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TORIBIO RODRÍGUEZ DE MENDOZA DE AMAZONAS

GRADUATE SCHOOL

THESIS TO OBTAIN THE ACADEMIC DEGREE OF DOCTOR IN SUSTAINABLE DEVELOPMENT SCIENCES WITH MENTION IN MANAGEMENT OF NATURAL RESOURCES AND ENVIRONMENT

METHODOLOGY TO DETERMINE THE SUSTAINABILITY LEVEL OF GEOGRAPHICAL ZONES ACCORDING TO ITS MAJOR USE. APPLICATION IN THREE DISTRICTS OF THE AMAZONAS REGION, 2020

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Research classification according to the “Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development”:

1.00.00 Natural Sciences
1.05.00 Earth Sciences, Environmental Sciences
1.05.08 Environmental Sciences

Dedication

To my parents, Carlo Magno and Zoila Ysabel, for still believing and trusting me as if I were a child.

To my son, Carlo André Joseph, who motivates me every day with his omnipresence.

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To the professors and administratives of the Graduate School, who helped tirelessly throughout this time.

To each of the citizens who participated in the fieldwork, as pollsters or as respondents, without them the final work would not have been possible.

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ANEXO 6-K

VISTO BUENO DEL ASESOR DE TESIS PARA OBTENER EL GRADO ACADÉMICO DE MAESTRO ( )/ DOCTOR (x)

El que suscribe el presente, docente de la UNTRM (x)/Profesional externo ( ), hace constar que ha asesorado la realización de la Tesis titulada METHODOLOGY TO DETERMINE THE SUSTAINABILITY LEVEL OF GEOGRAPHICAL ZONES ACCORDING TO ITS MAJOR USE. APPLICATION IN THREE DISTRICTS OF THE AMAZONAS REGION, 2020; cuyo autor HEISELY MORI PELAEZ es estudiante del VI ciclo/egresado ( ) de la Escuela de Posgrado, Maestría ( ) / Doctorado (x) en CIENCIAS PARA EL DESARROLLO SUSTENTABLE, con correo electrónico institucional heisely.mori.epg@untrm.edu.pe.

El suscrito da el Visto Bueno a la Tesis mencionada, dándole pase para que sea sometida a la revisión por el Jurado Evaluador, comprometiéndose a supervisar el levantamiento de observaciones que formulen en Acta en conjunto, y estar presente en la sustentación.

Chachapoyas, 20 de noviembre del 2022

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Firma y nombre completo del Asesor

JORGE LUIS MAICELO QUINTANA, PhD

Evaluation jury

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ANEXO 6-O

CONSTANCIA DE ORIGINALIDAD DE LA TESIS PARA OBTENER EL GRADO ACADÉMICO DE MAESTRO ( ) / DOCTOR ( )

Los suscritos, miembros del Jurado Evaluador de la Tesis titulada:
METHODOLOGY TO DETERMINE THE SUSTAINABILITY LEVEL OF GEOGRAPHICAL ZONES ACCORDING TO ITS MAJOR USE. APPLICATION IN THREE DISTRICTS OF THE AMAZONAS REGION, 2020,
presentada por el estudiante ( )/egresado (*X*) *HEISELY MORI PELAEZ*
de la Escuela de Posgrado, Maestría ( ) / Doctorado (*X*) en *CIENCIAS PARA EL DESARROLLO SUSTENTABLE*,
con correo electrónico institucional *heisely.mori.epg@untrm.edu.pe*,
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a) La citada Tesis tiene *10* % de similitud, según el reporte del software Turnitin que se adjunta a la presente, el que es menor (*X*) / igual ( ) al 25% de similitud que es el máximo permitido en la UNTRM.

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Chachapoyas, *28* de *diciembre* del *2022*

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Act of evaluation

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ANEXO 6-S

ACTA DE SUSTENTACIÓN DE TESIS PARA OBTENER EL GRADO ACADÉMICO DE MAESTRO ( ) / DOCTOR (X)

En la ciudad de Chachapoyas, el día 04 de abril del año 2023, siendo las 8:00 horas, el aspirante Ms. Heisely Mori Pelaez, Asesorado por Ph.D. Jorge Luis Maicelo Quintana, defiende en sesión pública presencial (X) / a distancia ( ) la Tesis titulada: "Methodology to determine the sustainability level of geographical zones according to its major use, Application in three districts of the Amazonas Region, 2020", para obtener el Grado Académico de Maestro ( )/Doctor (X) en CC para el Des. Sustentable, mención Gestión de los RRNN y MA, a ser otorgado por la Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas; ante el Jurado Evaluador, conformado por:

Presidente: Dr. Rainer Marco Lopez Lapa
Secretario: Dr. Luis Nilton Murga Valderrama
Vocal: Dr. Hugo Frias Torres.

Procedió el aspirante a hacer la exposición de la Introducción, Material y método, Resultados, Discusión y Conclusiones, haciendo especial mención de sus aportaciones originales. Terminada la defensa de la Tesis presentada, los miembros del Jurado Evaluador pasaron a exponer su opinión sobre la misma, formulando cuantas cuestiones y objeciones consideraron oportunas, las cuales fueron contestadas por el aspirante.

Tras la intervención de los miembros del Jurado Evaluador y las oportunas respuestas del aspirante, el Presidente abre un turno de intervenciones para los presentes en el acto de sustentación, para que formulen las cuestiones u objeciones que consideren pertinentes.

Seguidamente, a puerta cerrada, el Jurado Evaluador determinó la calificación global concedida a la sustentación de la Tesis de Maestría ( )/Doctorado (X), en términos de:

A probado (X) por Unanimidad (X)/Mayoría ( ) Desaprobado ( )

Otorgada la calificación, el Secretario del Jurado Evaluador lee la presente Acta en esta misma sesión pública. A continuación se levanta la sesión.

Siendo las 10:50 horas del mismo día y fecha, el Jurado Evaluador concluye el acto de sustentación de la Tesis para obtener el Grado Académico de Maestro ( )/Doctor (X).

SECRETARIO PRESIDENTE

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Abstract

Sustainability could be defined as the maintenance of a system over time. Sustainability assessment consists of evaluating the level of deterioration of ecosystems and then projecting their conservation for use by future generations. For this purpose, many methodologies have been developed, which measure the sustainability of a specific objective, but most of them have two deficiencies: they cannot be applied to any geographical area, and, they do not apply to developing countries. In this research, a hybrid methodology is proposed to measure the level of sustainability of geographic areas according to their major use as a result of evaluating various methodologies. For the tool construction, the pillars of the triple helix of sustainability were used: environmental, social and economic; 23 themes were defined and 146 indicators were built. For the compilation of field information, the author developed and applied six questionnaires and the data was normalized using the Min-Max technique. Indicators and themes were weighted using expert opinion and added linearly. The Peruvian Sustainability Assessment Tool (PESAT) was applied to three cities: La Jalca, San Nicolás and Cajaruro, obtaining that the sustainability level of the three was around to 50% of the scale considered, the most sustainable was San Nicolás. The highest composite indicator corresponded to the Environmental pillar, and the lowest, below 50%, to the Economic pillar. When evaluating the composition of the indicators through the uncertainty and sensitivity analyzes, it was found that the sub-indicators followed a normal distribution trend, the weights were well defined and the results were significant.

Keywords: Composite indicators, Geographical data, Sustainability assessment.

Chapter I.

Introduction

"What you measure affects what you do. If you don't measure the right thing, you don't do the right thing".
Joseph Stiglitz, 2001 Nobel Memorial Prize
in Economic Sciences.

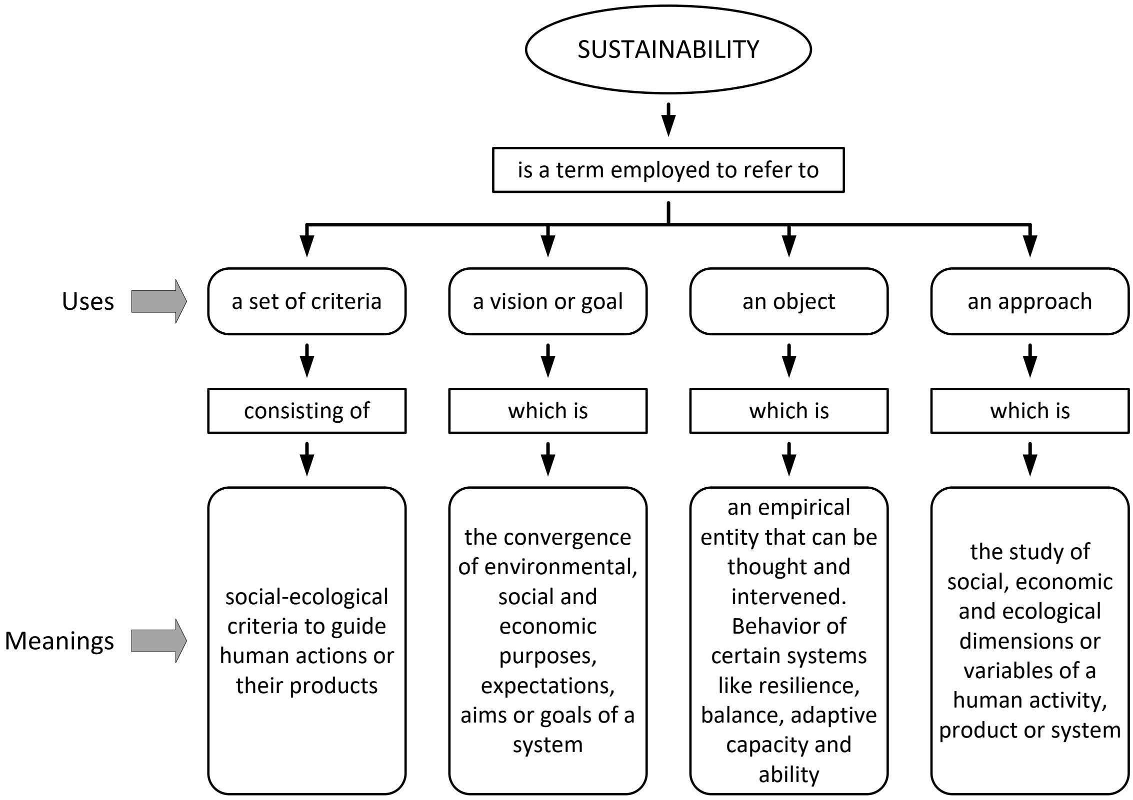
The Industrial Revolution originated notable changes in terrestrial ecosystems, which respond to the intensification of the means of production, especially in the second half of the 20th century, a fact that consolidated the transition of societies towards urbanized and industrialized states. This process brought with it human migrations from the countryside to urban areas for work purposes and in search of better living conditions. In this context, which still exists, it is essential to build systems of indicators that help to understand the current performance of societies and predict future trends that affect the progressive degradation or sustainability of the ecosystem services where human life develops (Machado et al., 2007).

Sustainability refers to the maintenance of a system over time (Garcia, 2007). Sustainability is worrying about a better common future, in which environmental, social and economic aspects are balanced to achieve a better quality of life (United Nations Educational, Scientific and Cultural Organization, 2021). Sustainability implies the subsistence of life, especially of humanity. If society recognizes and values the importance of sustainability, then it will make better use of its resources, showing itself more connected to nature and effectively dealing with ecological uncertainties (Song & Moon, 2019).

For a better understanding, the Figure I.1 illustrates different uses and meanings of the sustainability concept, that scientist use nowadays.

Figure I.1

Uses and meanings of the concept of sustainability



Note: Adapted from Salas-Zapata and Ortiz-Muñoz, 2019

The concept of "sustainable development" was formally introduced by the Brudtland Report in the late 1980s (World Commission on Environment and Development, 1987), defined from the point of view of satisfying human needs, through which current generations satisfy their own, but without compromising the ability of future generations to satisfy theirs. In this sense, sustainable development implies limitations, which are defined by the current state of technology and the type of social organization that act on natural resources, as well as by the capacity of the biosphere to absorb the impacts of human activities.

In recent years, the concept of sustainable development has been used to define the holistic behavior and performance of the economy, social development and the management of natural resources (Mofidi et al., 2018).

Analyzing the concept from the scientific point of view, sustainability is an attitude and a philosophy, which through the review of indicators of economic growth, social well-being and environmental conservation, seeks to optimize productive processes, by reducing and/or elimination of unnecessary activities or inputs from the supply of raw material, production, commercialization and consumption, without affecting the added value of the product, but promoting the reduction of the harmful environmental impact (Naderi et al., 2019).

Sustainability is now on the agenda of all countries thanks to the United Nations, an organization that defined the seventeen Sustainable Development Goals (United Nations, 2021), included in The 2030 Agenda for Sustainable Development, as urgent targets for all member countries.

The sustainability assessment consists of evaluating the level of deterioration of natural resources and the projection of their conservation for their use by future generations (St Flour & Bokhoree, 2021; Waas et al., 2014). Sustainability assessment is based on a detailed and multidimensional investigation of human well-being and ecological conservation, seeking, on the one hand, the necessary responses to maintain ecosystems, and on the other hand, increasing the environmental responsibility of society and governments (Sterling et al., 2020).

A wide variety of methodologies have been developed to assess sustainability, especially for agricultural activities (Acosta-Alba & Van der Werf, 2011; Kassem et al., 2017; Schader et al., 2014; Wustenberghs et al., 2015). Binder and Feola (2012) classified the sustainability evaluation techniques, tools and methodologies into three typologies:

- Top-down methods which focus on farm assessment.
- Top-down methods which study regional assessment including some stakeholder participation.
- Bottom-up methods which consider the regional scale with integrated participatory or transdisciplinary approach, including multiple stakeholders as user group.

In this sense, the proposed model corresponds to top-down methods with the participation of some stakeholders, such as local authorities and business owners from all sectors present in the city.

To build the methodology, the most common methods to assess the sustainability of agriculture, cities, forests, grasslands, wetlands, among others, were reviewed. This practice served to define, first the pillars, second the themes and third, the indicators to be used, which should have certain characteristics to be chosen, Among those that stand out, ease of obtaining it; appropriate scaling, considering that indexes must be built considering that 100% means full compliance and 0% means no compliance; relevance and impact on the performance of families and companies settled in the community under study (Pakzad et al., 2017).

Agriculture activity began around 13,000 BC, when early humans started domesticating plants and animals to produce food (Harari, 2015). Agriculture is one of the largest economic activities in the world, being the livelihood of approximately 86% of the rural population of the entire planet. Consequently, it has a significant impact on the growth of the Gross Domestic Product (GDP), mainly in developing countries. According to historical data, the growth of the agricultural GDP generates at least twice the reduction of poverty, compared to the growth of the GDP of other economic sectors (World Bank, 2008).

Otherwise, agriculture has strong impacts on environment as a result of alteration of ecosystems, land uncovering, habitat fragmentation, desertification, pollution, soil erosion, eutrophication, loss of biodiversity, among other harmful effects (Fan et al., 2012).

According to World Bank (2017), Peruvian agriculture is low-tech and not intensive, even with these characteristics it is the main source of employment for the population and for that reason it faces five dilemmas:

- The agricultural sector constitutes an important part of the economy, its slowdown affects general growth.
- An expanding agricultural sector diversifies the Peruvian economy and reduces dependence on the extractive sectors, so the other sectors depend on their performance.
- The growth led by agriculture benefits the poorest, so if this sector grows slowly, reducing poverty becomes difficult.
- Peru is dependent on food imports, so the weakness of this sector could affect national food security.
- Climate-smart agricultural practices that help to effectively mitigate Climate change should be promoted.

Neyra (2011) carries out an analysis of the transformations that Peru has undergone in the first decade of the 21st century, the most important of which are trade openness through free trade agreements and the process of territorial decentralization. He affirms that both processes are developed over heterogeneous territorial spaces, since the interior regions of the country have serious limitations to take advantage of these phenomena and promote their local development. Among these limitations are low development and integration of regional markets, low penetration in the financial market and little development of labor markets. Added to these difficulties is the fragmented organization of the territory, with a high number of district municipalities with low institutional capacity.

With the Peruvian reality portrayed in the previous paragraphs, using the sustainability assessment methodologies that work in developed countries could generate spurious results, which is why the need for an own model is evident, which collects the characteristics of a country in the process of development, but that it also serves to compare its results with other existing methodologies, that is, it has a rigorous standard in its construction and is usable in any geographical space. For this reason it was decided to propose a tool to assess the sustainability.

The main goal of this thesis is to propose a methodology to evaluate the sustainability of geographical areas, according to their major use, designed for development countries such as Peru, understanding sustainability as the resilience capacity of both physical spaces and ecosystems that are erected on it. The specific research objectives are the following: Prepare, validate and apply the methodology and then carry out the ecologica, social and economic characterization of three selected cities. This exercise served to compare the level of sustainability of the three cities and propose policies or actions to improve their environmental performance.

Finally, the contribution to society is that the research helps the population to know about their situational status and that decision makers have one more tool to determine what actions to take, to direct public spending towards growth in harmony with the environment.

Chapter II.

Material and methods

2.1. Sustainability assessment

Sustainability assessment is a rigorous and complex task. This activity not only deals with multidisciplinary aspects (environmental, social and economic), but also incorporates cultural elements based mainly on values. On many occasions, sustainability evaluation is used to develop public policies, as a support to decision makers. For this convenience, it is becoming popular to evaluate products, institutions, sectors and policies. In this context, the evaluation of sustainability faces challenges mainly in the delimitation of boundaries between activities and actions that effectively contribute to achieving sustainable development and those that do not (Sala et al., 2015).

For Hayati et al. (2010), there are five levels of influencing sustainability: international, national, community, farm and field. This study proposes a methodology at community[1] level, where, according to the author, economic and social/institutional components have an primary interacting, while ecological has an secondary role.

2.1.1. Land classification for its major cover use

A broad definition of land, conceptualizes it as the place where all human activities are carried out, as well as the source of all the materials necessary for this performance. Under this premise, the use of land by man varies according to the purposes for which it serves, which may be food production, housing provision, extractive activities, material

[1] For a detailed explanation see the Glossary, Appendix A.

processing, recreational activities, among others. So, land use is defined by the influence of two forces: human needs and the environmental processes that take place (Briassoulis, 2019).

Land cover, which for the purposes of this research will be also call major use of a geographical area, refers to the physical and biological occupation existing on the land's surface, which includes vegetation, water, artificial structures and only soil (Maina et al., 2020).

To assess sustainability, methodologies based on major land use were sought. To begin with, the classification for the land that Anderson et al. (1976) proposed was used, which is reproduced in Table II.1. This table will be used to define an space to focus the sustainability assessment identifying the characteristics of the area under study to locate it in one of the types described in level I of the classification. Defining a space is important because from here a process of discrimination of indicators will begin, according to the characteristics of each land. For the application of the investigation, Level I of the classification will be used, considering as major use spaces that exceed 50% of the characteristics considered.

Table II.1

Land use and land cover classification system

	Level I		Level II
1	Urban or built-up Land	11	Residential
		12	Commercial and Services
		13	Industrial
		14	Transportation, communications, and utilities
		15	Industrial and commercial complexes
		16	Mixed urban or built-up land
		17	Other urban or built-up land
2	Agricultural Land	21	Cropland and Pasture
		22	Orchands, Groves, Vineyards, Nurseries, and Horticultural Areas
		23	Confined Feeding Operations

		24	Other Agricultural Land
3	Rangeland	31	Herbaceous Rangeland
		32	Shrub and Brush Rangeland
		33	Mixed Rangeland
4	Forest Land	41	Deciduous Forest Land
		42	Evergreen Forest Land
		43	Mixed Forest Land
5	Water	51	Streams and Canals
		52	Lakes
		53	Reservoirs
		54	Bays and Estuaries
6	Wetland	61	Forested Wetland
		62	Nonforested Wetland
7	Barren Land	71	Dry Salt Flats
		72	Beaches
		73	Sandy Areas other than Beaches
		74	Bare Exposed Rock
		75	Strip Mines Quarries, and Gravel Pits
		76	Transitional Areas
		77	Mixed Barren Land
8	Tundra	81	Shrub and Brush Tundra
		82	Herbaceous Tundra
		83	Bare Ground Tundra
		84	Wet Tundra
		85	Mixed Tundra
9	Perennial Snow or Ice	91	Perennial Snowfields
		92	Glaciers

Note: Adapted from Anderson et al., 1976.

2.1.2. Tools for sustainability assessment

Sustainability assessment frameworks, tools and methods are reviewed and compared in this section. The most common ones were chosen for this purpose.

2.1.2.1. Sustainability assessment in Urban or Built-Up Lands

Rapid urbanization assigns cities a central position to solve global problems while maintaining the provision of services for a growing population with limited resources. Technological development provides solutions to smart cities promoting the optimization of their efficiency and quality in the provision of services to the population, using information and communication technologies (Huovila et al., 2019).

In recent years, many tools have been developed for evaluating urban sustainability at different scales. These methodologies range from individual buildings, neighborhoods, cities and urban regions, and even districts. All these initiatives have been carried out seeking to sensitize the population to promote sustainability. Today, there are numerous tools to assess sustainability, although many of them only at a theoretical level, since they have rarely been applied in a specific city or urban area (Sharifi et al., 2020).

Among all the methodologies reviewed for urban sustainability assessment, the following are considered the most important.

Leadership in Energy and Environmental Design (LEED)

LEED for Cities and Communities is a methodology that after evaluating the level of sustainability certifies the area under study with various levels of achievement. Among the objectives of the methodology are the promotion of responsible and sustainable plans that contribute to the improvement and maintenance of the living conditions of the inhabitants. In its structure it uses 14 indicators grouped into 5 categories: energy, water, waste, transport and quality of life. The most important category is quality of life, which includes indicators related to education, equity, prosperity, and health and safety (U.S. Green Building Council, 2020, 2021).

Building Research Establishment Environmental Assessment Methodology (BREEAM)

BREEAM was launched in 1990, being the world's first environmental assessment method for new building designs. In its logic, it uses the approach of the balanced scorecard, with negotiable characteristics, which allows users or evaluated, to decide the optimal performance of a project or city. As of 2011, the methodology includes more actors involved in the issue of sustainability, expanding their support from the planning of new urban areas. This expansion considers in greater detail the social and economic impacts on the development of urban life. In its structure it considers five categories: social and economic well-being, resources and energy, land use and ecology, transportation and movement and governance (Building Research Establishment Ltd., 2017).

Comprehensive Assessment System for Built Environment Efficiency (CASBEE)

CASBEE is a method for evaluating and certifying buildings and the built environment for environmental performance. The philosophy of the model is based on reducing the use of resources and environmental loads associated with the built environment, and consequently improving the quality of life of the inhabitants. The methodology was developed in 2001 through the collaboration of academia, industry and the government, through the formation of a research committee, called the Sustainable Construction Consortium of Japan. In its structure, CASBEE is made up of four categories: environmental aspects, social aspects, economic aspects and environmental load (Institute for Building Environment and Energy Conservation, 2013, 2021).

Green Star

Launched by the Green Building Council of Australia in 2003. Green Star is a holistic tool for the evaluation, classification and certification of the sustainability of buildings, fitouts and communities. The main objective of the methodology is to help reduce the climate impact on buildings that serve as housing for the population, for this it promotes the conservation of biodiversity, the efficient use of resources and the use of a green economy, and through these actions promote the improvement of the quality of life of the inhabitants. For its conformation, Green Star uses five categories: economic prosperity, environment, innovation, livability and governance (Green Building Council of Australia, 2021).

German Sustainable Building Council (DGNB)

The DGNB assessment and certification system was developed by the German Sustainable Building Council to assess and certify the sustainability of buildings and districts. The DGNB System certification is an international tool, based on European norms and standards, which can be applicable worldwide. The implementation of the DGNB System in each country is carried out according to its own characteristics, so its structure varies from community to community. The methodology uses five dimensions: environmental quality, economic quality, socio-cultural functional quality, technical quality and process quality (German Sustainable Building Council, 2021).

2.1.2.2. Sustainability assessment in Agricultural Lands

There are several methodologies to measure the sustainability of agriculture, so this study will begin by reviewing these methodologies to identify their conceptual structure and from this information propose the expansion of a methodology to any geographic area. To propose what indicators to use in the methodology to be developed, four methods for measuring sustainability in agriculture will be reviewed, the sames what were evaluated by Gaviglio et al. (2017), adding the SAFA methodology, which is gaining more importance lately.

***Indicateur de Durabilité des Exploitation* (Farm Sustainability Indicators) (IDEA)**

The IDEA method makes use of indicators based on sustainable agriculture objectives. In this sense, sustainable agriculture is defined by the goals it intends to achieve, which are defined by all the actors involved, seeking to improve the situation of producers but without harming the environment where they operate. This is a method for evaluating the sustainability of the farm level, it is structured in 10 main objectives or themes and 42 indicators. The methodology was developed in France in 1998 and updated several times. Nowadays is in Version 3 (Baccar et al., 2016; Biret et al., 2019).

Response-Inducing Sustainability Evaluation (RISE)

The RISE sustainable agriculture assessment methodology was developed at the Faculty of Agricultural, Forest and Food Sciences of the Bern University of Applied Sciences. The philosophy of the model is based on its definition of sustainable agriculture, which it considers to be a sufficiently profitable activity, respectful of its environment and which provides sufficient conditions for an adequate life to all those involved. RISE studies the means of production, farmer education and the production chain in detail. This is a tool developed to assess the agricultural sustainability at the farm level. This methodology employs 10 topics or themes and 46 indicators (Bern University of Applied Sciences, 2021).

Analysis of Farm Technical Efficiency and Impacts on Environmental and Economic Sustainability (SOSTARE)

The SOSTARE methodology assesses the sustainability of agriculture through two guidelines: first, the environment, through the analysis of the impact of agricultural practices on soil, water, air, etc., and by observing trends in survival of the main species dependent on this activity; second, the economy, through the analysis of the different production methods available, to choose the most efficient and with the least harmful impact on the environment. This is a diagnostic tool for farmers and institutions that assesses the overall performance of farms. The model was developed in 2015 in Italy for the evaluation of the sustainability of farms in the Parco del Ticino. The method is made up of 12 sub-dimensions or themes and 37 indicators (Paracchini et al., 2015).

Monitoring Tool for Integrated Farm Sustainability (MOTIFS)

This is a sustainability assessment tool developed in Belgium in 2008. The methodology is used for the integrated assessment of farm sustainability. The main difference of this methodology is that it presents the results in real time and throughout a study period, so evaluating sustainability is a task with a defined term, which cannot be a day, or a specific observation. The method is based on a set of 3 levels of sustainability aspects and 10 themes that include 47 indicators (Meul et al., 2008).

Sustainability Assessment of Food and Agriculture Systems (SAFA)

SAFA methodology was developed specifically to evaluate food and agricultural activity and its effects on the environment and the population. The main idea behind the methodology is that the sustainability of this activity is based on four dimensions: good governance, environmental integrity, economic resilience and social well-being. SAFA is formed through a holistic framework that involves sustainable farming, livestock, fishing, forestry production, aquaculture, etc. among other aspects of the production chain, such as post-harvest, processing, distribution and commercialization, activities that are grouped into 59 themes (Food and Agriculture Organization of the United Nations, 2014).

2.1.2.3. Sustainability assessment in Rangelands

Rangelands can be defined as lands where the native vegetation is predominantly grasses, grass-like plants and possibly shrubs or scattered trees, they are used mainly for raising animals such as cattle for example. The main methods for evaluating the sustainability of these areas are listed below.

Sustainable Rangelands Roundtable Methodology

This methodology values rangelands as a source of survival for the populations settled in its jurisdiction. In this sense, the Round Table on Sustainable Grasslands developed criteria and indicators to evaluate their sustainability, on topics grouped into three pillars: environmental, social and economic. The idea of the methodology is to know the current situation of these areas and to promote cooperation between the academy, the government, the owners and users, to improve and conserve them (Sustainable Rangelands Roundtable, 2020). This methodology employs 5 criteria or themes and 64 indicators (Evans et al., 2010; Joyce et al., 2010; Karl et al., 2010; McCollum et al., 2010; Mitchell et al., 2010).

Near East Forestry and Range Commission (NEFRC) FAO Methodology

From 1997 until 2015, some countries in the Near East and North Africa region operationalized the criteria and indicators for Sustainable Management of Forests and Rangelands by incorporating them in various ways and at various levels in forest and rangelands policies, plans and/or programs, as a basis or framework for carrying out environmental monitoring and impact assessments in the region.

In June 2015, to strengthen the adoption and use of the methodology, the FAO through its Regional Office for the Near East and its Forestry Department in Rome, and in collaboration with IUCN Regional Office for West Asia, organized an expert consultation meeting in Cairo. Based on the results of the meeting, the participating countries endorsed 7 criteria and 33 indicators for use at sub-regional and national levels (Food and Agriculture Organization of the United Nations, 2017b).

2.1.2.4. Sustainability assessment in Forest Lands

Forests lands are areas covered with trees or other woody vegetation. Below are the most common sustainability assessment methods for these areas.

The Ministerial Conference on the Protection of Forests in Europe (MCPFE) Methodology

Forests are heavily dependent on human settlements and in some countries constitute an important part of their resources. Urban growth and the search for natural spaces, far from the city, impacts on forest ecosystems. Following concern about this trend, the MCPFE was established as a concerted political effort to protect and strengthen the sustainable management of European forests. To fulfill its mission, criteria and indicators were established to be used by each participating nation. The last revision of these indicators was carried out at the Fourth Ministerial Conference in Vienna (April 2003), where it was agreed to establish the structure in 6 criteria or themes and 43 indicators (Wolfslehner et al., 2003).

FAO's Sustainable Forest Management Tool

The tool aims to promote the use of criteria and indicators to strengthen results-based management in forest policy design, planning and monitoring, ultimately to improve Sustainable Forest Management. Based on highly consultative processes around the world, the tool discusses how to improve the use of criteria and indicators and integrate them in national forest programmes and other frameworks for Sustainable Forest Management. This methodology uses 6 criteria or themes and 34 indicators (Julve et al., 2017).

The Center for International Forestry Research (CIFOR) Methodology

CIFOR is a non-profit organization conducting scientific research on forest use and management with a primary focus on developing countries. CIFOR proposes a compilation of criteria and indicators that reflects the current state of the forests under study and that constitute a starting point for planning actions and interventions, both public and private. The methodology is structured with 6 principles, 24 criteria or themes, and 98 indicators (Center for International Forestry Research, 1999).

2.1.2.5. Sustainability assessment in Water and Wetlands

Water sources such as rivers, lakes and ponds, together with wetlands, are important ecosystems that host various forms of life. These resources can be easily damaged, either by human action or by natural events, therefore it is important to study their sustainability, in the sense of conserving and using them efficiently. The most common methods for sustainability assessment of water and wetlands in the academic and applied fields are shown below.

The Driver-Pressure-State-Impact-Response Framework (DPSIR) Methodology

The Driver-Pressure-State-Impact-Response (DPSIR) framework is a tool that allows measuring various geographical spaces from indicators that analyze the situational state of the object under study and allow feedback of the results to policy makers, to evaluate the effectiveness and relevance of the main actions taken.

The methodology uses the idea of a chain of events, which begin with the DRIVING forces, which are carried out by human activities or economic sectors, and are transmitted through PRESSURES, which are waste or emissions, to new STATES, which can be biological, physical or chemical, thus emerging IMPACTS on the ecosystems involved, which ultimately leads to the emergence of RESPONSES, in the form of policies or interventions. As a reflection on this methodology, a careful analysis must be carried out to determine the cause-effect relationships of a situation under study, since a poorly defined chain could generate unreliable results. The methodology uses 36 indicators (Kristensen, 2004).

The Water Poverty Index (WPI)

The Water Poverty Index is a complex and holistic methodology that uses water and human well-being indicators to measure the impact of water scarcity on the quality of life in human settlements. Several academics and institutions have contributed in its development, so its authorship could not be attributed to a particular person. The index focuses on poor people, who are the most vulnerable and most affected by inadequate access to water. The methodology comprises 5 components or themes and 22 subcomponents or variables that collect environmental, social and economic information related to water scarcity (Sullivan et al., 2003).

IUCN Integrated Wetland Assessment Toolkit

This methodology proposed by the International Union for Conservation of Nature (IUCN), consists of a set of integrated and holistic tools that allow investigating the links between biodiversity, the economy and livelihoods in wetlands. Its main objective is to study the dilemmas between conservation and development. The convergence of several tools allows individual evaluations of each aspect of wetlands to be carried out, to later analyze them and, if necessary, integrate them in order to know the object under study in as much detail as possible (Springate-Baginski et al., 2009).

2.2. Proposal of a sustainability assessment methodology

To elaborate the primary model, a pilot survey was applied in the town of Lonya Chico, district of Lonya Chico, province of Luya. This information helped to calibrate the indicators (construction of a baseline), in addition to determining the weights of composite indicators. This populated center has been chosen, due to the number of productive units and the willingness of local authorities to collaborate with the investigation.

This decision has been agreed with the Research Advisor and the specialists consulted to validate the tools applied in the study.

Consequently, the data that will be used in this section correspond to this district, being able to generalize it to other geographical zones, as will be shown in the next chapter, where the sustainability of three geographical zone will be evaluated, with totally uneven morphological, social and economic characteristics.

2.2.1. Scope

In 2015, all United Nations member states adopted the 2030 Agenda for Sustainable Development, as a shared plan to achieve peace and prosperity for all people and the planet, now and in the future. For this purpose, 17 Sustainable Development Goals were established, which should be incorporated into the public policies of all countries as soon as possible. In this agenda, it is recognized that the end of poverty must be through strategies to improve health, education, economic growth, together with actions to reduce inequality, climate change and the degradation of forests and oceans (United Nations, 2021).

In this order of ideas, the Global Sustainable Development Report 2019 (United Nations, 2019) establishes that sustainable development must provide the necessary evidence to achieve important and tangible solutions to the social, economic and political problems that currently affect societies. The same document categorizes the following types of sustainability challenges to be faced:

- Simple challenges: Scientific evidence is used for decision-making and planning activities.
- Complex challenges: The evidences are taken as true, the existence of gaps in knowledge can be overcome by increasing the observation of social and ecological systems.

- Complicated challenges: There is sufficient evidence, but to achieve its implementation it is necessary to appeal to social consensus.
- Wicked challenges: They are the most difficult to solve. In these situations, there is little evidence with low social support, so decisions can no longer be based on observations, making them risky.
- Chaos: Problem situations are unknown and cannot be negotiated.

To realize the proposed framework, the focus was in the complicated, wicked and chaos challenges.

To define the scope of the model, systems theory will be used, which requires the definition of the limits of the system, as well as a hierarchy of levels of aggregation. To do this, it starts from the agricultural land use systems, which can be defined as: cropping system (field level), farming system (farm level), watershed/village (local level) and landscape/district (regional level). As for the higher levels, there would be a national, supranational and global (Hayati et al., 2010). For this research, the elements of local level are used, because the focus is in variable extension of lands.

It is necessary to have a model that measures sustainability based on the Peruvian reality, a developing country.

The key contribution of this thesis is expand the popular assessment methodologies a one framework that can be used in every geographic zone.

2.2.2. Framework

Sala et al. (2015) propose a Methodological Framework for Sustainability Assessment, which can be summarized as:

2.2.2.1. Architecture

Speak of sustainability is to relate theory to actions. These actions can be applied in policies, in planning, in processes or in products. Consequently, it is necessary to assess these actions to define the degree of sustainability of the system where they operate, thus defining the evaluation of sustainability. The framework for this sustainability assessment consists of two main parts: the principles and the procedure (Sala et al., 2015).

The Top-Down and Bottom-Up Hybrid approach was used in the framework, to permit more participation of stakeholders in its use and construction (Dialga, 2019).

2.2.2.2. Sustainability Assessment Principles

The principles that are necessary to evaluate sustainability are defined below (Sala et al., 2015):

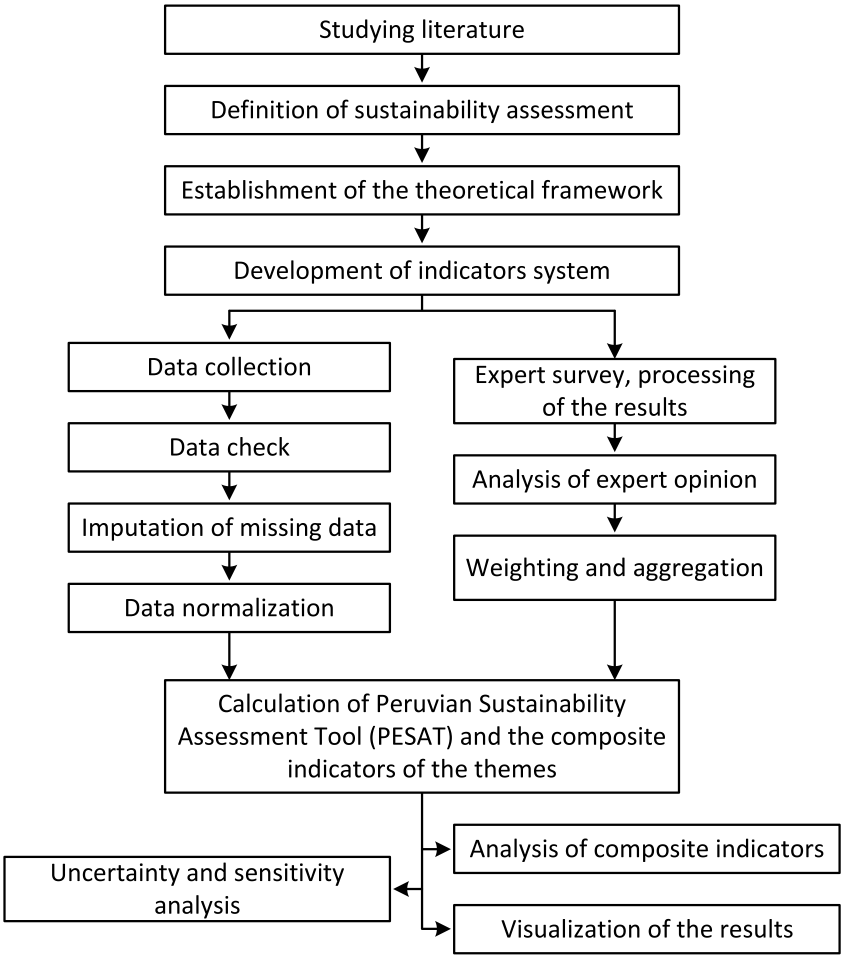
1. Guiding vision: Sustainability objectives must be defined, based on an analysis of the resources available to use and the resources that can be inherited for future generations.
2. Essential considerations: Include all relationships between the government, businessmen, and society, as well as an analysis of the social, economic, and environment where human activities take place, incorporating the strengths, risks, and uncertainties that would impact ecosystems.
3. Adequate scope: Clearly define a time horizon for the sustainability assessment, as well as the delimitation of the geographic space that will be studied.
4. Framework and indicators: Establishing a structure for the sustainability assessment, based on objective criteria, with theoretical support, it is important that it uses standardized, reliable and comparable inputs.
5. Transparency: It is important that the data, the data source, the analysis and the results are transparent and accessible to the public. The assumptions, techniques, choices, and interactions within the model must be clear and understandable.
6. Effective communications: The language to be used must be clear and precise, to ensure that all those involved understand what and why the corresponding activities are being carried out.
7. Continuity and capacity: The results must be evaluated from time to time, to see if improvements or setbacks have been achieved, also, evaluate how much it would cost to improve the sustainability of the areas under study.
8. Broad participation: The evaluation of sustainability is a joint task between academia, entrepreneurs, government and citizens, the quality of the results depend on their involvement.

2.2.2.3. Sustainability Assessment Procedure

Valkó (2015) proposes a research process to develop a sustainability assessment methodology, which is used in this research, with minor adjustments. Figure II.1 reproduces the scheme that was followed.

Figure II.1

Flow chart of the methodology development



Note: Adapted from Organisation for Economic Co-Operation and Development, 2008b, and Valkó, 2015.

2.2.3. Development of indicators system

To assess sustainability, a set of indicators is generally used, which have their own scales, dimensions and sources of collection, which may seem difficult to manage. It is then necessary to integrate all these indicators into composite indicators, which summarize all the information collected and give us an idea of the concept of sustainability in the space where they are applied, making it possible to work with these results to propose new scenarios and their corresponding analysis (Gómez-Limón & Sanchez-Fernandez, 2010).

2.2.3.1. Pillars and Themes definition

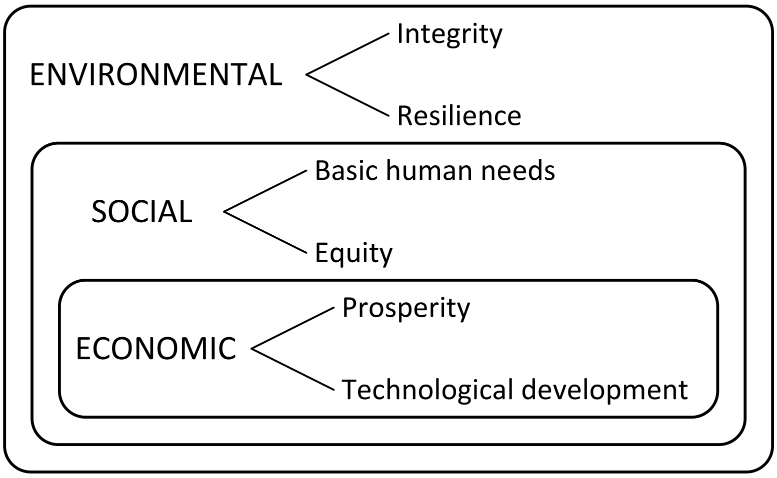
To define the dimensions of sustainable development in this research, the three traditional pillars of sustainability are used: Environmental, Social and Economic, also known as the triple bottom line (Eslami et al., 2021; Gladysz et al., 2020; Pirouz et al., 2020).

Although there is no unanimous definition for each of the three dimensions, it can be defined how they will be used in the present study. Environmental sustainability deals with biodiversity, environmental protection, regeneration, the reduction of pollution and environmental emissions, applied to individuals, species, or complex ecosystems. Social sustainability can be understood as the ability of citizens to conserve their environment, for this it is necessary to know how they satisfy their basic human needs, without neglecting the interrelationships in society and their perception of future generations. Economic sustainability is strongly influenced by the financial viability of companies or projects, so their investment, forms of production, financing, marketing and profits must be analyzed (Boar et al., 2020; Cornet, 2016).

This research uses the three dimensions mentioned, and the Figure II.2 shows the nested sustainability dimensions, based on Brundtland conceptualization.

Figure II.2

Nested Sustainability Dimensions



Note: Adapted from Cornet, 2016.

To determine the themes to use (second level, criteria, components, categories, etc.), several frameworks were merged, in function of the level sustainability assessment previously defined.

Table II.2 summarizes the themes chosen. The detailed table, and its construction is showed in Appendix B.

Table II.2

Themes proposed

Pillar	Themes
Environmental	Biodiversity
	Soil
	Water
	Waste management
	Air
	Energy
	Landscape
Social	Food security and provision
	Education and culture
	Human health and safety
	Social and related services
	Housing and population
	Working conditions
	Household income
	Ethics and people behavior
	Governance
Economic	Industry entry
	PSM[2]: Production management
	SSM[3]: Production management
	TSM[4]: Production management
	QSM[5]: Production management
	Commercialization
	Profitability

Note: PSM = Primary Sector Manufacturing, SSM = Secondary Sector Manufacturing,

[2]PS: Agriculture, forestry and fishing

[3]SS: Mining, manufacturing, electricity, gas, steam and air-conditioning supply, water supply, waste management and construction

[4]TS: Wholesale and retail, transportation and storage, accommodation and food services, financial and insurance activities, professional, scientific and technical activities

[5]QS: Public administration and defense, education, human health, arts, entertainment and recreation, other service activities

TSM = Tertiary Sector Manufacturing, QSM = Quaternary Sector Manufacturing.
Adapted from Baccar et al., 2016; Bern University of Applied Sciences, 2021; Building Research Establishment Ltd., 2017; Fiksel et al., 2012; Food and Agriculture Organization of the United Nations, 2014; German Sustainable Building Council, 2021; Green Building Council of Australia, 2021; Hulleman and Marijs, 2021; Institute for Building Environment and Energy Conservation, 2021; Lebacq et al., 2013; Meul et al., 2008; Organisation for Economic Co-Operation and Development, 2008a; Paracchini et al., 2015; Sarkar et al., 2011; Song and Moon, 2019.

Having set out themes to be assessed, indicators are chosen, modified and revised again. The careful choice of indicators is critical in order to achieve a good methodology.

2.2.3.2. Selection of indicators

Assessment of sustainability is a complex task, involving many factors. Developing a comprehensive suite of indicators is one useful way to begin. Sustainable development indicators must adequately show the achievement of the sustainability objectives in addition to measuring the key aspects that favor the improvement or reduction of the sustainability levels under study (Gorlachuk et al., 2018; Nguyen et al., 2019).

From a scientific perspective, according to the recommendations of Ehler and Douvere (2009), effective indicators should have the following characteristics:

1. Readily measurable: Through standardized scales and reliable data sources.
2. Cost effective: Avoid excess expenses to get the information.
3. Concrete: Indicators that are directly observable and measurable should be preferred.
4. Interpretative: The information collected must reflect the phenomenon under study and its meaning understood by all those involved.
5. Grounded in theory: Indicators should be based on widely accepted scientific theory.
6. Sensitive: Indicators should vary their results when the situation under study varies.
7. Responsive: Indicators must respond quickly to actions on the phenomenon under study, proposing explanations for what happened.
8. Specific: Indicators should respond to a specific need and detail it as much as possible.

Once the possible indicators that evaluate sustainability have been collected, a screening must be carried out, for which the following criteria is used (Reytar et al., 2014):

1. Available: Is it possible to get the data that the indicator requests?.
2. Accurate: Does the indicator present accurate, reliable and representative data?.
3. Consistent: Is the information that supports the indicator consistent between observations and between studies?.
4. Frequent: Is there information that can be collected or updated periodically?.
5. Proximate: Does the indicator belong to the issue of sustainability assessment?.
6. Relevant: The indicator and the data it generates provide information to measure sustainability?.
7. Differentiating: The indicator and the information it generates can be used to compare two scenarios?.

The main achievement of the model is that it should evaluate the sustainability of any geographic area, so it should be able to measure and weight any economic activity found in that space. Because many models measure the sustainability only of agriculture, to expand it to any economic activity, the criterion of economic sectors was used, proposed by Hulleman and Marijs (2021), thus employing four economic sectors: Primary, Secondary, Tertiary and Quarterly, because industries within sectors have similar impacts on the environment.

The literature review compiled 7 431 indicators. In a first revision they were reduced to 2 436. And reviewing specialized literature, related with consistence, appropriateness and importance, second revision reduced them to only 500. Finally, thanks to the pilot survey, 146 indicators were chosen. Table II.3 shows the selected indicators. However, in Appendix C., the detailed list of indicators with their main characteristics is included.

Table II.3

Set of indicators and composite indicators

Pillar	Themes	Code	Indicators
Env	Biodiversity	EN01	Coverage of protected areas
		EN02	Existence of updated national natural resources and range policy, strategy, legislation and regulations
		EN03	Structural diversity in relative terms: crop plants

	EN04	Density of number per hectare: main plants
	EN05	Structural diversity in relative terms: domesticated animals
Soil	EN06	Land exposure to natural events: Tillage erosion risk, and other natural effects
	EN07	Soil erosion (% and total area eroded)
	EN08	Macronutrient: N
	EN09	Macronutrient: P
	EN10	Macronutrient: K
	EN11	Soil pH
	EN12	Percentage of land affected by salinity
	EN13	Soil pollution (levels and control)
	EN14	Soil organic matter (SOM) content
Water	EN15	Water quality index
	EN16	Water salinity
	EN17	Exceedance of critical loads of pH in water
	EN18	Volume of water withdrawn from superficial sources
	EN19	Volume of water withdrawn from groundwater sources
	EN20	Use of alternative resources: rainwater, recycled, etc.
	EN21	Degree of integrated water resources management implementation assessing four components: policies, institutions, management tools and financing
	EN22	Reports of conflict over water use
	EN23	Total industrial water consumption per capita
	EN24	Total domestic water consumption per capita
Waste management	EN25	Volume of wastewater produced by the company
	EN26	Volume of solid waste produced by the company
	EN27	Percentage of city population with regular solid waste collection (residential)
	EN28	Percentage of city population served by wastewater collection
	EN29	Total per capita municipal solid waste collected
Air	EN30	Volume of air pollutants emissions produced by

			the companies in the ecosystem (Ammonia, Carbon dioxide (CO2), Nitrogen oxide (NOx), Sulphur Oxides (SOx), Particular Matter (PM) and Volatile Organic Compounds (VOC))
		EN31	Volume of air pollutants emissions produced by the population in the ecosystem
		EN32	Air quality index
		EN33	Emission of greenhouse gases per capita
	Energy	EN34	Amount of electric energy supplied to the industry
		EN35	Amount of electric energy supplied to the families
		EN36	Amount of energy from fossil fuels
		EN37	Amount of energy from renewable sources
		EN38	Percentage of domestic gas consumption
	Landscape	EN39	Long-term land tenure, land use and usufruct rights
		EN40	Share of industrial/commercial area in total area
		EN41	Land cover conversion from natural state to artificial state
		EN42	Formal and informal urban human settlements area

Soc	Food security and provision	S01	Total agricultural area per 1 000 population
		S02	Food self-sufficiency ratio
	Education and Culture	S03	Adult literacy rate
		S04	Women's average years in education institutions
		S05	Men's average years in education institutions
		S06	Primary education student/teachers ratio
		S07	Percentage of people with higher education degrees
		S08	Computers, laptops, tablets, or other digital learning devices available for primary and secondary school students
	Human health and safety	S09	Life expectancy
		S10	Maternal mortality rate
		S11	Child mortality rate
		S12	Suicide rate per 1 000 population
		S13	Number of doctors per 1 000 population

	S14	Number of nurses per 1 000 population
	S15	Access to basic health care services in the neighborhood
	S16	Population covered with health insurance, public or private
	S17	Number of homicides per 1 000 population
Social and related services	S18	Availability of basic infrastructure for water supply
	S19	Availability of basic infrastructure for electricity distribution
	S20	Rate of mobile (cellular phone) ownership
	S21	Number of internet connections per 100 population
Housing and population	S22	Net migration rate
	S23	Population density
	S24	Distribution of households according to typology and headship
	S25	Length of residence in the community
	S26	Housing floor area per person
	S27	Square meters of public recreation space per capita
	S28	Green area per capita
	S29	Proportion of youth (aged 15–24 years) in the community not in education, employment or training
Working conditions	S30	Percentage of the labor force employed distributed by sectors
	S31	Proportion of the employed population that works on its own account or in a family business
	S32	Proportion of women in managerial positions
	S33	Jobs–housing ratio
	S34	Wage difference between genders
	S35	Social protection (benefits, pension)
Household income	S36	Percentage of households receiving a pension/ remittance or wage
	S37	Income per capita
	S38	Population living below national poverty line
Ethics and people	S39	Women's involvement in decision making about

	behavior		economic activities
		S40	Believe that religion or spirituality can bring joy and happiness
		S41	Civic responsibility and community engagement
		S42	Perception on social inclusion
		S43	Citizens with positive view of the state
		S44	Percentage of young people who want to continue the economic activity of their parents
		S45	Annual number of cultural events per capita
	Governance	S46	Governance index
		S47	Satisfaction with the service of the political representative in the region
		S48	Women as a percentage of total elected authorities
		S49	Municipal budget per inhabitant
		S50	Percentage of city services accessible online

Eco	Industry entry	EC01	Percentage of owners who have bank loans for productive activities
		EC02	Solvency (= own capital/total capital)
		EC03	Payback period (years needed for return of the initial investment)
		EC04	Innovation hubs in the city
	PSM: Production management	EC05	Arable cropland, permanent cropland, permanent pasture and other agricultural land share in the total land area
		EC06	Proportion of adequately trained workers
		EC07	Percentage of industry jobs which are permanent
		EC08	Fertilizer use
		EC09	Pesticide use
		EC10	Availability of seeds
		EC11	Harvest plants and rotation period
		EC12	Diversity of activities in the sector
		EC13	Percentage of organic farming in utilized agricultural area

	EC14	Share of certified companies
	EC15	Apply of computing platforms and ICT solutions
	EC16	Area of technified irrigated land in total agricultural area
	EC17	Productivity of labor (main crop)
	EC18	Productivity of land (main crop)
	EC19	Cooperation between stakeholders (industry, academia, policy sectors, etc.)
	EC20	Years of experience in the industry
	EC21	Existence of education programs (university, technical, particular) related to the industry
SSM: Production management	EC22	Proportion of adequately trained workers
	EC23	Percentage of industry jobs which are permanent
	EC24	Share of certified companies
	EC25	Apply of computing platforms and ICT solutions
	EC26	Productivity of labor (main product or service)
	EC27	Productive diversification
	EC28	Cooperation between stakeholders (industry, academia, policy sectors, etc.)
	EC29	Years of experience in the industry
	EC30	Existence of education programs (university, technical, particular) related to the industry
TSM: Production management	EC31	Vehicles in use by populated area (per km^2)
	EC32	Restaurants, hotels, stores and bazaars by populated area (establishments per km^2)
	EC33	Proportion of adequately trained workers
	EC34	Percentage of industry jobs which are permanent
	EC35	Share of certified companies
	EC36	Apply of computing platforms and ICT solutions
	EC37	Productivity of labor (main product or service)
	EC38	Cooperation between stakeholders (industry, academia, policy sectors, etc.)
	EC39	Years of experience in the industry
	EC40	Existence of education programs (university,

		technical, particular) related to the industry
QSM: Production management	EC41	Number of bars/discotheques per local population
	EC42	Proportion of adequately trained workers
	EC43	Percentage of industry jobs which are permanent
	EC44	Share of certified companies
	EC45	Apply of computing platforms and ICT solutions
	EC46	Productivity of labor (main product or service)
	EC47	Cooperation between stakeholders (industry, academia, policy sectors, etc.)
	EC48	Years of experience in the industry
	EC49	Existence of education programs (university, technical, particular) related to the industry
Commercialization	EC50	Industry production volume (year)
	EC51	Local consumption of the production
	EC52	Use of platforms for digital and mobile buying/ payment
Profitability	EC53	Annual profit of local companies
	EC54	Stability of income over time

Note: Every theme will be a composite indicator. Env = Environmental, Soc = Social, Eco = Economic. ICT = Information and Communications Technology, PSM = Primary Sector Manufacturing, SSM = Secondary Sector Manufacturing, TSM = Tertiary Sector Manufacturing, QSM = Quaternary Sector Manufacturing.

Now, having the indicators, it is necessary to group them, for this purpose, the technique known as indicator composition will be used. The concept of composite indicators was popularized in the 1990s, initially to compare countries, then it was extended to other situations and disciplines, being used today by institutions such as United Nations, World Bank, European Commission, among others (Talukder et al., 2017).

Among the advantages of using composite indicators are that they can summarize complex, multi-dimensional situations with the participation of the most important stakeholders, and, they can help to place key issues at the center of the policy arena and the public opinion. The disadvantages are that they can show erroneous results if they are poorly constructed or interpreted carelessly, and, the selection of indicators and weights could be the subject of political dispute (Organisation for Economic Co-Operation and Development, 2008b).

In the construction of composite indicators, transparency is essential, both in design, use, and refinement. The researchers must have a clear understanding of what is intended to measure, for what purpose, and for which target users and audiences, for this, is important a collective work throughout process (United States Agency for International Development, 2014).

Basically, a typical composite indicator "*CI*" is built as follows (Organisation for Economic Co-Operation and Development, 2008b):

$$CI = \sum_{q=1}^{Q} w_q I_q$$

Where I_q is the normalized variable, w_q is the weight attached to I_q,

$$\sum_q w_q = 1, 0 \leqslant w_q \leqslant 1 \text{ (for all } q = 1, \ldots, Q).$$

This formula indicates that composite indicators are the addition (or product or other mathematical expressions) of normalized indicators that include weights. The following sections will explain the components of the formula, as well as the possible variants that can be used.

2.2.3.3. Questionnaire Development

Since the proposed model can be used in any geographical area, it is understood that it will cover any human activity, so six questionnaires were developed to collect primary data (Appendix D.) and model the system as a whole. Table II.4 shows the types of questionnaires developed. It is expected that the six questionnaires will be applied simultaneously or in the same data collection period to avoid distortions or biases in the opinion of the participants.

Table II.4

Structure of the questionnaires

Code	Description	Questions	Indicators covered
Q1	Employers - Primary Sector	86	59
Q2	Employers - Secondary Sector	44	27

Q3	Employers - Tertiary Sector	40	28
Q4	Employers - Quaternary Sector	41	27
Q5	Local Authority	25	38
Q6	Inhabitant	38	38

2.2.3.4. Data collection

Following the recommendations of Johnson and Christensen (2019), the data come from the questionnaires detailed in section 2.2.3.3., in addition to other two important sources: field observations and secondary information. The latter includes administrative data, generated by public entities and NGOs, as well as censuses and other reliable and up-to-date information.

The application of the pilot survey was carried out on November 20-23, 2020. The district evaluated is briefly described in Table II.5. This district was chosen because of the approach with the Mayor and the facilities he proposed to provide official information on the main indicators.

Table II.5

Brief description of the Lonya Chico district

Item	Description
Area	83.82 km^2
Population	1 147 inhabitants (Census of the year 2017)
Villages and hamlets	14 (Biggest Lonya Chico)
Foundation	January 2, 1875
Mayor	Efraín Guerra Gómez (2019-2022)
Agricultural units	264 (2018)
Agricultural area	602 Ha (2018)
Production	Coffee (220 Ha), Corn (160 Ha), Bean (92 Ha), Potato (88 Ha)

Note: Adapted from Instituto Nacional de Estadística e Informática, 2021, and Ministerio de Desarrollo Agrario y Riego, 2021.

For the pilot survey, it was ensured that at least five subjects were surveyed for each type of questionnaire. In total 50 representative households, entrepreneurs and authorities were surveyed (see Table II.6).

Table II.6

Applied questionnaires in the pilot survey

Code	Description	Total applied	Complete
PI-Q1	Employer - Primary Sector	10	10
PI-Q2	Employer - Secondary Sector	5	5
PI-Q3	Employer - Tertiary Sector	5	5
PI-Q4	Employer - Quaternary Sector	5	5
PI-Q5	Local Authority	5	5
PI-Q6	Inhabitant	20	20

In the data set, the time-scale for the measurement of indicators was present observation, like a photography of the present situation. To follow with the next steps, subjective information was converted into qualitative forms.

2.2.3.5. Data check

The data check was carried out in the field with the help of two key informants selected to verify the information from the questionnaires survey, this in order to avoid incomplete surveys and repeated interviewees. The final correction of the information will be made in the data normalization step.

Due to the fact that the variables have been validated with specialists in the subject, theoretically they are not correlated to each other because they are variables that deal with unrelated subjects. And, following to Mathai and Haubold (2018), it is useless to calculate the correlation if there is no relationship between the two variables, since the correlation only applies to linear relationships. On the contrary, if there is a strong relationship between the two variables, but it is not linear, the received correlation may be misleading or spurious, and subsequent calculations may be wrong or unnecessary. In this sense, it is not necessary to perform a correlation analysis for this investigation.

2.2.3.6. Imputation of missing data

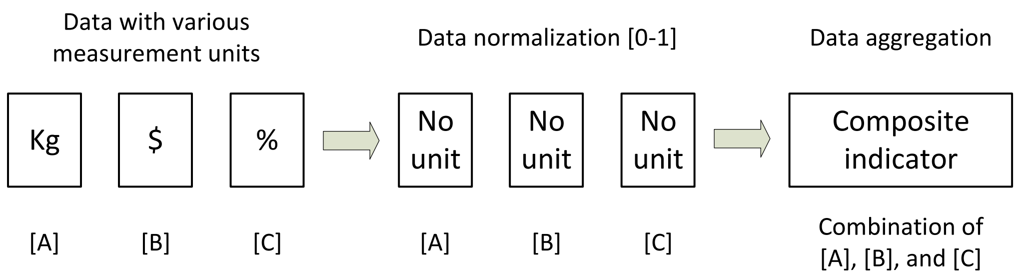
To avoid missing data, the applied surveys were reviewed in the field; if any were incomplete, they were immediately discarded and continued searching participants for apply the survey, when at least five of each type of questionnaire were completed, the task was concluded. This means that all applied surveys were used.

2.2.3.7. Data normalization

Bas (2014), defines the objectives of data normalization, such as adjustments to the observation series promoting that the data do not have different measurement units, so that they do not have different ranges of variation and also, to avoid atypical data. The process is summarized in Figure II.3

Figure II.3

Representation of normalization for constructing a composite indicator



Note: Adapted from Talukder et al., 2017.

Because the objective is to build an index that shows the degree of sustainability of a geographical area, then, the higher the index, the better the level of conservation of natural resources and the environment. Following this idea, the indicators and indices that support sustainability should be higher and those that decrease sustainability should have lower values. This logic will be followed in the construction of the composite indicators.

Using different normalization techniques produces different results in the indicators, which translates into different composite indicators (Jacobs et al., 2004; Organisation for Economic Co-Operation and Development, 2008b; Tate, 2012).

A variety of normalization techniques are available (see, for example, Table II.7). In this research, to evaluate the model, Min-Max technique of data normalization was used, in its standard form and wiht target variation (replacing the maximum value of the indicator with a target or reference value) taking into consideration that the observations of each variable are uneven and there is the need to obtain values between 0 and 1 (or percentage).

However, the five techniques shown will be used to calculate the composite indicators and the robustness of the model.

Table II.7

Most common data normalization techniques

Name	Formula	Description
Ranking	$I_{iq} = rank(x_{iq})$	Where I is the transformed variable of x for indicator i for unit n and $rank(x_{iq})$ replaces the observation x_{iq} with its rank in the serie
Decimal	$I_{iq} = \frac{x_{iq}}{10^j}$	Where I is the transformed variable of x for indicator i for unit n and j is the smallest integer such that: $max(\|I_{iq}\|) < 1$
Z-score (standardization)	$I_{iq} = \frac{x_{iq} - \mu_n}{\sigma_n}$	Where I is the transformed variable of x for indicator i for unit n and μ_n represents the mean and σ_n is the standard deviation of the observations
Min-max	$I_{iq} = \frac{x_{iq} - x_{min}}{x_{max} - x_{min}}$	Where I is the transformed variable of x for indicator i for unit n and x_{min} and x_{max} are the minimum and maximum observations
Sum	$I_{iq} = \frac{x_{iq}}{\sum_{i=1}^{n} x_{iq}}$	Where I is the transformed variable of x for indicator i for unit n and $\sum_{i=1}^{n} x_{iq}$ is the sum of observations

Note: Adapted from Jacobs et al., 2004; Kosareva et al., 2018; Organisation for Economic Co-Operation and Development, 2008b; Rajeswari and Thangavel, 2020; Vafaei et al., 2010.

2.2.3.8. Expert participation and contributions

To carry out the final calibration of the model, as well as to determine the weights and aggregation techniques, meetings were held with experts on the subject, in virtual meetings (through the Zoom platform) and face-to-face (in the city of Chachapoyas) in the month of November 2020. The results were consolidated in the same month.

The experts were chosen according to their importance in the field of research and teaching, in topics related to the present investigation. Appendix F. summarizes their academic formation and contributions to the study.

From the opinion of the experts, the following conclusions were reached:

- The indicators to be used were validated, including the formulas, scales and resources for data collection.
- Since the model is farm level, it is recommended to use the following weights for the pillars: Environmental, 30%; Social, 35%; and, Economic, 35%.
- For the issues of Environmental dimension, weights of 10% will be used, except for Water, Waste management and Energy, which will have weights of 20%.
- For the topics of Social dimension, weights of 10% will be used, except Education and culture and Ethics and people behavior, which will have weights of 15% each one.
- For the topics of Economic dimension, 10% weights will be used, except PSM: Production management, which will have 25% and SSM: Production Management, which will have 20%, TSM: Production management, which will have 15%, due to these activities are the ones that most affect the environment where they operate.
- Indicators within a theme will have the same weight.

2.2.3.9. Weighting and aggregation

The weights assigned to the indicators reflects their relative importance in the study of a phenomenon. For its determination, several expert and statistical approaches have been developed, however, the most common approach is the use of equal weights for all indicators. As a general rule, the same weighting is used as an option, when not all the relationships between the indicators are known and it cannot be determined which of them contributes more to the understanding of the situation under study (Tate, 2012). In this research, the weights proposed by the specialists were used, detailed in section 2.2.3.8.

Aggregation is the technique through which the normalized indicators are merged to get a single indicator or composite indicator, carried out through mathematical functions. There are several aggregation methods available. The most used are linear[6] (arithmetic mean), geometric[7] (multiplication) and multi-criteria (Greco et al., 2019).

In this section, the linear and geometric aggregation methods will be used, to then compare them and define the most appropriate one to use later investigations. The results of apply aggregation techniques for the composite indice Governance (Social Pillar) applied on the arithmetic means of the variables (Freudenberg, 2003) are shown in Table II.8.

Table II.8

Composite indicator Governance using min-max normalization and linear and geometric aggregation

Indicators	Mean	Weights[8]	Composite value for linear aggregation	Composite value for geometric aggregation
S46	0.6	0.2		
S47	0.55	0.2		
S48	0.4	0.2	0.40580238	0.34661341
S49	0.379	0.2		
S50	0.1	0.2		

It is observed that geometric aggregation notably influences low indicators, even if one of them is zero, the aggregation will be zero, so linear aggregation, which better reflects the value of the series, is preferred.

To evaluate the composite indicator corresponding to the Social Pillar, it is used again both aggregation techniques over the linear aggregation of the themes, obtaining the results shown in Table II.9.

[6] The formula is $CI_i = \sum_{i=1}^{n} w_q I_{iq}$. Where CI_i is the composite indicator, w_q is the weight associated to the indicator and I_{iq} are the normalized indicators.

[7] The formula is $CI_i = \prod_{i=1}^{n} I_{iq}^{w_q}$. Where CI_i is the composite indicator, w_q is the weight associated to the indicator and I_{iq} are the normalized indicators.

[8] Within the themes, all the weights are equal

Table II.9

Composite indicator Social using min-max normalization and linear and geometric aggregation

Themes	C.I.L.	Weights	Composite value for linear aggregation	Composite value for geometric aggregation
Food security and provision	0.4585	0.1		
Education and culture	0.4651	0.15		
Human health and safety	0.7740	0.1		
Social and related services	0.5515	0.1		
Housing and population	0.5617	0.1	0.52357273	0.51474193
Working conditions	0.4671	0.1		
Household income	0.4402	0.1		
Ethics and people behavior	0.5862	0.15		
Governance	0.4058	0.1		

Note: C.I.L. = Composite indicators obtained with linear aggregation.

On the results shown, it is evident that geometric aggregation is less than the arithmetic one, so the lineal aggregation is preferred, which will be used in the present investigation.

2.2.3.10. Analysis of composite indicators

In practice, for the elaboration of composite indicators, difficulties may appear in each of the steps to be followed, such as in the selection of the indicators, the weight assigned to them, the normalization technique used and the aggregation method chosen.

Various statistical tests can help to ensure that the composite is robust and not heavily dependent on the choice of standardization or weighting approaches or on the levels of aggregation of sub-components. The robustness could be performed using correlation between different normalization techniques, just as Freudenberg (2003) and Hudrlíková and Kramulová (2013) suggest, and verifying whether the results of the composite indicator are heavily influenced by the choice of technique.

Following are the results of applying the other types of normalization to the data and creating the composite indicators for the topics that have been raised (Table II.10).

Table II.10

Composite indicators for the themes, using five normalization techniques and linear aggregation

Themes	Composite values for Ranking normalization	Composite values for Decimal normalization	Composite values for Z-score normalization	Composite values for Min-max normalization	Composite values for Sum normalization
Biodiversity	2.06	0.28652	U.V.	0.50965714	0.1
Soil	1.44444444	0.30325586	-0.10540926	0.8842778	0.1
Water	1.95	0.3488048	U.V.	0.60358198	0.075
Waste management	1.0	0.264	U.V.	0.58066667	0.12
Air	1.0	0.30875	U.V.	0.8665625	0.0825
Energy	8.34111111	0.05891111	0.0	0.565	0.03688889
Landscape	3.2	0.14633333	U.V.	0.755	0.15555556
Food security and provision	1.0	0.35850044	U.V.	0.45850044	0.25
Education and culture	2.33333333	0.20433333	U.V.	0.46514575	0.065
Human health and safety	1.44444444	0.14231111	U.V.	0.77395556	0.07666667
Social and related services	4.25	0.46015	U.V.	0.5515	0.12
Housing and population	3.225	0.04156761	U.V.	0.56165739	0.11875
Working conditions	5.6	0.24733333	U.V.	0.46711111	0.03333333
Household income	3.03333333	0.08733333	U.V.	0.44019608	0.08333333

Ethics and people behavior	2.02857143	0.0647619	U.V.	0.58619048	0.04857143

Themes	Composite values for Ranking normalization	Composite values for Decimal normalization	Composite values for Z-score normalization	Composite values for Min-max normalization	Composite values for Sum normalization
Governance	1.99	0.23304	U.V.	0.40580238	0.17
Industry entry	6.83777778	0.06668889	U.V.	0.44972222	0.02555556
PSM: production management	2.87647059	0.2155	U.V.	0.43154575	0.07647059
SSM: production management	1.97777778	0.11244444	U.V.	0.36851852	0.13333333
TSM: production management	2.67	0.37375	U.V.	0.5843875	0.16
QSM: production management	1.97777778	0.21790204	U.V.	0.68181769	0.2
Commercialization	8.06666667	0.10932	0.0	0.44611348	0.04
Profitability	9.56	0.1352	0.0	0.4304	0.04

Note: U.V. = Undefined value. This happens when all observations have the same value, a fact that occurs frequently when applying the questionnaires.

To carry out a first robustness analysis, the behavior of the composite indicators is graphically analyzed, for each of the pillars, the results can be seen in Figures II.4 to II.6. In these figures it is observed that the most usable results, in relation to percentage quantities, would be those obtained with normalization using the Min-Max technique.

Figure II.4

Composite indicators for pillar Environmental, using four normalization techniques

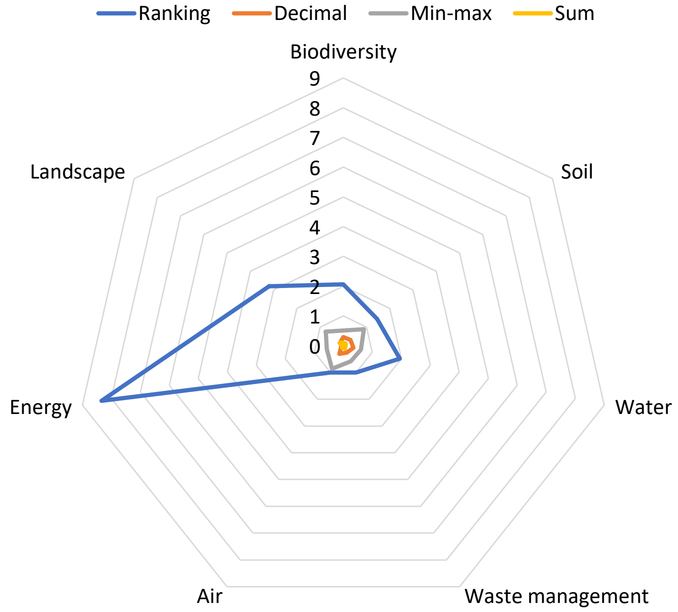


Figure II.5

Composite indicators for pillar Social, using four normalization techniques

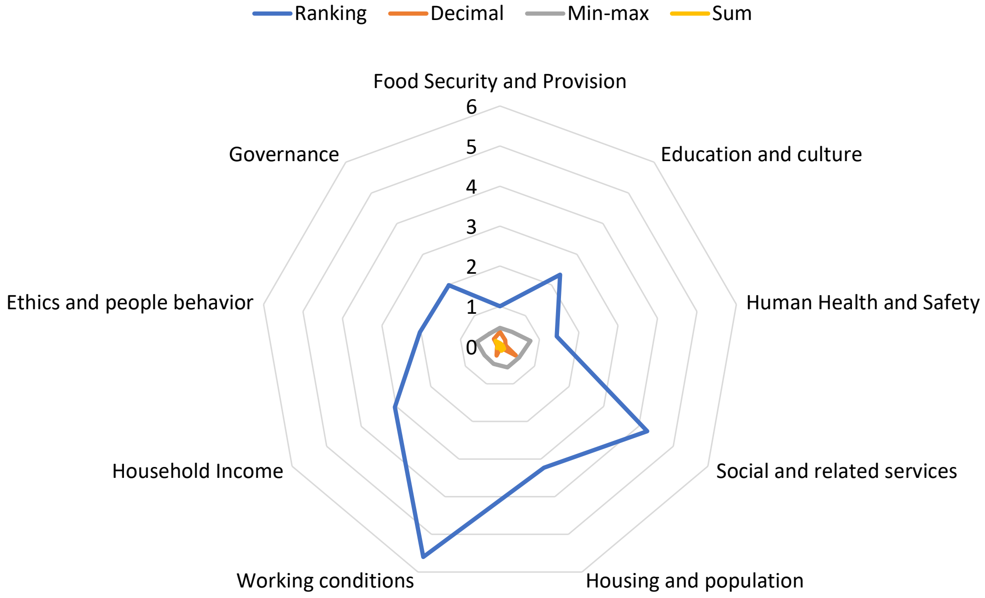
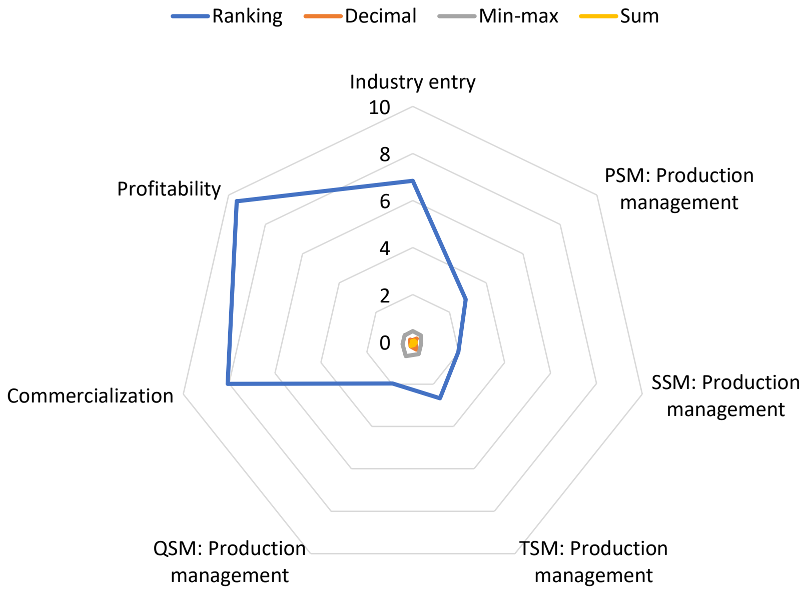


Figure II.6

Composite indicators for pillar Economic, using four normalization techniques



The next step is calculate the correlation matrix, for this, the four normalization techniques will be evaluates, excluding Z-score because is not possible calculate all the composite indices with this technique. Results are shown in Table II.11.

Table II.11

Spearman correlation between normalization methods

	Ranking	Decimal	Min-Max	Sum
Ranking	1.00	-0.41	-0.38	-0.54
Decimal	-0.41	1.00	0.22	0.31
Min-Max	-0.38	0.22	1.00	0.22
Sum	-0.54	0.31	0.22	1.00

The correlation coefficient close to 1 implies that the values of composite indicators remain unchanged when different methods are applied. In this research, the correlation coefficient results for the four normalization methods varied a lot, and they do not show a strong correlation, so this criterion cannot be used.

The criterion to be used will then be the percentage variation of the composite indicators, which is why normalization using the Min-Max technique and linear aggregation is chosen.

2.2.4. Calculation of the Peruvian Sustainability Assessment Tool (PESAT) general index

To construct a strong methodology, it was sought to comply with eight desirable attributes suggested by Farrugia (2007), among which are: accuracy, simplicity and ease of comprehension, methodological soundness, suitability for international and temporal comparisons, transparency, accessibility (availability), timeliness and frequency, and flexibility.

According to what is shown in section 2.2.3., the structure of the proposed methodology uses Min-Max normalization and linear aggregation, the representation is summarized in Table II.12.

Table II.12

Peruvian Sustainability Assessment Tool (PESAT) structure

Pillar	Weights	Themes	Weights	Indicators	Weights
Environ-mental	0.3	Biodiversity	0.1	EN01-EN05	Equal
		Soil	0.1	EN06-EN14	Equal
		Water	0.2	EN15-EN24	Equal
		Waste management	0.2	EN25-EN29	Equal
		Air	0.1	EN30-EN33	Equal
		Energy	0.2	EN34-EN38	Equal
		Landscape	0.1	EN39-EN42	Equal
Social	0.35	Food security and provision	0.1	S01-S02	Equal
		Education and culture	0.15	S03-S08	Equal
		Human health and safety	0.1	S09-S17	Equal
		Social and related services	0.1	S18-S21	Equal
		Housing and population	0.1	S22-S29	Equal
		Working conditions	0.1	S30-S35	Equal
		Household income	0.1	S36-S38	Equal
		Ethics and people behavior	0.15	S39-S45	Equal
		Governance	0.1	S46-S50	Equal
Economic	0.35	Industry entry	0.1	EC01-EC04	Equal
		PSM: production management	0.25	EC05-EC21	Equal
		SSM: production management	0.2	EC22-EC30	Equal

TSM: production management	0.15	EC31-EC40	Equal
QSM: production management	0.1	EC41-EC49	Equal
Commercialization	0.1	EC50-EC52	Equal
Profitability	0.1	EC53-EC54	Equal

With the PESAT, the sustainability of Lonya Chico is calculated, first obtaining the composite indicators of the themes (see Table II.10 - fifth column, calculated previously to assess the robustness of composite indicators), then calculating the composite indicators for the pillars and finally for the general sustainability index (see Table II.13).

Table II.13

PESAT application in Lonya Chico: General sustainability index

Pillar	Composite values	General index
Environmental	0.65139947	
Social	0.52357273	0.54318906
Economic	0.47005361	

In Table II.13, the value of the general sustainability index 0.54318906 means that there is a 54.32% probability of maintaining the ecosystem properly using the natural resources as it has been done, so that they can then meet the needs of future generations.

Rates greater than 50% are considered acceptable and rates greater than 80% as optimal.

2.2.4.1. Uncertainty and sensitivity

In the construction of composite indicators, steps are followed in which subjective judgments must be made, such as the selection of the indicators, the treatment of missing values, the determination of the weights of the indicators, the choice of the aggregation methods, etc. All these subjective choices are part of the quality of the model, and together they determine whether it is a good structure or a model that is not well specified and has predictive weaknesses (Organisation for Economic Co-Operation and Development, 2008b). In this sense, the quality of the model should be evaluated, which depends on the strength of the assumptions, so the associated uncertainties in each section of the model construction process must be analyzed.

Following to Saisana et al. (2005), in this document two types of uncertainties are studied: selection of the indicators and uncertainty in the weights of the indicators, this is why the Min-Max has already been defined as the only normalization technique and the linear as the only aggregation technique.

For this purpose, Saisana and Saltelli (2008) and Vaida-Muntean et al. (2014) recommend two statistical tools: Uncertainty analysis and Sensitivity analysis, the first one focuses on how uncertainty in the input factors propagates through the structure of the composite indicator and affects the values of the general index, and the last one analyzes how much each individual contribution of uncertainty affects to the output variance.

Uncertainty Analysis

The calculations for uncertainty analysis made in this section correspond to the suggestions made by Organisation for Economic Co-Operation and Development (2008b), Saisana et al. (2005), and Saltelli et al. (2008).

Let CI be the composite value for indicators $c, c = 1, \ldots, m$. Then:

$$CI_c = f_{rs}\left(X_1; X_2; \ldots; X_{146}; T_1; T_2; \ldots; T_{23}; P_1; P_2; P3; w_{s,1}; w_{s,2}; \ldots; w_{s,172}\right)$$

Where X_i are the 146 normalized indicators used in the methodology, T_j are the 23 themes (composite indicators) used, and P_k are the 3 pillars considered. Also, the function f_{rs}, includes $r = 1$ and $s = 1$, where the index r refers to the aggregation system (lineal) and index s refers to the weighting scheme (expert opinion). Note that r can include various aggregation methods like lineal, geometric, non-compensatory multi-criteria approach, among others; and s can include benefit of the doubt approach, unobserved components model, budget allocation process, among others.

The uncertainty analysis is conducted as a single Monte Carlo experiment, involving the use of triggers to decide which aggregation system and weighting scheme to adopt. The value obtained by the composite indicator for each experiment is an output of the uncertainty analysis. This statistic captures the relative shift in the position of the entire methodology in a single number, and it can be calculated as:

$$\overline{R_s} = \frac{1}{M} \sum_{c=1}^{27} \left|\text{Value}_{\text{ref}}(CI_c) - \text{Value}(CI_c)\right|$$

The uncertainties are transferred into a set of scalar input factors, such that the resulting $\overline{R_s}$ is a non-linear function of the uncertain input factors, and the estimated probability distribution function of $\overline{R_s}$. The results of applying this approach are shown in Figure II.7, where the composite value y has the value of 5.096571 while the mean is 5.077, implying that the distribution can be considered as normal; with the first-order error propagation $u(y)$ is 0.2848008, where the greatest uncertainty is provided by the variables EN03 and EN04, so special care must be taken with them. Note that the variable EN01 does not provide uncertainty because its value is zero.

Figure II.7

Uncertainty evaluation for Biodiversity composite indicator using Monte Carlo simulation

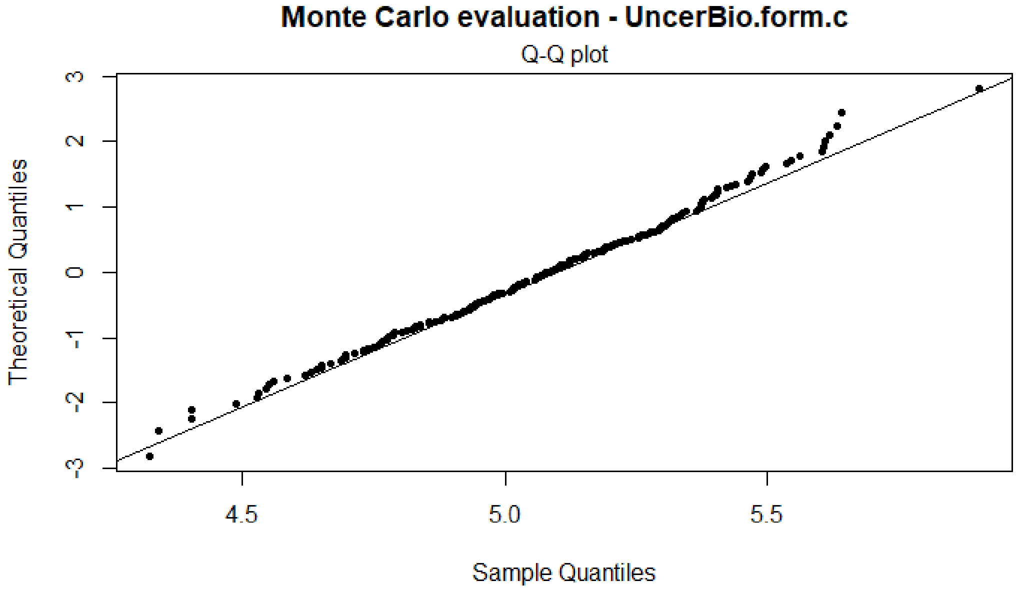
```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~EN01 * 2 + EN02 * 2 + EN03 * 2 + EN04 * 2 + EN05 * 2,
     x = Biodiversity, u = UncerBio, method = "MC",     cor = UncerBio.cor)

Expression: ~EN01 * 2 + EN02 * 2 + EN03 * 2 + EN04 * 2 + EN05 * 2

Evaluation method:  MC

Budget:
     x         u          c  u.c        distrib distrib.pars
EN01 0.0000000 0.00000000 NA         NA norm    mean=0, sd=0
EN02 0.5000000 0.05000000  2 0.10000000 norm    mean=0.5, sd=0.05
EN03 0.8166667 0.08166667  2 0.16333333 norm    mean=0.8166667, sd=0.08166667
EN04 0.9142857 0.09142857  2 0.18285714 norm    mean=0.9142857, sd=0.09142857
EN05 0.3173333 0.03173333  2 0.06346667 norm    mean=0.3173333, sd=0.03173333

   y:  5.096571
u(y):  0.2848008

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  4.324   4.905   5.080   5.077   5.297   5.904

> contribs(UncerBio.form.c, as.sd=TRUE)
      EN01       EN02       EN03       EN04       EN05
        NA 0.10000000 0.16333333 0.18285714 0.06346667
```

Figure II.8 shows the quantile-quantile (Q-Q) plot for the theoretical and sample quantiles of the Biodiversity composite indicator, with the results, the two batches appear to have come from populations with a common distribution.

Monte Carlo evaluation shows (FigureII.9) that the mean (0.5109) divide the curve symmetrically, so the function can be treated as a tendency to the normal distribution, accepting the estimators of the Monte Carlo simulation. In the case of the correlation of

Figure II.8

Q-q plot for Biodiversity composite indicator using Monte Carlo simulation



Note: A normal Q–Q plot comparing randomly generated, theoretical quantities on the vertical axis to a sample quantities on the horizontal axis. The li - nearity of the points suggests that the data are normally distributed.

the indicators in the Monte Carlo simulation (Figure II.10), it is observed that EN04 is preferred to the others, although slightly.

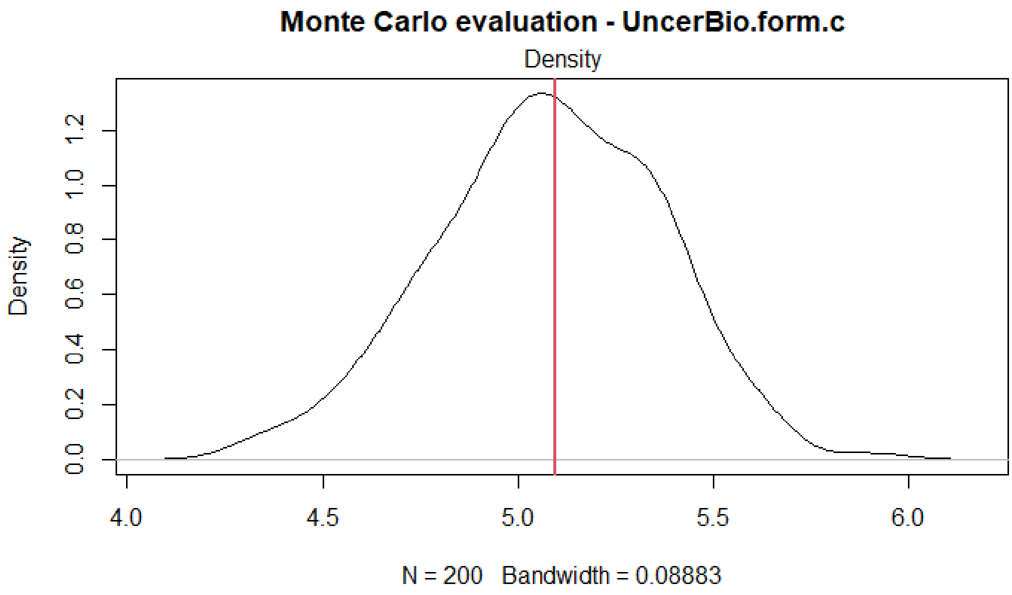
This analysis is shown only for the case of the Biodiversity composite indicator, but it must be performed for all composite indicators, as will be done in the applicative part of this research.

The same procedure was carried out for the composite indicators of the pillars, the results of which are shown in Figures II.11 to II.14. In Figure II.11 there is no significant covariance automatically included (column u.c), also the composite value of y has the value 0.52357273 and the mean is 0.5237, then the distribution can be considered as normal. The first-order error propagation $u(y)$ is 0.01884834, where the greatest uncertainty is provided by the variables Ethics and people behavior (0.0088) and Human health and safety (0.0077) both with low values.

In the quantile-quantile (Q-Q) plot for the theoretical and sample quantiles of the Social composite indicator (Figure II.12), the two batches appear to have come from populations

Figure II.9

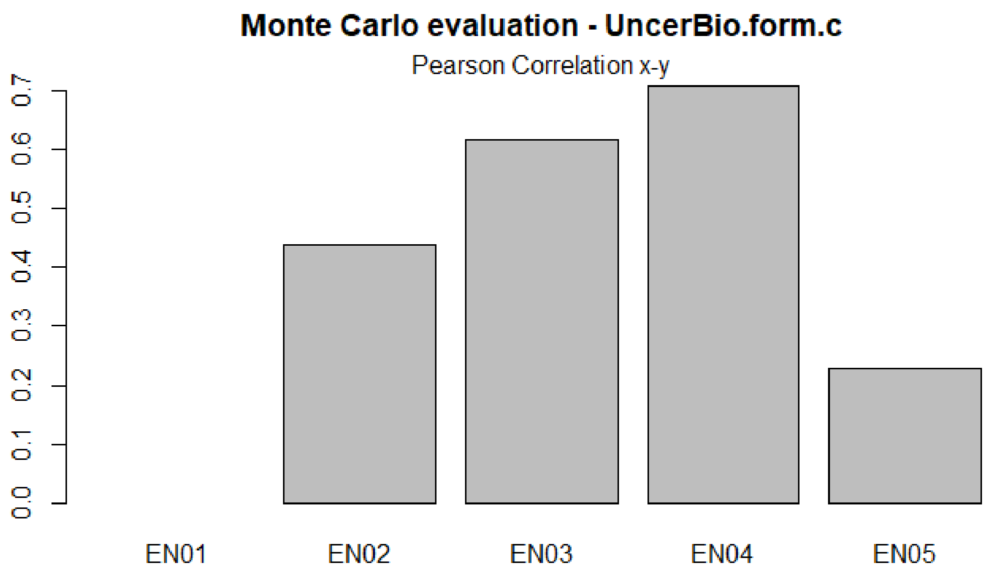
Density plot for Biodiversity composite indicator using Monte Carlo simulation



Note: Probability density function, or density, for the Biodiversity composite - indicator, can be interpreted as providing a relative likelihood that the value - of the random variable would be close to that sample. The curve looks like the curve of the normal distribution

Figure II.10

Correlation for Biodiversity composite indicator using Monte Carlo simulation



Note: Correlation comparison of the five indicators included in the Biodiversity composite indicator.

with a common distribution. Monte Carlo evaluation shows (FigureII.13) that the mean (0.5241) divide the curve symmetrically, so the function can be treated as a tendency to the normal distribution, accepting the estimators of the Monte Carlo simulation. In the case of the correlation of the indicators in the Monte Carlo simulation (Figure II.14), it is observed that Human health and safety and Housing and population are preferred to the others.

Figure II.11

Uncertainty evaluation for Social composite indicator using Monte Carlo simulation

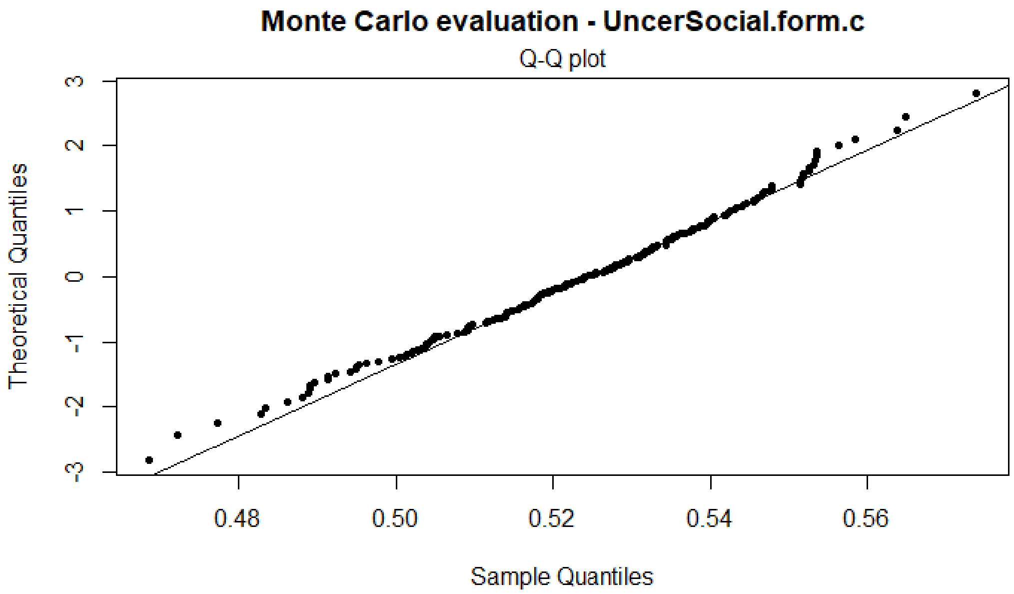
```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Food * 0.1 + Educat * 0.15 + Health * 0.1 + Servic * 0.1 + Popula * 0.1 +
    Workin * 0.1 + Income * 0.1 +     Ethics * 0.15 + Govern * 0.1, x = Social, u = UncerSocial,
    method = "MC", cor = UncerSocial.cor)

Expression: ~Food * 0.1 + Educat * 0.15 + Health * 0.1 + Servic * 0.1 + Popula * 0.1 + Workin * 0.1
    + Income * 0.1 + Ethics * 0.15 + Govern * 0.1

Evaluation method:  MC

Budget:
       x         u          c    u.c         distrib distrib.pars
Food   0.4585004 0.04585004 0.10 0.004585004 norm    mean=0.4585004, sd=0.04585004
Educat 0.4651457 0.04651457 0.15 0.006977186 norm    mean=0.4651457, sd=0.04651457
Health 0.7739556 0.07739556 0.10 0.007739556 norm    mean=0.7739556, sd=0.07739556
Servic 0.5515000 0.05515000 0.10 0.005515000 norm    mean=0.5515, sd=0.05515
Popula 0.5616574 0.05616574 0.10 0.005616574 norm    mean=0.5616574, sd=0.05616574
Workin 0.4671111 0.04671111 0.10 0.004671111 norm    mean=0.4671111, sd=0.04671111
Income 0.4401961 0.04401961 0.10 0.004401961 norm    mean=0.4401961, sd=0.04401961
Ethics 0.5861905 0.05861905 0.15 0.008792857 norm    mean=0.5861905, sd=0.05861905
Govern 0.4058024 0.04058024 0.10 0.004058024 norm    mean=0.4058024, sd=0.04058024

   y:  0.5235727
u(y):  0.01884834

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.4687  0.5123  0.5240  0.5237  0.5369  0.5737

> contribs(UncerSocial.form.c, as.sd=TRUE)
       Food      Educat      Health      Servic      Popula      Workin      Income      Ethics
0.004585004 0.006977186 0.007739556 0.005515000 0.005616574 0.004671111 0.004401961 0.008792857
     Govern
0.004058024
```

Sensitivity Analysis

At this point it should be clarified that because the proposed methodology uses means of indicators in the construction of composite indicators, the sensitivity analysis as stated in Organisation for Economic Co-Operation and Development (2008b), cannot be carried out, because it will not be possible to work with the variances of the indicators. But, to evaluate the sensitivity of the composite indicators, the weighted comparison will be used (Becker et al., 2017). It is not applicable to the themes, because all the weights are the same, so it will be done for the pillars and the general index. Figure II.15 shows the results

Figure II.12

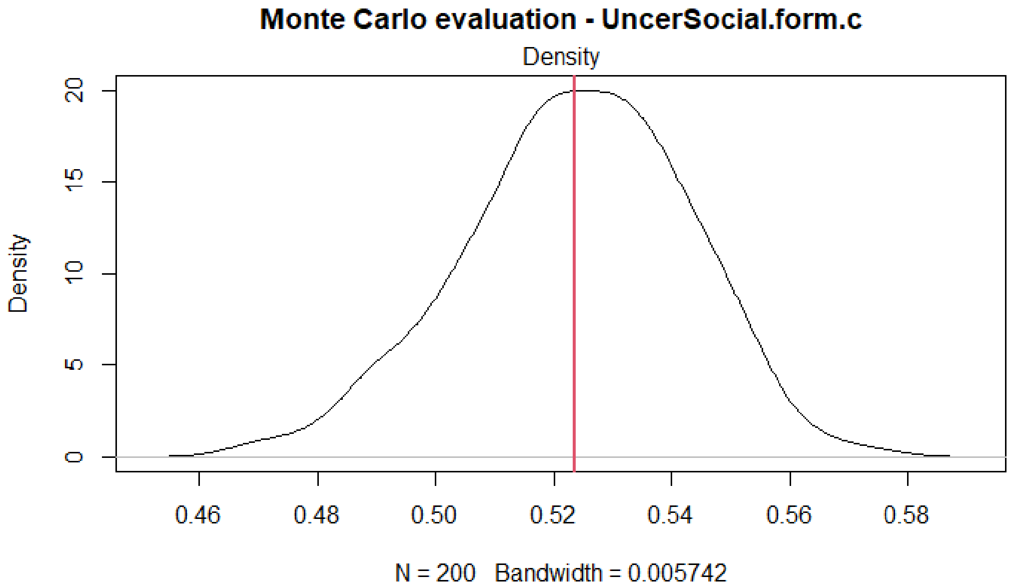
Q-q plot for Social composite indicator using Monte Carlo simulation



Note: A normal Q–Q plot comparing randomly generated, theoretical quantities on the vertical axis to a sample quantities on the horizontal axis. The - linearity of the points suggests that the data are normally distributed.

Figure II.13

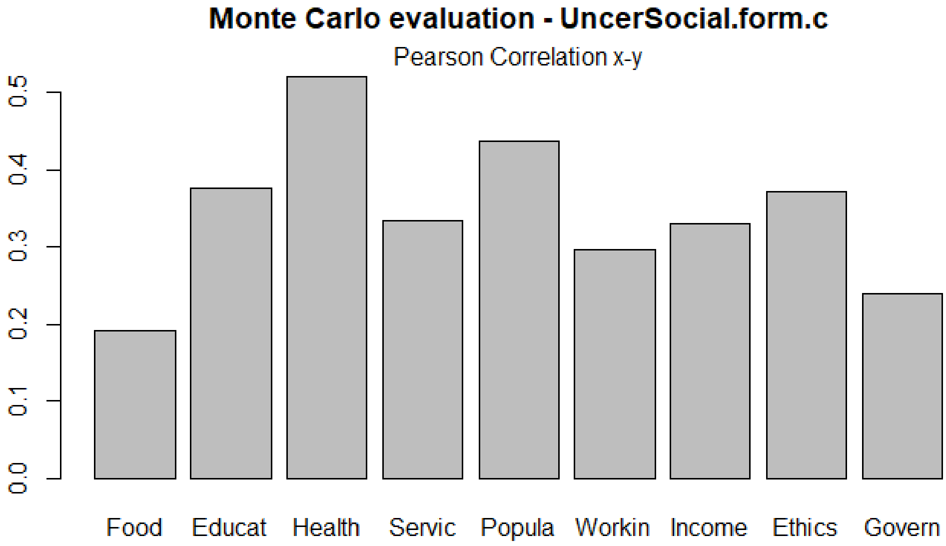
Density plot for Social composite indicator using Monte Carlo simulation



Note: Probability density function, or density, for the Social composite indicator, can be interpreted as providing a relative likelihood that the value of the random variable would be close to that sample. The curve looks like the curve of the normal distribution

Figure II.14

Correlation for Social composite indicator using Monte Carlo simulation

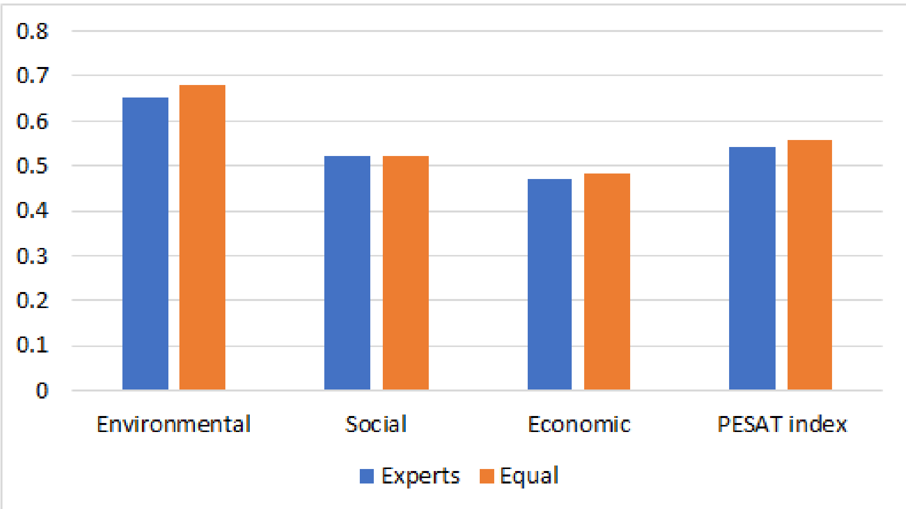


Note: Correlation comparison of the nine indicators included in the Social composite indicator.

of evaluate the weights in the model.

Figure II.15

Sensitivity analysis for Pilot Assessment



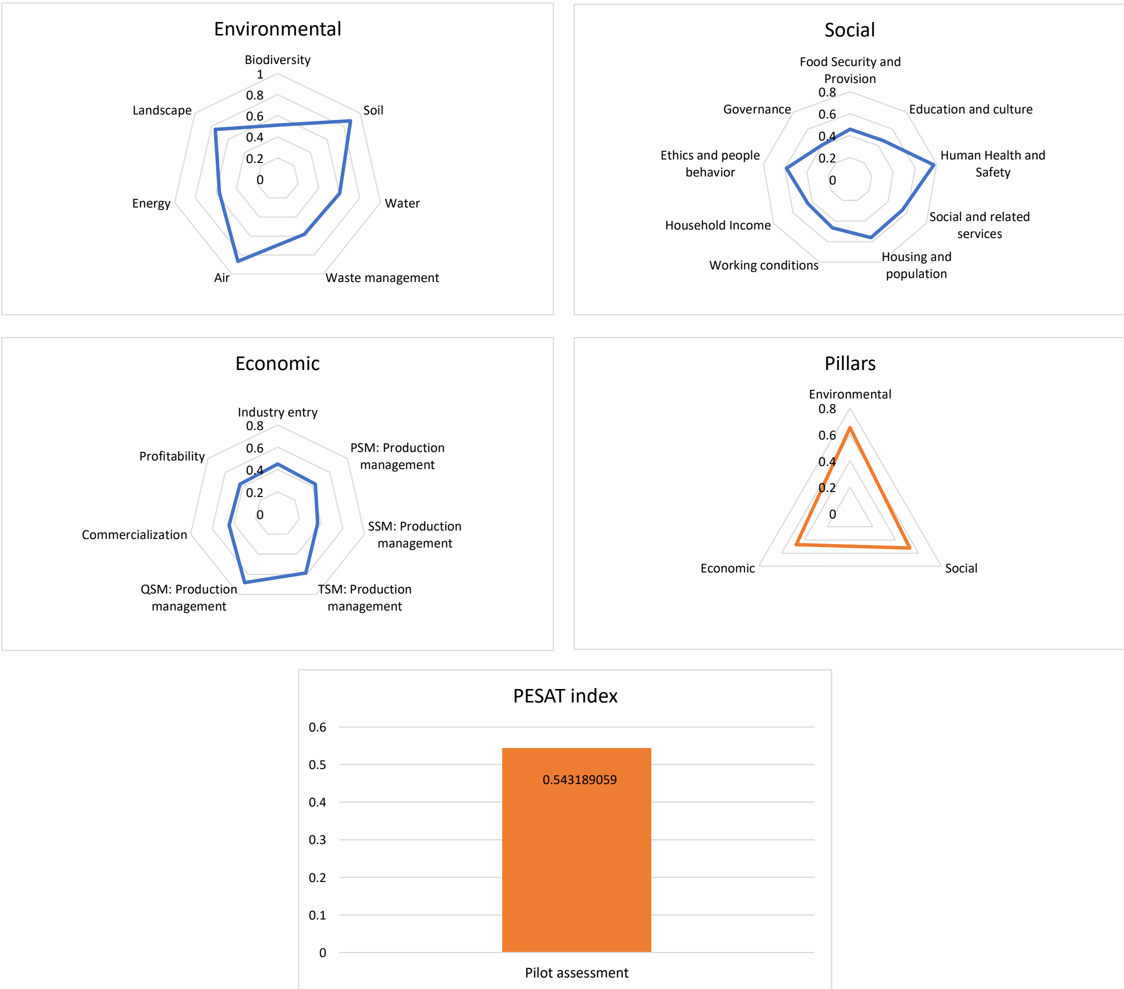
In Figure II.15, it is observed that the composite values are slightly higher for the equal weights, in the three pillars and consequently also in the general index. But it does not change the trend or generate conflicts in the results, so it can be concluded that the model is correctly weighted.

2.2.4.2. Visualization of the results

For a better visualization of the results, the use of bars is proposed for the general indices, while for the results of the pillars or themes it would be radar graphs, which allow the results to be observed more clearly, in the same space and compared with ease. Figure II.16 shows the results for the pilot application of the methodology, which would be the pattern for future evaluations.

Figure II.16

Visualization of the results for pilot assessment in Lonya Chico



However, according to the audience to which the information is directed, other means of visualization of the results can be chosen.

2.3. Validation of the proposal methodology

2.3.1. Advantage

The main advantage of the proposed model is that it can evaluate the sustainability of any geographical area, regardless of the predominant economic activity. Another advantage is that you do not need an exact number of observations for each sector, what can be done is to take the sample size and divide it among the sectors present, since in some places there are no tertiary or quaternary sector ventures. In these cases, the surveys are redistributed and for the composite index of the pillar, the weights are redistributed proportionally to the initial ones.

As already mentioned, the PESAT was designed specifically for developing countries, so it works very well in Peru.

2.3.2. Limitations

The proposal is still at a germinal level, so indicators can be included or removed, which could enrich the results and make better assessments. Due to the scarce availability of economic resources of the author, it was not possible to carry out more complex evaluations, with more indicators and hence to decrease or increase them, weights variation exercises were not carried out either, which could refine the general results.

Statistics in Peru is a forgotten and little used branch. Many of the respondents did not have the predisposition to answer the questionnaires, so much time was wasted trying to explain each indicator and the possible response scenarios. It would be important for the government to carry out awareness campaigns so that citizens know that field studies help them in the end.

2.3.3. Recommendations for its application

Steps to follow for its application

Regarding what has been worked on in the present investigation, the steps to apply the methodology would be the following:

- Identification and preparation of a brief profile of the area to be studied.
- Initial contact with authorities and leaders in the area.
- Scheduling of the field study, which should be a maximum of one week.

- For field work, carry out a pre-survey of samples and then apply the questionnaires.
- Evaluate the collected data following the sequence shown in sections 2.2.3. and 2.2.4.
- Prepare the final draft of the proposal and discuss it with the authorities and leaders of the area under assessment.
- Elaborate the final report.

Analysis and interpretation of the information collected

The results showed in the present research were calculated mainly with Microsoft Excel 2016 and the statistical tests with the R package (version 4.1.0) and R-Studio (version 1.4.1717). It is recommended to use the same version software or superior to analyze the data.

Chapter III.

Results

This chapter brings together the findings of the PESAT methodology application in three cities of Amazonas region, in order to evaluate and compare the sustainability of these geographical areas.

3.1. Apply in three districts

Due to the conception of the methodology, a city of the district was chosen to be evaluated. The selection of the three cities corresponded to the following factors:

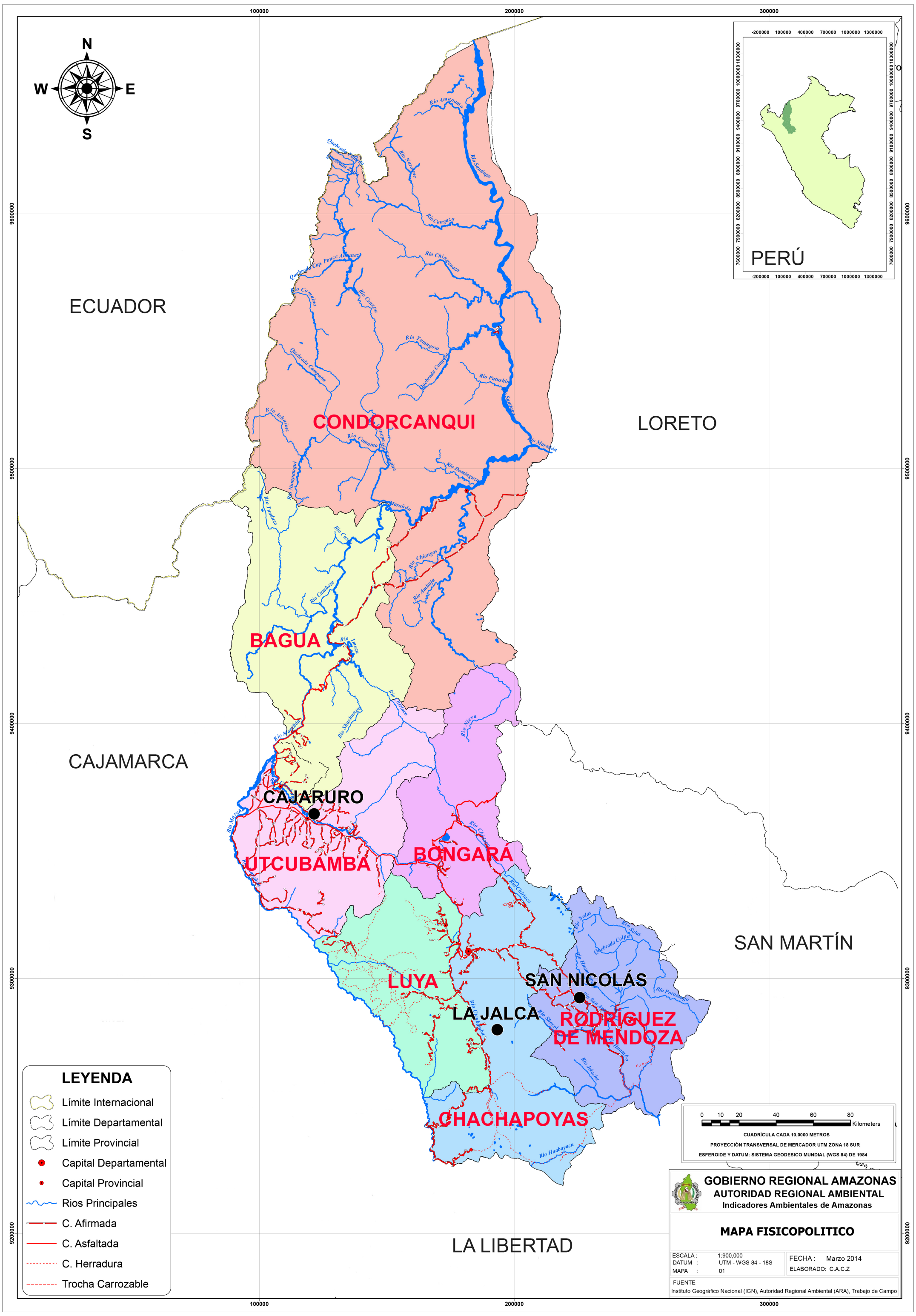
- Population quantity.
- Geographical characteristics: climate, altitude, extension, etc.
- Agricultural productive units.
- Provincial location.
- Preliminary contacts with authorities and representative persons.

With these factors, the cities selected were: Cajaruro (Cajaruro district, Utcubamba province), La Jalca (La Jalca district, Chachapoyas province) and San Nicolás (San Nicolás district, Rodríguez de Mendoza province). The geographic location is shown in Figure III.1, and the summary data for each city will be presented at the beginning of each section.

The application was made in one district at a time, with the participation of the author of this research and two assistants, students of the Fifth Semester of Economics of the Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas.

Figure III.1

Location of the three cities where the PESAT application will be carried out



3.1.1. Sustainability assessment in La Jalca

3.1.1.1. Brief profile of the region

Table III.1

Brief description of the La Jalca district

Item	Description
Area	380.39 km^2
Altitude	2 800 m.a.s.l.
Region	Quechua
Population	5 522 inhabitants (Census of the year 2017)
Villages and hamlets	15 (Biggest La Jalca)
Foundation	September 5, 1538
Mayor	Walter Humberto Culqui Velásquez (2019-2022)
Agricultural units	874 (2018)
Agricultural area	4 692 Ha (2018)
Production	Potato (2 961 Ha), Corn (469 Ha), Bean (450 Ha), Wheat (211 Ha)

Note: Adapted from Instituto Nacional de Estadística e Informática, 2013; Instituto Nacional de Estadística e Informática, 2018; Instituto Nacional de Estadística e Informática, 2021; and Ministerio de Desarrollo Agrario y Riego, 2021.

3.1.1.2. Application of the methodology

Table III.2 shows the technical specifications of the application of the questionnaires in the district of La Jalca.

Table III.2

Technical specifications for La Jalca application

Item	Description
Object of the activity	Generate information from primary sources in the district of La Jalca
Universe	Population, local authorities and owners of businesses in the district of La Jalca

Sample size	LJ-Q1 Employers - Primary Sector: 108
	LJ-Q2 Employer - Secondary Sector: 25
	LJ-Q3 Employer - Tertiary Sector: 25
	LJ-Q4 Employer - Quaternary Sector: 25
	LJ-Q5 Local Authority: 10
	LJ-Q6 Inhabitant: 166
	Total: 359 surveys[1]
Sampling methods	Non probability sampling: Purposive or judgmental sampling (Taherdoost, 2016)
Date of application	March 12-16, 2021

3.1.1.3. Summarizing and tabulating collected data

The results of the application of the survey were systematized in a spreadsheet, to later be normalized using the Min-Max technique. With these values and using the weights from section 2.2.3.9. and linear aggregation, the composite indicators calculated for the PESAT themes are shown in Table III.3.

Table III.3

Composite indicators for the PESAT themes, La Jalca district

Themes	Composite values
Biodiversity	0.4517
Soil	0.7235
Water	0.6739
Waste management	0.7302
Air	0.8077
Energy	0.5284
Landscape	0.7468
Food security and provision	0.4098
Education and culture	0.5235

[1]The following formula was used: $n = \frac{Z^2.p.q.N}{d^2.(N-1)+Z^2.p.q}$ (Aguilar-Barojas, 2005), where: Z = Confidence level (to 95%, Z = 1.96), p = approximate proportion of the phenomenon under study in the reference population (0.5), q = proportion of the reference population that does not have the phenomenon under study (q = 1 - p = 0.5), N = population size (5 522), d = absolute precision level (0.05).

Human health and safety	0.7533
Social and related services	0.6401
Housing and population	0.5088
Working conditions	0.4389
Household income	0.3465
Ethics and people behavior	0.5423
Governance	0.3774
Industry entry	0.3712
PSM: production management	0.3453
SSM: production management	0.3496
TSM: production management	0.4683
QSM: production management	0.3916
Commercialization	0.3776
Profitability	0.4923

The second composition generates the composite values for the PESAT pillars, and the third composition originates the global sustainability index for the district under study, reflected in Table III.4.

Table III.4

Composite indicators for the PESAT pillars, La Jalca district

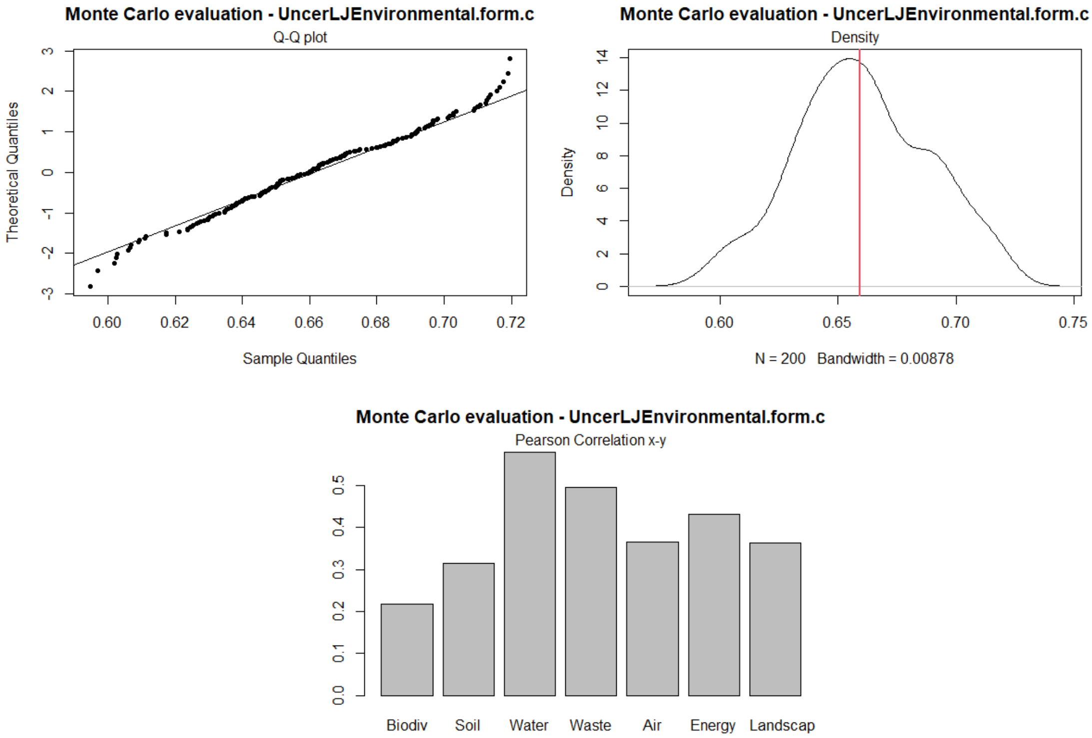
Pillar	Composite values	General index
Environmental	0.6595	
Social	0.5073	0.5118
Economic	0.3898	

In this case, the general index of 51.44% indicates that the city of La Jalca conserves about half of its environment so that future generations can satisfy their needs, just as the population of that geographic space does today.

Next, the uncertainty analysis associated with the model is carried out. The results for the Environmental pillar are shown in Figure III.2, while for the Social and Economic pillars they are presented in Appendix E. There it can be seen that the variables under study, the theoretical and the observed, come from the same sample, that the distribution follows a normal trend and that the correlation is within the permissible limits, so the results are accepted.

Figure III.2

Uncertainty analysis for the Environmental pillar, La Jalca district



For the sensitivity analysis, the results of the pillars compositions are contrasted, with the weights used and the same weights for all topics. The results are shown in Figure III.3, where it is observed that the results are maintained, so it is concluded that there is no volatility of variations due to the weights used.

3.1.2. Sustainability assessment in San Nicolás

3.1.2.1. Brief profile of the region

Table III.5

Brief description of the San Nicolás district

Item	Description
Area	206.01 km^2

Altitude	1 295 m.a.s.l.
Region	Yunga
Population	6 016 inhabitants (Census of the year 2017)
Villages and hamlets	13 (Biggest San Nicolás)
Foundation	February 5, 1875
Mayor	Helder Rodríguez Zelada (2019-2022)
Agricultural units	870 (2018)
Agricultural area	3 989 Ha (2018)
Production	Coffee (2 550 Ha), Corn (140 Ha), Bean (123 Ha), Sugar Cane (122 Ha)

Note: Adapted from Instituto Nacional de Estadística e Informática, 2013; Instituto Nacional de Estadística e Informática, 2018; Instituto Nacional de Estadística e Informática, 2021; and Ministerio de Desarrollo Agrario y Riego, 2021.

3.1.2.2. Application of the methodology

Table III.6 shows the technical specifications of the application of the questionnaires in the district of San Nicolás.

Table III.6

Technical specifications for San Nicolás application

Item	Description
Object of the activity	Generate information from primary sources in the district of San Nicolás
Universe	Population, local authorities and owners of businesses in the district of San Nicolás
Sample size	LJ-Q1 Employers - Primary Sector: 110 LJ-Q2 Employer - Secondary Sector: 25 LJ-Q3 Employer - Tertiary Sector: 25 LJ-Q4 Employer - Quaternary Sector: 25 LJ-Q5 Local Authority: 10 LJ-Q6 Inhabitant: 166

	Total: 361 surveys[2]
Sampling methods	Non probability sampling: Purposive or judgmental sampling (Taherdoost, 2016)
Date of application	March 26-30, 2021

3.1.2.3. Summarizing and tabulating collected data

The results of the application of the survey were systematized in a spreadsheet, to later be normalized using the Min-Max technique. With these values and using the weights from section 2.2.3.9. and linear aggregation, the composite indicators calculated for the PESAT themes are shown in Table III.7.

Table III.7

Composite indicators for the PESAT themes, San Nicolás district

Themes	Composite values
Biodiversity	0.5779
Soil	0.7037
Water	0.6801
Waste management	0.7864
Air	0.8221
Energy	0.6708
Landscape	0.4653
Food security and provision	0.3844
Education and culture	0.5183
Human health and safety	0.7133
Social and related services	0.7023
Housing and population	0.5520
Working conditions	0.4155
Household income	0.4376
Ethics and people behavior	0.5523

[2] The following formula was used: $n = \frac{Z^2.p.q.N}{d^2.(N-1)+Z^2.p.q}$ (Aguilar-Barojas, 2005), where: Z = Confidence level (to 95%, Z = 1.96), p = approximate proportion of the phenomenon under study in the reference population (0.5), q = proportion of the reference population that does not have the phenomenon under study (q = 1 - p = 0.5), N = population size (6 016), d = absolute precision level (0.05).

Governance	0.4963
Industry entry	0.3634
PSM: production management	0.4331
SSM: production management	0.2835
TSM: production management	0.3699
QSM: production management	0.3637
Commercialization	0.2820
Profitability	0.3957

The second composition generates the composite values for the PESAT pillars, and the third composition originates the global sustainability index for the district under study, reflected in Table III.8.

Table III.8

Composite indicators for the PESAT pillars, San Nicolás district

Pillar	Composite values	General index
Environmental	0.6844	
Social	0.5308	0.5174
Economic	0.3609	

In this case, the general index of 50.01% indicates that the city of San Nicolás conserves about half of its environment so that future generations can satisfy their needs, just as the population of that geographic space does today.

Next, the uncertainty analysis associated with the model is carried out. The results for the Social pillar are shown in Figure III.4, while for the Environmental and Economic pillars they are presented in Appendix E. There it can be observed, according to the results for San Nicolás, that in the uncertainty analysis, the variables under study, the theoretical and the observed, come from the same sample, that the distribution follows a normal trend and that the correlation is is within the permissible limits, so the results are accepted.

For the sensitivity analysis, the results of the pillars compositions are contrasted, with the weights used and the same weights for all topics. The results are shown in Figure III.5,

Figure III.3

Sensitivity analysis for La Jalca Assessment

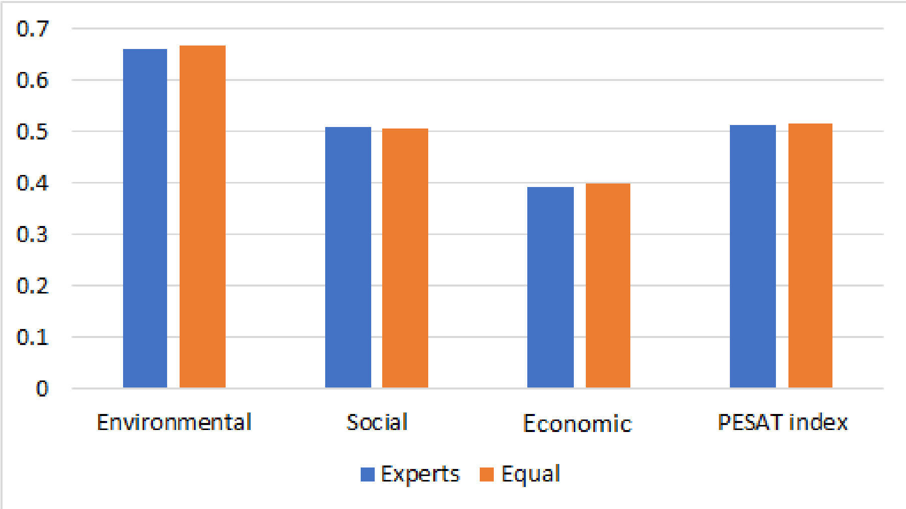
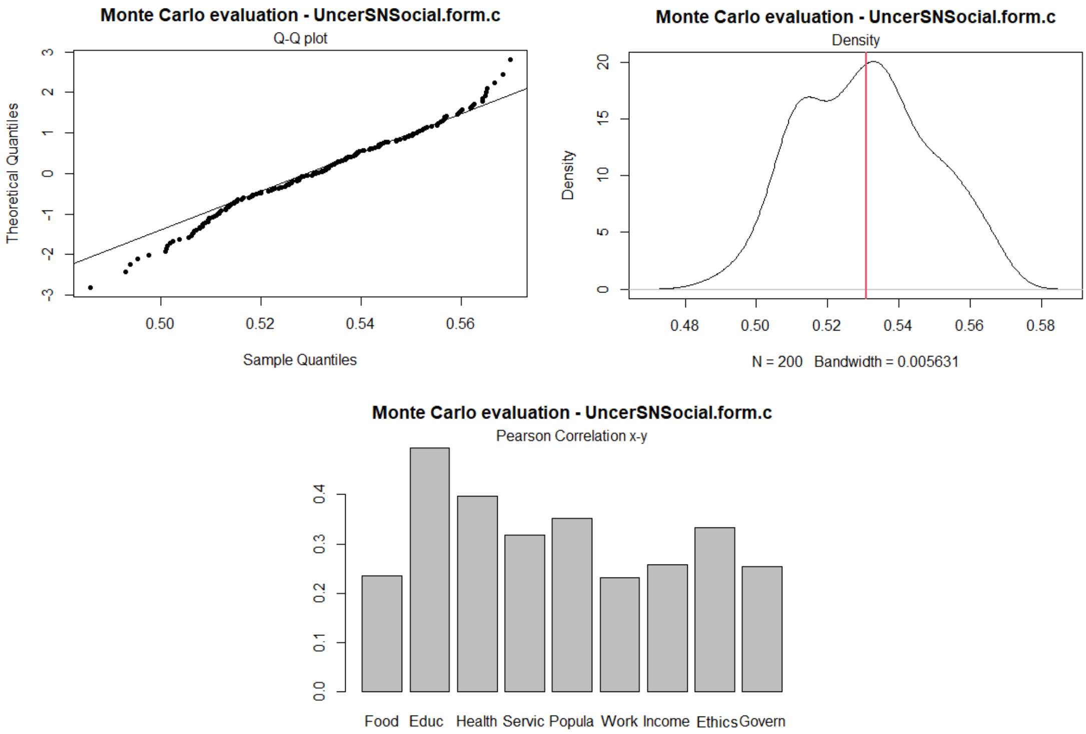


Figure III.4

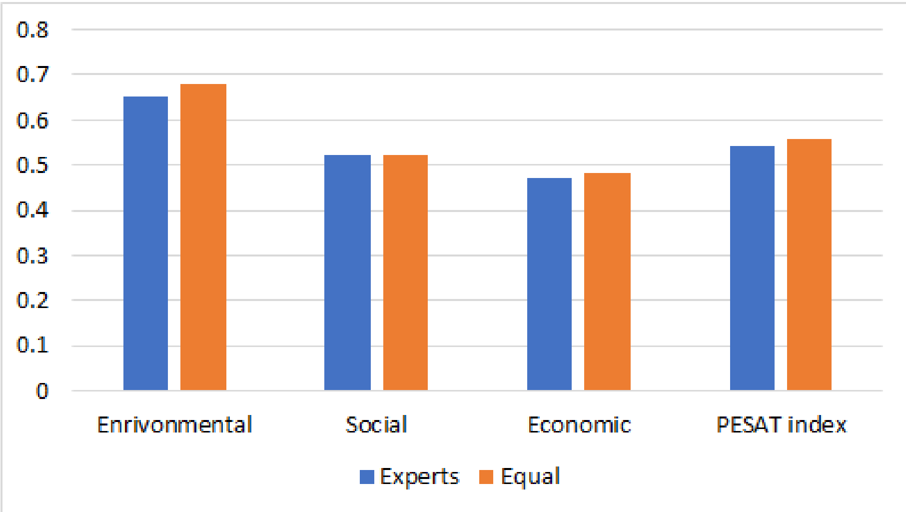
Uncertainty analysis for the Social pillar, San Nicolás district



where it is observed that the results are maintained, so it is concluded that there is no volatility of variations due to the weights used.

Figure III.5

Sensitivity analysis for San Nicolás Assessment



3.1.3. Sustainability assessment in Cajaruro

3.1.3.1. Brief profile of the region

Table III.9

Brief description of the Cajaruro district

Item	Description
Area	1 763.23 km^2
Altitude	490 m.a.s.l.
Region	Selva Alta
Population	28 488 inhabitants (Census of the year 2017)
Villages and hamlets	10 (Biggest Cajaruro)
Foundation	September 17, 1964
Mayor	Hildebrando Tineo Díaz (2019-2022)
Agricultural units	5 213 (2018)
Agricultural area	13 983 Ha (2018)
Production	Rice (19 089 Ha), Coffee (2 153 Ha), Corn (735 Ha), Cocoa (609 Ha)

Note: Adapted from Instituto Nacional de Estadística e Informática, 2013;

Instituto Nacional de Estadística e Informática, 2018;
Instituto Nacional de Estadística e Informática, 2021; and
Ministerio de Desarrollo Agrario y Riego, 2021.

3.1.3.2. Application of the methodology

Table III.10 shows the technical specifications of the application of the questionnaires in the district of Cajaruro.

Table III.10

Technical specifications for Cajaruro application

Item	Description
Object of the activity	Generate information from primary sources in the district of Cajaruro
Universe	Population, local authorities and owners of businesses in the district of Cajaruro
Sample size	LJ-Q1 Employers - Primary Sector: 115 LJ-Q2 Employer - Secondary Sector: 28 LJ-Q3 Employer - Tertiary Sector: 28 LJ-Q4 Employer - Quaternary Sector: 28 LJ-Q5 Local Authority: 10 LJ-Q6 Inhabitant: 170 Total: 379 surveys[3]
Sampling methods	Non probability sampling: Purposive or judgmental sampling (Taherdoost, 2016)
Date of application	April 23-27, 2021

3.1.3.3. Summarizing and tabulating collected data

The results of the application of the survey were systematized in a spreadsheet, to later be normalized using the Min-Max technique. With these values and using the weights from

[3]The following formula was used: $n = \dfrac{Z^2.p.q.N}{d^2.(N-1)+Z^2.p.q}$ (Aguilar-Barojas, 2005), where: Z = Confidence level (to 95%, Z = 1.96), p = approximate proportion of the phenomenon under study in the reference population (0.5), q = proportion of the reference population that does not have the phenomenon under study (q = 1 - p = 0.5), N = population size (28 488), d = absolute precision level (0.05).

section 2.2.3.9. and linear aggregation, the composite indicators calculated for the PESAT themes are shown in Table III.11.

Table III.11

Composite indicators for the PESAT themes, Cajaruro district

Themes	Composite values
Biodiversity	0.4949
Soil	0.6569
Water	0.5983
Waste management	0.5849
Air	0.7925
Energy	0.6196
Landscape	0.5444
Food security and provision	0.3739
Education and culture	0.5011
Human health and safety	0.7118
Social and related services	0.6343
Housing and population	0.4135
Working conditions	0.4299
Household income	0.3723
Ethics and people behavior	0.5793
Governance	0.4388
Industry entry	0.3372
PSM: production management	0.4338
SSM: production management	0.2761
TSM: production management	0.2762
QSM: production management	0.3593
Commercialization	0.3333
Profitability	0.3045

The second composition generates the composite values for the PESAT pillars, and the third composition originates the global sustainability index for the district under study, reflected in Table III.12.

Table III.12

Composite indicators for the PESAT pillars, Cajaruro district

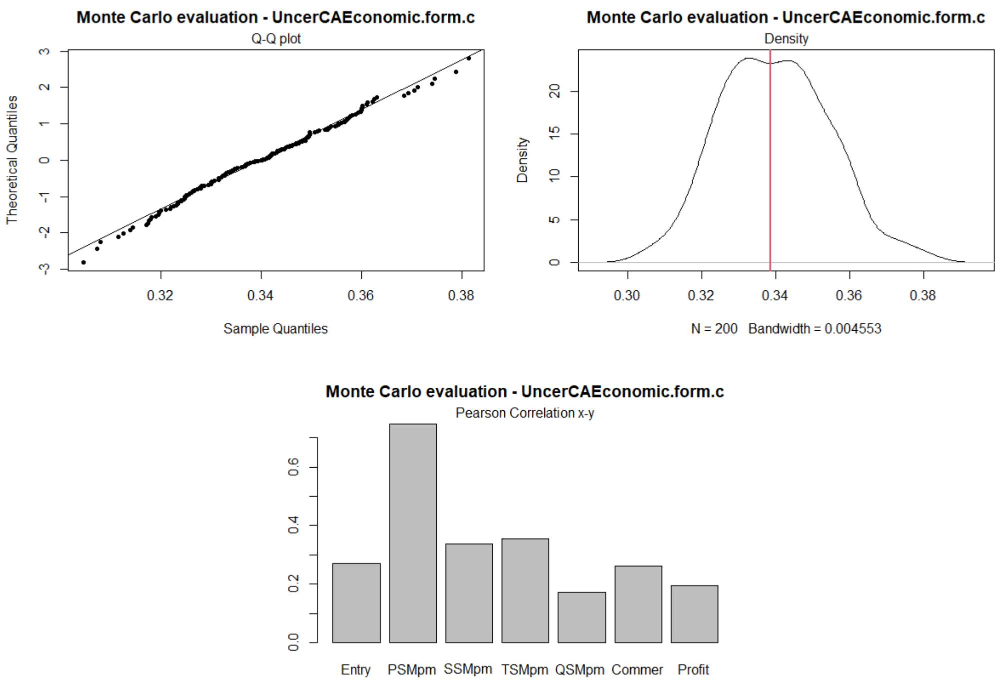
Pillar	Composite values	General index
Environmental	0.6094	
Social	0.4995	0.4761
Economic	0.3385	

In this case, the general index of 47.48% indicates that the city of Cajaruro conserves about half of its environment so that future generations can satisfy their needs, just as the population of that geographic space does today.

Next, the uncertainty analysis associated with the model is carried out. The results for the Economic pillar are shown in Figure III.6, while for the Environmental and Social pillars they are presented in Appendix E. There it can be observed, according to the results for the other two cities, that in the uncertainty analysis, the variables under study, the theoretical and the observed, come from the same sample, that the distribution follows a normal trend and that the correlation is is within the permissible limits, so the results are accepted.

Figure III.6

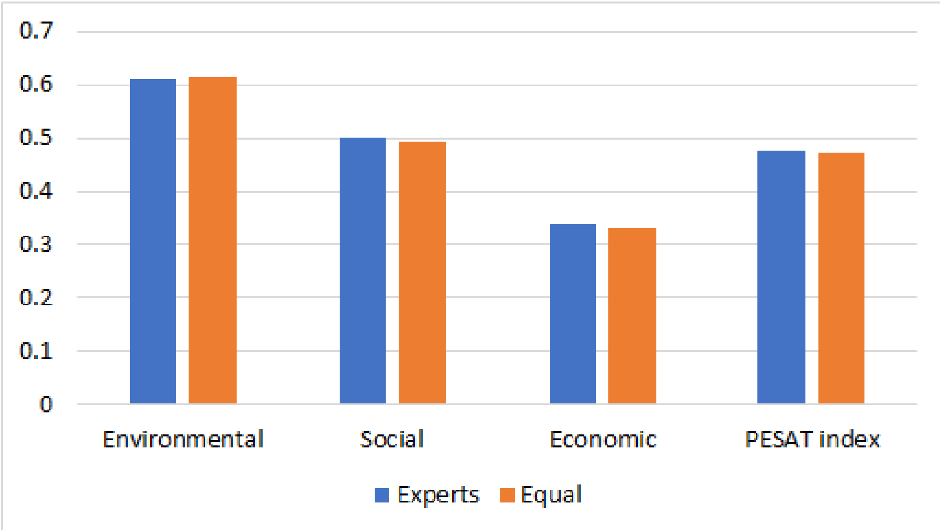
Uncertainty analysis for the Economic pillar - Cajaruro



For the sensitivity analysis, the results of the pillars compositions are contrasted, with the weights used and the same weights for all topics. The results are shown in Figure III.7, where it is observed that the results are maintained, so it is concluded that there is no volatility of variations due to the weights used.

Figure III.7

Sensitivity analysis for Cajaruro Assessment



3.2. Comparative between the three cities

The comparative analysis will start with the themes, then the pillars and culminate with the general indexes.

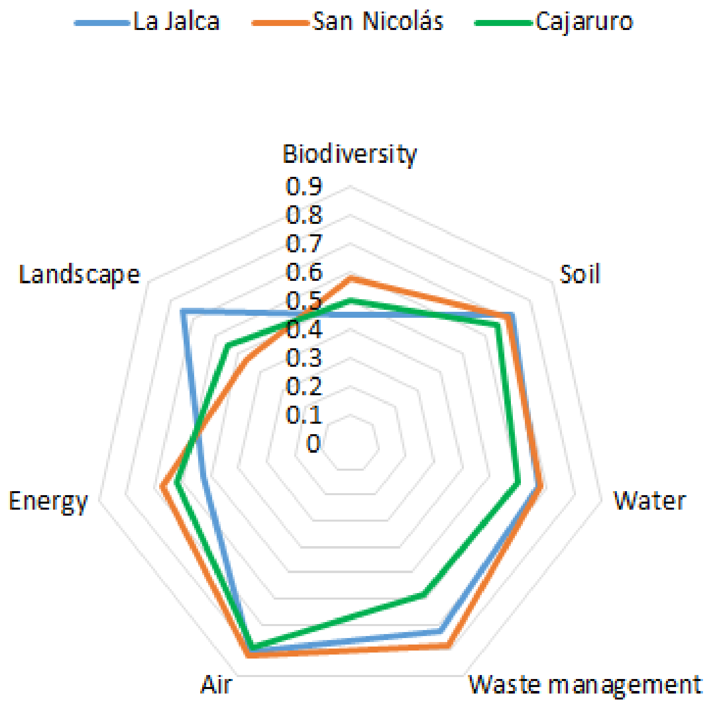
3.2.1. Themes for Environmental Pillar

Figure III.8 shows the results of the three evaluations in a single graph. It is useful to visually identify the differences between city and city. The environmental pillar is made up of seven themes and 42 indicators. This pillar is important, but at the level of study that has been proposed, that is, at local level, then this pillar would be the least weighted, because the public policies and actions carried out by the inhabitants do not substantially affect the environment. At least not, in the short term.

Of the seven themes, the most even is Air. The most unequal is Landscape, with differences greater than eight percentage points between city and city. La Jalca leads, because it has a smaller commercial area and also has a lower conversion value from natural to artificial lands.

Figure III.8

Comparative radar diagram for Environmental Pillars



San Nicolás scores the highest on five of the seven themes, ranking second on the Soil theme and third on the Landscape theme.

3.2.2. Themes for Social Pillar

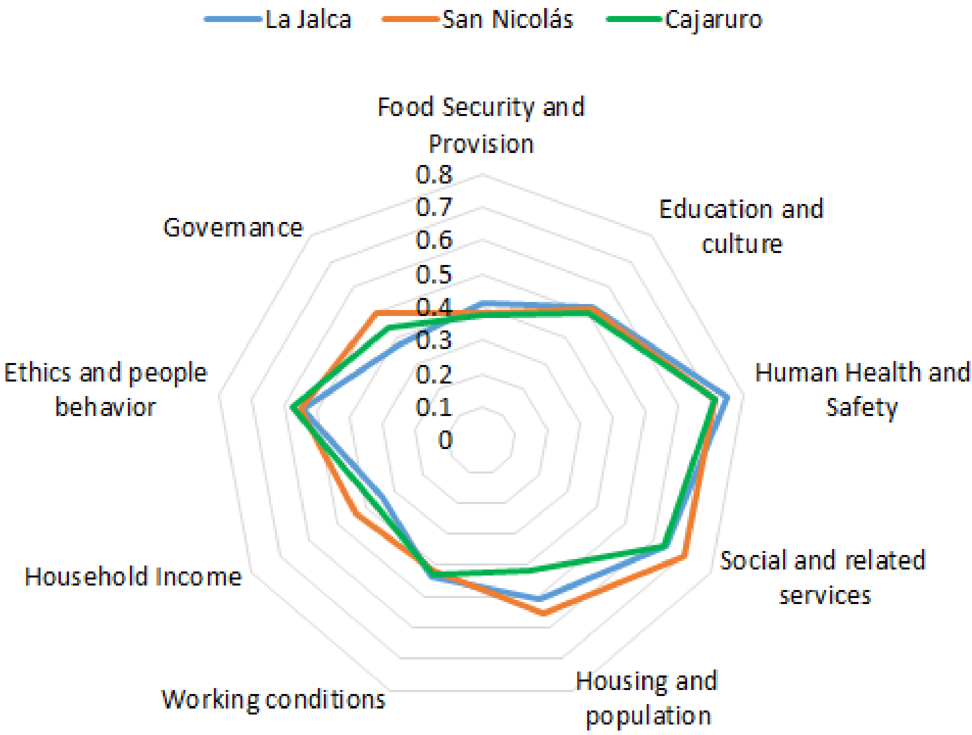
The results obtained for the Social pillar are shown graphically in Figure III.9. The values fo the composite indicators are quite similar in the nine themes, perhaps it is because the socio-cultural realities are similar in the Amazonas region, so than the populations share uses, customs, knowledge and values.

The most differentiated issue is Housing and Population, where the difference between the best and worst performers is fourteen percentage points. The Governance theme is also notably differentiated, which is mainly due to the amount of budget assigned to each inhabitant and the amount of services that the local government offers online.

In this pillar, the cities of La Jalca and San Nicolas lead in four themes each, while the city of Cajaruro leads only in Ethics and people behavior, this because it is more sociable and with greater equality between men and women, unlike the other two cities.

Figure III.9

Comparative radar diagram for Social Pillars



3.2.3. Themes for Economic Pillar

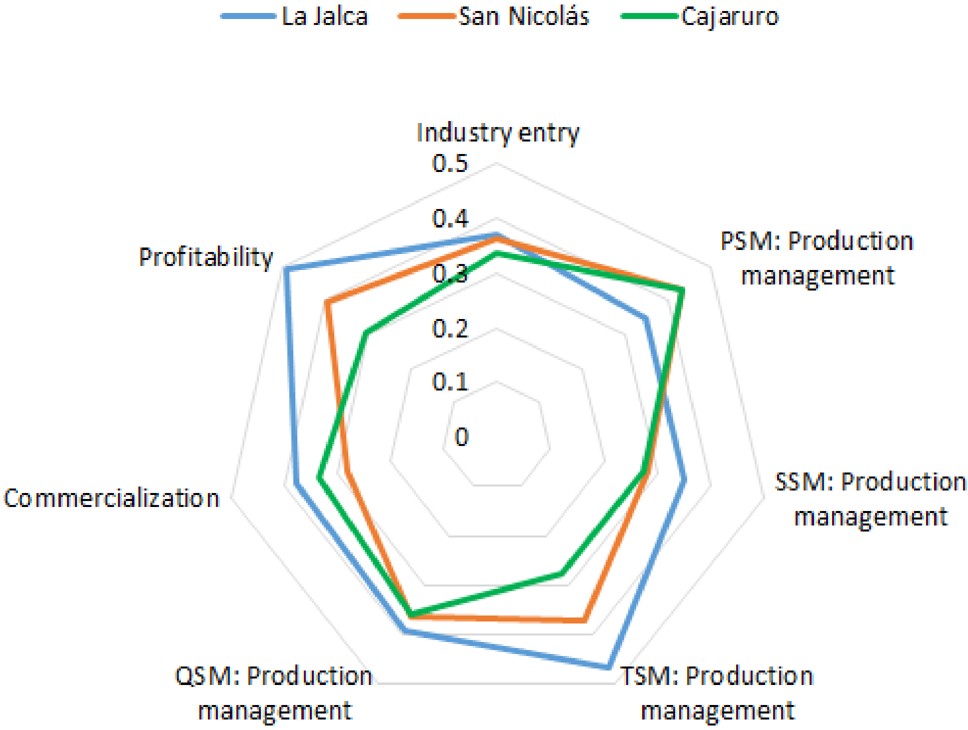
The results of the composition of indicators of Economic pillar are shown in Figure III.10. There it is observed that none of the themes passes 50% of the proposed centesimal scales, so the results of the subsequent compositions will be limited by these values.

The values of the composite indicators in this pillar are low because there are many zeros in the observations that make up the indicators. This fact is due to the fact that the economies of the Amazonas region are quite weak and production, in a good part, is for local consumption only or for self-consumption. Added to a limited investment promotion policy, with informal companies and without access to productive credits. As recognized by the interviewees in the study.

Again the results are quite similar for the three cities, differing in TSM issues: Production management, due to the number of companies located in the Tertiary sector and access to financing in each place; and Profitability, where the worst located, Cajaruro, has a production centered on rice.

Figure III.10

Comparative radar diagram for Economic Pillars



In this pillar, leadership is slightly obtained by La Jalca, due to the fact that it has a more orderly production system with a greater variety of products, unlike the other two cities, where most of its production is monoculture, coffee in San Nicolás and rice in Cajaruro. Associativity in the region is scarce, so the productive units are small with little bargaining power for both suppliers and buyers.

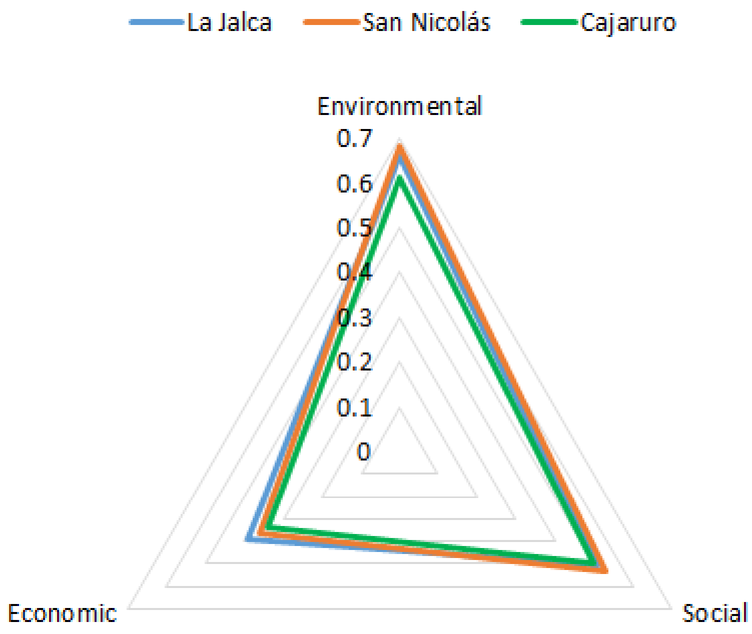
It is important to highlight that competitiveness in the Amazonas region is quite limited, with low use of technological resources in production and commercialization.

3.2.4. Pillars and General Indexes

Next, in Figure III.11, the results of composing the pillars are shown, for visual comparison. In the case of the Amazon region, the results for the three cities are quite similar. One could speak of a tie between the cities of La Jalca and San Nicolás, mainly due to the weights used, since the first one leads in the Economic pillar, while the second one leads in the Environmental and Social pillars.

Figure III.11

Comparative radar diagram for the pillars

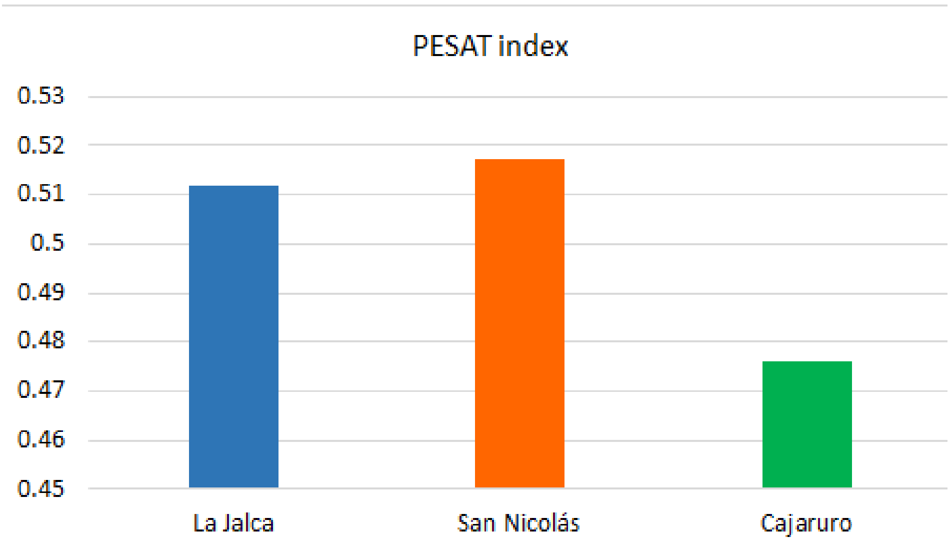


The observation is reiterated that the Economic pillar is the lowest of the three, with values below 50%.

Finally, Figure III.12 shows the values of the general indices for each of the cities, showing the technical tie between the cities of La Jalca and San Nicolás, with 51.18% and 51.74% respectively.

Figure III.12

Comparative bar diagram for the cities



Regarding the results, it is mentioned that since it is a composite indicator, one could not speak of a level of confidence, one would only have to use the results for comparative purposes, so that similar values if they generate an ordering and a differentiation.

Chapter IV.

Discussion

Nowadays, societies have drastically changed their way of thinking and are more concerned with caring for the environment (Ellsmoor, 2019; Pew Research Center, 2021). In this effort, it is necessary to evaluate the current state of the environment where the communities settle and then propose policies and actions that lead to the protection of natural resources and ecosystems as a whole (Mullender et al., 2017). This academic proposal is consistent with this global trend.

4.1. Construction of the methodology

In the literature, there are several methods to evaluate sustainability, based on holistic and non-holistic models. Because agriculture has a greater impact on the environment, this activity has been more studied than others, with a great variety of models that evaluate agricultural sustainability (Food and Agriculture Organization of the United Nations, 2017a).

The main objective of this research was to propose a methodology to determine the level of sustainability of the geographic areas, according to their major use. Therefore, the lands were divided according to the classification proposed by Anderson et al. (1976), to study them separately and then integrate them into a single methodology.

Then, in section 2.1.2., the most common sustainability assessment methods were described for each of the determined geographic areas, in order to extract the common points and the structure of the tools.

With the information from the most widely used environmental assessment methods, the development of an own methodology began, with the scientific rigor that it deserved.

The first step was to define the scope, for this the Sustainable Development Goals were reviewed (Streimikis & Balezentis, 2020; United Nations, 2021) and then the scope of the model was determined, which would be at the local level, such as the models studied by Ness et al. (2007).

The second step was to define the framework, for this the structures proposed by Sala et al. (2015), Organisation for Economic Co-Operation and Development (2008b) and Valkó (2015) were used, discriminating according to what was sought to be measured.

To determine the indicators to be used, the pillars were first defined, which according to Eslami et al. (2021), Gibson (2006), and Hacking and Guthrie (2008), three were chosen: Environmental, Social and Economic. The themes were then determined, which should be integrated into each of the pillars. For this, the RISE (Häni et al., 2003), SOSTARE (Paracchini et al., 2015) and IDEA (Zahm et al., 2006) methodologies were mainly evaluated, determining seven themes for the Environmental pillar, nine for the Social pillar and seven for the Economic pillar.

Here is another of the main contributions of the research. The challenge was to unite several methodologies into one, so it was decided that the Economic pillar be totally redesigned, to include all the economic activities that could occur in a single geographical space, for this, four themes were created that grouped companies with similar impacts on the environment, the Primary Sector, for agricultural, forestry and fishing companies; the Secondary Sector, for manufacturing, construction and aggregate companies; the Tertiary Sector, for wholesale and retail trade, transportation, accommodation and food services, information and communication companies and professional, scientific and technical activities; and the Quaternary Sector, for education, human health, arts, entertainment and recreation companies. The whole process of creating themes is shown in Appendix B.

For the selection of the indicators to be used, the literature on the particular topic was reviewed. It was possible to identify 7,431 indicators, and after several filters and revisions to reduce them to only 146. Each theme had at least two indicators.

To collect the data, six questionnaires were developed, which were applied to each of the research interest groups. A pilot survey was applied in November 2020 and the three final surveys between March and April 2021.

To perform the composite indices, the collected data were normalized, and coinciding with Krishna and Kumar (2015), the best technique was that of Min-Max. For the weighted of the indicators and indicators (for the second and third composition) the opinion of the experts summoned for the present investigation was used. The best aggregation technique was linear, as suggested by Tofallis (2014).

The analysis of the composite indicators was carried out through the analysis of uncertainty and sensitivity analysis, using the tools proposed by Organisation for Economic Co-Operation and Development (2008b) and Saisana and Saltelli (2008). The results of both analyzes show that the series come from distributions with a normal trend, that there is not a high correlation between the variables and, therefore, that the calculations are consistent.

With the fulfillment of the indicated steps, the Peruvian Sustainability Assessment Tool (PESAT) was already ready, for its application and use. The proposed model is a photograph of the moment, so the evaluation can be carried out in a single period, without the need for prolonged observations.

4.2. Application of the methodology

The PESAT was applied to three cities chosen for their heterogeneity in terms of population, climate, altitude, extension and number of agricultural production units. For the application of the methodology, the steps proposed by Passer et al. (2012) were followed.

The assessment in La Jalca required 359 surveys and was carried out from March 12 to 16, 2021. In the results, for the Environmental pillar, the highest value is obtained in the Air theme, which translates the purity of the environment in the indicator. In opposition, the highest value of the lowest item is Biodiversity, with 0.4517, mainly due to the fact that the district of La Jalca has little vegetation, both natural and in the productive systems.

For the social pillar in La Jalca, the theme with the highest value is Human health and safety due to the high life expectancy of the district and the number of doctors and nurses in the city's medical post. The theme with the lowest score is Household income, due to the low number of people receiving a salary and the high level of poverty registered in the district, according to the Instituto Nacional de Estadística e Informática (2018).

The Economic pillar is comparatively the most favorable for La Jalca, because even with all the commercial difficulties it has, it surpasses the other two cities in six of the seven themes. This could be due to the small population that it has, which causes the enterprises to be more impressive in the city. The composite value of this pillar is 38.98%, which is still quite low, if one seeks to develop a market economy and export the city's production.

The assessment in San Nicolás required 361 surveys and was carried out from March 26 to 30, 2021. This city leads the Environmental pillar comfortably, due to its geographical characteristics and the favorable climate it has. This city loses values in the indicators of protected areas, as it does not have any, and does not use technical irrigation or reuse of water, although in reality, thanks to the fertility of its lands, it is not necessary. But thinking in the long term, productive lands are being weakened without any control. In a previous investigation, Mori (2018) had already verified this situation in the province of Rodríguez de Mendoza.

Regarding the results of the Social pillar in San Nicolás, it can be stated that it has reasonably good indicators, with a representative government, little differentiation between male and female workers and with few young people who wish to continue with the profession of parents. Social services are offered regularly and to most of the population.

The Economic pillar in San Nicolás is the lowest of the pillars of the evaluations carried out. The main reason is the monoculture that predominates in the area (coffee) and the little commercialization of this product in the city, since it is sold only to intermediaries who distribute it to wholesalers or exporters. In addition to this situation, the farmland belongs to only a few, so the rest are dependent workers with seasonality marked by the harvest seasons of this product.

The assessment in Cajaruro required 379 surveys and was carried out from April 23 to 27, 2021. This city has the lowest indicators with respect to the other two in evaluation. In the Environmental pillar it reaches 60.94%, due to the presence of a protected area that maintains the main ecosystem under government control. Its flora and fauna is extensive, but less than that found in the other two cities. This city has high levels of pollution, due to the application of agrochemicals in agriculture and the presence of a large number of vehicles, especially motorcycles and motorcycle taxis.

For Cajaruro, the Social pillar reaches the value of 49.95%, showing certain gender equality and the satisfaction of basic needs in an acceptable way. It reaches the highest value in the Ethics and people behavior issue, compared to the other two cities, due to the greater number of migrants, especially from the coast, who promote equality of both sexes.

In the analysis of the results of the Economic pillar, Cajaruro surpasses La Jalca and San Nicolás in the PSM: Production management theme, due to the fact that it has a greater diversity of crops, which have several harvests per year and are commercialized directly, without resorting to intermediaries or wholesalers. Even with this result, the composite value for the pillar is the lowest compared to the other two cities, perhaps due to the fact that the largest number of workers do not own their means of production and the lack of income stability, which limits the large-scale production and the growth of local businesses.

Now, the comparative analysis shows similar trends in the three cities. First, the Environmental pillar is higher, the Social pillar is central, around 50%, and the Economic pillar is the lowest with an average of 38%. The explanation for this phenomenon is that the Amazonas region is an eminently agricultural space, but not throughout its territory.

According to Gobierno Regional de Amazonas and Instituto de Investigaciones de la Amazonía Peruana (2010), only 16.19% of the territory corresponds to productive zones and 8.49% is suitable for agricultural activities of urban-industrial vocation reach only 0.08% of the total territory. Therefore, and coinciding with the findings of Ulman et al. (2020), the environment is much more conserved due to the little human presence in the region.

In this environmental context, productive economic activities, other than conservation or recovery of ecosystems, are quite limited. In fact, the results show that the economic aspects in the three cities are quite low, so that the modernization of local industries seems a distant issue. Then, it seems natural that the Environmental pillar has a high value, while the Economic pillar is affected with values below the expected average. However, the proposed model still works with this peculiarity, but showing quite similar results. If more heterogeneous geographic areas are examined, markedly different results will be obtained.

The Social pillar deserves special attention, because here there are marked differences. The highest indicators are found in San Nicolás, due to the number of professionals that exist, both in health and education and the provision of basic home services, since the city is also the capital of the province of Rodríguez de Mendoza, unlike of the other two cities, which are district capitals. The results are similar to those obtained by Andrade (2016) when evaluating this pillar.

Unlike other sustainability evaluation methods (Bern University of Applied Sciences, 2021; De Mey & D'Haene, 2008; Food and Agriculture Organization of the United Nations, 2019; Grenz et al., 2009; Karl et al., 2010; Sauvenier et al., 2005; Sharifi et al., 2020; Spilsbury, 2005; Sustainable Rangelands Roundtable, 2020), the PESAT has prioritized people's thinking as a key part in the composition of sustainability, therefore, according to what was contributed by the specialists who participated in the study, the way of thinking of people determines their behavior and the final impact on the environment.

For this reason, the Ethics and people behavior theme was determined, which includes religious, cultural, political and gender indicators. In this matter, the highest value is obtained in Cajaruro (57.93%) compared to La Jalca (54.23%) and San Nicolás (55.23%). These results indicate that Cajaruro has a more organized, mature and equitable society as a whole, to face environmental problems with better perspectives and tools.

A cross-sectional analysis of the three pillars studied is found by evaluating the communication routes, which harm the productivity and commercialization of local companies, since in Amazonas the roads are in poor condition or in a precarious state of construction, hindering the mobility of products, both for inputs and final goods.

Other important points are the high dispersion of populated centers and the low number of inhabitants in these human settlements, phenomena that do not make possible the execution of impact projects, since being the underdeveloped country, most public policies are applied with the criterion of cost-benefit (Rehman & Mamoon, 2017; Robertson et al., 2019; Rodríguez, 2020), excluding Amazonas from the possibility of greater interventions by the government.

4.3. Research limitations and future research topics

Based on the results found in the three districts where the fieldwork was carried out, the hypothesis is validated and it is affirmed that if it is possible to develop a methodology to determine the level of sustainability of the geographical areas according to their major use, whose academic validity was found.

For the normalization of the variables, the Min-Max criterion has been used mainly, both in its standard form and in the variation distance from the target, so many of the indicators are strongly influenced by the target values, which have been determined especially for this studio. Varying these target values implies obtaining different results. It would be interesting to analyze the inclusion and/or application of other normalization methods in the study, Pollesch and Dale (2016) suggest several other methods that could be used.

The main limitation to carry out the investigation was money. The application of the surveys is time consuming and therefore expensive. It would have been an interesting exercise to have applied the methodology in three different regions, for example, one city from the Coast, another from the Sierra and the third from the Selva. Or maybe in three cities in South America. Another important limitation was time, since taking high field samples means a lot of time in interviews, which must then be processed and analyzed, these tasks also demand significant amounts of time.

It is as a pending task to deepen and refine the indicators to evaluate the sustainability of geographical areas according to their major use. Perhaps include new topics for the realization of the composite indicators. It can be stated that due to the definition of the indicators, geographical areas can also be analyzed for each pillar separately, using the indicators that compose it, which would give a partial, faster and more focused evaluation, but valid and reliable. This exercise could be carried out to apply the model to heterogeneous departments or cities located in different natural regions.

This research is a new way to measure the sustainability of a geographic space that will serve to know the situational state of the environment, compare it with other cities and mainly, help to decision-making for the development and implementation of public policies that support the sustainable growth of the country.

Chapter V.

Conclusions

1. In this research, a methodology was developed, validated and applied to determine the level of sustainability of geographic areas according to their major land. The main contribution was to integrate several methodologies in a single one that evaluated any geographical area.

2. To develop the methodology, the most common sustainability assessment methods were reviewed, based on them, a model applied to the reality of a developing country was adapted.

3. The construction of the model included the use of 146 indicators grouped into 23 themes, which in the end constituted three pillars: Environmental, Social and Economic.

4. For the elaboration of the composite indicators, the information collected from the field through six questionnaires, was normalized using the Min-Max technique, they were weighted on the opinion of experts who participated in the study and added by linear aggregation.

5. The model was applied in three cities in the Amazonas region with totally heterogeneous economic, social and environmental characteristics: La Jalca, San Nicolás and Cajaruro. The city with the best environmental performance was San Nicolás.

6. In the three cities evaluated, the highest results were obtained in the Environmental pillar, while the lowest, below 50%, in the Economic pillar, a fact that shows that

the Amazonas region is eminently agricultural, but with non-extensive production.

7. The proposed methodology is consistent and serves to make decisions based on the observation of indicators as a whole, which can model a geographic space to improve it, conserve it or compare it with another space.

Chapter VI.

Recommends

1. Sustainability is a continuous process, it would be interesting to apply the proposed methodology to the three cities every year, under the same conditions, to analyze the evolution of the main indicators and measure the impact of the policies and strategies applied by the governments.

2. The proposed methodology is valid and generates reliable and accurate results, it is left for future generations to add or remove indicators, to make it easier to apply and with a greater spectrum of application.

3. It would be important for an institution, perhaps a university body, to take the methodology embodied in this research and apply it to different geographical spaces in Peru, as a tool to measure the effectiveness of public policies.

4. The academic community is recommended to apply the various existing environmental assessment methods, including this proposal, to define its own methodology, which represents the reality of the country, with its characteristics and singularities.

5. To the students, use the points they consider pertinent in the investigation and delve into focused investigations, about indicators, composite indexes, and so on, which could enrich the proposal and generate more applied knowledge.

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Appendix A.

Glossary

Air quality index: The index proposed by The World Air Quality Project is used, available at https://aqicn.org/here/ (accessed February 1, 2021). The Air Quality Index is based on measurement of particulate matter ($PM_{2.5}$ and PM_{10}), Ozone (O_3), Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2) and Carbon Monoxide (CO) emissions.

Assessment: The act of judging or deciding the amount, value, quality, or importance of something, or the judgment or decision that is made (Cambridge Dictionary, 2021).

Community: A unified body of individuals, such as the people with common interests, characteristics or other linkage, living in a particular area, and often have a common cultural and historical heritage. In this research, community, is understand like cities (at least 50,000 inhabitants in contiguous dense grid cells), towns (at least 5,000 inhabitants in contiguous grid cells), rural areas (low-density grid cells) (World Bank, 2021).

Employer: Owner of a company legally constituted or farmer with at least 4 ha of productive lands in use.

Ethics and people behavior: Human, individual and collective behavior. It is sought that the collective well-being is the common objective in a community.

Food self-sufficiency ratio: It is the amount of products, out of a total of 20 basic ones that can be purchased from local producers, and survive without the need to import food.

Governance: Is all the processes of interaction be they through the laws, norms, power or language of an organized society over a social system (country, family, nation).

Governance index: The index proposed by the World Bank is used, available at http://info.worldbank.org/governance/wgi/ (accessed February 1, 2021). It uses six dimensions of governance: Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption.

Industry entry: The ability and conditions to enter an industry. It is understood as the economic and financial support of an entrepreneur to create a company.

Innovation hubs: They are centers for the transmission of technical or applied knowledge, such as Business Incubators, Continuous Training Centers, among others.

Landscape: Use of physical space either by natural action or by human action.

Net migration rate: The number of immigrants minus the number of emigrants over a period, divided by the total population of the receiving country over that period.

Social and related services: Basic services offered to households in populated centers and/or cities, such as electricity, drinking water, sewage, mobile telephony, internet, etc.

Social protection: Benefits that are inherent to workers, such as the right to paid vacations, bonuses and the periodic and punctual payment of a salary.

Soil Organic Matter: is the organic matter component of soil, consisting of plant and animal detritus at various stages of decomposition, cells and tissues of soil microbes, and substances that soil microbes synthesize.

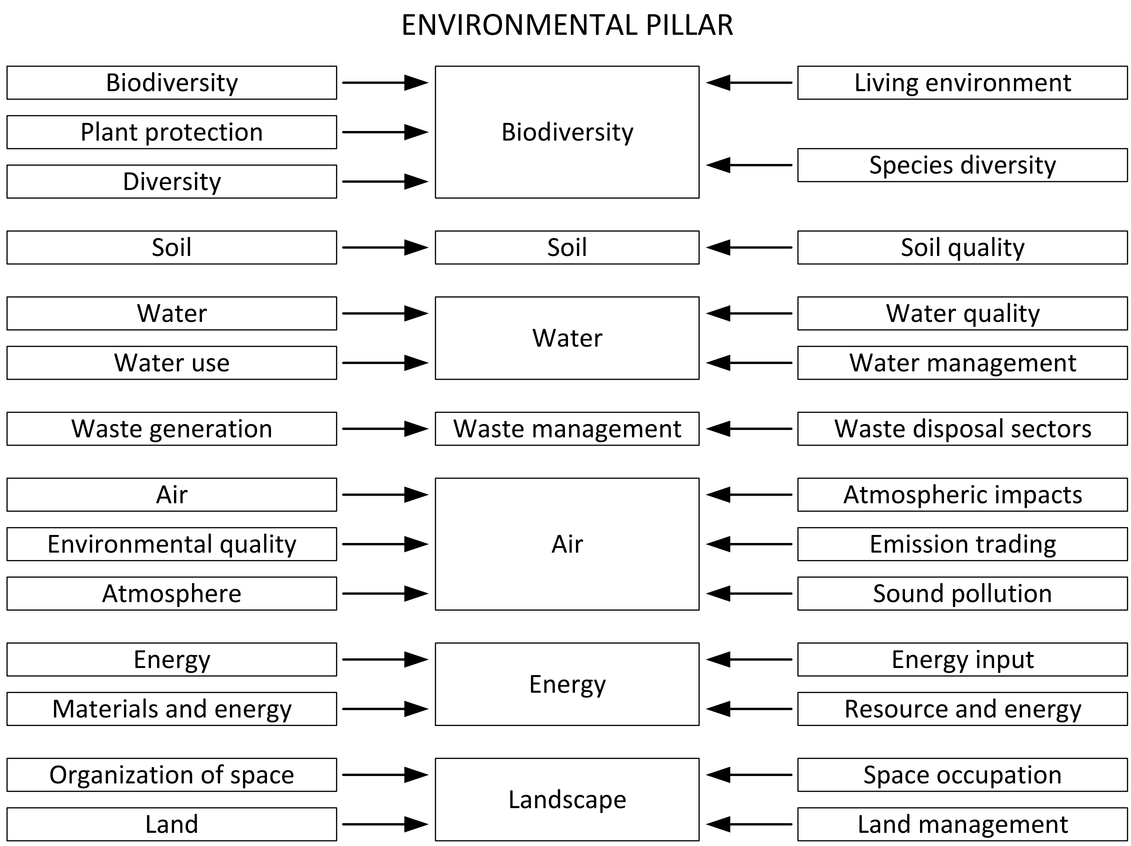
Volatile Organic Compounds: are compounds that have a high vapor pressure and low water solubility. VOCs typically are industrial solvents, such as trichloroethylene; fuel oxygenates, such as methyl tert-butyl ether (MTBE); or by-products produced by chlorination in water treatment, such as chloroform. VOCs are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry cleaning agents. VOCs are emitted as gases.

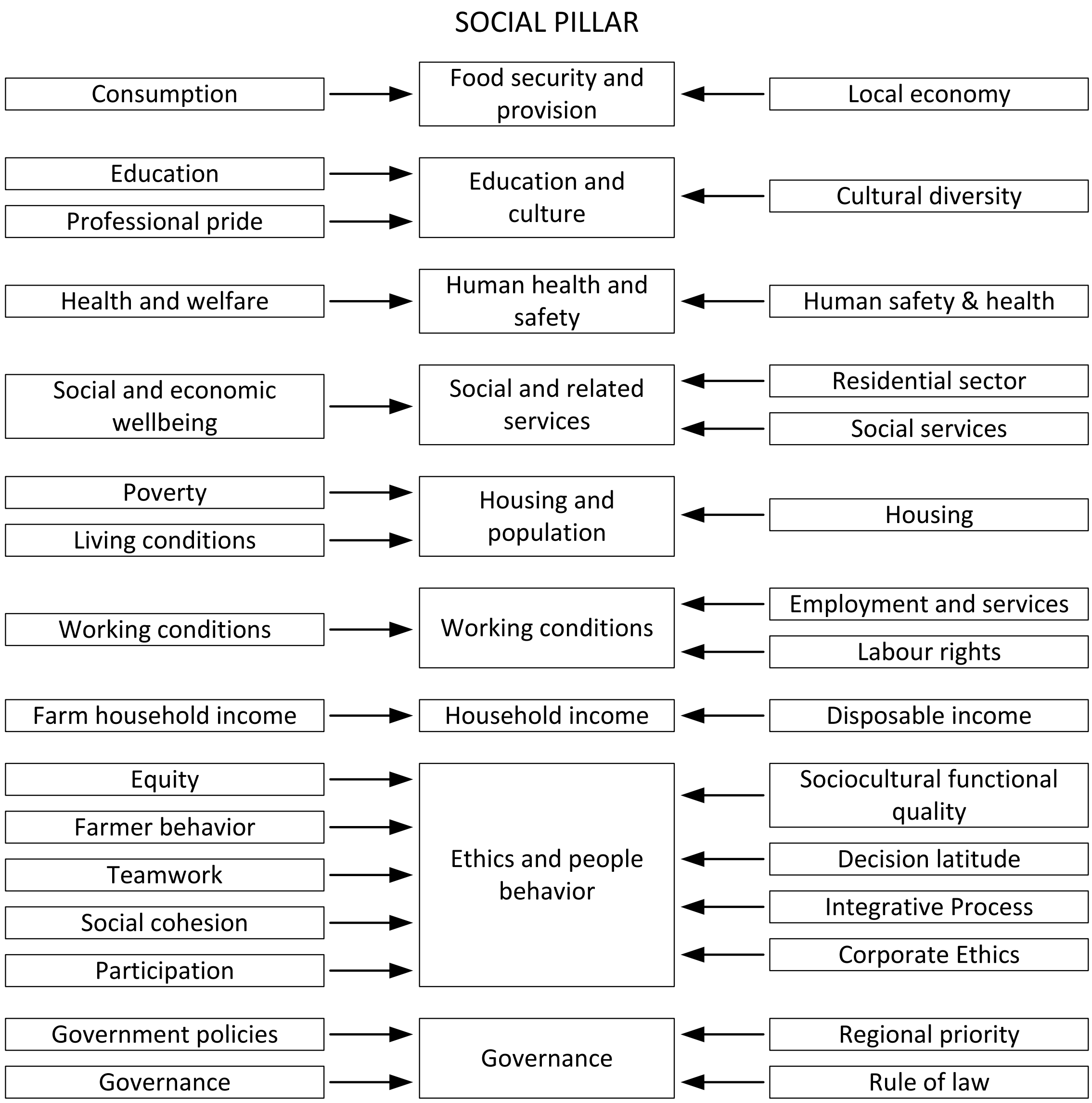
Water quality index: The index proposed by the organization Know Your H2O - Water Research Center is used, available at https://www.knowyourh2o.com/outdoor-3/water-quality-index-calculator-for-surface-water (accessed on 01 February 2021). It uses Dissolved Oxygen, Fecal Coliform, pH, Biochemical Oxygen demand, Temperature change, Total Phosphate, Nitrates, Turbidity, and Total Solids as criteria.

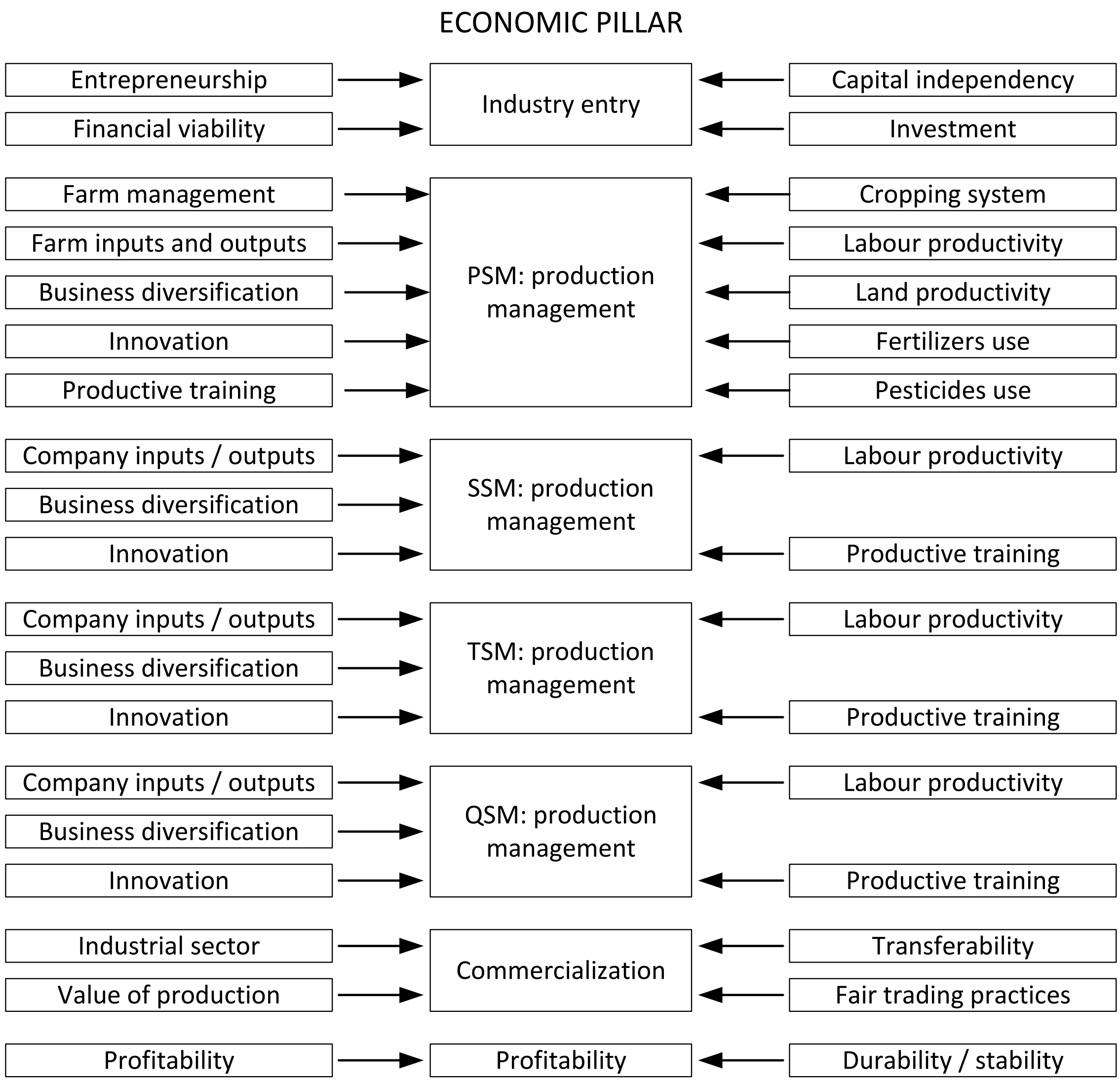
Appendix B.

Themes proposed

On the reviewed literature, 23 themes were elaborated, from several topics found, grouped by similarity, correspondence, relevance and significance.




SOCIAL PILLAR
Consumption
Food security and provision
Local economy
Education
Professional pride
Education and culture
Cultural diversity
Health and welfare
Human health and safety
Human safety & health
Social and economic wellbeing
Social and related services
Residential sector
Social services
Poverty
Living conditions
Housing and population
Housing
Working conditions
Working conditions
Employment and services
Labour rights
Farm household income
Household income
Disposable income
Equity
Farmer behavior
Teamwork
Social cohesion
Participation
Ethics and people behavior
Sociocultural functional quality
Decision latitude
Integrative Process
Corporate Ethics
Government policies
Governance
Governance
Regional priority
Rule of law



Note: Adapted from Baccar et al., 2016; Bern University of Applied Sciences, 2021; Biret et al., 2019; Building Research Establishment Ltd., 2017; Center for International Forestry Research, 1999; De Mey and D'Haene, 2008; Evans et al., 2010; Fiksel et al., 2012; Food and Agriculture Organization of the United Nations, 2014; German Sustainable Building Council, 2021; Green Building Council of Australia, 2021; Hulleman and Marijs, 2021; Institute for Building Environment and Energy Conservation, 2021; Lebacq et al., 2013; Meul et al., 2008; Organisation for Economic Co-Operation and Development, 2008a; Paracchini et al., 2015; Sarkar et al., 2011; Song and Moon, 2019; Sullivan et al., 2003; U.S. Green Building Council, 2020.

Appendix C.

Selected indicators

The following table shows the indicators used, the formula for their calculation, as well as the goal or objective of the expected values.

Pillar	Themes	Code	Indicators	Formula	Goal / Target	Source for get the data					
						EQ1	EQ2	EQ3	EQ4	LAQ	IQ
Env	Biodiversity	EN01	Coverage of protected areas	(PA/TA)*100%	0.30					LAQ	
Env	Biodiversity	EN02	Existence of updated national natural resources and range policy, strategy, legislation and regulations	No existence = 0%, Existence obsolete = 50%, Existence updated = 100%	1					LAQ	
Env	Biodiversity	EN03	Structural diversity in relative terms - crop plants	Principal specie/km2	3300	EQ1					
Env	Biodiversity	EN04	Density of number per hectare - main plants	PlantsQuantity/km2	7300	EQ1					
Env	Biodiversity	EN05	Structural diversity in relative terms - domesticated animals	Principal specie/km2	150	EQ1					
Env	Soil	EN06	Land exposure to natural events: Tillage erosion risk, and other natural effects	1- days of natural events/365	1	EQ1					
Env	Soil	EN07	Soil Erosion (% and total area eroded)	1 - (TAE/TA)	1	EQ1					

Pillar	Themes	Code	Indicators	Formula	Goal / Target	Source for get the data					
						EQ1	EQ2	EQ3	EQ4	LAQ	IQ
Env	Soil	EN08	Macronutrient: N	Percentage	0.003	EQ1					
Env	Soil	EN09	Macronutrient: P	Percentage	0.300	EQ1					
Env	Soil	EN10	Macronutrients: K	Percentage	0.003	EQ1					
Env	Soil	EN11	Soil pH	Ratio (no unit)	6.500	EQ1					
Env	Soil	EN12	Percentage of land affected by salinity	1 - (LAS/TL)	1	EQ1					
Env	Soil	EN13	Soil pollution (levels and control)	∑ (Components), Level = {50% = low, 25% = medium, 0% = high}, Control = {0% = low, 25% = medium, 50% = high}	1	EQ1					
Env	Soil	EN14	Soil organic matter (SOM) content	Percentage	0.3	EQ1					
Env	Water	EN15	Water quality index	WQI	0.95	EQ1					
Env	Water	EN16	Water salinity	1 -gr/L	0.99	EQ1					
Env	Water	EN17	Exceedance of critical loads of pH in water	|Observed pH - Recommended pH|	0	EQ1					
Env	Water	EN18	Volume of water withdrawn from superficial sources	(WWSS/TW)*100%	0.8	EQ1					
Env	Water	EN19	Volume of water withdrawn from groundwater sources	(WWGS/TW)*100%	0.2	EQ1					
Env	Water	EN20	Use of alternative water resources: rainwater, recycled, etc.	(TAWR/TW)*100%	0.1	EQ1					
Env	Water	EN21	Degree of integrated water resources management implementation assessing four components: policies, institutions, management tools and financing	∑ (Components), Component = {0% = low, 12.5% = medium, 25% = high}	1	EQ1					
Env	Water	EN22	Reports of conflict over water use	# conflicts vigentes, {0 = 100%, 1-3 = 50%, 4-9 = 25%, 10+ = 0%}	1	EQ1				LAQ	
Env	Water	EN23	Total industrial water consumption per capita	(litres/day)	4000	EQ1					
Env	Water	EN24	Total domestic water consumption per capita	(litres/day)	100						IQ
Env	Waste management	EN25	Volume of wastewater produced by the company	L/day	300	EQ1					
Env	Waste management	EN26	Volume of solid waste produced by the company	kg/day	50	EQ1					
Env	Waste management	EN27	Percentage of city population with regular solid waste collection (residential)	(PWRSWC/TP)*100%	1					LAQ	
Env	Waste management	EN28	Percentage of city population served by wastewater collection	(PSWWC/TP)*100%	1					LAQ	
Env	Waste management	EN29	Total per capita municipal solid waste collected	kg/inhabitant*day	20					LAQ	
Env	Air	EN30	Volume of air pollutants emissions produced by the companies in the ecosystem (Ammonia, Carbon dioxide (CO2), Nitrogen oxide (NOx), Sulphur Oxides (SOx), Particular Matter (PM) and Volatile Organic Compounds (VOC)).	1- Emissions (g/m3)/#companies	1	EQ1	EQ2	EQ3	EQ4		
Env	Air	EN31	Volume of air pollutants emissions produced by the population in the ecosystem.	1 - Emissions (g/m3)/#inhabitants	1						IQ
Env	Air	EN32	Air quality index	Index	1					LAQ	
Env	Air	EN33	Emission of greenhouse gases per capita	1 - Emissions (g/m3)/#inhabitants	1	EQ1	EQ2	EQ3	EQ4		IQ
Env	Energy	EN34	Amount of electric energy supplied to the industry	Average Kw/company	200	EQ1	EQ2	EQ3	EQ4		
Env	Energy	EN35	Amount of electric energy supplied to the families	Average Kw/person	30						IQ
Env	Energy	EN36	Amount of energy from fossil fuels.	L/#inhabitants	25	EQ1	EQ2	EQ3	EQ4		IQ
Env	Energy	EN37	Amount of energy from renewable sources	EConsumption/#inhabitants	1	EQ1	EQ2	EQ3	EQ4		IQ
Env	Energy	EN38	Percentage of domestic gas consumption	(PWGDS/TP)*100%	1						IQ

Pillar	Themes	Code	Indicators	Formula	Goal / Target	Source for get the data					
						EQ1	EQ2	EQ3	EQ4	LAQ	IQ
Env	Landscape	EN39	Long-term land tenure, land use and usufruct rights	{0% = no possesion, 40% = risk posetion, 80% = possesion without titles, 100% = legal titles}	1					LAQ	IQ
Env	Landscape	EN40	Share of industrial/commercial area in total area	(ICA/TA)*100%	0.3					LAQ	
Env	Landscape	EN41	Land cover conversion from natural state to artificial state	(ALS/TL)*100%	0.4					LAQ	
Env	Landscape	EN42	Formal and informal urban human settlements area	(HAL/TL)*100%	0.4					LAQ	
Soc	Food Security and Provision	S01	Total agricultural area per 1 000 population	(TAA(km2)/1000*Inhabitants)	1	EQ1					
Soc	Food Security and Provision	S02	Food self-sufficiency ratio	local production / representative basket	0.5						IQ
Soc	Education and culture	S03	Adult literacy rate	Ratio (no unit)	10.5					LAQ	
Soc	Education and culture	S04	Women's average years in education institutions	Years	19						IQ
Soc	Education and culture	S05	Men's average years in education institutions	Years	19						IQ
Soc	Education and culture	S06	Primary education student/teachers ratio	Ratio (Students/Ratio)	15					LAQ	
Soc	Education and culture	S07	Percentage o people with higher education degrees	(PWHED/TP)*100%	0.1						IQ
Soc	Education and culture	S08	Computers, laptops, tablets, or other digital learning devices available for primary and secondary school students	Average of levels, {Average of devices}, {#devices/#students}	2					LAQ	IQ
Soc	Human Health and Safety	S09	Life expectancy	Years	76.9					LAQ	
Soc	Human Health and Safety	S10	Maternal mortality rate	(#MD/#M)*100%	0					LAQ	
Soc	Human Health and Safety	S11	Child mortality rate	(#CD/#C)*100%	0					LAQ	
Soc	Human Health and Safety	S12	Suicide rate	(#S/#Inhabitants)*100%	0					LAQ	
Soc	Human Health and Safety	S13	Number of doctors per 1 000 population	#D*1000/inhabitants	50					LAQ	
Soc	Human Health and Safety	S14	Number of nurses per 1 000 population	#N*1000/inhabitants	100					LAQ	
Soc	Human Health and Safety	S15	Access to basic health care services in the neighborhood	Average distance, {0-1Km = 100%, 1-4Km = 80%, 4-10Km = 50%, 10-20Km = 20%, 20+Km = 0%}	1					LAQ	IQ
Soc	Human Health and Safety	S16	Population covered with social security or private insurance	(#PWS/#TP)*100%	1						IQ
Soc	Human Health and Safety	S17	Number of homicides per 1 000 population	Homicides/1000	0					LAQ	
Soc	Social and related services	S18	Availability of basic infrastructure for water supply	(TPWS/TP)*100%	1					LAQ	
Soc	Social and related services	S19	Availability of basic infrastructure for electricity distribution	(TPWS/TP)*100%	1					LAQ	
Soc	Social and related services	S20	Rate of mobile (cellular phone) ownership	(TPWS/TP)*100%	1					LAQ	IQ
Soc	Social and related services	S21	Number of internet connections per 100 population	TPWS/1000inhabitants	0.3					LAQ	IQ
Soc	Housing and population	S22	Net migration rate	Rate	0.02					LAQ	
Soc	Housing and population	S23	Population density	#inhabitants/km2	100					LAQ	
Soc	Housing and population	S24	Distribution of households according to typology	Typology = {Married = 100%, Joint = 70%, Separated = 30%}	1						IQ
Soc	Housing and population	S25	Length of residence in the community	Years, {>10y = 100%, Between 5 and 10 y = 60%, <5y = 20%}	1						IQ
Soc	Housing and population	S26	Housing floor area per person	#members/AreaHouse	5						IQ
Soc	Housing and population	S27	Square meters of public recreation space per capita	km2/inhabitants	2					LAQ	

Pillar	Themes	Code	Indicators	Formula	Goal / Target	Source for get the data					
						EQ1	EQ2	EQ3	EQ4	LAQ	IQ
Soc	Housing and population	S28	Green area (hectares) per capita	km2/inhabitants	2					LAQ	
Soc	Housing and population	S29	Proportion of youth (aged 15–24 years) in the community not in education, employment or training	1 - #Y/inhabitants	1					LAQ	IQ
Soc	Working conditions	S30	Percentage of the labor force employed distributed	Sectors = {Prim = 0%, Sec = 50%, Ter = 80 %, Quat = 100%}	1	EQ1	EQ2	EQ3	EQ4		
Soc	Working conditions	S31	Proportion of the employed population that works on its own account or in a family business	(#wse/#w)*100%	0.5						IQ
Soc	Working conditions	S32	Proportion of women in managerial positions	(#WMP/#MP)*100%	0.5	EQ1	EQ2	EQ3	EQ4		
Soc	Working conditions	S33	Jobs–housing ratio	Ratio	3						IQ
Soc	Working conditions	S34	Wage difference between genders	(Av.Fem/Av.Male)	1	EQ1	EQ2	EQ3	EQ4		
Soc	Working conditions	S35	Social protection (benefits, pension)	Yes = 100%, No = 0%	1	EQ1	EQ2	EQ3	EQ4		IQ
Soc	Household Income	S36	Percentage of households receiving a pension, remittance or wage	#houses/TotalHouses	1						IQ
Soc	Household Income	S37	Income per capita	S/ per month	2380						IQ
Soc	Household Income	S38	Population living below national poverty line	(PBNPL/TP)	0.2					LAQ	
Soc	Ethics and people behavior	S39	Women's involvement in decision making about economic activities	Percentage	0.5						IQ
Soc	Ethics and people behavior	S40	Believe that religion or spirituality can bring joy and happiness	Percentage	1						IQ
Soc	Ethics and people behavior	S41	Civic responsibility and community engagement	Percentage	1						IQ
Soc	Ethics and people behavior	S42	Perception on social inclusion	Percentage	1						IQ
Soc	Ethics and people behavior	S43	Citizens with positive view of the state	Percentage	1						IQ
Soc	Ethics and people behavior	S44	Percentage of young people who want to continue the economic activity of their parents	Binary {Yes = 1, No = 0}	0.5						IQ
Soc	Ethics and people behavior	S45	Annual number of cultural events per capita	Events/population	0.1					LAQ	IQ
Soc	Governance	S46	Governance index	Index (The World Bank)	1					LAQ	
Soc	Governance	S47	Satisfaction with the service of the political representative in the region	Binary {Yes = 1, No = 0}	1						IQ
Soc	Governance	S48	Women as a percentage of total elected authorities	Percentage	0.5					LAQ	
Soc	Governance	S49	Municipal budget per inhabitant	S/ per year	5546					LAQ	
Soc	Governance	S50	Percentage of city services accessible online	Percentage	1					LAQ	
Eco	Industry entry	EC01	Percentage of owners who have bank loans for productive activities	Binary {Yes = 1, No = 0}	1	EQ1	EQ2	EQ3	EQ4		IQ
Eco	Industry entry	EC02	Solvency (= own capital/total capital)	Own capital/Total capital	1	EQ1	EQ2	EQ3	EQ4		
Eco	Industry entry	EC03	Payback period (years needed for return of the initial invesment)	Years	5	EQ1	EQ2	EQ3	EQ4		
Eco	Industry entry	EC04	Innovation hubs in the city	Number of hubs	1	EQ1	EQ2	EQ3	EQ4		
Eco	PSM: Production management	EC05	Arable cropland, permanent cropland, permanent pasture and other agricultural land share in the total land area	Percentage	0.9	EQ1					
Eco	PSM: Production management	EC06	Proportion of adequately trained workers	Percentage	1	EQ1					
Eco	PSM: Production management	EC07	Percentage of industry jobs which are permanent	Percentage	1	EQ1					
Eco	PSM: Production management	EC08	Fertilizer use	UseArea/TotalAgriculturalArea	0.33	EQ1					
Eco	PSM: Production management	EC09	Pesticide use	UseArea/TotalAgriculturalArea	0.33	EQ1					

Pillar	Themes	Code	Indicators	Formula	Goal / Target	Source for get the data					
						EQ1	EQ2	EQ3	EQ4	LAQ	IQ
Eco	PSM: Production management	EC10	Availability of seeds	Own = 100%, All get it = 0%	0.5	EQ1					
Eco	PSM: Production management	EC11	Harvest plants and rotation periode	Harvest by 5 hears	10	EQ1					
Eco	PSM: Production management	EC12	Diversity of activities in the sector	Count, 0 to 5	2	EQ1					
Eco	PSM: Production management	EC13	Percentage of organic farming in utilised agricultural area	Percentage	0.6	EQ1					
Eco	PSM: Production management	EC14	Share of certified companies	Percentage	0.5	EQ1					
Eco	PSM: Production management	EC15	Apply of computing platforms and ICT solutions	Percentage	0.5	EQ1					
Eco	PSM: Production management	EC16	Area of technified irrigated land in total agricultural area	Percentage	1	EQ1					
Eco	PSM: Production management	EC17	Productivity of labor (main crop)	Gross output per workers (TAP/workers)	10000	EQ1					
Eco	PSM: Production management	EC18	Productivity of land (main crop)	Gross output per hectare (TAP/ha)	30000	EQ1					
Eco	PSM: Production management	EC19	Cooperation between stakeholders (industry, academia, policy sectors, etc.)	Sum. Industry/Academia/ Govern ment/Others = {Low = 0%, Basic = 12.5%, High = 25%}	1	EQ1					
Eco	PSM: Production management	EC20	Years of experience in the industry	Years	10	EQ1					
Eco	PSM: Production management	EC21	Existence of education programs (university, technical, particular) related to the industry	Quantity	1	EQ1					
Eco	SSM: Production management	EC22	Proportion of adequately trained workers	Percentage	0.75		EQ2				
Eco	SSM: Production management	EC23	Percentage of industry jobs which are permanent	Percentage	1		EQ2				
Eco	SSM: Production management	EC24	Share of certified companies	Percentage	0.5		EQ2				
Eco	SSM: Production management	EC25	Apply of computing platforms and ICT solutions	Number of processes / Total processes	0.6		EQ2				
Eco	SSM: Production management	EC26	Productivity of labor (main product or service)	Gross output per workers (TAP/workers)	20000		EQ2				
Eco	SSM: Production management	EC27	Productive diversification	Number of diversifications	3		EQ2				
Eco	SSM: Production management	EC28	Cooperation between different stakeholder (industry, academia, policy sectors, etc.)	Sum. Industry/Academia/ Govern ment/Others = {Low = 0%, Basic = 12.5%, High = 25%}	1		EQ2				
Eco	SSM: Production management	EC29	Years of experience in the industry	Years	10		EQ2				
Eco	SSM: Production management	EC30	Existence of education programs (university, technical, informal) related to the industry	Quantity	1		EQ2				
Eco	TSM: Production management	EC31	Vehicles in use by populated area (vehicles per km2)	Quantity of vehicles / km2	2			EQ3		LAQ	
Eco	TSM: Production management	EC32	Restaurants, hotels, stores and bazaars by populated area (establishments per km2)	Average. {Kind of company/km2}	2			EQ3		LAQ	
Eco	TSM: Production management	EC33	Proportion of adequately trained workers	Percentage	1			EQ3			
Eco	TSM: Production management	EC34	Percentage of industry jobs which are permanent	Percentage	1			EQ3			
Eco	TSM: Production management	EC35	Share of certified companies	Percentage	0.6			EQ3			
Eco	TSM: Production management	EC36	Apply of computing platforms and ICT solutions	Number of processes / Total processes	1			EQ3			
Eco	TSM: Production management	EC37	Productivity of labor (main product or service)	Gross output per workers (TAP/workers)	30000			EQ3			
Eco	TSM: Production management	EC38	Cooperation between stakeholders (industry, academia, policy sectors, etc.)	Sum. Industry/Academia/ Govern ment/Others = {Low = 0%, Basic = 12.5%, High = 25%}	1			EQ3			
Eco	TSM: Production management	EC39	Years of experience in the industry	Years	10			EQ3			
Eco	TSM: Production management	EC40	Existence of education programs (university, technical, informal) related to the industry	Quantity	20			EQ3			

Pillar	Themes	Code	Indicators	Formula	Goal / Target	Source for get the data					
						EQ1	EQ2	EQ3	EQ4	LAQ	IQ
Eco	QSM: Production management	EC41	Number of bars/discotheques per local population	Average. {Kind of company/km2}	0.01				EQ4		
Eco	QSM: Production management	EC42	Proportion of adequately trained workers	Percentage	1				EQ4		
Eco	QSM: Production management	EC43	Percentage of industry jobs which are permanent	Percentage	1				EQ4		
Eco	QSM: Production management	EC44	Share of certified companies	Percentage	1				EQ4		
Eco	QSM: Production management	EC45	Apply of computing platforms and ICT solutions	Number of processes / Total processes	1				EQ4		
Eco	QSM: Production management	EC46	Productivity of labor (main product or service)	Gross output per workers (TAP/workers)	100000				EQ4		
Eco	QSM: Production management	EC47	Cooperation between stakeholders (industry, academia, policy sectors, etc.)	Sum. Industry/Academia/ Govern ment/Others = {Low = 0%, Basic = 12.5%, High = 25%}	1				EQ4		
Eco	QSM: Production management	EC48	Years of experience in the industry	Years	10				EQ4		
Eco	QSM: Production management	EC49	Existence of education programs (university, technical, informal) related to the industry	Quantity	50				EQ4		
Eco	Commercialization	EC50	Industry production volume (year)	All production including sub products and other incomes (S/)	500000	EQ1	EQ2	EQ3	EQ4		
Eco	Commercialization	EC51	Local consumption of the production	Percentage	0.5	EQ1	EQ2	EQ3	EQ4		
Eco	Commercialization	EC52	Use of platforms for digital and mobile buying/payment	Percentage of operations	0.8	EQ1	EQ2	EQ3	EQ4		
Eco	Profitability	EC53	Annual profit of local businesses	(Income - expenses)*100/expenses	0.5	EQ1	EQ2	EQ3	EQ4		
Eco	Profitability	EC54	Stability of income over time	Binary {Yes = 1, No = 0}	1	EQ1	EQ2	EQ3	EQ4		

Note: Env = Environmental, Soc = Social, Eco = Economic. EQ1 = Employer - Primary Sector Questionnaire, EQ2 = Employer - Secondary Sector Questionnaire, EQ3 = Employer - Tertiary Sector Questionnaire, EQ4 = Employer - Quaternary Sector Questionnaire, LAQ = Local Authority Questionnaire, IQ = Inhabitant Questionaire. Adapted from Antunes et al., 2017; Bachev et al., 2017; Cervera-Ferri and Ureña, 2017; De Mey and D'Haene, 2008; De Olde et al., 2016; European Commission, 2017; Evans et al., 2010; Food and Agriculture Organization of the United Nations, 2003; Food and Agriculture Organization of the United Nations, 2017b; Food and Agriculture Organization of the United Nations, 2019; García, 2015; Grenz et al., 2009; Gudmundsson et al., 2016; Hardi and Pinter, 1995; Ibrahim et al., 2019; Intergovernmental Oceanographic Commission, 2006; Institute for Building Environment and Energy Conservation, 2013; Jesinghaus, 2007; Joyce et al., 2010; Karl et al., 2010; Lebacq et al., 2013; McCollum et al., 2010; Meul et al., 2008; Mitchell et al., 2010; Mota-López et al., 2017; Organisation for Economic Co-Operation and Development, 2001; Organisation for Economic Co-Operation and Development, 2003; Organisation for Economic Co-Operation and Development, 2008a; Organisation for Economic Co-Operation and Development, 2013; Organisation for Economic Co-Operation and Development, 2017; Quiroga, 2001; Reytar et al., 2014; Ryan et al., 2016; Sauvenier et al., 2005; Schuschny and Soto, 2009; Secretariat of the Convention on Biological Diversity, 2006; Sharifi et al., 2020; Spilsbury, 2005; Sullivan et al., 2003; United Nations, 2007; United Nations Conference on Trade and Development, 2019; Walker, 2002; World Tourism Organization, 2004; Zandebasiri et al., 2017.

Appendix D.

Questionnaires

Six questionnaires were prepared, according to the characteristics of the study groups involved. These questionnaires are presented below.

Employer - Primary Sector Questionnaire

QUESTIONNAIRE

EMPLOYERS - PRIMARY SECTOR

AGRICULTURE, FORESTRY AND FISHING

CODE: ______ DATE: ______

POLLSTER: ______

PART 1. GENERAL INFORMATION

1.1. Full Name: ______

1.2. Age: ______ 1.3. Sex: Female: ______ Male: ______

1.4. Address: ______

1.5. City: ______

1.6. District: ______ 1.7. Province: ______

1.8. Marital Status: Single: ______ Coupled: ______

1.9. Educational level:

Of the respondent:		Of the partner:	
Can't write name	☐	Can't write name	☐
Can read and write	☐	Can read and write	☐
Primary	☐	Primary	☐
Secondary	☐	Secondary	☐
Technical studies	☐	Technical studies	☐
Technical career	☐	Technical career	☐
University studies	☐	University studies	☐
Bachelor	☐	Bachelor	☐
Titled	☐	Titled	☐
Master	☐	Master	☐
Doctorate	☐	Doctorate	☐

1.10. Number of family members (living together): ☐

1.11. Percentage of participation in the company: ☐

1.12. Years of experience in the industry: ☐

PART 2. INFORMATION RELATED TO MEANS OF PRODUCTION

2.1. Does the land you cultivate have a property title? Yes ☐ No ☐

2.2. What is the land area under your managemente? (in Km2) ☐

2.3. What area is currently used for agricultural purposes? (in Km2) ☐

2.4. From de agricultural lands, how is the type of cultivation?:

Irrigated land	☐	Area (Km2):	☐
Arable cropland	☐	Area (Km2):	☐
Permanent cropland	☐	Area (Km2):	☐
Permanent pasture	☐	Area (Km2):	☐
Fishery	☐	Area (Km2):	☐
Other: ☐		Area (Km2):	☐

2.5. Have your lands exposure to natural events? Yes ☐ No ☐

Tillage erosion	Low	☐	Medium	☐	High	☐
Hurricanes	Low	☐	Medium	☐	High	☐
Huaycos	Low	☐	Medium	☐	High	☐
Inundaciones	Low	☐	Medium	☐	High	☐
Other: ☐	Low	☐	Medium	☐	High	☐

2.6. Has your production organic treatment? No ☐ Yes ☐ Area (km2): ☐

2.7. Have your lands soil erosion? No ☐ Yes ☐ Area (km2): ☐

2.8. Are your lands affected by salinity? No ☐ Yes ☐ Area (km2): ☐

2.9. Quality of lands:

Macronutrient: N (kg/Ha)		Soil pH	
Macronutrient: P (kg/Ha)		Soil organic matter (kg/Ha)	
Macronutrient: K (kg/Ha)			

2.10. Soil pollution level: Low ☐ Medium ☐ High ☐

2.11. Soil pollution control activities: No ☐ Yes ☐ How?: ☐

2.12. Soil pollution avoidance activities: No ☐ Yes ☐ How?: ☐

PART 3. INFORMATION RELATED TO PRODUCTION MANAGEMENT

3.1. Do you know the water pollution index for the water that do you use? No ☐ Yes ☐ How much?: ☐

3.2. Water has salinity problems? No ☐ Yes ☐ Level? (dS/m): ☐

3.3. Do you know the water pH for the water that do you use? No ☐ Yes ☐ Level: ☐

3.4. Do you use water from groundwater sources? No ☐ Yes ☐ Quantity (L/day) ☐

3.5. Do you use water from superficial sources? No ☐ Yes ☐ Quantity (L/day) ☐

3.6. Do you use alternative water resources?

Source	Yes	No	Quantity (L/ Quantity (L/day)
Rainwater			
Recycled			

3.7. Do you have any trouble to use water sources? No ☐ Yes ☐ Which one?: ☐

3.8. Degree of integrated water resourses managment implementation:

Policies:	Low ☐	Medium ☐	High ☐
Institutions:	Low ☐	Medium ☐	High ☐
Management tools:	Low ☐	Medium ☐	High ☐
Financing:	Low ☐	Medium ☐	High ☐

3.9. Main crop: ☐ Area (m2): ☐

3.10. Second crop: ☐ Area (m2): ☐

3.11. Third crop: ☐ Area (m2): ☐

3.12. Fourth crop: ☐ Area (m2): ☐

3.13. Fifth crop: ☐ Area (m2): ☐

3.14. Harvest times:
Main crop: Every ☐ months

Second crop:	Every		months
Third crop:	Every		months
Fourth crop	Every		months
Fifth crop:	Every		months

3.15. Approx quantity of invasive alien species (x Km2):

3.16. What is the density of your crop plants (x Km2)

3.17. What is the density of the total plants in your land? (x Km2)

3.18. Do you produce your own seeds? If yes, where do yo produce them? If no, from where do you buy your seeds?

Seed:		Where	Cost (x Km2)
Yes			
No			

Seed:		Where	Cost (x Km2)
Yes			
No			

3.19. Approx quantity of invasive alien species (x Km2):

3.20. Main poultry: Quantity (average):

3.21. Second poultry: Quantity (average):

3.22. Third poultry: Quantity (average):

3.23. What is the density of the poultry in your land? (x Km2)

3.24. Do you produce your own babys? If yes, where do yo produce them? If no, from where do you buy your babys?

Poultry:		Where	Cost (x Month)
Yes			
No			

Poultry:		Where	Cost (x Month)
Yes			
No			

3.25. Main cattle: Quantity (average):

3.26. Second cattle: Quantity (average):

3.27. Third cattle: Quantity (average):

3.28. What is the density of the cattle in your land? (x Km2)

3.29. Do you produce your own babys? If yes, where do yo produce them? If no, from where do you buy your babys?

Cattle:		Where	Cost (x Month)
Yes			
No			

Cattle:		Where	Cost (x Month)
Yes			
No			

3.30. Main fish specie: [ ] Quantity (average): [ ]

3.31. Second fish specie: [ ] Quantity (average): [ ]

3.32. Third fish specie: [ ] Quantity (average): [ ]

3.33. What is the density of your fishery? (x m2) [ ]

3.34. Do you produce your own alevins? If yes, where do yo produce them? If no, from where do you buy your alevins?

Specie:		Where	Cost (x Month)
Yes			
No			

Specie:		Where	Cost (x Month)
Yes			
No			

3.35. Who do you turn to for technical advice?

No one	
Agro veterinary	
Neighbors / Friends	
Private Engineer / Specialist	
Engineer / Specialist from State	
Agrary Agency	
Municipality	
Staff of the Agricultural cooperative	
Other:	

3.36. What is the main reason to seek technical advice?

[ ]

3.37. Agrochemicals use:

Commercial name	Type*	Principal Uses	Use frecuency	Year quantity

* Fertilizer, pesticide, medicines, etc.

3.38. Energy use in the company:

Energy	Source*	Principal Uses	Month quantity
Electricity			
Gas			
Fuel			
Other:			

* Source: public red, hydroelectric, eolic,digestor, motor, gas station, etc.

3.39. Emissions from the company:

Commercial name	From what processes	Year quantity
Greenhouse gases		
Ammonia		

Carbon dioxide (CO2)		
Nitrogen oxide (NOx)		
Sulphur Oxides (SOx)		
Particular Matter (PM)		
Volatile Organic Compounds (VOC)		

3.40. Waste produce by the company:

Waste	From what processes	Year quantity
Solid Waste		
Waste Water		
Hazardous waste*		

* Radioactive, electronic, oils, and similars

3.41. Do you have any process or product certified?

No ☐

Yes ☐ Which one?: ☐ Certifier: ☐

3.42. Use of ICT solutions in the company:

ICT solutions	Provider	Process	Time implemented

PART 4. INFORMATION RELATED TO PERSONAL MANAGEMENT

4.1. How many people are you employing?

Season	F (18 - 25)	F (>25)	M (18 - 25)	M (>25)
High demand				
Permanent				

4.2. Average daily working time in full time employments:

<8 Horas: ☐ 9 Horas ☐ 10 Horas ☐

11 - 12 Horas ☐ >12 horas ☐

4.3. Distribution and training of workers:

Position	F (Unsk)	M (Unsk)	F (S-Uns)	M (S-Uns)	F (Prof)	M (Prof)
Managerial						
Technical						
Operative						
Support						

4.4. Social benefits for workers:

Position	Health Insurance	Benefits payment	Paid vacations
Managerial			
Technical			
Operative			
Support			

4.5. Salaries payment:

Position	Female average month salary	Male average month salary
Managerial		
Technical		
Operative		
Support		

PART 5. INFORMATION RELATED TO ECONOMIC AND FINANCING ASPECTS

5.1. Total amount of crop production (last year):

Month	Qtty 1	P. U. 1	T. P. 1	Qtty 2	P. U. 2	T. P. 2
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

1 = main crop, 2 = second crop

5.2. Total amount of poultry production (last year):

Month	Qtty 1	P. U. 1	T. P. 1	Qtty 2	P. U. 2	T. P. 2
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

1 = main poultry, 2 = second poultry

5.3. Total amount of cattle production (last year):

Month	Qtty 1	P. U. 1	T. P. 1	Qtty 2	P. U. 2	T. P. 2
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

1 = main cattle, 2 = second cattle

5.4. Total amount of fish production (last year):

Month	Qtty 1	P. U. 1	T. P. 1	Qtty 2	P. U. 2	T. P. 2
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

1 = main specie, 2 = second specie

5.5. Your production shares market with imported similar products?

No ☐

Yes ☐ Which one?: ☐ Since?: ☐

Which one?: ☐ Since?: ☐

5.6. Where do you sale your products?

Product	Sale Place / Company / People	Distance traveled

5.7. Do you know if your production is exported?

No ☐

Yes ☐ Where?: ☐

5.8. Do you use digital platforms for pay providers or sell products?

Source	Method*	From since
Buy:		
Sell:		

* Credit card, debit card, mobile bank (phone), internet (laptor or pc)

5.9. Income levels and profit

Month	Income	W. Pay.	Inputs	T & O	Profit
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

W. Pay. = Workers Payments, T & O = Taxes and Obligations

5.10. To start your company, what was the composition of the inicial capital?

Own sources:	S/		that means:		%
Partner:	S/		that means:		%
Credit:	S/		that means:		%

Entity:			
Amount (Suns):		Time of credit:	months

5.11. What was de payback period for your investment? ____ years.

5.12. Actually, Do you have any agriculture loans or micro credit? If yes, from where did you get that loan and what was the purpose of the loan?

Entity:			
Amount (Suns):		Time of credit:	months
Credit purpose:			

PART 6. COMPLEMENTARY INFORMATION

6.1. Productive education in the community within last year:

Institution	Level*	Program	Cost+

* University, technical, local government, particular. + If is statal, cost = 0

6.2. Cooperation between stakeholders:

Institution	Type*	Kind of Cooperation	Frequency

* University, technical, local government, supplier, particular

6.3. Innovation hubs in the city

Entity:	
Programs:	
Since:	

Employer - Secondary Sector Questionnaire

QUESTIONNAIRE

EMPLOYERS - SECONDARY SECTOR

MANUFACTURING, WATER, ELECTRICITY AND CONSTRUCTION

CODE: ______ DATE: ______

POLLSTER: ______

PART 1. GENERAL INFORMATION

1.1. Full Name: ______

1.2. Age: ______ 1.3. Sex: Female: ☐ Male: ☐

1.4. Address: ______

1.5. City: ______

1.6. District: ______ 1.7. Province: ______

1.8. Marital Status: Single: ☐ Coupled: ☐

1.9. Educational level:

Of the respondent:		Of the partner:	
Can't write name	☐	Can't write name	☐
Can read and write	☐	Can read and write	☐
Primary	☐	Primary	☐
Secondary	☐	Secondary	☐
Technical studies	☐	Technical studies	☐
Technical career	☐	Technical career	☐
University studies	☐	University studies	☐
Bachelor	☐	Bachelor	☐
Titled	☐	Titled	☐
Master	☐	Master	☐
Doctorate	☐	Doctorate	☐

1.10. Number of family members (living together): ☐

1.11. Percentage of participation in the company: ☐

1.12. Years of experience in the industry: ☐

PART 2. INFORMATION RELATED TO MEANS OF PRODUCTION

2.1. The local that you use, is owned or rented? Owner ☐ Alquilado ☐

2.2. If you are the owner, Does the local have a property title? Yes ☐ No ☐

2.3. What is the area of your local? (in m2) ☐

PART 3. INFORMATION RELATED TO PRODUCTION MANAGEMENT

3.1. Do you know the water pollution index for the water that do you use? No ☐ Yes ☐ How much?: ☐

3.2. Do you use water from groundwater sources? No ☐ Yes ☐ Quantity (L/day) ☐

3.3. Do you use water from superficial sources? No ☐ Yes ☐ Quantity (L/day) ☐

3.4. Do you use alternative water resources?

Source	Yes	No	Quantity (L/ Quantity (L/day)
Rainwater			
Recycled			

3.5. Who do you turn to for technical advice?

No one	
University	
Neighbors / Friends	
Private Engineer / Specialist	
Engineer / Specialist from State	
Municipality	
Other:	

3.6. What is the main reason to seek technical advice?

☐

3.7. Energy use in the company:

Energy	Source*	Principal Uses	Month quantity
Electricity			
Gas			
Fuel			
Other:			

* Source: public red, hydroelectric, eolic,digestor, motor, gas station, etc.

3.8. Emissions from the company:

Commercial name	From what processes	Year quantity
Greenhouse gases		
Ammonia		
Carbon dioxide (CO2)		
Nitrogen oxide (NOx)		
Sulphur Oxides (SOx)		
Particular Matter (PM)		
Volatile Organic Compounds (VOC)		

3.9. Waste produce by the company:

Waste	From what processes	Year quantity
Solid Waste		
Waste Water		
Hazardous waste*		

* Radioactive, electronic, oils, and similars

3.10. Do you have any process or product certified?

No ☐

Yes ☐ Which one?: ____ Certifier: ____

3.11. Use of ICT solutions in the company:

ICT solutions	Provider	Process	Time implemented

PART 4. INFORMATION RELATED TO PERSONAL MANAGEMENT

4.1. How many people are you employing?

Season	F (18 - 25)	F (>25)	M (18 - 25)	M (>25)
High demand				
Permanent				

4.2. Average daily working time in full time employments:

<8 Horas: ☐ 9 Horas ☐ 10 Horas ☐

11 - 12 Horas ☐ >12 horas ☐

4.3. Distribution and training of workers:

Position	F (Unsk)	M (Unsk)	F (S-Uns)	M (S-Uns)	F (Prof)	M (Prof)
Managerial						
Technical						
Operative						
Support						

4.4. Social benefits for workers:

Position	Health Insurance	Benefits payment	Paid vacations
Managerial			
Technical			
Operative			
Support			

4.5. Salaries payment:

Position	Female average month salary	Male average month salary
Managerial		
Technical		
Operative		
Support		

PART 5. INFORMATION RELATED TO ECONOMIC AND FINANCING ASPECTS

5.1. Total amount of main production (last year):

Month	Qtty 1	P. U. 1	T. P. 1	Qtty 2	P. U. 2	T. P. 2
January						
February						
March						
April						
May						
June						

July						
August						
September						
October						
November						
December						

1 = main production, 2 = second production

5.2. Total amount of main services delivered (last year):

Month	Qtty 1	P. U. 1	T. P. 1	Qtty 2	P. U. 2	T. P. 2
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

1 = main service, 2 = second service

5.3. Your production shares market with imported similar products/services?

No [ ]
Yes [ ] Which one?: [ ] Since?: [ ]
Which one?: [ ] Since?: [ ]

5.4. Where do you sale your products? Where do you have more clients?

Product	Sale Place / Company / People	Distance traveled

5.5. Do you know if your production is exported? No [ ] Yes [ ] Where?: [ ]

5.6. Do you use digital platforms for pay providers or sell products/services?

Source	Method*	From since
Buy:		
Sell:		

* Credit card, debit card, mobile bank (phone), internet (laptor or pc)

5.7. Income levels and profit

Month	Income	W. Pay.	Inputs	T & O	Profit
January					
February					
March					
April					
May					
June					

July					
August					
September					
October					
November					
December					

W. Pay. = Workers Payments, T & O = Taxes and Obligations

5.8. To start your company, what was the composition of the inicial capital?

Own sources:	S/		that means:		%
Partner:	S/		that means:		%
Credit:	S/		that means:		%

Entity:			
Amount (Suns):		Time of credit:	months

5.9. What was de payback period for your investment? [ ] years.

5.10. Actually, Do you have any productive loans or micro credit? If yes, from where did you get that loan and what was the purpose of the loan?

Entity:			
Amount (Suns):		Time of credit:	months
Credit purpose:			

PART 6. COMPLEMENTARY INFORMATION

6.1. Productive education in the community within last year:

Institution	Level*	Program	Cost+

* University, technical, local government, particular. + If is statal, cost = 0

6.2. Cooperation between stakeholders:

Institution	Type*	Kind of Cooperation	Frequency

* University, technical, local government, supplier, particular

6.3. Innovation hubs in the city

Entity:	
Programs:	
Since:	

Employer - Tertiary Sector Questionnaire

QUESTIONNAIRE

EMPLOYERS - TERTIARY SECTOR

COMMERCE, TRANSPORTATION, COMMUNICATION, ACCOMMODATION
FOOD, FINANCIAL, PROFESSIONAL AND SUPPORT SERVICES

CODE: ☐ DATE: ☐

POLLSTER: ☐

PART 1. GENERAL INFORMATION

1.1. Full Name: ☐

1.2. Age: ☐ 1.3. Sex: Female: ☐ Male: ☐

1.4. Address: ☐

1.5. City: ☐

1.6. District: ☐ 1.7. Province: ☐

1.8. Marital Status: Single: ☐ Coupled: ☐

1.9. Educational level:

Of the respondent:		Of the partner:	
Can't write name	☐	Can't write name	☐
Can read and write	☐	Can read and write	☐
Primary	☐	Primary	☐
Secondary	☐	Secondary	☐
Technical studies	☐	Technical studies	☐
Technical career	☐	Technical career	☐
University studies	☐	University studies	☐
Bachelor	☐	Bachelor	☐
Titled	☐	Titled	☐
Master	☐	Master	☐
Doctorate	☐	Doctorate	☐

1.10. Number of family members (living together): ☐

1.11. Percentage of participation in the company: ☐

1.12. Years of experience in the industry: ☐

PART 2. INFORMATION RELATED TO MEANS OF PRODUCTION

2.1. The main local/vehicle that you use, is: Owner ☐ Rented ☐

2.2. If you are the owner, Does the local have a property title? Yes ☐ No ☐

2.3. Do you know how many vehicles there are in your community?

Public transportation	☐	or	☐	%
Private uses	☐	or	☐	%
Government	☐	or	☐	%
Motorcycle o Tricycle	☐	or	☐	%

2.4. How many Km of adecuate roads, there are in your community?

Pavimento		Km2 or		%
Afirmado		Km2 or		%
Trocha		Km2 or		%

2.5. Do you know how many locals for services there are in your community?

Restaurants		or		%
Hotels & Hostels		or		%
Stores		or		%
Boutiques		or		%

PART 3. INFORMATION RELATED TO PRODUCTION MANAGEMENT

3.1. Main service: ______ Area (m2): ______

3.2. Second service: ______ Area (m2): ______

3.3. Third service: ______ Area (m2): ______

3.4. High demand times: ______ to ______ (______) months

3.5. Energy use in the company:

Energy	Source*	Principal Uses	Month quantity
Electricity			
Gas			
Fuel			
Other:			

* Source: public red, hydroelectric, eolic,digestor, motor, gas station, etc.

3.6. Emissions from the company:

Commercial name	From what processes	Year quantity
Greenhouse gases		
Ammonia		
Carbon dioxide (CO2)		
Nitrogen oxide (NOx)		
Sulphur Oxides (SOx)		
Particular Matter (PM)		
Volatile Organic Compounds (VOC)		

3.7. Do you have any process or product certified?

No ☐

Yes ☐ Which one?: ______ Certifier: ______

3.8. Use of ICT solutions in the company:

ICT solutions	Provider	Process	Time implemented

PART 4. INFORMATION RELATED TO PERSONAL MANAGEMENT

4.1. How many people are you employing?

Season	F (18 - 25)	F (>25)	M (18 - 25)	M (>25)
High demand				
Permanent				

4.2. Average daily working time in full time employments:

<8 Horas: [ ] 9 Horas [ ] 10 Horas [ ]
11 - 12 Horas [ ] >12 horas [ ]

4.3. Distribution and training of workers:

Position	F (Unsk)	M (Unsk)	F (S-Uns)	M (S-Uns)	F (Prof)	M (Prof)
Managerial						
Technical						
Operative						
Support						

4.4. Social benefits for workers:

Position	Health Insurance	Benefits payment	Paid vacations
Managerial			
Technical			
Operative			
Support			

4.5. Salaries payment:

Position	Female average month salary	Male average month salary
Managerial		
Technical		
Operative		
Support		

PART 5. INFORMATION RELATED TO ECONOMIC AND FINANCING ASPECTS

5.1. Total amount of services (Suns, last year):

Month	Qtty 1	P. U. 1	T. P. 1	Qtty 2	P. U. 2	T. P. 2
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

1 = main service, 2 = second service

5.2. Do you know if your production is exported? No [ ] Yes [ ] Where?: [ ]

5.3. Do you use digital platforms for pay providers or sell products?

Source	Method*	From since
Buy:		
Sell:		

* Credit card, debit card, mobile bank (phone), internet (laptor or pc)

5.4. Income levels and profit

Month	Income	W. Pay.	Inputs	T & O	Profit
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

W. Pay. = Workers Payments, T & O = Taxes and Obligations

5.5. To start your company, what was the composition of the inicial capital?

Own sources:	S/		that means:		%
Partner:	S/		that means:		%
Credit:	S/		that means:		%

Entity:			
Amount (Suns):		Time of credit:	months

5.6. What was de payback period for your investment? [ ] years.

5.7. Actually, Do you have any agriculture loans or micro credit? If yes, from where did you get that loan and what was the purpose of the loan?

Entity:			
Amount (Suns):		Time of credit:	months
Credit purpose:			

PART 6. COMPLEMENTARY INFORMATION

6.1. Productive education in the community within last year:

Institution	Level*	Program	Cost+

* University, technical, local government, particular. + If is statal, cost = 0

6.2. Cooperation between stakeholders:

Institution	Type*	Kind of Cooperation	Frequency

* University, technical, local government, supplier, particular

6.3. Innovation hubs in the city

Entity:	
Programs:	
Since:	

Employer - Quaternary Sector Questionnaire

QUESTIONNAIRE
EMPLOYERS - QUATERNARY SECTOR
EDUCATION, HEALTH, ARTS, ENTERTAINMENT AND RECREATION

CODE: [ ] DATE: [ ]

POLLSTER: [ ]

PART 1. GENERAL INFORMATION

1.1. Full Name: [ ]

1.2. Age: [ ] 1.3. Sex: Female: [ ] Male: [ ]

1.4. Address: [ ]

1.5. City: [ ]

1.6. District: [ ] 1.7. Province: [ ]

1.8. Marital Status: Single: [ ] Coupled: [ ]

1.9. Educational level:

Of the respondent:		Of the partner:	
Can't write name	[ ]	Can't write name	[ ]
Can read and write	[ ]	Can read and write	[ ]
Primary	[ ]	Primary	[ ]
Secondary	[ ]	Secondary	[ ]
Technical studies	[ ]	Technical studies	[ ]
Technical career	[ ]	Technical career	[ ]
University studies	[ ]	University studies	[ ]
Bachelor	[ ]	Bachelor	[ ]
Titled	[ ]	Titled	[ ]
Master	[ ]	Master	[ ]
Doctorate	[ ]	Doctorate	[ ]

1.10. Number of family members (living together): [ ]

1.11. Percentage of participation in the company: [ ]

1.12. Years of experience in the industry: [ ]

PART 2. INFORMATION RELATED TO MEANS OF PRODUCTION

2.1. The local that you use, is owned or rented? Owner [ ] Rented [ ]

2.2. If you are the owner, Does the local have a property title? Yes [ ] No [ ]

2.3. What is the area of your local? (in m2) [ ]

2.4. What is the capacity for your local? [ ] people

2.5. Do you know how many locals for services there are in your community?

Education (Schools)	[ ]	or	[ ]	%
Health Centers	[ ]	or	[ ]	%
Bar & Discoteques	[ ]	or	[ ]	%
Recreos campestres	[ ]	or	[ ]	%

PART 3. INFORMATION RELATED TO PRODUCTION MANAGEMENT

3.1. Main service: ____ Area (m2): ____

3.2. Second service: ____ Area (m2): ____

3.3. Third service: ____ Area (m2): ____

3.4. High demand times: ____ to ____ (____) months

3.5. Energy use in the company:

Energy	Source*	Principal Uses	Month quantity
Electricity			
Gas			
Fuel			
Other:			

* Source: public red, hydroelectric, eolic,digestor, motor, gas station, etc.

3.6. Emissions from the company:

Commercial name	From what processes	Year quantity
Greenhouse gases		
Ammonia		
Carbon dioxide (CO2)		
Nitrogen oxide (NOx)		
Sulphur Oxides (SOx)		
Particular Matter (PM)		
Volatile Organic Compounds (VOC)		

3.7. Waste produce by the company:

Waste	From what processes	Year quantity
Solid Waste		
Waste Water		
Hazardous waste*		

* Radioactive, electronic, oils, and similars

3.8. Do you have any process or service certified?

No ____

Yes ____ Which one?: ____ Certifier: ____

3.9. Use of ICT solutions in the company:

ICT solutions	Provider	Process	Time implemented

PART 4. INFORMATION RELATED TO PERSONAL MANAGEMENT

4.1. How many people are you employing?

Season	F (18 - 25)	F (>25)	M (18 - 25)	M (>25)
High demand				
Permanent				

4.2. Average daily working time in full time employments:

<8 Horas: [ ] 9 Horas [ ] 10 Horas [ ]

11 - 12 Horas [ ] >12 horas [ ]

4.3. Distribution and training of workers:

Position	F (Unsk)	M (Unsk)	F (S-Uns)	M (S-Uns)	F (Prof)	M (Prof)
Managerial						
Technical						
Operative						
Support						

4.4. Social benefits for workers:

Position	Health Insurance	Benefits payment	Paid vacations
Managerial			
Technical			
Operative			
Support			

4.5. Salaries payment:

Position	Female average month salary	Male average month salary
Managerial		
Technical		
Operative		
Support		

PART 5. INFORMATION RELATED TO ECONOMIC AND FINANCING ASPECTS

5.1. Total amount of service (Suns, last year):

Month	Qtty 1	P. U. 1	T. P. 1	Qtty 2	P. U. 2	T. P. 2
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

1 = main service, 2 = second service

5.2. Your company shares market with imported similar services?

No [ ]

Yes [ ] Which one?: [ ] Since?: [ ]

Which one?: [ ] Since?: [ ]

5.3. Do you use digital platforms for pay providers or sell products?

Source	Method*	From since
Buy:		
Sell:		

* Credit card, debit card, mobile bank (phone), internet (laptor or pc)

5.4. Income levels and profit

Month	Income	W. Pay.	Inputs	T & O	Profit
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

W. Pay. = Workers Payments, T & O = Taxes and Obligations

5.5. To start your company, what was the composition of the inicial capital?

Own sources:	S/		that means:		%
Partner:	S/		that means:		%
Credit:	S/		that means:		%

Entity:		
Amount (Suns):		Time of credit: months

5.6. What was de payback period for your investment? ______ years.

5.7. Actually, Do you have any agriculture loans or micro credit? If yes, from where did you get that loan and what was the purpose of the loan?

Entity:		
Amount (Suns):		Time of credit: months
Credit purpose:		

PART 6. COMPLEMENTARY INFORMATION

6.1. Productive education in the community within last year:

Institution	Level*	Program	Cost+

* University, technical, local government, particular. + If is statal, cost = 0

6.2. Cooperation between stakeholders:

Institution	Type*	Kind of Cooperation	Frequency

* University, technical, local government, supplier, particular

6.3. Innovation hubs in the city

Entity:	
Programs:	
Since:	

Local Authority Questionnaire

QUESTIONNAIRE
LOCAL AUTHORITIES

CODE: ____ DATE: ____

POLLSTER: ____

PART 1. GENERAL INFORMATION

1.1. Full Name: ____

1.2. Age: ____ 1.3. Sex: Female: ____ Male: ____

1.4. City: ____

1.5. District: ____ 1.6. Province: ____

1.7. Educational level:

Secondary		Bachelor	
Technical studies		Titled	
Technical career		Master	
University studies		Doctorate	

1.8. Years working in the public sector: ____

PART 2. ENVIRONMENTAL ISSUES

2.1. There are government protected areas in your community?

No ____

Yes ____ Which one?: ____ Area (km2): ____

Which one?: ____ Area (km2): ____

2.2. About the environmental and natural resources normative:

Environmental strategies	No		Old		Updated	
Environmental regulations	No		Old		Updated	
Environmental legilations	No		Old		Updated	
Environmental planning	No		Old		Updated	
Environmental management	No		Old		Updated	

2.3. There are any conflict to use water sources? No ____ Yes ____ Which one?: ____

2.4. Waste management in the community

Type of waste	Frequency	Attended people	Daily quantity
Domestic solid waste			
Industrial solid waste			
Domestic wastewater			
Industrial wastewater			
Hazardous waste*			

* medical, radioactive, electronic and similars

2.5. Land management in the community

Major land use	Area (Km2)	With legal title	Control authority
Total			
Free area (no owner)			
Agricultural lands			

Formal asentamientos			
Informal asentamientos			
Green areas			
Park and entertainment			
Streets land			
Houses and buildings			
Industrial area			
Commercial area			

PART 3. SOCIAL ISSUES

3.1. Educational institutions in the community

Level	Public	Private	Since
Pre Initial			
Initial			
Primary			
Secondary			
Technical Institute			
University			

3.2. Education management in the community

Level	Female	Male	Teachers Quantity
Students in level Initial			
Students in level Primary			
Students in level Secondary			
Students in Technical Institutes			
Studens in University			
Adult literacy rate			

3.3. Devices for education in the community

Level	PCs	Laptops	Tablets	Other:
Level Initial				
Level Primary				
Level Secondary				
Technical Institutes				
University				

3.4. Health institutions in the community

Level	Since	Public	Private	Doctors	Nurses
Posta médica sin médico					
Posta médica con médico					
Clinica					
Hospital					

3.5. Main human health indicators:

Description	Male	Female	Total
Life expectancy			
Maternal mortality rate	< >		
Child mortality rate			
Suicide rate			
Homicides			
Violent crimes agains women	< >		

3.6. Services supplied in the community:

Service	Provider	Coverage
Water		
Electricity		
Domestic gas		
Internet		
Mobile communication		

3.7. Population indicatos in the community:

Description	Male	Female	Total
Total population			
Young population (18-25 yo)			
PEA			
Emmigration rate			
Inmigration rate			
People living in poverty			
Unemployed young			
Unemployed people			

3.8. Cultural events in the community

Description	Annual frequency
Theather seasons	
Circus	
Festivals	
Folcloric parties	
Concerts	
Poetry contests	

3.9. Governance indicators in the community

Description	Male	Female	Total
Governability index	< >	< >	
Elected authorities			
Presupuesto municipal por habitante	< >	< >	
Public services on-line	< >	< >	

PART 4. ECONOMIC ISSUES

4.1. Do you know how many vehicles there are in your community?

Public transportation		or		%
Private uses		or		%
Government		or		%
Motorcycle o Tricycle		or		%

4.2. How many Km of adecuate roads, there are in your community?

Pavement		Km2	or		%
Affirmed		Km2	or		%
Carriage trail		Km2	or		%

4.3. Do you know how many locals for services there are in your community?

Restaurants		Education (Schools)	
Hotels & Hostels		Health Centers	
Stores		Bar & Discoteques	
Boutiques		Recreos campestres	

Inhabitant Questionnaire

QUESTIONNAIRE
INHABITANT

CODE: ______ DATE: ______

POLLSTER: ______

PART 1. GENERAL INFORMATION

1.1. Full Name: ______

1.2. Age: ______ 1.3. Sex: Female: ☐ Male: ☐

1.4. Address: ______

1.5. City: ______

1.6. District: ______ 1.7. Province: ______

PART 2. INFORMATION RELATED TO SOCIAL ASPECTS

2.1. Marital Status: Single: ☐ Bachelor: ☐ Widow/er: ☐ Divorced: ☐

Coupled: ☐ Joined: ☐ Married: ☐ Number of relation: ☐

2.2. Educational level:

Of the respondent:		Of the partner:	
Can't write name		Can't write name	
Can read and write		Can read and write	
Primary		Primary	
Secondary		Secondary	
Technical studies		Technical studies	
Technical career		Technical career	
University studies		University studies	
Bachelor		Bachelor	
Titled		Titled	
Master		Master	
Doctorate		Doctorate	

2.3. Age, educational status, and occupation of the children:

Family member	Sex	Age (Years)	Education (level)	Occupation
Husband				
Wife				
1st child				
2nd child				
3rd child				
4th child				
Other:				
Other:				
Other:				

2.4. Number of family members (living together): ______

2.5. Do you have any member of your family out of the community?

No			
Yes		Years out:	
Reason:			

2.6. The house where do you live, is owned?

2.7. The house where do you live, has a property title? No [ ] Yes [ ]

2.8. What is the constructer area in your house? (m2) [ ]

2.9. How many years are you living in the community: [ ]

2.10. Water sources for drinking:

Source	Monthly quantity	Monthly cost
Tube well (drinking water)		
Deep tube well		
Open well		
Shallow well		
Protected well		
Hand pump/paddle pump		
River		
Other:		

2.11. Energy use in the family:

Energy	Source*	Principal Uses	Month quantity
Electricity			
Gas			
Fuel			
Wood			
Other:			

* Source: public red, hydroelectric, eolic,digestor, motor, gas station, etc.

2.12. Emissions from the family:

Commercial name	From what processes	Year quantity
Greenhouse gases		
Ammonia		
Carbon dioxide (CO2)		
Nitrogen oxide (NOx)		
Sulphur Oxides (SOx)		
Particular Matter (PM)		
Volatile Organic Compounds (VOC)		

2.13. Telecommunications services in the community:

Service	Yes/No	From since	Respondant user
Cable internet			
Mobile internet			
Mobile operator Claro			
Mobile operator Movistar			
Mobile operator Bitel			
Mobile operator Entel			

2.14. Educational institutions in the community:

Institution	Yes/No	From since	Respondant user
Early stimulation centers			
EI Initial (PRONOEI)			
EI Primary			
EI Secondary			
Technical-productive EC			
EI Basic Special			
EI Basic Alternative			
Technical Institute of HE			
Private consultancies			
University			

2.15. Health institutions in the community:

Institution	Yes/No	From since	Respondant user
No one			
Health post without doctor			
Health post with doctor			
Health center without internment			
Health center with internment			
Hospital			

2.16. Do you have a health insurance? No [ ]
Yes [ ] Which one?: [ ]
How much you pay monthly for it? (S/): [ ]

2.17. Assets in the family

Name	Quantity	Year buyed	Price (S/)
Van			
Motorcycle			
Motorcycle taxi			
Bicycle			
TV			
Radio			
Mobile phone			
Personal computer			
Laptop			
Tablet			
Printer			
Furniture			
Washing machine			
Blender			
Microwave oven			
Refrigerator			
Electric water heater			
Therma with solar panel			
Other:			
Other:			

2.18. Green areas and recreational public spaces in the community

Name	Area (m2)	Distance*	Use frequency	Unitary cost
Zoo				

Park				
Deportive infrastructure				
Historic places				
Other:				

* Distance from your house

PART 3. INFORMATION RELATED TO ECONOMIC AND FINANCING ASPECTS

3.1. Main activity for working: ______

3.2. Years of experience in the activity: ______

3.3. Dou you work independently or employed? Independent ☐ Employed ☐
Company: ______ Months at year: ______

3.4. How many members of your family get salaries? ______

3.5. Anyone of your family works out of the community? No ☐ Yes ☐ Since when?: ______
Reason: ______

3.6. Do you think there are differences in salaries between genders? No ☐ Yes ☐ In favor of whom? ______

3.7. In the companies, for whom that work:

Member	Get paid on time?	Have health insurance?	Have benefits?

3.8. Family income

Description	Monthly	Year
Salaries		
Bonuses		
Other activities		
Other sellings		
Tips and drafts		
Other:		
Total		

3.9. Actually, Do you have any loans or micro credit? If yes, from where did you get it and what was the purpose of the loan?

Entity:		
Amount (S/):		Time of credit: months
Credit purpose:		

PART 4. INFORMATION RELATED TO COMMUNITY ENGADGEMENT

4.1. Decisions in the family (Whot takes them):

Description	Father	Mother	Children	Other
What economic activity to engage in				
What seed to use				
What food to prepare				
Where to find financing				

What tools to buy				
What appliances to buy				
Where to go for a walk or fun				
Where to educate children				

4.2. What is the importance of the following activities, in your opinion?

Activities	Very important	Important	Slightly important	Not important
Do you believe that religion or spirituality can bring joy and happiness				
You have civic responsibility and community engagement				
Do you think your community is inclusive				
What do you think about collective work				
What do you think about the government				
What do you think about the political representants in your community				

4.3. Your children want to continue your economic activity? No ☐ Yes ☐ Why? ☐

4.4. Cultural activities in the community:

Description	Annual frequency
Theather seasons	
Circus	
Festivals	
Folcloric parties	
Concerts	
Poetry contests	

4.5. Economic activities in the community:

Restaurants		or		%
Hotels & Hostels		or		%
Stores		or		%
Boutiques		or		%
Education (Schools)		or		%
Health Centers		or		%
Bar & Discoteques		or		%
Recreos campestres		or		%

Appendix E.

Statistical Results

This section shows the principal statistics used in the Thesis.

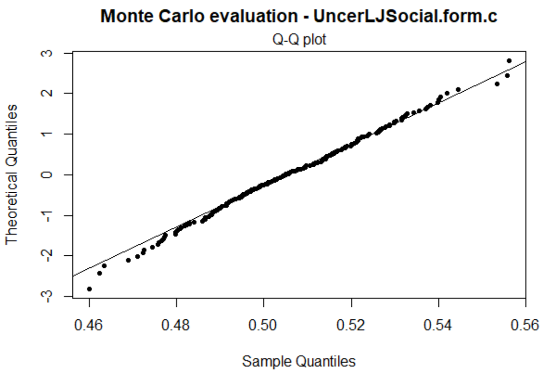
E.1. La Jalca assessment results

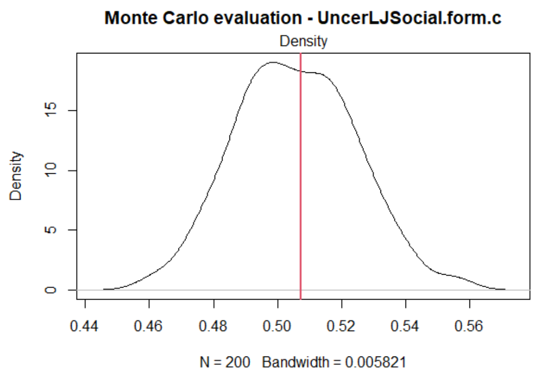
Uncertainty Analysis for Environmental Pillar - La Jalca

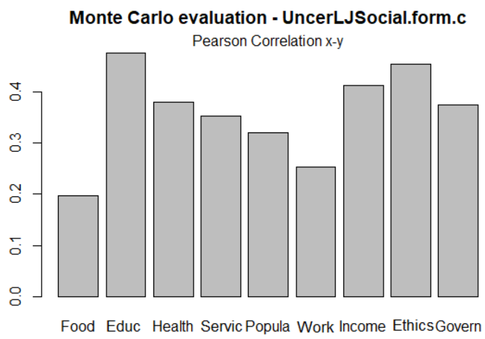
```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Biodiv * 0.1 + Soil * 0.1 + Water * 0.2 +     Waste * 0.2 + Air * 0.1 + Energy
 * 0.2 + Landscape * 0.1,     x = LJEnvironmental, u = UncerLJEnvironmental, method = "MC",     cor = U
ncerLJEnvironmental.cor)

Expression: ~Biodiv * 0.1 + Soil * 0.1 + Water * 0.2 + Waste * 0.2 + Air * 0.1 + Energy * 0.2 + Landsca
pe * 0.1

Evaluation method:  MC

Budget:
          x         u          c   u.c         distrib distrib.pars
Biodiv    0.4516621 0.04516621 0.1 0.004516621 norm    mean=0.4516621, sd=0.04516621
Soil      0.7235402 0.07235402 0.1 0.007235402 norm    mean=0.7235402, sd=0.07235402
Water     0.6738709 0.06738709 0.2 0.013477418 norm    mean=0.6738709, sd=0.06738709
Waste     0.7302222 0.07302222 0.2 0.014604444 norm    mean=0.7302222, sd=0.07302222
Air       0.8076708 0.08076708 0.1 0.008076708 norm    mean=0.8076708, sd=0.08076708
Energy    0.5283956 0.05283956 0.2 0.010567912 norm    mean=0.5283956, sd=0.05283956
Landscape 0.7467803 0.07467803 0.1 0.007467803 norm    mean=0.7467803, sd=0.07467803

   y:  0.6594631
u(y):  0.02814922

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.5948  0.6403  0.6599  0.6603  0.6825  0.7196
```

Uncertainty Analysis for Social Pillar - La Jalca

```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Food * 0.1 + Educat * 0.15 + Health * 0.1 +     Servic * 0.1 +
 Popula * 0.1 + Workin * 0.1 + Income * 0.1 +     Ethics * 0.15 + Govern * 0.1, x = LJS
ocial, u = UncerLJSocial,     method = "MC", cor = UncerLJSocial.cor)

Expression: ~Food * 0.1 + Educat * 0.15 + Health * 0.1 + Servic * 0.1 + Popula * 0.1 +
 Workin * 0.1 + Income * 0.1 + Ethics * 0.15 + Govern * 0.1

Evaluation method:  MC

Budget:
       x         u          c    u.c         distrib distrib.pars
Food   0.4098072 0.04098072 0.10 0.004098072 norm    mean=0.4098072, sd=0.04098072
Educat 0.5234587 0.05234587 0.15 0.007851880 norm    mean=0.5234587, sd=0.05234587
Health 0.7532812 0.07532812 0.10 0.007532812 norm    mean=0.7532812, sd=0.07532812
Servic 0.6400568 0.06400568 0.10 0.006400568 norm    mean=0.6400568, sd=0.06400568
Popula 0.5087856 0.05087856 0.10 0.005087856 norm    mean=0.5087856, sd=0.05087856
Workin 0.4388829 0.04388829 0.10 0.004388829 norm    mean=0.4388829, sd=0.04388829
Income 0.3465134 0.03465134 0.10 0.003465134 norm    mean=0.3465134, sd=0.03465134
Ethics 0.5423408 0.05423408 0.15 0.008135112 norm    mean=0.5423408, sd=0.05423408
Govern 0.3773993 0.03773993 0.10 0.003773993 norm    mean=0.3773993, sd=0.03773993

   y:  0.5073426
u(y):  0.01866282

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.4600  0.4920  0.5049  0.5057  0.5186  0.5562
```

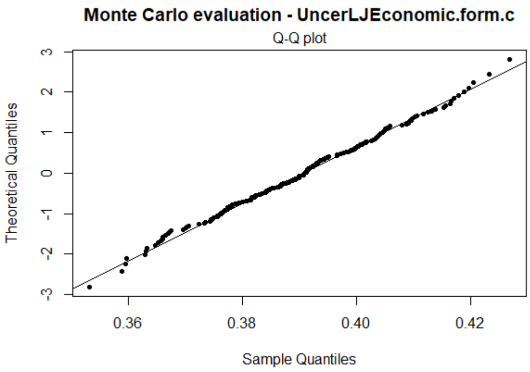


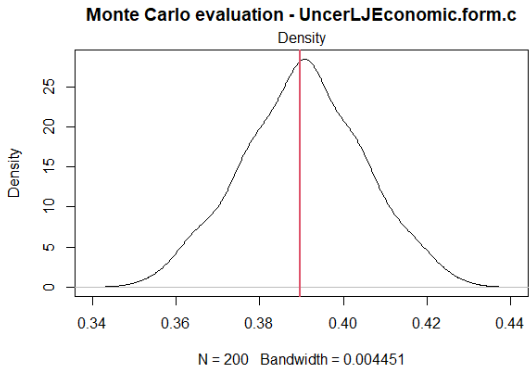


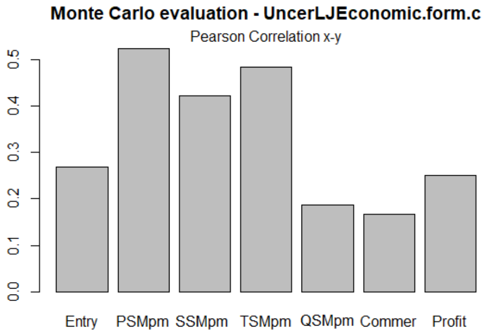


Uncertainty Analysis for Economic Pillar - La Jalca

```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Entry * 0.1 + PSMpm * 0.25 + SSMpm * 0.2 +     TSMpm * 0.15 + Q
SMpm * 0.1 + Commer * 0.1 + Profit * 0.1,     x = LJEconomic, u = UncerLJEconomic, meth
od = "MC", cor = UncerLJEconomic.cor)

Expression: ~Entry * 0.1 + PSMpm * 0.25 + SSMpm * 0.2 + TSMpm * 0.15 + QSMpm * 0.1 + Co
mmer * 0.1 + Profit * 0.1

Evaluation method:  MC

Budget:
       x         u          c    u.c         distrib distrib.pars
Entry  0.3712325 0.03712325 0.10 0.003712325 norm    mean=0.3712325, sd=0.03712325
PSMpm  0.3452741 0.03452741 0.25 0.008631854 norm    mean=0.3452741, sd=0.03452741
SSMpm  0.3495991 0.03495991 0.20 0.006991983 norm    mean=0.3495991, sd=0.03495991
TSMpm  0.4683016 0.04683016 0.15 0.007024523 norm    mean=0.4683016, sd=0.04683016
QSMpm  0.3915556 0.03915556 0.10 0.003915556 norm    mean=0.3915556, sd=0.03915556
Commer 0.3775703 0.03775703 0.10 0.003775703 norm    mean=0.3775703, sd=0.03775703
Profit 0.4923497 0.04923497 0.10 0.004923497 norm    mean=0.4923497, sd=0.04923497

   y:  0.3897544
u(y):  0.01433783

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.3531  0.3812  0.3908  0.3904  0.4004  0.4269
```



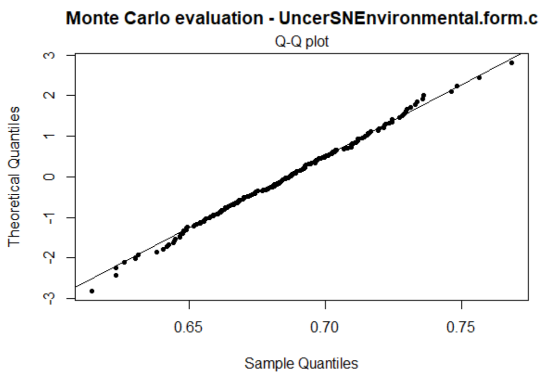


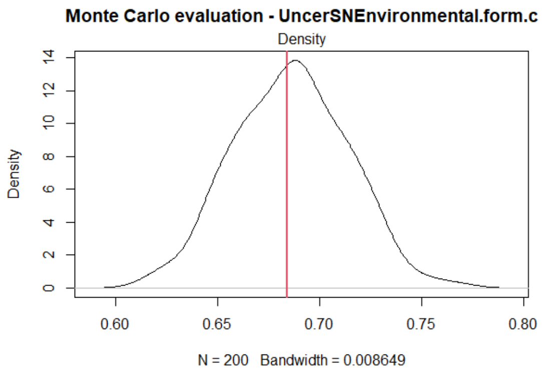


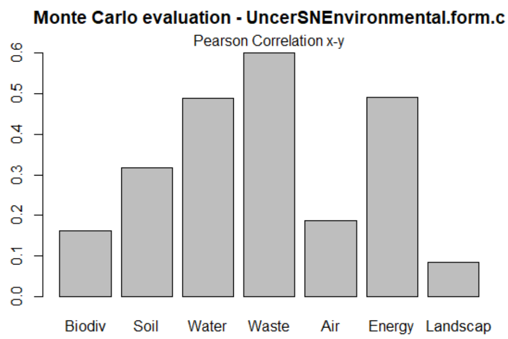
E.2. San Nicolás assessment results

Uncertainty Analysis for Environmental Pillar - San Nicolás

```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Biodiv * 0.1 + Soil * 0.1 + Water * 0.2 +     Waste * 0.2 + Air * 0.1 + Energy
 * 0.2 + Landscape * 0.1,     x = SNEnvironmental, u = UncerSNEnvironmental, method = "MC",     cor = U
ncerSNEnvironmental.cor)

Expression: ~Biodiv * 0.1 + Soil * 0.1 + Water * 0.2 + Waste * 0.2 + Air * 0.1 + Energy * 0.2 + Landsca
pe * 0.1

Evaluation method:  MC

Budget:
          x         u          c   u.c         distrib distrib.pars
Biodiv    0.5778511 0.05778511 0.1 0.005778511 norm    mean=0.5778511, sd=0.05778511
Soil      0.7036841 0.07036841 0.1 0.007036841 norm    mean=0.7036841, sd=0.07036841
Water     0.6801022 0.06801022 0.2 0.013602044 norm    mean=0.6801022, sd=0.06801022
Waste     0.7864727 0.07864727 0.2 0.015729455 norm    mean=0.7864727, sd=0.07864727
Air       0.8220584 0.08220584 0.1 0.008220584 norm    mean=0.8220584, sd=0.08220584
Energy    0.6707686 0.06707686 0.2 0.013415372 norm    mean=0.6707686, sd=0.06707686
Landscape 0.4653409 0.04653409 0.1 0.004653409 norm    mean=0.4653409, sd=0.04653409

   y:  0.6843622
u(y):  0.02772922

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.6144  0.6664  0.6866  0.6861  0.7048  0.7684
```





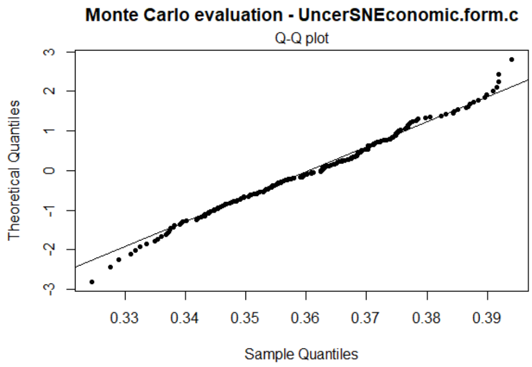


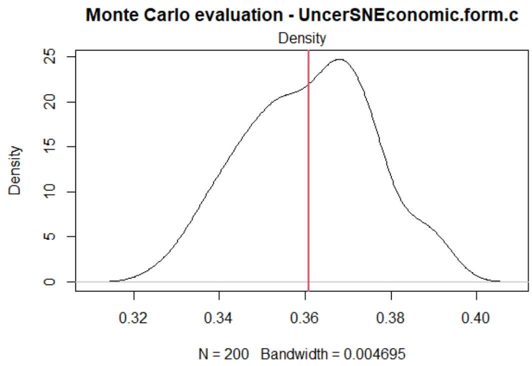
Uncertainty Analysis for Social Pillar - San Nicolás

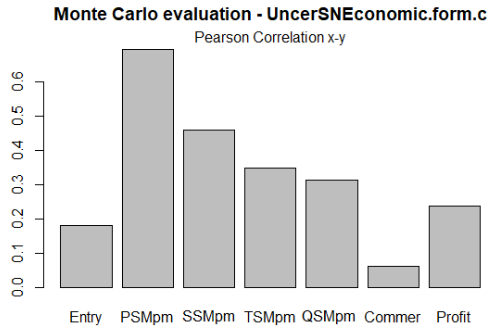
```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Food * 0.1 + Educat * 0.15 + Health * 0.1 +     Servic * 0.1 +
 Popula * 0.1 + Workin * 0.1 + Income * 0.1 +     Ethics * 0.15 + Govern * 0.1, x = SNS
ocial, u = UncerSNSocial,     method = "MC", cor = UncerSNSocial.cor)

Expression: ~Food * 0.1 + Educat * 0.15 + Health * 0.1 + Servic * 0.1 + Popula * 0.1 +
 Workin * 0.1 + Income * 0.1 + Ethics * 0.15 + Govern * 0.1

Evaluation method:  MC

Budget:
       x         u          c    u.c         distrib distrib.pars
Food   0.3843855 0.03843855 0.10 0.003843855 norm    mean=0.3843855, sd=0.03843855
Educat 0.5183293 0.05183293 0.15 0.007774939 norm    mean=0.5183293, sd=0.05183293
Health 0.7133365 0.07133365 0.10 0.007133365 norm    mean=0.7133365, sd=0.07133365
Servic 0.7023438 0.07023438 0.10 0.007023438 norm    mean=0.7023438, sd=0.07023438
Popula 0.5520354 0.05520354 0.10 0.005520354 norm    mean=0.5520354, sd=0.05520354
Workin 0.4155443 0.04155443 0.10 0.004155443 norm    mean=0.4155443, sd=0.04155443
Income 0.4376180 0.04376180 0.10 0.004376180 norm    mean=0.437618, sd=0.0437618
Ethics 0.5523351 0.05523351 0.15 0.008285026 norm    mean=0.5523351, sd=0.05523351
Govern 0.4962843 0.04962843 0.10 0.004962843 norm    mean=0.4962843, sd=0.04962843

   y:  0.5307544
u(y):  0.01805141

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.4859  0.5152  0.5308  0.5306  0.5435  0.5699
```

Uncertainty Analysis for Economic Pillar - San Nicolás

```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Entry * 0.1 + PSMpm * 0.25 + SSMpm * 0.2 +     TSMpm * 0.15 + Q
SMpm * 0.1 + Commer * 0.1 + Profit * 0.1,     x = SNEconomic, u = UncerSNEconomic, meth
od = "MC", cor = UncerSNEconomic.cor)

Expression: ~Entry * 0.1 + PSMpm * 0.25 + SSMpm * 0.2 + TSMpm * 0.15 + QSMpm * 0.1 + Co
mmer * 0.1 + Profit * 0.1

Evaluation method:  MC

Budget:
       x         u          c    u.c         distrib distrib.pars
Entry  0.3634696 0.03634696 0.10 0.003634696 norm    mean=0.3634696, sd=0.03634696
PSMpm  0.4330852 0.04330852 0.25 0.010827131 norm    mean=0.4330852, sd=0.04330852
SSMpm  0.2835033 0.02835033 0.20 0.005670065 norm    mean=0.2835033, sd=0.02835033
TSMpm  0.3698778 0.03698778 0.15 0.005548167 norm    mean=0.3698778, sd=0.03698778
QSMpm  0.3636646 0.03636646 0.10 0.003636646 norm    mean=0.3636646, sd=0.03636646
Commer 0.2820019 0.02820019 0.10 0.002820019 norm    mean=0.2820019, sd=0.02820019
Profit 0.3956757 0.03956757 0.10 0.003956757 norm    mean=0.3956757, sd=0.03956757

   y:  0.3609348
u(y):  0.01505266

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.3245  0.3497  0.3625  0.3609  0.3712  0.3941
```



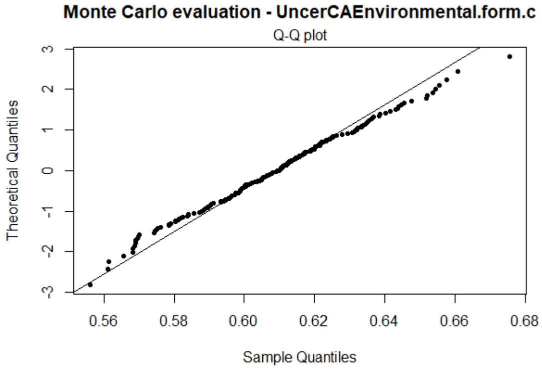


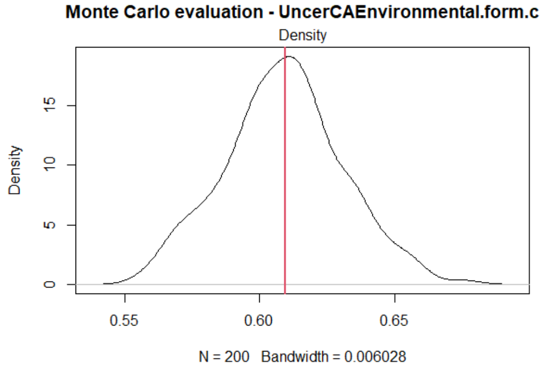


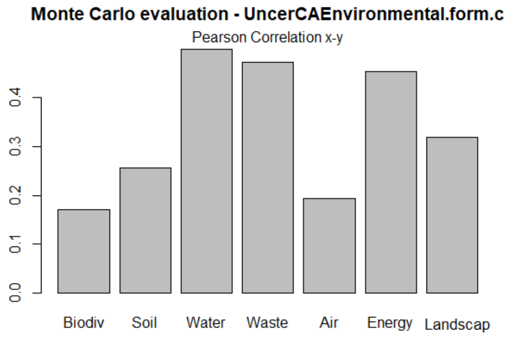
E.3. Cajaruro assessment results

Uncertainty Analysis for Environmental Pillar - Cajaruro

```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Biodiv * 0.1 + Soil * 0.1 + Water * 0.2 +     Waste * 0.2 + Air * 0.1 + Energy
 * 0.2 + Landscape * 0.1,      x = CAEnvironmental, u = UncerCAEnvironmental, method = "MC",     cor = U
ncerCAEnvironmental.cor)

Expression: ~Biodiv * 0.1 + Soil * 0.1 + Water * 0.2 + Waste * 0.2 + Air * 0.1 + Energy * 0.2 + Landsca
pe * 0.1

Evaluation method:  MC

Budget:
          x         u          c   u.c         distrib distrib.pars
Biodiv    0.4949165 0.04949165 0.1 0.004949165 norm    mean=0.4949165, sd=0.04949165
Soil      0.6568934 0.06568934 0.1 0.006568934 norm    mean=0.6568934, sd=0.06568934
Water     0.5983286 0.05983286 0.2 0.011966572 norm    mean=0.5983286, sd=0.05983286
Waste     0.5848957 0.05848957 0.2 0.011697913 norm    mean=0.5848957, sd=0.05848957
Air       0.7925000 0.07925000 0.1 0.007925000 norm    mean=0.7925, sd=0.07925
Energy    0.6195713 0.06195713 0.2 0.012391426 norm    mean=0.6195713, sd=0.06195713
Landscape 0.5444444 0.05444444 0.1 0.005444444 norm    mean=0.5444444, sd=0.05444444

   y:  0.6094345
u(y):  0.02188941

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.5562  0.5960  0.6096  0.6089  0.6219  0.6757
```

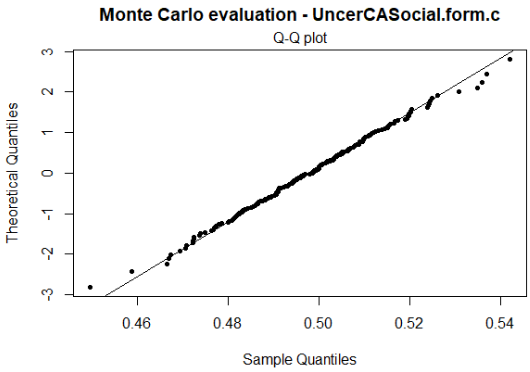


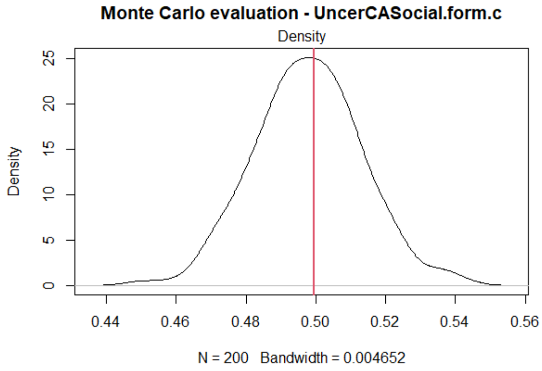


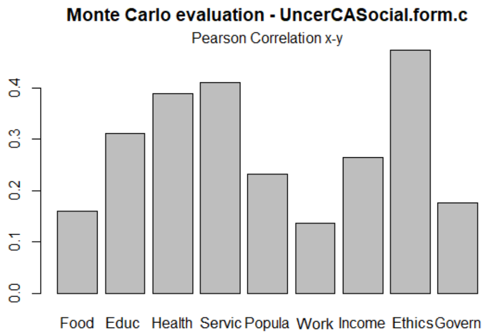


Uncertainty Analysis for Social Pillar - Cajaruro

```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Food * 0.1 + Educat * 0.15 + Health * 0.1 +     Servic * 0.1 +
 Popula * 0.1 + Workin * 0.1 + Income * 0.1 +     Ethics * 0.15 + Govern * 0.1, x = CAS
ocial, u = UncerCASocial,     method = "MC", cor = UncerCASocial.cor)

Expression: ~Food * 0.1 + Educat * 0.15 + Health * 0.1 + Servic * 0.1 + Popula * 0.1 +
 Workin * 0.1 + Income * 0.1 + Ethics * 0.15 + Govern * 0.1

Evaluation method:  MC

Budget:
       x         u          c    u.c         distrib distrib.pars
Food   0.3738824 0.03738824 0.10 0.003738824 norm    mean=0.3738824, sd=0.03738824
Educat 0.5011448 0.05011448 0.15 0.007517172 norm    mean=0.5011448, sd=0.05011448
Health 0.7117547 0.07117547 0.10 0.007117547 norm    mean=0.7117547, sd=0.07117547
Servic 0.6343403 0.06343403 0.10 0.006343403 norm    mean=0.6343403, sd=0.06343403
Popula 0.4135417 0.04135417 0.10 0.004135417 norm    mean=0.4135417, sd=0.04135417
Workin 0.4298654 0.04298654 0.10 0.004298654 norm    mean=0.4298654, sd=0.04298654
Income 0.3722771 0.03722771 0.10 0.003722771 norm    mean=0.3722771, sd=0.03722771
Ethics 0.5793209 0.05793209 0.15 0.008689814 norm    mean=0.5793209, sd=0.05793209
Govern 0.4387923 0.04387923 0.10 0.004387923 norm    mean=0.4387923, sd=0.04387923

   y:  0.4995152
u(y):  0.01539229

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.4497  0.4880  0.4985  0.4978  0.5080  0.5422
```







Uncertainty Analysis for Economic Pillar - Cajaruro

```
Uncertainty evaluation

Call:
  uncert.formula(obj = ~Entry * 0.1 + PSMpm * 0.25 + SSMpm * 0.2 +     TSMpm * 0.15 + Q
SMpm * 0.1 + Commer * 0.1 + Profit * 0.1,     x = CAEconomic, u = UncerCAEconomic, meth
od = "MC", cor = UncerCAEconomic.cor)

Expression: ~Entry * 0.1 + PSMpm * 0.25 + SSMpm * 0.2 + TSMpm * 0.15 + QSMpm * 0.1 + Co
mmer * 0.1 + Profit * 0.1

Evaluation method:  MC

Budget:
       x         u          c    u.c         distrib distrib.pars
Entry  0.3371999 0.03371999 0.10 0.003371999 norm    mean=0.3371999, sd=0.03371999
PSMpm  0.4338184 0.04338184 0.25 0.010845460 norm    mean=0.4338184, sd=0.04338184
SSMpm  0.2760865 0.02760865 0.20 0.005521731 norm    mean=0.2760865, sd=0.02760865
TSMpm  0.2761617 0.02761617 0.15 0.004142426 norm    mean=0.2761617, sd=0.02761617
QSMpm  0.3592857 0.03592857 0.10 0.003592857 norm    mean=0.3592857, sd=0.03592857
Commer 0.3332930 0.03332930 0.10 0.003332930 norm    mean=0.333293, sd=0.0333293
Profit 0.3045226 0.03045226 0.10 0.003045226 norm    mean=0.3045226, sd=0.03045226

   y:  0.3385263
u(y):  0.01459693

Monte Carlo evaluation using 200 replicates:

   y:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.3046  0.3297  0.3400  0.3398  0.3494  0.3813
```

Appendix F.

Expert support

F.1. Expert participation and contributions

The experts who supported the research are presented below, detailing their academic formation and the contribution they made.

Name	Formation	Contributions
Jorge Luis Maicelo Quintana	Zootechnicist Engineer Master in Agricultural Innovation for Rural Development Doctor in Sustainable Agriculture	Sustainability issues Weights and aggregation
Carlos Alberto Hinojosa Salazar	Public Accountant Master in Economic Sciences Doctor of Administration	Economic and Social issues Weights and aggregation
Cástula Alvarado Chuqui	Environmental Engineer Master of Superior Teaching and Educational Research Doctor in Education Administration	Social and Environmental issues Weights and aggregation

F.2. Tool validation

OPINIÓN DE EXPERTOS SOBRE EL INSTRUMENTO DE INVESTIGACIÓN

I. DATOS GENERALES:

1.1. **Apellidos y nombres del experto**: CÁSTULA ALVARADO CHUQUI
1.2. **Grado Académico**: DOCTORA EN ADMINISTRACIÓN DE LA EDUCACIÓN
1.3 **Profesión**: INGENIERA AMBIENTAL
1.4. **Institución donde labora**: UNIVERSIDAD NACIONAL TORIBIO RODRÍGUEZ DE MENDOZA DE AMAZONAS
1.5. **Cargo que desempeña**: DOCENTE NOMBRADA
1.6 **Denominación del Instrumento**: Elaboración y calibración de un modelo que mida la sustentabilidad de las zonas geográficas de acuerdo a su uso mayor.
1.7. **Autor del instrumento**: Ms. Heisely Mori Peláez
1.8 **Programa de postgrado**: Doctorado en Ciencias para el Desarrollo Sustentable

II. VALIDACIÓN

INDICADORES DE EVALUACIÓN DEL INSTRUMENTO	CRITERIOS Sobre los ítems del instrumento	Muy Malo	Malo	Regular	Bueno	Muy Bueno
		1	2	3	4	5
1. CLARIDAD	Están formulados con lenguaje apropiado que facilita su comprensión				X	
2. OBJETIVIDAD	Están expresados en conductas observables, medibles				X	
3. CONSISTENCIA	Existe una organización lógica en los contenidos y relación con la teoría				X	
4. COHERENCIA	Existe relación de los contenidos con los indicadores de la variable				X	
5. PERTINENCIA	Las categorías de respuestas y sus valores son apropiados				X	
6. SUFICIENCIA	Son suficientes la cantidad y calidad de ítems presentados en el instrumento				X	
	SUMATORIA PARCIAL				24	
	SUMATORIA TOTAL	24				

Nota: Mínimo aprobatorio 21 puntos en la sumatoria total

III. RESULTADOS DE LA VALIDACIÓN

3.1. Valoración total cuantitativa: ____24___

3.2. Opinión: FAVORABLE ___X__

DEBE MEJORAR ______

NO FAVORABLE ______

3.3. Observaciones: __Ninguna____

____

____

Chachapoyas, noviembre del 2020

____

Firma

OPINIÓN DE EXPERTOS SOBRE EL INSTRUMENTO DE INVESTIGACIÓN

I. DATOS GENERALES:

1.1. **Apellidos y nombres del experto**: CARLOS ALBERTO HINOJOSA SALAZAR
1.2. **Grado Académico**: DOCTOR EN ADMINISTRACIÓN
1.3. **Profesión**: CONTADOR PÚBLICO
1.4. **Institución donde labora**: UNIVERSIDAD NACIONAL TORIBIO RODRÍGUEZ DE MENDOZA DE AMAZONAS
1.5. **Cargo que desempeña**: DOCENTE NOMBRADO
1.6. **Denominación del Instrumento**: Elaboración y calibración de un modelo que mida la sustentabilidad de las zonas geográficas de acuerdo a su uso mayor.
1.7. **Autor del instrumento**: Ms. Heisely Mori Peláez
1.8 **Programa de postgrado**: Doctorado en Ciencias para el Desarrollo Sustentable

II. VALIDACIÓN

INDICADORES DE EVALUACIÓN DEL INSTRUMENTO	CRITERIOS Sobre los ítems del instrumento	Muy Malo	Malo	Regular	Bueno	Muy Bueno
		1	**2**	**3**	**4**	**5**
1. CLARIDAD	Están formulados con lenguaje apropiado que facilita su comprensión					X
2. OBJETIVIDAD	Están expresados en conductas observables, medibles				X	
3. CONSISTENCIA	Existe una organización lógica en los contenidos y relación con la teoría				X	
4. COHERENCIA	Existe relación de los contenidos con los indicadores de la variable				X	
5. PERTINENCIA	Las categorías de respuestas y sus valores son apropiados				X	
6. SUFICIENCIA	Son suficientes la cantidad y calidad de ítems presentados en el instrumento					X
	SUMATORIA PARCIAL				16	10
	SUMATORIA TOTAL	26				

Nota: Mínimo aprobatorio 21 puntos en la sumatoria total

III. RESULTADOS DE LA VALIDACIÓN

3.1. Valoración total cuantitativa: ___26___

3.2. Opinión: FAVORABLE ___X__

DEBE MEJORAR ______

NO FAVORABLE ______

3.3. Observaciones: _____Ninguna____

____

____

Chachapoyas, noviembre del 2020

____

Firma

Dr. Carlos A. Hinojosa Salazar