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Contextualised guidelines and indicators for smart and sustainable urban project definition at local level in developing countries

Abstract: Cities are undergoing significant transformations and face substantial challenges due to climate change and rapid urbanisation. Consequently, planning strategies around smart and sustainable urban development are key to addressing some of the most pressing challenges, such as climate change mitigation and adaptation, and improving resource efficiency. However, local governments have limited financial resources to achieve their development goals, and many times no criteria of sustainability are followed to define local projects. In this sense, it is necessary to include sustainable indicators that help local governments; in order to allow an efficient use of resources, ensure a greater impact and benefit for the citizens and residents of the area of intervention, as well as consolidate with them the established policy guidelines. This research is based on the work of MGI Morgenstadt Global Smart Cities Initiative in Piura-Peru, a project funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), with the primary objective to mitigate the consequences of climate change in the pilot cities, increase their resilience to climate risks, and preserve their natural resources. As part of this broader project, this paper seeks to define valuable contribution to sustainable principles oriented for the definition of urban development projects within the framework of the elaboration of the Metropolitan Development Plan Piura – Catacaos – Castilla – Veintiséis of Octubre 2020–2040. It explores the potential of science-based frameworks that consider sustainable aspects in the description of the project idea and strategies at the local level and provide relevant sustainability indicators for the measurement of the project scope regarding its outcomes and impacts. The methodology contributes to generating projects to transform Piura into a model city of ecological, economic and social sustainability, with accessible public spaces, adequate urban infrastructure designed for its inhabitants.

Key words: urban planning, sustainability, outcome, indicators, Piura (Peru)

Introduction

Cities are undergoing significant transformations and face substantial challenges due to climate change and constantly growing urbanisation. The concept of smart and carbon-neutral cities has emerged as a strategy focused on solutions for sustainable development, local adaptation, and the efficient use of resources.

Worldwide, different guidelines define goals and emphasise the fundamental role of cities as they are home to more than half of the world's population and responsible for approximately 70% of global greenhouse gas (GHG) emissions, in addition to being the most affected by rising temperatures, which is worsened by air pollution and the effects of heat islands (OECD 2008). Especially cities in developing countries that are rapidly growing are among the places that will be the worst hit by the effects of climate change. Cities represent a unique opportunity for emissions reduction, climate change mitigation and supporting sustainable development. Nevertheless, many times, there are no clearly defined guidelines or a requirement at the local level.

Morgenstadt Global Smart Cities Initiative (MGI) is a project funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), strengthening the development and implementation of sustainable transformation processes in

Fig. 1. Location Piura
Source: Authors.

model cities in India, Mexico and Peru. The primary objective is to mitigate the consequences of climate change in the pilot cities, to increase their resilience to climate risks, and to preserve their natural resources.

Peru is considered a country highly vulnerable to climate change, having seven of the nine aspects defined by the United Nations Framework Convention on Climate Change (UNFCCC) as specific concerns that increase the vulnerability of countries to climate change (UN 1992). The city of Piura is located in north-western Peru and is the capital of the Province of Piura and the Region of the same name (Fig. 1). Piura is located on a flat, slightly undulating terrain, crossed by the course of the Piura River. The most notable natural disasters are caused by the El Niño phenomenon (FEN) which, in its last event in 2017, affected the areas surrounding the river prone to flooding.

Piura has around 480.000 inhabitants (INIE 2017) and is, among the Peruvian cities, one with the highest population growth, with an intercensal growth rate of 2.3% (Zucchetti, Freundt 2018). It has experienced accelerated urban growth in the last 60 years, as has happened at the national level, where informal housing and unplanned territorial expansion began. It is estimated that informal or spontaneous constructions occupy about 70% of Piura's urbanised land. Informal expansion and settlements vulnerable to climate change is shown in Figure 2.

Fig. 2. Photographs 2022. Left: Informal urban expansion of the last two years without access to basic services. Right: Settlement close to natural wetlands vulnerable to flooding
Source: Authors.

The work is based on a contribution to sustainable principles oriented for the definition of urban development projects within the framework of the elaboration of the Metropolitan Development Plan (MDP) Piura – Catacaos – Castilla – Veintiséis de Octubre 2020–2040. The Ministry of Housing, Construction and Sanitation of Peru (MVCS) leads the development as part of the Comprehensive Plan for Reconstruction with Changes in the regions most affected by the events in 2017.

Local governments have limited financial resources to achieve their development goals, and many times no criteria of sustainability are followed to define

local projects. In this sense, it is necessary to include sustainable indicators that help local governments to measure urban planning activities. In this way, efficient use of resources, a greater impact and benefit for the citizens and residents of the area of intervention, as well as the joint consolidation of the established policy guidelines is ensured. The objectives of a project should not only be measured quantitatively but should also establish a clear link between these objectives and the impact of the project. Both the economic benefits and the consequences should be considered in the social sphere, bearing in mind the particularities of the social fabric of the city and socioeconomic trends.

In this context, the aim of this paper is to consider sustainable aspects in the description of the project idea and strategies at the local level and to provide relevant sustainability indicators for the measurement of the project scope regarding its outcomes and impacts. This contribution to the MDP explores the potential of science-based frameworks that support and outline the development of planning instruments considering the different pillars of sustainability and its development trends for prioritizing and implementing projects and strategies at the local level that reconcile the economic, social, and environmental aspects of human activities. These closely related pillars enable a viable and sustainable development, to which the projects contribute without depleting existing resources for future generations.

Theoretical background

The concept of sustainable development was first defined by the Brundtland Commission (1983–1987), formerly known as the World Commission on Environment and Development (WCED), where the term "sustainable development" was introduced as a progress that meets the needs of present generations without compromising the ability of future generations to meet their own needs. In turn, the definition of "sustainability" is the study of how systems function, maintaining their diversity and producing what is necessary to keep them in balance (UN, n.d.-a).

There were three major milestones for sustainable urban development in the last decade. First in 2015, the United Nations (UN) defined 17 Sustainable Development Goals (SDG) with the aim of eradicating poverty, promoting prosperity and well-being for people, protecting the environment, and tackling climate change, among others, to ensure peace and prosperity for the planet. Until 2030, this strategy guides the sustainable development of the 193 member states that have committed to its implementation (UN, n.d.-b). The SDGs are defined in a list of 169 SDG targets. The progress towards these targets is agreed to be tracked by 232 unique indicators. According to the United Nations Economic Commission for Europe (UNECE 2000), an indicator is "a data element that represents statistical data for a specified time, place, and other characteristics".

In the context of sustainability, indicators are important for providing information about the success of sustainability interventions in the current state and the progress in a broad sense by measuring the conditions and status of an

urban area with different emphases (EU 2018, Chao et al. 2020). Regarding these requirements, selecting appropriate indicators is the biggest challenge of each project, but, if done in an accurate way, also the biggest opportunity (Verma, Raghubanshi 2018). Especially the lack of data and its quality in low-income cities, like in many cities in Peru, impedes the use and measurement of sustainability indicators (Diep, Dodman 2015). Therefore, it is advisable "to focus on sound principles rather on specific methods" (Diep, Dodman 2015) and take easy to measure as well as more challenging indicators into account to monitor the complexity of a city in a suitable context. Observing this and selecting (1) specific, (2) measurable, (3) usable, (4) sensitive, (5) available and (6) cost-effective indicators, assures urban sustainability approaches (Chao et al. 2020). Indicators allow for the diagnosis of problems and pressures, and thus the identification of areas that would profit from being addressed through good governance and science-based responses. They also allow cities to monitor the success and impact of sustainability interventions (EU 2018).

The second milestone refers to the approval of the New Urban Agenda (NUA), at the International Conference on Housing and Sustainable Urban Development – Habitat III (UN 2016), which reaffirms the global commitment to sustainable urban development. The latter should be understood as a comprehensive and multi-sectoral process of change including aspects of urban management, environment and ecosystems, economic development, social equity, policy integration, and ideas to achieve effective solutions in a cooperative manner (Roosa 2010). Finally, within the framework of the UNFCCC, the Paris Agreement (PA) was enacted (UN 2015), with its long-term objective to limit the increase in global average temperature to less than 2°C above pre-industrial levels, and preferably to 1.5°C through measures to reduce GHGs, recognising that this would substantially reduce the impacts of climate change.

Thus, in the field of urban development, the concept of sustainability relates to the city's ability to sustain and reflect a complex balance between the environment and the economic and social development, known as the three pillars of sustainability (Purvis et al. 2019). These 'pillars' are part of various global standards and plans and are an essential aspect of addressing the urban challenges of today's cities. Following the publication of these three guidelines (SDG, NUA and PA), various organisations worldwide have begun to add a broader vision of the concept of sustainability, incorporating human aspects and emphasising issues such as gender equality, the importance of citizen participation in decision-making, and access to education and health as key to human development (REC, n.d.).

Peru has actively participated in the elaboration of the 2030 Agenda and led the second round of consultations to define the Participatory Monitoring for Accountability of the SDGs, which is one of the means of implementation. This was underlined by the country's commitment to be part of the 2030 Agenda and align with the SDGs in 2015 (ONU Perú 2015). However, the generation, systematisation and analysis of information on the current state of cities in the country is unsatisfactory and still in its first attempts. For this reason, in 2019 this first national report on urban indicators has compiled and analysed data and statistics

on Peruvian cities on issues related to urban development with a focus on sustainability in categories as diverse as the country itself. Although the importance of cities as engines of local, regional, and national development is recognised, there is also a lack of instruments to analyse, measure and interpret them.

First land use planning strategies started in Peru in the late 1980s (Chiarella Quinhoes, Yakabi 2016). Today, urban and territorial planning is carried out at the national, regional and local level by the authorities of the national government, the departmental and municipal governments (provincial and district) and through laws, decrees and regulations that establish various programmes and plans. The Supreme Decree No. 022-2016-Housing of Peru (MVCS – Perú 2016) is the technical-normative instrument that guides territorial management and sustainable urban development and "aims to regulate the technical procedures followed by local governments to national level, in the exercise of its competences in matters of land planning and management, territorial conditioning and urban development of its districts", in order to guarantee, among others, a rational and sustainable occupation of urban and rural centres and their areas. In addition, Organic Law 27972 of Municipalities establishes various types of management and development instruments, the application of which varies according to the needs and possibilities of the municipality. Yet, in 2019 only 15% have elaborated and approved the Urban Development Plan (UDP) or MDP (INEI 2019).

Sustainability is mentioned in the manual that guides local municipalities for the elaboration of their development plans, promoting the integral, sustainable, orderly and safe growth of the territory, with accessibility, adequate urban mobility and new housing solutions that are well located to prevent disaster risks. Moreover, it is worth mentioning that in July 2021 the Law No. 31313, Sustainable Urban Development Law (LDUS) (Congreso de la Republica 2021) was published. This law consolidates the regulation on territorial conditioning, urban planning, and the use and management of urban land. The objective of the LDUS is to regulate urban land by determining the conditions of its use and management, through territorial conditioning and urban planning.

Projects are defined by the Urban Investments Programme, which is the economic-financial management instrument that allows promoting public and private investments, to achieve the objectives defined in the MDP and UDP. The project portfolio includes a list of all investment projects that lead to the comprehensive development of the areas of intervention, which will correct deficiencies and enhance opportunities in the city, in a specified time (MVCS 2018).

Methodology

The contribution of this paper is structured in two steps: First, the reformulation of each project idea of the project portfolio included in the MDP of Piura. The potential of each project is read and studied with respect to the established sustainability criteria, and the performance according to the Morgenstadt sectors in terms of indicators where the project aims to close the gap or upgrade status quo.

The target set considers the initial situation of the projects in the city, the contribution of the reformulation to the overall vision of the city's development and the feasibility of the added elements and activities. Second, the application of outcome indicators and the definition of the impact area. The defined set of indicators for each project considers the initial situation of the city in the field of action, the feasibility according to local possibilities and the general vision of the city development.

The working process starts with the revision of the projects proposed and developed in the context of the MDP by the municipality as a basis and seeks to validate and integrate strategies, concepts and ideas to support the sustainability of them. Therefore, a literature review is conducted to allow the inclusion of a series of urban sustainability elements and actions, addressing the three pillars of sustainability.

Table 1 shows a summary of the three pillars of sustainability with proposed criteria and questions on how to apply them to projects. The social sustainability pillar includes four criteria: Citizen participation, positive impact on social inclusion, strengthening civil and political rights and vulnerable groups. These criteria contain questions on whether the project contemplates citizen participation in planning and implementation, its contribution around closing inequality gaps in the city and reducing social and spatial segregation, and if it benefits vulnerable social groups, such as adults, elderly, indigenous minorities, children, refugees, etc. The economic sustainability category asks about the structure and clarity of the project finances, a sustainable return on investment (SROI) and the potential of the project to shape partnerships or collaborations between different stakeholders that contribute to value creation. By incorporating the SROI criterion, the cost-benefit analysis goes beyond considering only the economic factors of a project. Thus, the social environmental impacts of the investment must also be considered. The objective is to understand how the project can be economically viable while contributing to society without damaging the environment. Environmental sustainability criteria include the project's potential contribution to GHG mitigation, the energy transition and, finally, the reduction of risks and vulnerability, as well as adaptation towards climate change challenges.

The list of questions is used to define the elements to be added to each project proposed in the MDP of Piura, strengthening the sustainability and ensuring that the gap reduction indicators of them includes, when necessary, new criteria to ensure a holistic sustainable implementation and provide details on how to measure and use a verifiable source. Within the MGI project and the Piura City Lab, indicators are used to measure the performance of the urban ecosystem called Morgenstadt framework developed. This methodology is based on the international standards such as ISO 37120:2014-2018 sustainable development of communities, ISO/TR 37150:2014 and ISO/TR 37151: 2015 smart community infrastructures (Radecki 2019). Relevant indicators from this framework were selected for each individual project.

The projects are validated by reviewing all relevant indicators on the impact of solutions against the criteria of the sustainability pillars together with the ones proposed within the Morgenstadt framework, including specific indicators for

the different urban sectors (mobility, energy, water, ICT, buildings, governance, logistics) and innovation cross cutting areas (smart city financing, urban governance & planning and digital business & service innovation.

The next two columns of the table help to evaluate the success of the project by measuring which changes will be reached by what will be done, defined by outcomes and the field of impact. The outcome represents the step before the final achievement of an impact and is directly related to the project activity (Diaz et al. 2022). Based on the MGI project, the IKI goals and the performance measurement framework from CITYkeys (Bosch et al. 2017), a set of impact and outcome areas were defined for measurement of smart city solutions to be implemented within the project and close the existing gap of development of the city. Thus, the

Table 1. Criteria of sustainability

	Criteria	Guiding questions	Field of impact	Outcome indicators	Related SDG
Environmental sustainability	gHG mitigation potential	Does the project include GHG mitigation?	Planet	Mitigative capacity	13
	Use of non- and renewable resources	Does the project include the transition to clean and renewable energy?		Materials, water, land	6, 7, 12
				Pollution & waste	3, 7, 12
	Contribution to urban resilience	Does the project contribute to risk mitigation?		Climate resilience	13
		Does the project contribute to adaptation in the face of diversities?		Adaptative capacity	11, 13
				Biodiversity conservation	14, 15
				Ecosystem	3, 11
		Does the project contribute to reducing vulnerability?	People	Safety	1, 3, 5, 10, 11
Social sustainability	Vulnerable groups	Does the project benefit vulnerable social groups (e.g., the elderly, indigenous minorities, children, refugees, etc.)?		Health	1, 3, 6, 7, 10
				Education	1, 3, 4, 5,10
				Reduction of vulnerability	1, 3, 4, 5, 10, 11
	Strengthening civil and political rights	Does the project foster the social capital of the city?		Diversity and social cohesion	5, 10, 11
	Citizen participation	Does the project include citizen participation in its planning and implementation?		Community involvement	10, 11
	Positive impact on social inclusion	Does the project contribute to the reduction of social and spatial segregation?		Access	3, 4, 5, 9, 10, 11
				Quality of housing & built environment	3, 9, 10, 11
		Does the project contribute to closing inequality gaps in the city?	Prosperity	Equity	1, 4, 5, 10, 11

	Criteria	Guiding questions	Field of impact	Outcome indicators	Related SDG
Economic sustainability	Financing	Does the project have a clear and structured financing plan for all its development?	Prosperity	Economic performance	8, 12
	Sustainable return on investment (SROI)	Does the project contemplate principles of SROI?		Green Economy	12
	Efficient use of resources and stakeholders	Does the project promote the configuration of alliances or collaborations between different stakeholders that contribute to the creation of value?		Attractiveness & competitiveness	8, 9, 16, 17
				Employment	8, 9
				Innovation	9, 17
	Planning and decentralisation	Does the project include vertical or decentralised coordination?	Governance	Multi-level-governance	16, 17
				Organisation	16, 17
	Local, national, regional and global outreach	Does the project have a potential for scale-up, e.g., increase in size, scope or range within the city?	Propagation	Scalability	16
		Does the project have a potential for replication or duplication in another location or time within the city?		Replicability	16, 17

Source: Own elaboration, based on the work of MGI Morgenstadt Piura team (Fraunhofer IAO, University of Stuttgart, University of Piura).

methodology aims to promote the conception of integrated and sustainable projects over time. For each project, an outcome indicator was defined to measure and quantify to reduce the gap in the sector that the project is aiming to improve. Furthermore, Table 1 links in its last column the guiding questions and outcome indicators to the specific SDGs that each of them is supporting.

Results

Applying the methodology described above, all 31 projects proposed in the portfolio draft of the MDP have been reformulated, adding gap indicators to support the monitoring of results in order to achieve a long-term impact. Table 2 shows one project selected as an example with the original text drafted by the consulting firm responsible for the MDP in Piura, as well as the additions made by the MGI team highlighted in bold.

As a first approach, the areas of potential impact of each of the projects have been analysed. The impact categories "planet" and "people" are identified based on the project idea description and initial gap indicators, and give reference to a project that supports climate resilience and the quality of the built environment for the benefit of the city's inhabitants. Starting from the two impact fields, outcomes relevant to the project were reviewed to reformulate the programme idea

Table 2. Reformulated description and gap reduction indicators for the programme "Disaster risk management and mitigation programme for prevention, emergency measures and local organisation for disaster response"

Name of programme and/or project	Disaster risk management and mitigation programme for prevention, emergency measures and local organisation for disaster response in the districts of Piura, Catacaos and Veintiséis de Octubre, province of Piura, department of Piura.
Description	1. Elaboration of studies and risk assessment (EVAR) of the urban area to identify special regulatory areas (ZRE) within the districts of Piura, Castilla, Catacaos and Veintiséis de Octubre. **Risks must be well identified. For example, in the case of flood risks, it is necessary to have a map of real blind basins in Piura, and a comprehensive definition of how the city's storm drainage will function in a situation of El Niño and without it.** 2. Elaboration of the geotechnical study and seismic microzonation of the soil of the districts of Veintiséis de Octubre, Piura and Catacaos. **Soil studies should include studies of the aquifer and water table in the urban territory. In this way, groundwater can be protected, and uninhabitable areas or the need for special structures in certain places can be defined in order to avoid dangers to the population. These studies should also provide a zoning of the risk of soil liquefaction in scenarios of El Niño and earthquakes.** 3. Implementation of the disaster risk prevention and reduction plan in the districts of Veintiséis de Octubre, Piura and Catacaos. **This should include the implementation of an early warning system in case of floods or disasters, as well as the installation of stations to measure river levels during the rainy season, connected to the city's emergency centres, in order to provide timely warnings to the population. In addition, the official means of information distribution must be clear, and it must be made very clear which institution is in charge of what (who installs the pumps in the blind basins, who issues the alert, etc.).** 4. Construction of riverbank and creek defences (between the Piura River and the Gallo Creek). **Riverbank defences in ravines must be accompanied by maintenance of the riverbeds. In the case of the Gallo stream, it is currently invaded, without a direct connection to a body of water (such as the Piura River, for example). Before riparian defences, it would be important to recover invaded areas of the river's marginal strip, such as the car park of the Open Plaza, Grifo Repsol, the widening of the Bolognesi bridge, and the declaration of urban creeks as intangible zones.** **5. Water education and water use. Provide education campaigns to the population on the importance of water care; what the El Niño phenomenon is and how it affects the city; the history of flooding over the years, etc. In order for the population to understand the phenomena that occur and to be prepared and avoid panic.**
Indicator / Gap reduction	– Percentage of population benefited by the study: 30%. – Percentage of critical points on riverbanks and streams not protected against hazards: 40% – **Determine the percentage of people living in areas vulnerable to floods.** – **Determine the percentage of population with access to storm drainage.** – **Determine the amounts of runoff that the current storm drainage system is capable of handling.** – **Determine the degree of resilience of the populations living in vulnerable areas.** – **Determine the resilience of families moved from flood-prone areas to non-flood-prone areas (how many of them remain in these new sites and how many of them return to vulnerable areas).** – **Determine what percentage of high-risk areas have been declared intangible.**

Source: Own elaboration.

Table 3. Reformulation of outcome and gap indicators of the programme "Disaster risk management and mitigation programme for prevention, emergency measures and local organisation for disaster response"

	Criteria	Guiding questions	Field of impact	Outcome indicators	Indicator / Gap reduction
Environtment	Contribution to urban resilience	Does the project contribute to risk mitigation?	Planet	Climate resilience	Percentage of critical points on riverbanks and streams not protected against hazards: 40%
		Does the project contribute to adaptation in the face of diversities?		Adaptative capacity	– **Determine the amounts of runoff that the current storm drainage system is capable of handling.**
				Biodiversity conservation	– **Determine what percentage of high-risk areas have been declared intangible.**
Social	Vulnerable groups	Does the project benefit vulnerable social groups (e.g., the elderly, indigenous minorities, children, refugees, etc.)?	People	Education	– **Determine the degree of resilience of the populations living in vulnerable areas.**
				Reduction of vulnerability	– **Determine the percentage of people living in areas vulnerable to floods.** – **Determine the resilience of families moved from flood-prone areas to non-flood-prone areas (how many of them remain in these new sites and how many of them return to vulnerable areas).**
	Positive impact on spatial inclusion	Does the project contribute to the reduction of social and spatial segregation?		Access	– **Determine the percentage of population with access to storm drainage.**
				Quality of housing & built environment	Percentage of population benefited by the study: 30%.

Source: Own elaboration.

and define indicators that can quantify and monitor whether the project succeeds in reducing the gap that the proposed programme is intended to address in the future. Within the new project description, aspects related to flood risks have been considered, with the integration of blind basin and storm drainage plans, as well as the definition of non-habitable zones to avoid risks for the population. Ideas for the implementation of an early warning system are also included, as well as education on water and its use to raise awareness among the population. Two impact gap indicators for the planet were added to support the idea of a programme increasing the city's adaptive capacity to climate change and biodiversity

conservation. In addition, the project has a high potential impact for people, especially with vulnerable groups, where six gap indicators have been added to measure the strengthening of environmental education, access, and vulnerability reduction, contributing to shortening the spatial and social segregation of the city (see Table 3).

Discussion

In this work, project definition and indicators were defined for assessing sustainable city projects that help to assess or evaluate single projects included in the urban development plan. There is a considerable body of common indicators used for most of the project ideas, applying the methodology in the MDP projects, as well as in the example presented, that shows the potential impact for holistic and sustainable project planning and design. The indicators indicate if the project meets social, economic and environmental criteria, by evaluating if those aspects are considered in the project design or not. Within the three aspects of sustainability a total of 25 outcome indicators have been defined which show an important set for guidance. They are formulated in such a way that they can easily be adapted to all kinds of urban projects and contexts. A weak definition of the indicators can lead to a non-sustainable project focusing on other interests.

However, the results should be evaluated with caution due to two methodological limitations that could affect the use of the defined outcomes: First, including economic gap indicators as well as adding sustainability economic pillar components had been difficult, as only project descriptions were available, not budget estimates or exhaustive portfolios. Secondly, MGI's contribution was only possible during the public consultation phase of the metropolitan development plan, so the projects had already been formulated jointly with different actors in the municipality and counted already with some political support. This situation difficult the incorporation of new elements or project proposals, hence the methodology is concentrated on refining the already formulated projects. Therefore, the efforts were limited to strengthening the already drafted project proposals and adding indicators to ensure considering a holistic sustainable approach. Furthermore, late engagement meant that the target values to be met could not be set, so that the contribution lays down only the indicators with values to be determined at a later stage. However, according to Bosch et. al. (2016), the indicators for sustainable city development focus on monitoring the evolution of a city towards an even more sustainable city and serve for decision-making. Indicator outcomes should be an important part of project selection and prioritisation. The sustainable indicators should be used in an early stage of project definition, in the design phase of a project, to give an impression of the expected performance based on design specifications.

The existing indicators do not include a baseline value, which hampers the assessment of the appropriateness of the gap indicator targets used to measure the performance of the proposed projects and programmes. Determining baseline

values is a key step towards achieving urban transformation as it evaluates the progress and assesses how the measures and actions taken are leading to improvements against the impact expected (Munier 2011).

Several cities around the globe have already implemented platforms with urban data for monitoring the cities' development. However, the availability or quality of data is limited – particularly in low-income cities, as it is the case for Piura. A balance needs to be struck between the need to generate better data (and the associated costs), and the need to address urgent development and sustainability needs more immediately (Diep, Dodman 2015).

In the case of Piura, indicators will depend on the scale at which they are being measured, as these may differ from one project to another. Moreover, in the presented case study, there are different data at district, province and regional level (Fernández et al. 2021), hindering the measurement over time of the achievement of solutions and progress at the urban level.

Sustainability indicators are a proven method for driving sustainable urban development, and hundreds of different sets and frameworks exist. As cities vary greatly in terms of available resources, population size and urban metabolic processes, this wealth of tools is useful. However, choosing appropriate sustainability indicators can be difficult (EU 2018). As the sustainable indicators of the city progress might change over time, other indicators such as health or lifestyle can become more important. In this sense, Evans et al. (2019) propose a framework for smart sustainable cities. It consists of technological and nontechnological components and involves community engagement, policymakers' learnings, innovation, and governance to cover all dimensions.

For further research it needs to be considered that the time component – "development over the years" – is an important feature. Establishing a frequency of monitoring for the indicators should be considered to keep track on the effectiveness of the implemented projects and the progress made. The indicators may be used to show to what extent overall policy goals will be reached or are reached by the single project implementation. This can be underlined by the definition of a benchmark system which helps to see project contribution and impact in relation to national or international standards. Recommendations include the development of a public monitoring plan as well as the implementation of an urban data platform to store the data in a centralised way. Furthermore, it is recommended to display the data through a user-friendly dashboard to raise awareness around urban development in the city and encourage citizen participation in the design process of urban projects.

Conclusions

This paper sought to contribute to sustainable principles oriented for the definition of urban development projects within the framework of the elaboration of the MDP of Piura 2020–2040. It explored the potential considering sustainable aspects in the description of the project idea and strategies at the local level and

provides relevant sustainability indicators for the measurement of the project scope regarding its outcomes and impacts. The focus of the activities consisted of strengthening projects developed within the MDP and their corresponding gap indicators by integrating holistic sustainable urban development criteria and concepts. One project was selected to show an exemplary case. However, during the work process all project ideas of the MDP were considered.

According to the results of this research, relevant indicators represent an effective approach to urban sustainability. Through the application of indicators and the development of qualitative and quantitative descriptors for the urban environment not only the effectiveness of ongoing processes of urban infrastructures but also the effect of implemented actions can be measured. To assess and thereby improve the performance of cities, urban sustainability indicators are very important tools.

Following the project implementation, further work measuring the progress and fulfilment of the city's objectives is recommended. Revision if necessary to replace them should be undertaken. In addition, the definition of targets for gap indicators that have not been determined should be further developed, as well as adding information on the source, frequency of measurement and scale of the indicator.

As a next step, a framework of indicators to evaluate the city's performance should be determined and applied in a standardised way. This measurement system should include benchmarks from other cities facing similar challenges and should be initiated at a regional or state level, so that lessons learned can also be shared with other cities within the country.

The methodology contributes to generating projects to transform Piura into a model city of ecological, economic and social sustainability, with accessible public spaces and adequate urban infrastructure designed for its inhabitants. In a second stage, standards can be determined, i.e. thresholds associated with each indicator that indicate whether a city is in a desirable sustainability space or whether remedial action is urgently needed.

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Nowe wytyczne i wskaźniki dotyczące inteligentnych i zrównoważonych projektów miejskich na poziomie lokalnym w krajach rozwijających się

Zarys treści: Strategie planowania inteligentnego i zrównoważonego rozwoju miast są kluczowe dla sprostania niektórym z najbardziej palących wyzwań, takich jak łagodzenie i zaadaptowanie zmian klimatycznych. Niniejsze badania, stanowiące część Globalnej Inicjatywy Inteligentnych Miast MGI Morgenstadt, mają na celu określenie wartościowego wkładu w zasady zrównoważonego rozwoju zorientowanego na definicję projektów rozwoju miejskiego w ramach opracowywania Planu Rozwoju Metropolitalnego Piura (Peru). Zbadano potencjał struktur opartych na podstawach naukowych, które uwzględniają aspekty zrównoważonego rozwoju w opisie pomysłów i strategii projektowych na poziomie lokalnym oraz dostarczają odpowiednich wskaźników do pomiaru zakresu projektu w odniesieniu do jego wyników i wpływu.

Słowa kluczowe: urbanistyka, zrównoważony rozwój, wyniki, wskaźniki, Piura (Peru)