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Mexico and PRONACES working towards becoming a smart city

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Abstract. This paper presents a comprehensive state-of-the-art analysis and mathematical modeling of the National Program for Smart Cities (PRONACES) initiatives in Mexico's journey towards smart city development. The focus is on examining how PRONACES integrates technological innovation with urban planning and sustainability, leveraging mathematical models to optimize and predict the outcomes of various smart city initiatives. The methodology includes a review of current literature to establish the state of the art, followed by the development and application of mathematical models to assess and forecast the effectiveness of PRONACES strategies. These models are based on a variety of parameters including urban growth, technology adoption, resource allocation, and environmental impact. Key findings demonstrate the significant role of PRONACES in transforming urban landscapes in Mexico. The mathematical models provide valuable predictions and insights into the potential outcomes of various smart city strategies, indicating pathways for efficient resource management, infrastructure development, and sustainable urban growth. The paper concludes with an emphasis on the importance of mathematical modeling in planning and implementing smart city initiatives. The challenges and opportunities presented by Mexico's unique urban landscape are discussed, along with recommendations for future research and policy-making in the field of smart urban development.

Keywords: Smart Cities, Mexico, PRONACES, Urban Technology, Sustainability.

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1 Introduction

Mexico needs to transform its academic research models and call on all sectors involved to participate in a transformation. This includes public and private higher education institutions, research centres, public sector institutions at the federal, state, or municipal levels, civil society organisations, businesses, and local and regional communities willing to conduct or responsibly support the humanistic, social, scientific, or technological development research activities necessary to contribute to these changes.

The National Strategic Programmes (PRONACES) are the priority initiative of the National Council of Humanities, Sciences, and Technologies (CONAHCYT). They respond to the need to promote the development of applied research on specific national problems that, due to their strategic importance and seriousness, require decisive attention and a comprehensive, deep, and broad solution. Their objective is to investigate the causes of these problems and to serve as a scaffold for producing these solutions.

Mexico's strategic priorities coincide with the 2030 Agenda and the Sustainable Development Goals set forth by the United Nations (UN). These priorities are oriented towards increasing the sovereignty of the Mexican nation in areas such as security, food, health, education, protection of life, the environment and ecosystems, access to water in quality and quantity, restoration

of a dignified and productive rural life, protection of migrants, and the preservation of democratic life in a complex society (García Garrios, n.d.). PRONACES is the foundation offered by CONAHCYT to members of the academic and technological communities to achieve these impossible challenges through access to resources to efficiently and effectively address these national challenges for the benefit of the population and the environment.

2 PRONACES and 2030 Goals

México has played an active role in the 2030 Agenda for Sustainable Development since its negotiations (gobmx, 2023). Throughout these discussions, the country advocated for the incorporation of its national priorities, which include: multidimensional poverty, gender equality, the rights of migrants regardless of their migratory status, social and economic inclusion, addressing the specific needs of middle-income countries, upholding human rights, conserving biodiversity, addressing climate change, and ensuring water access.

The Mexican Agency for International Development Cooperation (AMEXCID) is entrusted with the task of monitoring the 2030 Agenda for Sustainable Development, which encompasses the 17 Sustainable Development Goals (SDGs). This mandate stems from the International Cooperation Law for Development (art. 25, section IX). Under this law, AMEXCID's International Cooperation for Development Program (PROCID) is designated to ensure alignment with the Millennium Development Goals (MDGs) and other relevant cooperation agreements and conventions, thereby emphasizing the significance of the 2030 Agenda. Furthermore, the Coordination of National Digital Strategy (CEDN) under the Office of the Presidency of the Republic, in collaboration with the National Institute of Statistics and Geography (Inegi), has crafted an open-source platform. This platform showcases the progress made in monitoring and tracking the SDGs, positioning Mexico as a forerunner in publishing data related to the 2030 Agenda. The SDG Tracking Platform provides access to relevant indicators, Open Data, and visual insights on Sustainable Development in Mexico.

Projects under PRONACES are designed to serve as platforms for collaboration and convergence among the academic and technological communities. The aim is to enable a more efficient and effective utilization of public resources for the welfare of the population and the environment. The ultimate goal is to foster greater autonomy in addressing national challenges. These strategic priorities, identified through various studies and surveys, align with the Sustainable Development Goals outlined by the UN in its 2030 Agenda. Furthermore, they resonate with the National Development Plan set forth by the federal government (PRONACES, 2023).

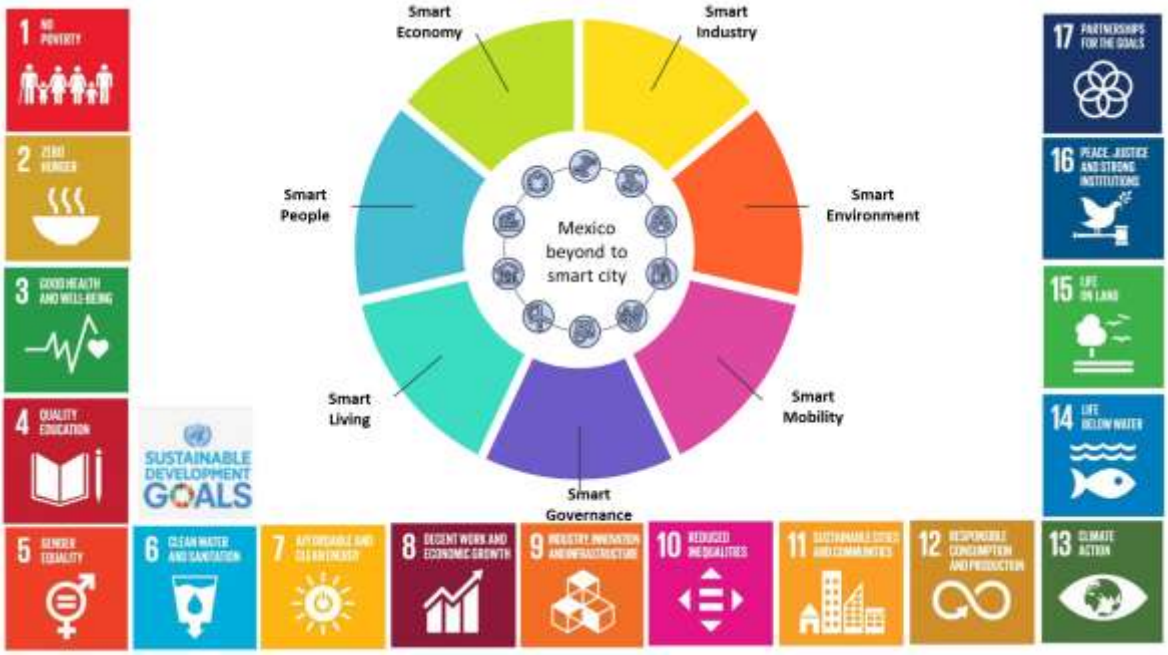

Figure 1. Aligning PRONACES to 2030 Agenda.

PRONACES advocates for proactive mechanisms to disseminate new theoretical, methodological, and practical knowledge garnered from ongoing research and pilot projects. Each initiative undergoes evaluation by academic peers possessing the

requisite experience and expertise to grasp the proposals that blend scientific insights with tangible impacts across social, cultural, environmental, and other realms. The significance and merit of these projects won't be solely quantified by publications or the training of human resources. Actions directed towards tangible transformations and addressing the genuine concerns of the Mexican populace will hold equal, if not greater, weight.

PRONACES will operate through multi-stakeholder groups led by academics to submit proposals for National Research and Advocacy Projects (PRONAII) for funding. These will be long-range projects (up to 5 years), and their first calls for proposals are about to open. The obstacles to achieving the goals can be classified into three types (García Garrios, n.d.):

- Obstacles to designing and building the appropriate intervention instruments
- Obstacles to forming the social subjects willing and able to transform the situation
- Obstacles (legal, ethical, cultural, etc.) to transform the field of action.

CONAHCYT proposes the development of projects that include scientific knowledge and methods with the support of government, the business sector and society; to disseminate new knowledge and theoretical, methodological, technical, institutional and organizational instruments; that give greater dimension to social subjects with capacities for transformation and propitiate new legal, normative and cultural fields. CONAHCYT proposed the PRONACES' categories (Figure 1): Toxic agents and polluting processes, Water, Culture, Education, Energy and climate change, Health, Human security, Socio-ecological systems, Food sovereignty, and Housing.
PRONACES requires participatory and collaborative integration in the generation of knowledge, perspectives, and solutions to needs. Each PRONACES proposes a general agenda that manifests in National Research and Advocacy Projects (PRONAII). These projects address problems in their structural and dynamic complexity to propose and implement actions that have an impact on the root causes and on the dynamics of control and reduction of their effects.

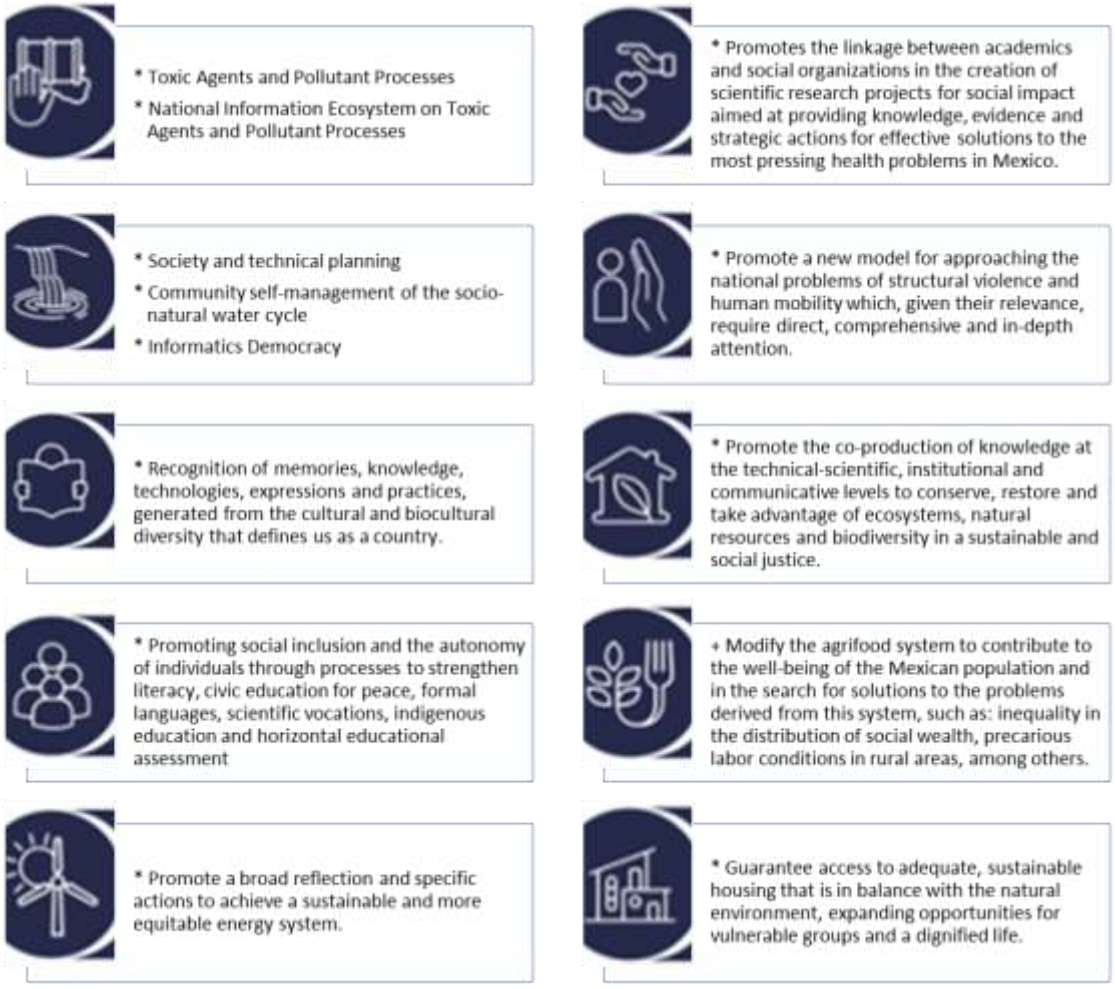

Figure 2. National Strategic Programs - PRONACES (PRONACES, 2023)

2.1 Ecosystem Restoration and Improved Public Health

Assuming that the primary objective of the programme is ecosystem restoration and improved public health, we might consider an objective function that seeks to maximise the welfare of affected communities. Mathematically, this can be translated as:

Objective Function:

$$\max Z = w_1 \times E + w_2 \times S$$

Subject to:

$$P \leq Pmax$$
$$I \leq Imax$$
$$T \leq Tmax$$
$$C \leq Cmax$$

Where: Z is total welfare, E represents the state of ecosystems (a metric that measures the quality of the environment), S is a public health metric (may be related to community health indicators), w_1 and w_2 are weights that determine the relative importance of each metric. These weights can be adjusted according to programme priorities, *Budgetary (P):* The amount of financial resources available to the programme is finite, Intervention capacity *(I*): There may be a limit to the number of projects or interventions that can be implemented in a given period, Technical constraints *(T):* Depending on the technologies and methods employed, there may be limitations on the capacity to remediate certain areas or treat certain diseases, Social and cultural constraints *(C):* Interventions must respect the cultures and wishes of local communities. These are only initial and rather general proposals. The precise formulation of the objective function and constraints would require a detailed understanding of the programme, its objectives, capabilities and limitations.

2.2. Water

Given that the objective is to design and manage solutions to socio-natural water cycle problems, we might consider an objective function that seeks to maximise the water welfare of communities, taking into account aspects of environmental justice and the common good:

Objective Function:

$$\text{Max } Z = w_1 \times B + w_2 \times J$$

Subject to:

$$C\text{org} + Cscience + Government + C\text{enterprise} \geq C\text{min}$$
$$Kscience + K\text{popular} \geq K\text{min}$$
$$P \geq P\text{min}$$
$$Mwater \leq Mavailable$$
$$Hhidro \leq Havailable$$
$$\text{HRhidro} \leq \text{HRavailable}$$
$$Twater \leq Tlimit$$
$$\text{Irequired} \leq Iavailable$$
$$Vutilised \leq Vavailable$$

Where: Z is the total water welfare, B is a metric representing the common good related to water (e.g. access, quality), J is a metric indicating the level of environmental justice achieved, w_1 and w_2 are weights that determine the relative importance of each metric, Cross-sectoral Collaboration (C): level of collaboration of each sector, *Cmin* is the minimum required level of cross-sectoral collaboration, Knowledge Integration (K): the contribution of each type of knowledge, *Kmin* is the minimum required level of knowledge integration, Implementation of Practices and Institutions (P): the level of implementation of ethical, political, economic, social and ecological practices and institutions, Financial Constraint: *Mwater* is the total estimated cost of all water-related activities and initiatives of the programme, Mavailable is the total budget allocated to the programme for water issues, Human Resource Expertise constraint: Where: *Hhydro* is the total number of experts in hydrology, hydraulic engineering, or related areas required for the programme, *Havailable* is the total number of these experts that are available to be assigned to the programme, Human Resource Expertise constraint: Where: *HRhydro* is the total number of experts in hydrology,

hydraulic engineering, or related areas required for the programme, *HRavailable* is the total number of these experts that are available to be assigned to the programme, Time constraint for water projects: Where: *Twater* is the estimated time to complete all water-related projects, *TLimit* is the maximum time available to execute and complete these projects, Infrastructure and Equipment Constraint: Where: *Irequired* is the infrastructure and equipment needed to carry out water projects (e.g. treatment plants, monitoring systems), *Iavailable* is the infrastructure and equipment currently available for the programme, Available Water Volume Constraint: Where: *Vutilised* is the total volume of water expected to be used in the programme initiatives, - *Vavailable* is the total volume of water available from designated sources.

These are initial proposals that aim to provide a basic structure. The precise formulation of the model would require a detailed understanding of the programme and collaboration with experts in the relevant areas. In addition, the exact metrics (such as B or J) would have to be precisely defined, possibly using specific indicators or scoring systems based on data and studies. These constraints help to ensure that programme initiatives and projects are implemented in a sustainable and efficient manner, considering the specific limits and challenges associated with water management.

2.3. Culture

The goal is to maximise the recognition and promotion of cultural and biocultural diversity, as well as to strengthen equity and social justice:

Objective Function:

$$max\ Z = w_1 \times D + w_2 \times E + w_3 \times J$$

Subject to:

$$Rcultural \geq Rmin$$
$$Scommunity + SScientific \geq Smin$$
$$D \geq Dmin$$
$$Ptotal \leq Pavailable$$
$$Hrequired \leq Havailable$$
$$Tproject \leq Tlimit$$
$$Mrequired \leq Mavailable$$

Where: Z is the weighted sum of the metrics, D represents the metric of cultural and biocultural diversity promoted and conserved, E is a metric related to equity in society, J indicates the level of social justice achieved, w_1, w_2 and w_3 are weights that determine the relative importance of each metric, Recognition of Cultural Diversity (R): Where *Rcultural* is the level of recognition and promotion of cultural diversity and *Rmin* is the minimum level required, Incorporation of Community Knowledge (S): Where S represents the contribution of each type of knowledge and *Smin* is the minimum required level of knowledge integration, Promotion of Human Rights and Freedom of Expression: Where D is the level of promotion and respect for human rights and freedom of expression. Financial Constraint (P): Where: *Ptotal* is the estimated total cost of all programme activities and initiatives, *Pavailable* is the total budget allocated to the programme, Human Resources Constraint (H): Where: *Hrequired* is the total number of staff required to carry out the programme activities, *Havailable* is the total number of staff available to be assigned to the programme, Time constraint (T): Where: *Tproject* is the estimated time to complete all programme activities, *TLimit* is the maximum time available to execute and conclude the programme, Material Resource Constraint (M): Where: *Mrequired* is the total amount of specific materials or resources needed for the programme (e.g. technology, physical spaces, equipment), Mavailable is the total amount of these resources that are available.

2.4. Education

The objective is to improve the social inclusion and autonomy of people through education.

Objective Function:

$$\text{Max } Z = w_1 \times L + w_2 \times C + w_3 \times F + w_4 \times I + w_5 \times E$$

Subject to:

Financial Constraint: $Peduc \leq Pavailable$
Human Resources Constraint: $Heduc \leq Havailable$
Time Constraint: $Teduc \leq Tlimit$
Educational Materials Constraint: $Mrequired \leq MAvailable$
Teaching Spaces Restriction: $Eutilised \leq Available$
Restriction on Cross-Sectoral Collaboration: $Cmin \leq Crealized \leq Cmax$
Knowledge Integration Restriction: $Smin \leq Srealized \leq Smax$

Where: Z is the total value of educational inclusion and autonomy, L is a metric related to literacy, C stands for civic education for peace, F refers to formal languages, I denote the inclusion and strengthening of indigenous education, E is horizontal educational assessment, w_1, w_2, w_3, w_4, w_5 are weights reflecting the relative importance of each metric in the programme, *Peduc* is the total estimated cost of all education-related activities and initiatives of the programme, *Pavailable* is the total budget allocated to the programme for education, *Heduc* is the total number of experts in education, literacy, civic education, formal languages, indigenous education and educational assessment required for the programme, *Havailable* is the total number of these experts that are available to be assigned to the programme, *Teduc* is the estimated time to complete all education-related projects, *TLimit* is the maximum time available to execute and conclude these projects, *Mrequired* is the amount of educational materials (books, digital tools, etc.) required for the programme, *Mavailable* is the amount of these materials that are available for the programme, *Eutilised* is the total number of spaces (classrooms, workshops, laboratories, etc.) expected to be used in the programme initiatives, *Edisavailable* is the total number of spaces available, *Crealised* is the level of cross-sectoral collaboration achieved, *Srealised* is the level of knowledge integration achieved.

2.5. Energy and Climate Change

The objective is to maximising sustainability, equity and mitigation of climate change impacts through the energy system.

Objective Function:

$$\text{Max } Z = w_1 \times E + w_2 \times A + w_3 \times C + w_4 \times Q$$

Subject to:

Financial Constraint: $Ptotal \leq Pavailable$
Specialised Human Resources constraint: $Hrequired \leq Havailable$
Energy Infrastructure Constraint: $Ienergy\_required \leq$ Ienergy_available
Renewable Sources Constraint: $Futilised \geq Fmıminimum\_required$
Air Quality Constraint: $Qactual \leq Qmax\_permitted$
Intersectoral and Multidisciplinary Collaboration Constraint: $Cmin \leq Crealised \leq Cmax$

Where: Z is the total value of sustainability and energy equity and climate change mitigation, E represents the energy sustainability metric, A is a metric related to access to energy services for the vulnerable population, C denotes climate change mitigation, Q is a metric related to air quality, w_1, w_2, w_3, w_4 are weights reflecting the relative importance of each metric in the programme, Financial Constraint: This means that the total budget for an energy project must be less than or equal to the available budget. It is a common constraint in energy projects and determines whether a project is economically feasible, Specialised Human Resources Constraint: This means that the number of specialised experts required for the project must be less than or equal to the number of experts available. This is crucial for the successful execution of the project, Energy Infrastructure Constraint: This indicates that the energy infrastructure needed for a project should be within what is currently available. This could refer to things like the electricity grid, power plants, etc, Restriction on Renewable Sources: This is an environmental target stipulating that a certain minimum percentage of energy must come from renewable sources, Air Quality Constraint: This restriction limits the amount of pollutants that can be emitted into the air, which is crucial for maintaining air quality.

2.6. Health

The purpose is to maximise efficiency and effectiveness in solving health problems through research:

Objective Function:

$$\text{Max } Z = w_1 \times R + w_2 \times C + w_3 \times I$$

Subject to:

$$\text{Financial Constraint: } Ptotal \leq Pavailable$$
$$\text{Specialised Human Resources Constraint: } HHealth \leq H\ Health\_available$$
$$\text{Collaborations Constraint: } Cactual \geq Cmınimum\_required$$
$$\text{Research Projects constraint: } Pexec \geq Pmin\_req$$
$$\text{Impact and Incidence constraint: } Iimplemented \geq ITarget$$

Where: Z is the total value of the effectiveness of the health solutions driven by the programme, R represents the metric related to the production of relevant research, C is a metric associated with collaboration and linkages between academic groups and social organisations, I denotes the impact and social incidence of the proposed solutions, w_1, w_2, w_3 are weights that reflect the relative importance of each metric in the programme. The financial constraint in health means that the total budget for any health project or initiative must be less than or equal to the available budget. This constraint is crucial for the effective planning and implementation of any health programme, Specialised Human Resources Constraint: This indicates that the number of specialised health professionals required for a project should be less than or equal to the number of such professionals available. This may include doctors, nurses, technicians, etc. Restriction on Collaborations: This constraint aims to ensure that there is a minimum number of active collaborations in a project or initiative. Collaborations can be between hospitals, research centres, universities, and other organisations. Restriction on Research Projects: This constraint aims to ensure that there is a minimum number of active collaborations in a project or initiative. Collaborations can be between hospitals, research centres, universities, and other organisations.

2.7. Human Security

Pronaces of Human Security aims to address complex and pressing issues related to human mobility and structural violence in Mexico. In order to design a strategic intervention based on this description, it is necessary to define a target function and constraints to guide the programme's implementation.

Objective Function:

$$Max\ Z = w1 \times M + w2 \times V$$

Subject to:

$$\text{Financial Constraint: } Ptotal \leq Pavailable$$
$$\text{Specialised Human Resources Constraint: } Hsecurity\_required \leq Hsecurity\_available$$
$$\text{Research Projects Constraint: } PExecuted \geq Pminimum\_required$$
$$\text{Human Mobility Impact Restriction: } MImpact\_realised \geq MImpact\_realised \geq MTarget$$
$$\text{Restriction on Attention to Structural Violence: } Vattention\_realised \geq VTarget$$
$$\text{Cross-sectoral Collaboration constraint: } Cmin \leq Crealised \leq Cmax$$
$$\text{Concrete Actions constraint: } Actions\_realised \geq Minimum\_requirement$$

Where: Z is the total value of effectiveness in addressing the issues, M represents the metric related to the management and respect for the rights of people in mobility situations, V denotes the metric associated with the attention and mitigation of structural violence, $w1$, $w2$ are weights that reflect the relative importance of each metric in the programme, *Crealised* is the level of cross-sectoral collaboration achieved, Actions_carried_out is the number of concrete actions carried out in the Minimum_required is the minimum number desired.

2.8. Socio-Economic Systems and Sustainability

For the National Strategic Programme on Socio-Economic Systems and Sustainability, the objective is clear: to co-produce knowledge and actions that translate into conservation, restoration and sustainable use of natural resources, all under an umbrella of social justice. Given this breadth of objectives and the inherent complexity of social-ecological systems, it is essential to establish a clear target function and relevant constraints to guide its implementation. A proposal for mathematically modelling this objective and its constraints is presented below. The aim is to maximise sustainability and social justice in the management of social-ecological systems.

Objective Function:

$$\text{Max } Z = w1 \times S + w2 \times J$$

Subject to:

Financial Constraint: Ptotal ≤ Pavailable
Specialised Human Resources Constraint: HSS&S_required ≤ HSS&S_available
Research Projects Restriction: Executed ≥ Pmınimum_required
Environmental Health Impact Restriction: SAimpact_realised ≥ SAbjective
Living Systems Degradation Attention Constraint: Datencion_realised ≥ Objective.
Transdisciplinary Collaboration Constraint: Cmin ≤ Crealised ≤ Cmax

Where: Z is the total value of sustainability and social justice in social-ecological systems management, S is a metric of sustainability of actions taken, J is a metric of social justice in the management of resources and actions, $w1$, $w2$ are weights reflecting the relative importance of each metric in the programme, Crealised is the level of transdisciplinary collaboration achieved.

2.9. Food Sovereignty

The National Strategic Programme for Food Sovereignty seeks to transform the Mexican agrifood system to achieve better welfare of the population by addressing the challenges inherent to this system. To define a strategic intervention based on this description, a clear objective function and constraints to guide its implementation are needed. The aim is to maximise food sovereignty and social welfare in the agri-food system. A mathematical modelling proposal is presented below:

Objective Function:

$$\text{Max } Z = w1 \times SA + w2 \times BS$$

Subject to:

Financial Constraint: Ptotal ≤ Pavailable
Specialised Human Resources Constraint: Food_required ≤ Food_available
Research Projects Constraint: Pexecuted ≥ Pmın_ required
Healthy Food Production Restriction: ASproduction_realised ≥ ASobjective
Strengthening of Small and Medium Producers constraint: PMstrengthening_realised ≥ PMobjective
Trans- and Multi-disciplinary Collaboration constraint: Cmin ≤ Cmin ≤ Cmax achieved.

Where: Z is the total value of food sovereignty and welfare in the agri-food system, SA is a food sovereignty metric, considering the production and distribution of healthy and culturally appropriate food, BS is a social welfare metric, considering equity and labour conditions in the agri-food sector, $w1$, $w2$ are weights reflecting the relative importance of each metric in the programme, Crealised is the level of collaboration achieved.

2.10. Housing

The description of the programme that seeks to address the challenges of sustainable housing and habitat in Mexico, an objective function is needed that reflects the core purpose of the programme, as well as constraints that guide its implementation and maximise its impact. This proposed objective function and constraints provides an initial structure for the planning and monitoring of the programme focused on sustainable housing and habitat in Mexico. The purpose is to maximise sustainability and fairness in access to housing and habitat.

Objective Function:

$$\text{Max } Z = w1 \times VH + w2 \times JS$$

Subject to:

Financial Constraint: Ptotal ≤ Pavailable

Specialised Human Resources Constraint: Hrequired_housing ≤ Havailable_housing
Restriction on Research Projects: Pexecuted ≥ Pmın_ required
Participatory Social Action constraint: ASPrealised ≥ ASPobjective
Restriction on Adherence to International Agendas: IAcompliance≥ AIobjective
Cross-sectoral Collaboration constraint: Cmin ≤ Crealised ≤ Cmax

Where: *Z* is the total value of sustainability and fairness in access to housing and habitat, *VH* is a metric that reflects the quality and accessibility of sustainable housing and habitat, *JS* is a metric that measures social justice in the access and distribution of housing and habitat, *w1, w2* are weights reflecting the relative importance of each metric in the programme, IACompliance represents the extent to which the programme has achieved alignment with international agendas, such as UN Sustainable Development Goal 11, Crealised is the level of cross-sectoral collaboration achieved.

2 México as a Smart City

A city's need to develop smart capabilities is directly linked to population growth, as well as the government's ability to optimize it and distribute services equitably. In the case of Mexico, the cities with the greatest need to create smart solutions in order to comply, despite their limitations, with the provision of public services, education and health care are four cities with large populations: Mexico City, Puebla, Guadalajara and Monterrey.

To access the benefits and unleash the potential of a smart and sustainable city, it is essential that the strategic definition, development and deployment of initiatives consider the following success factors presented in figure 3.

Figure 3. Success factors to become a smart city (Millán, 2023).

Guarneros Olmos (2023) mentions that Mexico is a country that can be at the forefront of technology and in this process, the construction of smart cities is a fundamental part, as they allow users to stay always connected; however, their construction requires a complex infrastructure behind. Mexico has four places recognized as potential smart cities by the Inter-American Development Bank (IDB): Querétaro, with its Maderas project; the Digital Creative City and Smart Tequila, in Jalisco, and Smart City, in Puebla. In addition, Mexico City has several characteristics that lead it towards this category, such as WiFi connection in public places, surveillance equipment and intelligent lighting. Monterrey, with its "sustainable ecosystem" strategy, is also moving in this direction. Even Leon has an objective related to this issue, since it invested 65 million pesos to

deploy sensors in key points of the territory, according to the 'Smart Cities Index' of EasyPark and the 'Cities in Motion Index' of the IESE Business School.

De la Rosa (2022) posits that technology permeates every facet of our daily routines: from communication and shopping to work, and even, at times, during our sleep. The Ministry of Foreign Affairs (SRE) has embarked on an initiative dubbed "Interconnecting Smart Cities." This ambitious endeavor aims to innovate and enrich the daily lives of citizens. Hugo Isaak Zepeda, the General International Urban Coordinator at the SRE, elaborated in an interview that the project's blueprint involves hosting forums across the nation's cities. The objective is to harness technology to discern the primary needs of the populace in these regions, paving the way to craft and implement public policies addressing those needs. To date, this initiative has spanned 23 forums in 23 distinct municipalities in Mexico.

The initiative's second phase involves the formation of Agenda 2030 councils, bringing together councilors, federal authorities, and academics. These councils are crucial for sculpting the governmental actions slated for implementation. To date, the initiative has engaged 15,000 participants. "Each city is unique, functioning as its own ecosystem. The 'Easy' project's roll-out is closely tied to these forums, which aim to pinpoint territorial needs in collaboration with the academia, business sector, and public entities," Zepeda elucidated in an interview with Forbes Mexico (De la Rosa, 2022). Specific challenges identified highlight the program's tailored approach: in Reynosa, Tamaulipas, the primary concern is migration; in Juarez, Chihuahua, it's the binational system; and in Queretaro, the focus is on the new urban agenda. In Reynosa, in October the Agenda 2030 council is held with aldermen, federal entity and academia. This council is to detect that within the 17 axes of the 2030 agenda, which are the ones that impact the most, such as migration, environment and territory. With this we are going to take information that we collect and tell them what is the greatest concern of the inhabitants. The council will meet every month so that the actions that are proposed are constantly measured and bring results," he said (De la Rosa, 2022).

4 Conclusions

The unfolding smart cities initiative in Mexico reveals promising prospects for advancing this urban development approach to other regions within the country. Evidently, crafting a citizen-centric strategy that mirrors the distinct realities of each locality is paramount. Such a tailored approach paves the way for a strategic roadmap, facilitating the innovative integration of technology. The aim is to engage, inform, and link citizens within these smart urban landscapes, ultimately redounding to the greater good of all residents (refer to Figure 4).

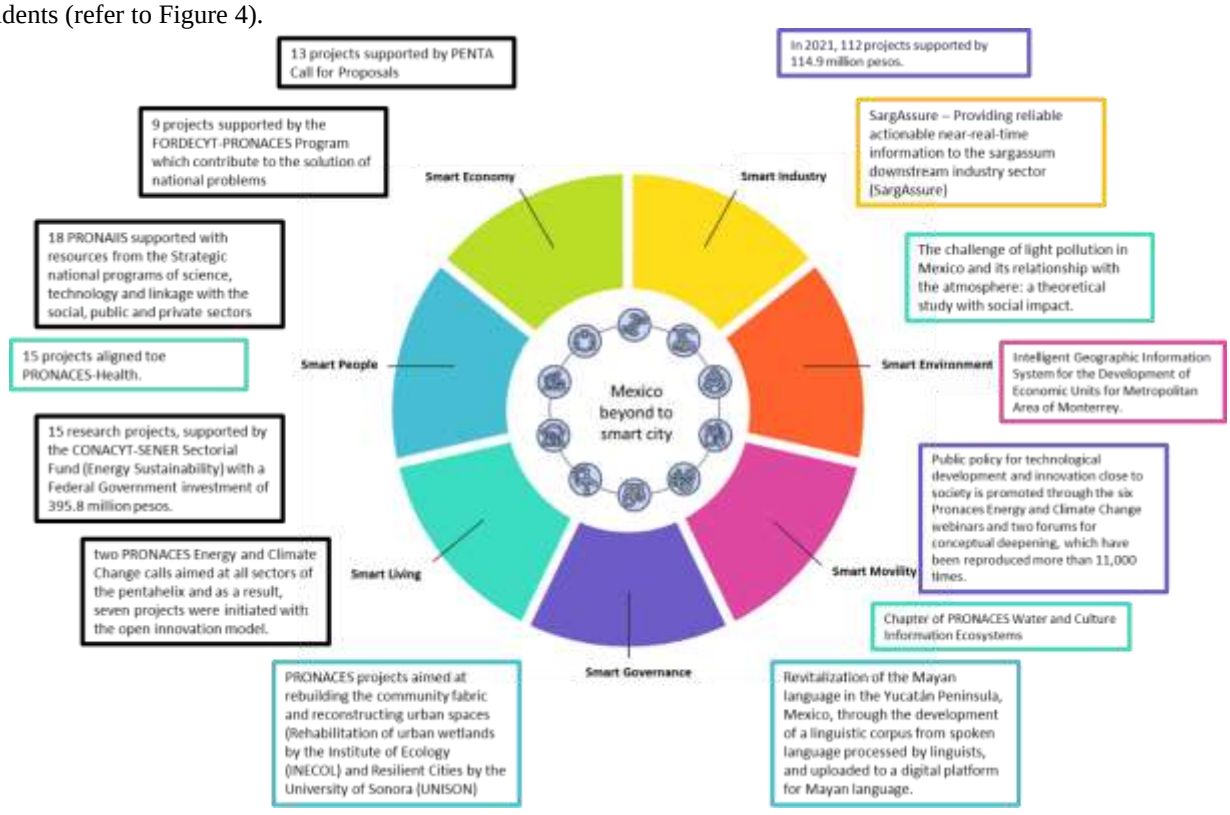

Figure 4. Review of Mexican PRONACES Projects aligned to Smart cities (CONACYT, 2021; Proyectos PRONACES, 2022).

References

CONACYT (2021). Avances y Resultados 2021. Programa Derivado del Plan de Desarrollo 2019-2024 [PDF]. https://www.siicyt.gob.mx/index.php/transparencia/informes-conacyt/programa-institucional-2/4970-logros-pi-2021/file

De la Rosa, Y. (2022). ¿Sabes qué son las ciudades inteligentes? En México ya hay un plan para impulsarlas. https://www.forbes.com.mx/sabes-que-son-las-ciudades-inteligentes-en-mexico-ya-hay-un-proyecto-para-impulsarlas/

García Barrios, R. (n.d.). ¿Qué son las PRONACES?. https://conahcyt.mx/que-son-los-pronaces/

Gobmx (2023). La agenfa 2030 y la AMEXCID. https://www.gob.mx/amexcid/acciones-y-programas/la-agenda-2030-y-la-amexcid

Guarneros Olmos, F. (2023). México tiene ciudades en camino a ser Smart, pero les falta infraestructura. https://expansion.mx/tecnologia/2023/04/26/mexico-smart-cities-sin-infraestructura

Millán, C. (2023). Smart Cities en México. Factores de Éxito. https://kpmg.com/mx/es/home/tendencias/2021/10/ao-smart-cities-en-mexico-factores-de-exito.html

PRONACES imagen (2023). Imagen de PRONACES – CONACYT [Imagen]. https://www.facebook.com/ConahcytMX/photos/a.329003573858818/4482959568463177/?type=3

PRONACES (2023). Programas Nacionales Estratégicos. https://conahcyt.mx/pronaces/

Proyectos PRONACES (2022). Proyectos Enero – Diciembre 2022. CentroGeo - centro público de investigación en Ciencias de Información Geoespacial, integrado al Sistema Nacional de Centros de Investigación CONAHCYT. https://www.centrogeo.org.mx/archivo/archivo-transparencia/programa-institucional/2922-programa-institucional-seguimiento-proyectos-pronaces-2022/file

Tnet4iot (2023). What is a smart city? https://tnet4iot.com/smart-iot-solutions/smartcity/