



## CHAPTER 4

# ENVIRONMENTAL AWARENESS FOR SUSTAINABLE DEVELOPMENT WITH MEANINGFUL LEARNING<sup>1</sup>

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**ABSTRACT:** The education sector at the local level around the world has great challenges regarding global awareness actions in the student population, to creatively convey the importance of environmental protection as an action of social responsibility toward future generations. That is why SGD 4 of the 2030 goals represents a key link to encourage students at different educational levels to develop initiatives to take care of natural resources and empathy for well-being, health, and sport as key factors for better living conditions in the population. Beyond conceptual understanding, academic practices and research are required to manage knowledge of sustainable development.

**KEYWORDS:** 2030 goals, social innovation, sustainable development, SDG 4, sectoral competitiveness.

## 1. INTRODUCTION

The great global challenges to raise awareness among the population about the importance of actions for sustainable development reflect local, regional, and national efforts, with systemic initiatives promoted by different sectors of society, especially the 2030 Agenda for Sustainable Development Goals (SDGs) established by the United Nations (UN), have become an international benchmark for setting commitments, targets, and indicators in each of the 17 SDGs [1]. SDG 4: Quality Education is the objective of the analysis in this document as a contribution to the State of the Art of Development from the Higher-Level Education Sector in the City of Tijuana, Baja California, Mexico, with national and international linkage actions. The methodological emphasis of the research is the awareness of Social Innovation for Sustainable Development [2]. The research begins with the analysis of the regulations of the Mexican Government for the training and updating of

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teachers, which includes the focus on empowerment and management of academic activities, linkage, social service, and development of projects through the SDGs in the classes of different educational programs. Methodologically, social innovation is influenced by improving sustainable development, and thus, sectoral competitiveness. Analysis was carried out on the social impact of progress in the implementation of SDGs. Follow-up was carried out on Educational Social Service Activities to support the development of Node Programs to develop the Social and Solidarity Economy [3]. Initiatives are taken to develop TecNM Scientific Research Projects to promote sectoral linkages through scientific dissemination activities. Likewise, the activities of national and international linkage through the productivity of the Academic Body (ITTIJ-CA-12) and the National Network for Research in Social and Solidarity Economy (RIESS) of the National Technological Institute of Mexico [4]. The research addresses the following topics, from the conceptual approach, and the evidence focused on SDG4, quality education, is the main objective of research:

1. Guidelines of the Program for the Professional Development of Teachers (PRODEP)
2. Fifth Systemic Helix Methodology (QHS) and Dictionaries of Sectoral Competencies (DCS) for Sectoral Development and Social Innovation
3. Municipal Development Agenda (MDA)
4. Center for Research and Documentation of the Public, Social, and Cooperative Economy—Mexico (CIRIEC)
5. TecNM Scientific Research Projects
6. TecNM's NODESS Tijuana Project
7. Commission for the Promotion of the Social and Solidarity Economy
8. Training Program in Social and Solidarity Economy (SSE) (Diploma, Master's, and Doctorate)
9. TecNM Academic Body ITTIJ-CA-12
10. Voluntary Report on Progress on the SDGs in Cities
11. TecNM Social and Solidarity Economy (SSE) Research Network

## 2. METHODS AND MATERIALS

According to the State of the Art of Bibliometrics of Scopus Article Databases, Web of Science on the topic of SDG 4, and Quality Education, there are great challenges and critical roles that depend on the teaching practices of teachers [5], to influence motivation and awareness of the elements and actions that make up the quality of life from the student phase to the professional phase [6], being the teacher who plays a key role as a mentor of good practices, tasks, projects, social service, professional practices, essays, theses, publications, and the development of

critical thinking through the development of scientific research and development initiatives [7–9].

The great expectation of a professor and researcher in the development of an article, or research report, is to disseminate the findings, product of teaching, and research activities, as well as the link with the different sectors of society as part of the efforts of full-time professors and researchers with national accreditation.

This chapter presents the efforts of good practices to develop a roadmap that can be replicated in a local, national, and international systemic context, as a framework of reference for activities from academia and applied research.

In Mexico, full-time professors must accredit by regulation a certification named PRODEP (Desirable Profile), which includes the need to empower the 2030 Agenda and develop actions within their classes on the understanding and awareness of each SDG [10].

With the focus of the Fifth Helix Methodology (QHS in Spanish), the importance and benefits of linking with the representatives of the society are illustrated by government, companies, academia, associations—business chambers, and consultants, to influence actions to raise awareness among the population from the local level in a city, with small efforts and constant actions and seek the relevance and belonging of the society with each SDG, as well as the affinity in the sense of social responsibility.

In the case of INAFED (National Institute for Federalism and Municipal Development), the 2030 Agenda is promoted in public policy actions in the municipalities in the Municipal Development Plans, in coordination with the academic sector to train society in public spaces and civic squares, as well as through mass media such as social networks and giant screens for public dissemination of information on the SDGs. In the specific case of the city of Tijuana, Baja California, efforts have been made to provide the necessary resources.

For example, in Avenida Revolución, the most famous street in the city, there is a mega screen with the capacity to view information from more than 85,000 people daily. From the Tijuana Institute of Technology of TecNM, different efforts have been developed, as is the case of the research project developed between the TecNM Campus Tijuana and the Municipal Institute of Citizen Participation of Tijuana (Table 1) with the support of the National Research Network in Social and Solidarity Economy (RIESS).

The project is made up of more than 100 national and international researchers including the University of Guadalajara [11] and CIATEJ Research Center—CONAHCYT [12]. The research project has the support and methodological backing of the Executive Secretariat of the National Council of the 2030 Agenda for Sustainable Development of the Global Economic Intelligence Unit of the Ministry of Economy of

the Government of Mexico as a strategy to contribute to the achievement of priority projects for the country, through collaboration with the Government and Academia.

	Objectives	Feedback/goals
1	Diagnosis and municipal training in the necessary competencies of higher education students on the Sustainable Development Goals (SDGs) of the 2030 Agenda	TecNM, at the national level, has more than 600,000 students throughout Mexico, with social service activities, dissemination through digital media, social networks (TikTok, YouTube, and Facebook), in squares and public spaces, the goal of 1,000,000 people empowered and aware of the importance of the SDGs can be achieved.
2	Diagnosis and development of workshops for methodological competencies, to encourage the design of research projects for higher education students on the SDGs.	There is low participation of students in TecNM Research Project Calls, so it is necessary to train and motivate them to develop the scientific research profile, emphasis on the 2030 Agenda, priority issues for the country, and regional and local development.
3	Evaluation and design of a methodological proposal to encourage the development of subnational voluntary reports in cities on the progress of the SDGs.	Currently, Mexico has only presented national reports with statistical averages of the progress made in the Sustainable Development Goals (SDGs); there are no municipal subnational reports (ISNM). Tijuana is in the process of completing the First Municipal Subnational Report, and the learning curve could be replicated in other cities.

Table 1. Project: municipal observatory of competencies for sustainable development goals (SDGs) Mexico 2030 agenda.

## Program for the professional development of teachers (PRODEP)

According to the Rules of Operation of the Program for the Professional Development of Teachers, issued by the Ministry of Public Education of the Government of Mexico in 2021, the guidelines are linked with the purpose of having a reference framework that allows identifying the actions that contribute to the fulfillment of the Sustainable Development Goals of the 2030 Agenda in the classroom through the educational programs. To this end, the PRODEP Program includes the 2030 Agenda for Sustainable Development as an Institutional Objective, contributing to action plan initiatives for people, planet, and prosperity. It also aims to strengthen universal peace within a larger concept of freedom. The importance of eradicating poverty in all its forms and dimensions, including extreme poverty, is recognized as the greatest challenge facing the world and is a prerequisite for sustainable development. The 2030 Agenda includes 17 SDGs; in the context of the education sector, it establishes SDG4, quality education, aimed at guaranteeing inclusive and equitable quality education, to promote lifelong learning opportunities for all, the great challenge of society on the planet [13].

The history of the PRODEP Program dates to 1996, when the Program for the Professional Development of Teachers began at the university level for higher level, called PROMEP (Teacher Improvement Program), whose purpose was to invigorate the work of teachers working at the higher level. In normal education, it was later instituted, in 2009, within the PROMEP (Program to Strengthen Normal Schools), in which it was included as a new need in the field of knowledge generation in collegiate groups. Teachers would carry out research in addition to teaching, but reality shows scenarios different from those desired by several factors with the Priority Objective of revaluing teachers as fundamental agents of the educational process, with full respect for their rights, based on their professional development, continuous improvement, and vocation for service.

UNESCO states that the achievement of education for all was boosted in terms of coverage at the time. For the 2030 Agenda, education expands its scope beyond access, promoting learning achievements, different ways of accessing knowledge, safe and healthy educational environments, innovative methodologies, and the approach to lifelong education. In addition to educational achievement, quality education promotes skills for the promotion of peace, conflict resolution, mutual understanding, and sustainability; therefore, as far as young people are concerned, education must be related to their needs and interests, in which they incorporate significant learning and enable their adequate inclusion in the labor markets and the achievement of their projects of life [14].

## Methodology QHS and DCS for sectoral development

Initiatives have been developed from academia, and the areas of postgraduate research, such as the Fifth Systemic Helix Methodologies (QHS) Methodology in Spanish, aimed at sectoral integration processes to analyze, evaluate, and promote projects where the different representatives of society interact, such as the government sector, education, companies, business chambers—unions, and specialized consultants [15]. In the case of the Sectoral Competency Dictionary Methodology (DCS Methodology in Spanish), this methodology strategy proposes the design of labor, professional, and research competencies for the design of Competency Standards [16] and thus respond effectively to the relevance and validity of knowledge skills, and attitudes necessary at each occupational level and position.

## Municipal development agenda (MDA)

The Technological Institute of Tijuana of the TecNM, through the postgraduate program of master's in administration as a Verification Unit, is the headquarters of the training work for the Public Servants of the State of Baja California. The training

modules focus on delivery-reception of the Municipal Public Administration and Consultative Guide of Municipal Performance, which contemplates sustainable objectives according to the Global Agendas as is the case of the 2030 Goals of the UN [17]. The municipal development verification program is promoted by the National

Institute for Federalism and Municipal Development (INAFED), which depends on the Ministry of the Interior (SEGOB) and is coordinated by the state governments to promote the improvement of Municipal Management. Currently, the five municipalities of the State of Baja California have implemented the INAFED program as a strategy for identifying and monitoring areas of opportunity generated through the verification processes developed by higher education institutions (HEIs) in Mexico [18].

In Baja California, the HEIs that develop the activity of social and academic responsibility of contributing with highly prepared professors for the application of the Instruments of the Municipal Development Agenda (ADM), now called the Municipal Development Guide (GDM), are the Technological Institute of Tijuana, through its Master's program in administration, and the Technological University of Tijuana. According to INAFED's national verification results, the municipalities that achieve the best results receive an Annual Recognition and Distinction at the Ministry of the Interior in Mexico City. Each year, the results generate opportunities for the development of action plans according to the gaps identified because of the surveys that are applied to the society as a complementary action to the annual verification of municipal performance and management, as a strategy to promote the strengthening and recognition of the talent management of public servants in Mexico.

## Public and social economics research

Since the founding in May 2019 of CIRIEC Mexico (International Centre of Research and Information on the Public, Social, and Cooperative Economy), the Tijuana Institute of Technology of the TecNM has been part of the structure of the organization, occupying the Vice Presidency in the Northern region of Mexico. CIRIEC Mexico is a nonprofit association and national chapter linked to CIRIEC International, which is based in Belgium.

CIRIEC Mexico was born as a promise and a hope to contribute to another way of doing things in the economy. In the research and the very close accompaniment with the entities of the Social and Solidarity Economy (EESS) in their territory, under their cultural and socioeconomic contexts, with their resources (most of the time incredibly scarce), we hope that CIRIEC Mexico, little by little, achieves the cohesion and professional coherence required to face the social requirements of the countryside and the city [19].

## TecNM scientific research projects

Strategies to influence Sustainable Development through Teaching and Research have generated initiatives to contribute to SDG 4: Quality Education. Observatory of the Integration of Engineering in the Economic Development Ecosystem of the Baja California Peninsula. The research focused on two areas of interest: the relevance of the study program for engineering careers at the TecNM in the region.

First, identification of the professional competencies of the engineers who intervene in the supply chain within the companies and manage local supply as a competitive strategy in the regional economic development ecosystem.

The second focus is the factors that intervene in entrepreneurship as MSMEs in the strategic services sector as a key strategy for the promotion of local supply as a professional development of engineers graduated from TecNM in the Baja California Peninsula [20].

Observatory of Sustainable Development in Graduate Study Programs in Baja California: the scientific research project focused on carrying out a systemic analysis in higher education institutions that incorporate the dimension of sustainability in their graduate level curricula in the State of Baja California through teaching, research, and university management. To cement the variables to develop an Observatory of Sustainable Development of Graduate Study Plans in Baja California [21] as a tool for the analysis of the culture of sustainability and inclusion in the current university model, the project integrated three specific objectives:

1. To determine the level of culture of Sustainable Development in the Graduate Study Plans in Baja California.
2. To evaluate the implementation of the Sustainable Development Goals in the Graduate Study Plans in Baja California.
3. To design the perspective of the variables for an Observatory of Sustainable Development of Graduate Study Plans. The Project of the Observatory of Sustainable Development in Graduate Study Programs in Baja California is a continuation of the project Observatory of the Integration of Engineering in the Economic Development Ecosystem of the Baja California Peninsula.

The entry into force of the United Nations 2030 Agenda in 2015 makes it possible to promote sustainable development in its social, economic, and environmental dimensions. SDG 4 of the 2030 Agenda obliges the actors involved to carry out a series of actions in this area, guaranteeing inclusive and equitable quality education and promoting lifelong learning opportunities for all.

Among the benefits and impacts of the research project is the alignment with UNESCO's Medium-Term Strategy 2008–2013, which highlighted that development and economic prosperity require the capacity of states to teach their citizens and

provide them with a culture and awareness about learning about sustainable development and the benefits for quality of life and integral development in society. It would provide local professional development for engineers who graduated from TecNM in the Baja California Peninsula.

## **TecNM's NODESS Tijuana project**

The actions are derived from the TecNM Institutional Development Plan since 2019 to promote a NODESS Project (Nodes for the Development of Social and Solidarity Economy) of the City of Tijuana, integrated strategic allies; the Municipal Institute of Citizen Participation of the Municipality of Tijuana and the Confederation of Cooperatives of the Northern Border of Mexico, to promote the UN 2030 Goals, oriented to the thematic line of food sovereignty, with specific objectives to map the needs of the supply chain and areas of opportunity in social innovation. This is in accordance with the National Strategic Programs (PRONACES) of CONAHCYT (National Council of Humanities, Science and Technology), focusing efforts on the Supply Chain of the Dough and Tortilla Industry [22].

The project undertaken in 2019 as NODESS TIJUANA, crystallized, achieving the TecNM Tijuana, the national registry as the FIRST NODESS in the Northern Border Region of Mexico, occupying the leadership in the Border Municipalities of Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas. The main objective of the NODESS TIJUANA Model presented at the national level by the TecNM Tijuana campus is the multiplier development of NODESS projects with a systemic approach (Fifth Systemic Helix) for the institutional link with the different sectors of society and with the aim of empowering the learning curve generated in the principles of the Social and Solidarity Economy.

TecNM Tijuana contributes to academic linkage and strategic research actions to the collaborative work with the Municipal Institute of Citizen Participation of the City of Tijuana as a Member of the Sectoral Subcommittees for the monitoring of the progress of objectives and goals of the Municipal Development Plan 2022–2024 and the Strategic Plan for Municipal Development 2022–2036, all under the focus of alignment of competencies from undergraduate and graduate educational programs to the National Strategic Programs of CONAHCYT, so that altogether, we can contribute to the challenges of the National Plan in each region of Mexico [23].

## Commission for the promotion of the social and solidarity economy

Nowadays, communities in Mexico, whether urban or rural, must be thought of from a sustainability approach, this new approach to sustainable development.

involves three main spheres in perfect balance: economic, social, and environmental aspects. Social development cannot be generated without economic development and care for the environment, always bearing in mind that the goal of action must be for the benefit of the development of people in an inclusive way and their communities.

The installation of the “Commission for the Promotion of the Social Economy” aims to identify the needs of the business exercise of the representatives of the Social and Solidarity Economy through the systematization of social innovations, aligned with the objectives of the national development plan to reduce the gaps of social inequality, as well as the instrumentalization of a social economy observatory of the goals for sustainable development of the 2030 Agenda, in the ecosystem of economic development of the City of Tijuana, to combat poverty and hunger. It requires the will to work in a coordinated manner the government, academia, social sector, representatives of civil society, as well as the citizens of Tijuana, with a systemic development approach [24].

## TecNM training program in social and solidarity economy

At the national level, the initiative of the National Technological Institute of Mexico (TecNM) has been generated to offer a Training Program in Social and Solidarity Economy, which integrates diplomas, master’s, and doctorates aimed at all people interested in the development, management, organization, and implementation of social and community development projects with a focus on Social and Solidarity Economy. The modality is face-to-face and mixed, and the doctorate is proposed to be virtual in an asynchronous way, thus seeking an offer of national and international scope based in TecNM Tijuana [25]. The general contents of the training in Social and Solidarity Economy (SSE) integrate aspects such as:

- a) Fundamentals of SSE: introduction to economics, introduction to SSE, dimensions and features that identify SSE, purposes of SSE, and values.
- b) Context of SSE: currents of the SSE, the SSE, and other alternative economies in Mexico: challenges and perspectives.
- c) Legal Framework, Ecosystems, Innovation, and Entrepreneurship in SSE: legal framework that regulates the social sector of the economy and its economic activity in Mexico, types of cooperative societies, SSE ecosystems and innovation, and social entrepreneurship.

d) SSE Preliminary Projects and SSE Case Studies: elements of an SSE draft project, participatory tools for the development of an SSE draft project, and international and national experiences of SSE projects: case studies and presentation of an SSE draft project.

## **TecNM academic body ITTIJ-CA-12**

The PRODEP Academic Body is a modality of conducting research with groups of research professors and researchers from one or more lines of research. Academic bodies are groups of full-time professors who share one or more lines of generation or application of knowledge (research or study) in discipline or multidisciplinary topics and a set of academic objectives and goals. At the Tijuana Institute of Technology of the TecNM, the first multidisciplinary team was formed to attend the topic of Sustainable Development, aligned with the UN's 2030 Goals.

The name of the Academic Body: "Sectorial Competitiveness, Social Innovation and Sustainable Development." It obtained its registration at the national level in Mexico in 2023, after a trajectory since 2019, code: ITTIJ-CA-12, founded in the Department of Economic and Administrative Sciences with Professors and Researchers with PRODEP Accreditation (Program for the Professional Development of Teachers) and National Distinction before CONAHCYT (National Council of Humanities, Science and Technology) of the Government of Mexico, as Members of the National System of Researchers. In the area of Economic and Administrative Sciences with Lines of Generation and Application of Knowledge: (1) sectoral competitiveness and (2) social innovation and sustainable development [26].

## **Voluntary report on progress on the SDGs in cities**

Mexico will present its Fourth Voluntary National Report on the 2030 Agenda for Sustainable Development in 2024. The Executive Secretariat of the National Council of the 2030 Agenda supports efforts at the national level to develop subnational reports, and such is the case of the City of Tijuana through the processes of specialized training and orientation to shape the information of actions developed from the local level and thus add to the national results. The Municipal Institute of Citizen Participation (IMPAC) and the National Technological Institute of Mexico (TecNM) Tijuana Campus work in coordination with the NODESS Tijuana Program in the advancement of awareness of the UN 2030 goals, with workshops, conferences, and seminars at the local, state, national, and international levels of the good practices developed in the City of Tijuana toward the awareness of youth in primary, secondary, high school, and universities, as well as the different sectors of society.

For a greater context of the challenges that Mexico (United Mexican States, official name) must address the phases of awareness, empowerment, and specific actions

in each municipality, Mexico has 32 Federal Entities (states) and 2475 municipalities, according to the National Institute of Statistics and Geography (INEGI), with a population of 131.1 million people and with a growth of 0.9 [27]. According to the UN's 2030 Agenda reports, Mexico has the following Voluntary Subnational Reports presented in Table 2, which includes state governments 8 out of 32 and municipal governments 5 out of 2475 [28].

Since 2015, the importance of the 2030 Agenda has been actively promoted, man-aging through different actions and tools planning at the local level, in cities, regions, state governments, and country governments, to implement actions in each SDG. According to the United Nations report of the Department of Economic and Social Affairs, Table 3 presents the records of the countries that annually submit voluntary reports of a state, regions, or even at the city level [29].

The challenges are great, but the unity of all sectors of society can generate surprising actions. That is why the key role of SDG 4, from the education sector, as an agent of change and leader, is to integrate, motivate, and articulate the different sectors of society; the reflection of the capabilities of society is its level of education.

Year	State government	Municipal government
2023	Puebla, State of Mexico	Tizayuca
2022	Oaxaca	-
2021	Tabasco, Durango, Mexico City (Capital), State of Mexico	Merida, Guadalajara
2020	Yucatan	-
2019	Mexico City (Capital), Oaxaca	-

Table 2. Mexico's 2030 agenda voluntary subnational reports.

## TecNM social and solidarity economy (SSE) research network

TecNM Research Networks are the voluntary association of researchers or people interested in collaborating to address a problem of regional, national, or international magnitude from a multidimensional perspective and in an articulated way between national and international actors from academia, government, companies, and civil society. Networks can be understood as incubators of cooperation, where interactions, collaborations, and transfers between partners contribute to generating a multitude of outputs and results, both tangible and intangible [30]. Since 2023, TecNM Campus Tijuana has been the national leader of the research network in social and solidarity economy, with the purpose of developing research projects for three years of validity of accreditation as a nationwide network. The network is made up of committees for the training of human resources, professional practices, social service, certification of competencies, and development of initiatives to update the relevance of curricula and programs at different educational levels.

Year	Participating countries	Number of countries
2023	Morocco, Australia, and Argentina. Belgium, Denmark, United States, Finland, Portugal, Uruguay, Brazil, Mexico, Malaysia, Japan, Netherlands	14
2022	Malaysia, Jordan, Netherlands, Spain, Brazil, Germany, Argentina, Portugal, United Kingdom, Uruguay, Bolivia, Paraguay, Belgium, Denmark, Italy, Australia, Guatemala, Tanzania, Mexico, Colombia, Finland, Japan, China	23
2021	Malaysia, Brazil, Norway, Finland, Mexico, Belgium, Peru, United States, Denmark, Japan, Spain, Argentina, South Africa, United Kingdom, Indonesia, Germany, South Korea, Norway, Canada, Sweden, China	21
	Spain, Germany, Finland, Belgium, Uruguay, United States, Brazil, Greece, Argentina, China, South Korea, Mexico, Mozambique, Albania	14
2020	Brazil, Spain, United States, United Kingdom, Finland, Mexico, Portugal, Argentina, Japan, Bolivia, South Korea, Philippines, Germany, Belgium	14
2019	Spain, Japan, Bolivia, United States, South Korea	5
2018	Philippines, Belgium, Australia, Spain, Brazil, Germany	6

Table 3. Cities of the world with a voluntary local report of agenda 2030.

The focus of the research network is to support undergraduate and graduate students in projects that impact the different sectors of society, develop projects to analyze the capacities of supply, supply chain, productive ecosystems and productive vocations in the north, center and south of Mexico. The linkage activities promoted by the research groups and the Nodes for the Promotion of the Social and Solidarity Economy, known as NODESS, aim to promote different methodological strategies of intervention in organizations, for the analysis of the factors that encourage sectoral development, the application of the QHS Methodology; it integrates representatives of academia, government, companies, associations and consultants.

The UN 2030 Agenda is a central point of the research network's work axes with an impact on the development and well-being of society, toward a sustainable approach, as well as the axes of the national development plan and the reference of local and state development plans. The vision of the academy is to seek dialogue and synergies between the different sectors of society, to know the needs and to develop solid solutions.

### 3. RESULTS

Under the systemic analysis of information generated in Mexico, the last decade has been oriented to the contributions in favor of quality education for the awareness of sustainable development and the empowerment of the 17 Sustainable Development Goals (SDGs) of the UN 2030 Agenda. The statistics of the Ministry of Public Education in Mexico indicate that there is a gap between the goals and the indicators established to raise awareness among the population.

That is why, the Mexican regulations for the training and updating of full-time teachers with accreditation of the Program for the Professional Development of Teachers for the Higher Type (PRODEP) have generated actions to bring the information of the SDGs to the classrooms, but before transmitting the knowledge to the students, teachers must be trained at different educational levels to ensure that they are prepared to transmit the importance of each SDG in an effective and dynamic way. From the context of its evolution of the SDGs, Millennium Goals, it is for this reason that the national statistics on full-time teachers reflect a starting point of the need for greater efforts, programs that encourage the preparation of teachers and personnel who update educational programs to insert in each subject the necessary points toward critical thinking of Sustainable Development—concern for environmental conditions and the impact on future generations.

Table 4 presents the statistics of the universe of full-time professors. The statistic invites us to reflect that full-time professors are only 15% accredited in programs that include empowerment on the SDGs, but full-time professors in most educational institutions only represent 30% of total professors. As 70% of professors have a contractual and employment relationship of part-time or by subject hours, this generates great concern for achieving the mechanisms for training and updating teachers [31].

At TecNM 5 out of 10 engineers graduate nationwide, according to PRODEP statistics it has 8,286 full-time professors and 3,650 professors are accredited in PRODEP, a challenge of 66% of professors must prepare and be accredited with the Desirable Profile. The development of academic productivity mechanisms is a key to promoting that teachers are accredited with a desirable profile, for these skills and experience are required for research, project development and publication of articles and book chapters, as well as the training of human resources through these.

That is why Table 5 presents the list of articles published by the Academic Body with registration ITTIJ-CA-12 of the Technological Institute of Tijuana of the TecNM with the lines of Research: a) Sectoral Competitiveness and b) Social Innovation and Sustainability.

Mexico Universe		Accredited		TecNM Universe		Accredited	
276.000	100%	42,508	15%	8286	100%	3650	44%

Table 4. Number of full-time professors with PRODEP accreditation

Total articles	Citation	Index h	Index i10
114	198	7	5

Table 5. Published articles on the QHS and DCS methodology.

Development, with a multidisciplinary team of researchers, with Collaboration Agreements at the national and international level [32]. The publications and citations obtained are products of research projects developed within the framework of national calls for scientific research projects for full-time professors and researchers and sectoral linkage activities. Table 6 shows the relationship between the number of full-time professors of the TecNM and the composition of academic bodies for research. The contractual situation of the professors limits the development of the desirable profile (PRODEP) and, with it, the comprehensive training to develop activities of academic management, linkage, research, and not only teaching. Part-time professors, or hourly professors, represent more than 70% of professors.

Year	2016	2017	2018	2019	2020	2021
Full-time teacher	1750	2174	2930	3285	3478	3509
Academic bodies	559	682	682	817	848	868
% PRODEP	32	31	23	25	24	25

Table 6. Evolution of the PRODEP indicators in TecNM

The Technological Institute of Tijuana received the Recognition of the Ministry of the Interior through the National Institute for Federalism and Municipal Development (INAFED) for the activities of Linkage and Advisory as an accredited VERIFICATION UNIT (UV) to develop the methodological application of the Municipal Development Agenda in the Municipalities of the State of Baja California as part of the objectives and social responsibility of linkage and applied research. The Ministry of the Interior, through the National Institute for Federalism and Municipal Development, INAFED, seeks to strengthen the capacities of municipal governments in the fulfillment of the SDGs. For this reason, on July 7, it will present a strategy so that, together, we achieve the objectives set out in the 2030 Agenda, considering the different realities, capacities, and levels of development of each municipal space, with full respect for its autonomy.

To achieve the goals of the SDGs, it is necessary for all of us, the three levels of government, the private sector, and civil society, to join and channel actions to transform our country and the world into a better place. Figure 1 shows images of the activities to train public employees of the municipalities of the cities of Mexicali, Ensenada, Tecate, Playas de Rosarito, and Tijuana, Baja California, Mexico.



Figure 1. 1,000,000 student project trained in SDGs UN 2030 goals.

The National Institute for Federalism and Municipal Development (INAFED) of the Ministry of the Interior of the Government of Mexico states that the 2030 Agenda is an innovative development framework. Due to its scope, as well as the comprehensiveness of its policies, in compliance with its 17 Sustainable Development Goals (SDGs) and its 169 targets, it requires the broad involvement of all actors in all orders and levels of government. INAFED points out that “it is a commitment of the state” to implement the SDGs in all the municipalities of Mexico, but it requires the participation of the states, municipalities, the productive and social sectors, and citizens in general. Pointing out that “we are all actors responsible for its compliance and beneficiaries of its results.” For this reason, it is a priority to promote the articulation of collaboration schemes and synergies between these actors. In the case of the National Technological Institute of Mexico, Tijuana Campus, it has become a Verification Unit of the Municipal Development Agenda, which contemplates the evaluation of actions aimed at the SDGs in the Cities.

Under the traffic light evaluation scheme: (a) green refers to evidence of sufficient compliance, (b) yellow there is evidence of attempts, partial evidence, but they reflect actions to initiate projects that are oriented toward the objectives of the SDG targets, and (c) red is the evaluation corresponding to the actions not developed and proposed in the municipal development plan; it is a reflection that no action was initiated; there is no minimum evidence of efforts to influence the SDGs [33].



Figure 2. Social services activities with students for SDGs UN 2030 goals.

Figure 2 shows images of the evaluation processes carried out in each municipality of the State of Baja California, Mexico. Through professors and researchers who develop the verification processes of the Municipal Development Agenda, the principle of impartiality in the process of evaluation of municipal management is fulfilled. Once the evaluation processes have been carried out by the members of the Verification Unit of the Municipal Development Agenda (ADM), the results are sent to the national offices of INAFED in Mexico City. Once the results of the 2469 municipalities have been analyzed, a national ceremony will be held, and the best municipal compliance results will be announced. In 2019, the City of Tijuana had the best compliance result [34].

The Municipal Development Agenda (ADM) has evolved since 2022 and has changed its name to the Municipal Performance Advisory Guide (GDM). It is made up of eight modules that cover areas of responsibility of all municipal governments: Organization, Finance, Territorial Management, Public Services, Environment, Social Development, Economic Development, and Open Government. These are broken down into 31 themes and 115 indicators, of which 80 are management and establishing the substantive documents for the municipal administration, and 30 are performance indicators that quantitatively measure the results achieved.

The participation of the municipalities is voluntary and will be formalized through an Act of the City Council and the registration application where the liaison is designated by the Municipal President. The new GDM contemplates mechanisms to carry out remote implementation, where the use of information technologies is essential when supporting the strengthening of municipalities, giving guidance so that higher education institutions can continue to collaborate with the same rigor as in person [35].

The GDM contemplates a specific item for the theme of education and aims to contribute to the strengthening of infrastructure, equipment, coverage, and provision of educational services in the municipality. Emphasizing three key aspects: education is a means to acquire, update, complete, and expand your knowledge, skills, abilities, and aptitudes that allow you to achieve your personal and professional development. Consequently, they contribute to their well-being and the transformation and improvement of the society they are a part of.

Basic education: it is made up of the initial, preschool, primary, and secondary levels. The services included in this type of education, among others, are (I) initial schooling and nonschooling; (II) general, indigenous, and community preschool; (III) general, indigenous, and community primary; (IV) secondary, including general, technical, community, or regional modalities authorized by the Secretariat; (V) secondary for workers, and; (VI) telesecondary. Figure 3 presents the activities of the team of researchers that make up the Scientific Council of CIRIEC Mexico (International Center for Research and Information on the Public, Social, and Cooperative Economy).

The Board of Directors of CIRIEC Mexico was founded in 2018 in Acapulco, Guerrero, because of linkage and cooperation efforts between researchers from Mexico with representatives of CIRIEC Colombia, Brazil, Costa Rica, and Spain. CIRIEC Mexico was founded with four Vice Presidencies: TecNM Tijuana Institute of Technology; Indigenous Cooperative of Guerrero; Pascual Cooperative; and Autonomous University of Chapingo. Partner institutions were such as Universidad del Valle de México, Universidad Nacional Autónoma de México, Meritorious Autonomous University of Puebla. CIRIEC Mexico has been characterized by advancing in the analysis of the government’s public policies, in the Social and Solidarity Economy, the promotion of cooperativism and sustainable development.



Figure 3. Liaison activities between CIRIEC Mexico and TecNM Tijuana.

There is generation of intervention mechanisms in organizations for the analysis of productive chain ecosystems for the well-being of the most marginalized society. In this sense, various activities of an intellectual nature and linkage with the different sectors of society have been organized, seeking systemic actions of collaboration and management with the authorities of the federal, state, and local levels of government. With the development of systemic initiatives generated through the identification of good practices in society, the competencies of specialized talent are strengthened, encouraging the application of the Fifth Systemic Helix Methodology (QHS in Spanish), for the integration of the different sectors of society and with it the map- ping of productive vocations, supply chains, cementing the structure of regional development ecosystem models and a national benchmark [36].

## TecNM SDG progress mapping report

The advances made by academia to influence quality education (SDG 4) have involved the development of scientific research projects to methodologically influence the analysis of the success factors or inhibitors of the lacing of the competencies of Sustainable Development.

The project called Observatory of Sustainable Development in Graduate Study Programs in Baja California was promoted with the purpose of contributing to the lines of research of the postgraduate of the Master's Degree in Administration and Academic Body of the Technological Institute of Tijuana of the TecNM. In Figure 4, the presentation of results of the Research Project to the Society is presented. The entry into force of the United Nations 2030 Agenda in 2015 has made it possible to promote sustainable development in its social, economic, and environmental dimensions.

The agenda promotes the integration of the Education for Development (ED) and Education for Sustainability agendas. Goal 4: Quality Education of the 2030 Agenda obliges the actors involved to carry out a series of actions in this area, guaranteeing inclusive and equitable quality education and promoting lifelong learning opportunities for all. Among the benefits and impacts of the research project is the alignment with UNESCO's Medium-Term Strategy 2008–2013, which has highlighted that development and economic prosperity require the capacity of States to teach and provide their citizens with a culture and awareness about learning sustainable development and the benefits for quality of life and integral development in the society [37].



Figure 4. TecNM scientific projects with QHS methodology.

The Research Project Observatory of Sustainable Development in Graduate Study Programs in Baja California allowed a systemic analysis to be carried out on the problems raised in the scientific research project based on the limited information on the level of progress in the relevance and impact of the Sustainable Development Goals (SDGs) for the progress in the 2030 Goals of the UN (United Nations Organization) and the Programs National Strategic Programs (PRONACES) promoted by the National Council of Science and Technology (CONAHCYT) for the strengthening of sectoral sustainable development in the national territory, through the Study Plans of Graduate Programs in Mexico [38, 39].

The research project had three specific objectives:

1. Determine the level of culture of Sustainable Development in the Graduate Study Plans in Baja California,
2. Evaluate the implementation of the Sustainable Development Goals in the Graduate Study Plans in Baja California,
3. Design the prospective of the variables for an Observatory of Sustainable Development of Postgraduate Study Plans.

The results of the research project Observatory of Sustainable Development in Graduate Study Programs in Baja California propose the following approaches to the level of culture on the Sustainable Development Goals (SDGs) [40]. It is estimated on average that the level of culture is 53%, and the specific scope of SDGs is as follows:

- a) SDG 1: no poverty = 16% visible in graduate curricula in Baja California
- b) SDG 2: zero Hunger = 16% visible in graduate curricula in Baja California
- c) SDG 3: good health and well-being = 83% visible in graduate curricula in Baja California
- d) SDG 4: quality education = 83% visible in graduate curricula in Baja California
- e) SDG 5: gender equality = 48% visible in graduate curricula in Baja California
- f) SDG 6: clean water and sanitation = 32% visible in graduate curricula in Baja California
- g) SDG 7: affordable and clean energy = 48% visible in graduate curricula in Baja California
- h) SDG 8: decent work and economic growth = 32% visible in graduate curricula in Baja California
- i) SDG 9: industry, innovation, and infrastructure = 48% visible in graduate curricula in Baja California
- j) SDG 10: reduced inequalities = 48% visible in graduate curricula in Baja California
- k) SDG 11: sustainable cities and communities = 64% visible in graduate curricula in Baja California
- l) SDG 12: responsible production and consumption = 80% visible in graduate curricula in Baja California
- m) SDG 13: climate action = 48% visible in graduate curricula in Baja California
- n) SDG 14: life below water = 32% visible in graduate curricula in Baja California
- o) SDG 15: life on land = 80% visible in graduate curricula in Baja California
- p) SDG 16: peace, justice, and strong institutions = 64% visible in graduate curricula in Baja California
- q) SDG 17: partnerships to achieve the goals = 80% visible in graduate curricula in Baja California

## TecNM NODESS Tijuana project

The purpose of the formation of NODESS projects is to generate alliances between institutions of higher education, local government, and organizations of the social sector of the population to promote development, well-being, and build ecosystems. That is why Figure 5 presents the profile of NODESS Tijuana,

which specializes in three strategic issues: (1) food sovereignty, (2) culture, and (3) education. With a metropolitan field of action and strategies for liaison and academic management, the goal was to train and raise awareness among more than 100,000 people throughout the State of Baja California, adding the efforts of professors, researchers, and representatives of the Society [41].

The training and awareness activities managed by NODESS Tijuana have been managed through the design of Social Service programs, which is a requirement for a degree in high school and higher education in Mexico. Social service refers to a voluntary activity that students do in a school or community. This activity is carried out to help others, raise awareness of education, and learn from life. Social services are carried out by some students who commit to dedicating their time and effort to doing something useful, allowing them to acquire experience, skills, and knowledge to be better people and better professionals. That is why students are trained as instructors, after receiving specialized training in the training of people and the content of the 17 SDGs, to develop talks, workshops, and seminars with students of different educational levels. The students who have participated as instructors also develop complementary activities such as videos and activities on social networks to promote the understanding of each SDG and generating awareness in children. Figure 6 shows the activities of workshops to train students, teachers, employees of business associations, trade unions, companies, and anyone interested in learning about the UN's 2030 Agenda [42].



Figure 5. TecNM's NODESS Tijuana program.

As part of the results of the exercises in seminars, vodcasts, workshops, courses, and conferences on the SDGs with students from different educational levels, see Figure 7, surveys are carried out with the mentimeter tool, to develop word cloud, see Figure 8, to know what are the necessary actions to be developed by all to achieve progress in the implementation that affect the objectives and targets of each Sustainable Development Goal of the 2030 Agenda; the results are interesting. Words with greater emphasis are Solidarity, Commitment, Responsibility, Love, Empathy, Respect, Innovation, Collaboration, Partnerships, Equality, Development, Teamwork, Leadership, Effort, Well-being, Goals, Recycling, Support, Knowledge, Learning, Volunteers, Discipline, Motivation, Awareness, Organization, Tolerance, Work, Equity, and Equality. Empathy, Respect, Innovation, Collaboration, Partnerships, Equality, Development, Teamwork, Leadership, Effort, Well-being, Goals, Recycling, Support, Knowledge, Learning, Volunteers, Discipline, Motivation, Awareness, Organization, Tolerance, Work, Equity, and Equality.



Figure 6. Dissemination of the SDGs of the UN 2030 goals.



Figure 7. Project 100,000 students trained with NODESS Tijuana program.



Figure 8. Exercise word cloud in SDG seminars with students.

## TecNM social economy and solidarity training program

The Tecnológico Nacional de México, as a Public Education institution aligned with the needs of the Federal Government, has designed a Continuing and Postgraduate Education program on Social and Solidarity Economy (SSE), which includes a special focus on sustainable development through the strengthening of the ecosystems of communities and the national territory [43].

The Social and Solidarity Economy Training Program (FESS) is integrated with the Development of Educational Programs for Diplomas, Master's, and Doctorates. Figure 9 presents the list of strategic allies, professors, researchers, and specialists of the TecNM at the national level who have participated in the design of the educational programs [44].



Figure 9. National researchers on social economy of the TecNM, UdeG, and Ciatej.

## General objective

Academic training in social and solidarity economy issues represents in the human resources of social and productive organizations the opportunity to strengthen talent management in skills to identify, manage, implement, and evaluate innovative projects with social responsibility and sustainability, in accordance with the demands of the regional, national, and international environment.

## Specific objectives

Develop critical thinking in the local, regional, national, and international context with the contributions of the Social and Solidarity Economy from a sustainable perspective in ecosystems and supply chains. Apply administrative, economic, and financial tools that contribute to the improvement of the management, operation, and development of Social and Solidarity Economy initiatives. Generate initiatives with imagination, innovation, and intuition, which promote social and economic awareness for development, with strategies that meet the needs of communities. Manage projects based on the principles and practices of the social, solidarity, and community economy with a collective social vision with sectoral competitiveness and sustainable development.

For the design of educational programs aimed at the Social and Solidarity Economy, as well as the efforts to comply with the UN 2030 Agenda, it is necessary to identify the state of the Art developed in the last decade in Mexico. Table 7

presents the actions carried out in different higher education institutions, as well as the initiatives of the law from the government to favor the development of the social economy, solidarity, and social innovation through cooperativism [45]. Figure 10 shows the regional event organized by the University of Guadalajara, Social Leader, a training program for community leaders with initiatives in the SDGs, methodologically oriented projects to generate social innovation and well-being actions in the communities, and this program has collaborated through the Collaboration Network of Academic Bodies of the Technological Institute of Tijuana and CIATEJ—CONAHCYT Research Center [46].



Figure 10. Award of the social leader program of the University of Guadalajara.

Actions developed in Mexico on SSE		Year
1	Social and Solidarity Economy Law	2012
2	Social and Solidarity Economy Law (Reform)	2019
3	Universidad IBEROAMERICANA	2013
4	INAES and Universidad IBEROAMERICANA convened the Academy of Social and Solidarity Economy	2015
5	MASTER'S DEGREE IN SOCIAL AND SOLIDARITY ECONOMY Autonomous University of Guerrero (CONACYT)	2018
6	Presentation in the Chamber of Deputies in Mexico City CIRIEC Mexico Project (Founding Researchers) TecNM Tijuana (IES del Norte)	2018
7	CIRIEC Mexico Project	2019
8	CIRIEC Mexico (TecNM Tijuana–Vice-Presidency)	2020
9	Presidency of the Promotion of the Social Economy of the City of Tijuana—IMPAC—ODS	2021
10	Pre NODESS, NODESS, RED NODESS del TECN	2022
11	Social Entrepreneurship Law Initiative	2023

12	Diploma and master's degree Project in Social and Solidarity Economy of the TecNM	2023
13	Project of the INTERNATIONAL NETWORK of Social and Solidarity Economy of the TecNM (RIESS)	2024
14	PhD in Social and Solidarity Economy of the TecNM	2024

Table 7. TecNM training program in social and solidarity Economy.

The social and solidarity economy (SSE) is a set of initiatives based on a paradigm shift based on the collaborative work of people and the collective production of goods for self-consumption. To meet the needs of their members and their communities where they are developed, SSE seeks to generate relationships of solidarity and trust, community spirit and participation by strengthening the processes of productive integration, supply chains, value chain, sustainable consumption, distribution of savings and loans, and models of social innovation and sustainable development.

### PhD project in social and solidarity economy at TecNM

The Tijuana Institute of Technology TecNM has been characterized by training and updating the management team of companies and organizations for more than 50 years in the City of Tijuana and in the region of Baja California, where outstanding professionals and researchers who have made important contributions to different sectors of society have graduated locally, nationally, and internationally. The TecNM Campus Tijuana offers an online and asynchronous Doctorate in Social and Solidarity Economy with Professional Guidance with a high academic level to strengthen professional competencies, providing the opportunity to update knowledge, learning and skills, as well as competencies for applied research.

The Department of Economic and Administrative Sciences has maintained the traditional postgraduate master's degree in administration for more than 30 years. This new postgraduate degree has an impact both nationally and internationally. The structure of the curriculum of the Doctorate in Social and Solidarity Economy at TecNM is shown in Figure 11 and is adapted to the demand for highly qualified professionals in an increasingly competitive world, in a cross-border region characterized by the economic dynamism of the cities of Tijuana, Baja California and San Diego, California [47].

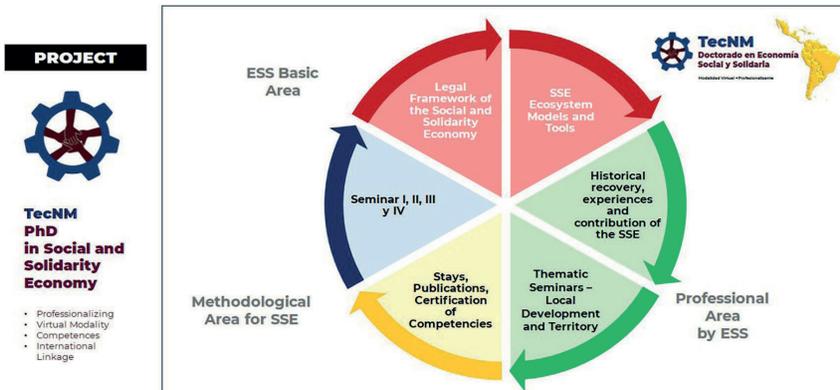


Figure 11. Structure of the curriculum of the PhD in SSE at TecNM.

The PhD in Social and Solidarity Economy generates an opportunity to meet the needs of the community of students and graduates of the sector of Higher Technological Education Institutions from different regions of the State of Baja California, nationally and even internationally. This is for a greater sectoral linkage under a sense of social responsibility and with the firm commitment of lines of knowledge generation oriented to the National Strategic Sectoral Programs

(PRONACE). To overcome the frontiers of knowledge in the ecosystem of economic, social, and solidarity development, the field of action of research in sectoral competitiveness, sustainable development, and social innovation is promoted.

Figure 12 shows the institutions that are part of the National Research Network (RIESS) in Social and Solidarity Economy of the TecNM. The Postgraduate Courses with a Professional Orientation train students for specialized professions, including stays of professionals and certification of competencies as a strategic part of the development of projects that mitigate, reduce, and improve the problematic situations that will arise as an applied research project by the Students of the PhD in Social and Solidarity Economy generating greater emphasis on practices and experience, for the strengthening of new knowledge, skills, and attitudes for the benefit of well-being and social progress.



Figure 12. TecNM social and solidarity economy (SSE) research network.

The National Research Network on Social and Solidarity Economy (RIESS) of the TecNM has members from the Technological Higher Education Institutions, Technological Institutes and Public Universities, and Research Centers in the States of Baja California, Baja California Sur, Sonora, Chihuahua, Jalisco, State of Mexico, Querétaro, San Luis Potosí, Tamaulipas, Veracruz, Oaxaca, Tabasco, Campeche, Yucatán, and Quintana Roo. The RIESS Network divides the national territory into three: Zone 1, Northern Mexico; Zone 2, Central Mexico; and Zone 3, Southern Mexico. Figure 13 shows the international links with researchers from countries such as El Salvador, Costa Rica, Panama, Colombia, Brazil, Argentina, and Chile [48].



Figure 13. International linkage of the social and solidarity economy network.

#### 4. CONCLUSIONS AND REFLECTIONS

In the State of Baja California, Mexico, efforts have been made to integrate the Environmental Education Committee of regional scope, defining general agreements for periodic meetings to systematize the progress of the agreements defined in the State Environmental Education Committee; one of the key points of the Committee is to update the report on the progress of the UN 2030 Goals through the leadership of the Tijuana Institute of Technology, the National Network of Social and Solidarity Economy (RIESS) and the Researchers of the Academic Body: "Sectorial Competitiveness, Social Innovation and Sustainable Development" ITTIJ-CA-12 of the TecNM Tijuana Campus [49].

The city of Tijuana managed to obtain the registration of the First NODESS in a border city in Northern Mexico in 2022, and the objective is to achieve inter-institutional work with the different educational institutions in the State of Baja California and in Mexico to identify actions in favor of the 17 Sustainable Development Goals (SDGs). To define the gaps in each SDG and thus develop joint projects and initiatives, it is worth mentioning that the Technological Institute of Tijuana is promoting through a Social Service Program with the goal of training and sensitizing 10,000 students of different educational levels in Tijuana and raising awareness among 100,000 people throughout the State of Baja California.

The TecNM RIESS National Research Network aims to disseminate the importance of the 17 SDGs, PRONACES (National Strategic Programs of the Federal Government) and NODESS programs in other cities of the country through the sum of efforts of all sectors of society and inter-institutional linkage [50].

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