as the production of compost from organic waste or the sale of recyclable waste such as cardboard, paper, glass, ferrous material, PET, and waste electrical and electronic equipment.

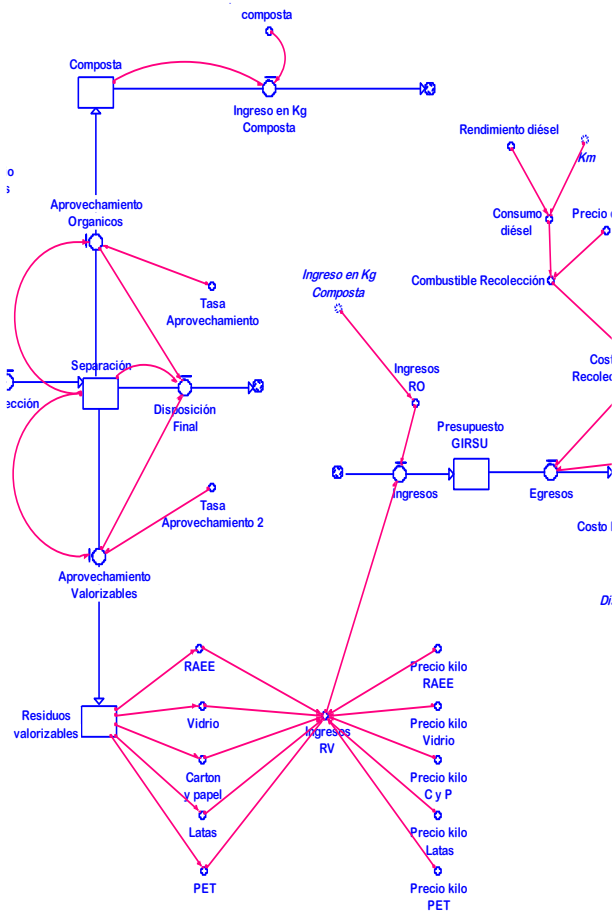


Figure 11 Dynamic model of the improvement proposal (Part 2)

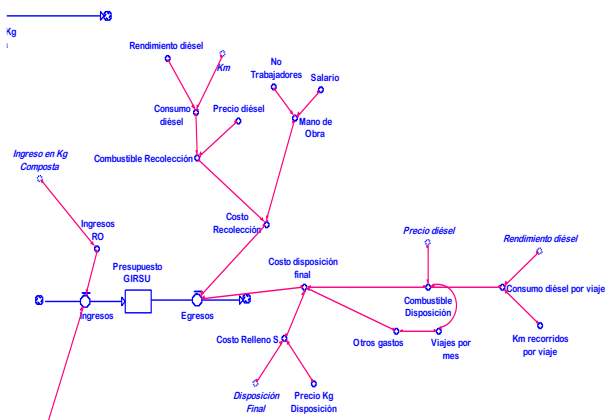


Figure 10 Dynamic model of the improvement proposal (part 3)

Months	Recolección	Aprovechamiento Organicos	Aprovechamiento Valorizables	Disposición Final
Jan	703,040.11	219,846.41	131,153.54	347,740.25
Feb	600,699.45	214,107.29	131,960.63	356,972.19
Mar	430,995.24	191,940.29	112,751.29	296,007.88
Apr	399,480.99	142,232.57	80,897.81	207,964.87
May	426,559.28	140,017.79	74,962.58	184,480.62
Jun	430,709.88	134,910.36	80,068.16	211,883.74
Jul	424,383.27	147,886.94	80,843.68	201,976.26
Aug	768,445.53	134,079.61	79,856.74	210,646.92
Sep	574,615.32	254,986.96	144,237.23	369,221.74
Oct	824,266.31	202,169.94	107,855.30	264,590.09
Nov	817,760.06	250,244.91	154,714.79	419,306.61
Dec	520,244.31	282,212.30	153,493.56	382,054.20

Figure 11 Results of the Dynamic Model of the Improvement Proposal

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Conclusions

From the results achieved in this research in accordance with the objectives set out, it is concluded that obtaining and analysing information is key to assessing the performance of the collection system and adjusting it in a timely manner according to the changing needs of the municipality as it experiences both population and commercial growth.

Therefore, by using this type of GPS device, it is possible to interact with a large number of parameters that are not traditionally considered, such as the effects of traffic on the different roads, the change in the type of vehicles, the mileage on each route that represents the fuel expenditure and, most importantly, the change in the collection method used with all its implications, among others.

A main recommendation is the creation and dissemination of adequate processes and protocols for the disposal and, when necessary, the management of the waste generated, and through this type of strategy, alternatives for the disposal of waste can be offered, such as the creation of deposits for recoverable waste, the creation of programmes that teach the management of compost, among others.

It is recommended for future work to add the economic data of the management system, which will allow for a clearer vision of the impact that can be achieved with the implementation of the suggested policies of waste separation and recovery, entering into a circular economy scheme.

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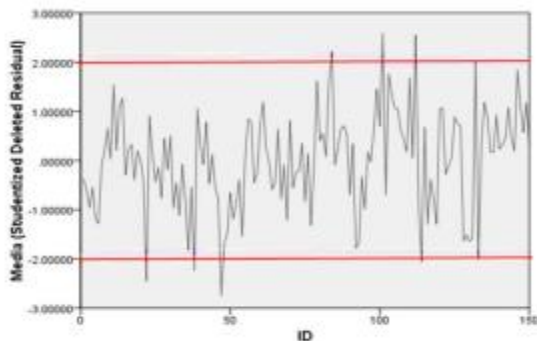
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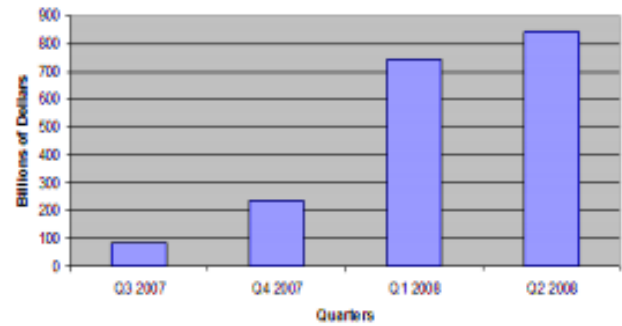


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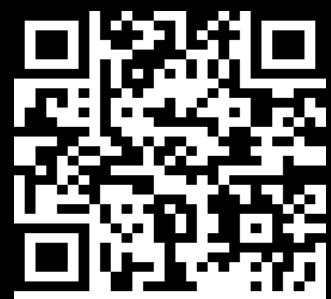
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