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Concept Note in Science, Technology, and Innovation 2019 – 2024

For the cooperation between the Swedish International Development Agency (Sida) and Universidad Mayor de San Simón (UMSS)

Dirección de Investigación Científica y Tecnológica
COCHABAMBA - BOLIVIA

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Cochabamba, March 2019

Contents

Glossary of Terms

Acronym	Full Name
STA	Scientific and Technological Activities
STIA	Scientific, Technological, and Innovation Activities
ANUCTI	Agencia Nacional de Ciencia, Tecnología e Innovación [National Agency for Science, Technology, and Innovation]
APEAESU	Agencia Plurinacional de Evaluación y Acreditación de la Educación Superior Universitaria [Plurinational Agency for the Evaluation and Accreditation of Higher University Education]
ESG	The Standards and Guidelines for Quality Assurance in the European Higher Education
CAAURII	Consorcio Académico de Acceso y Uso de Recursos de Información para la Investigación [Academic Consortium on Access and Use of Information Resources]
CEI	Comité de Ética en Investigación [Research Ethics Committee]
CEPAP	Centros de Excelencia Plurinacional para la Productividad [Plurinational Centres of Excellence in Productivity]
CEUB	Comité Ejecutivo de la Universidad Boliviana [Bolivian University Executive Committee]
CPE	Constitución Política del Estado [Political Constitution of the State]
CRES	Consejos Regionales Económicos y Sociales [Economic and Social Regional Councils]
STI	Science, Technology, and Innovation
DAF	Dirección Administrativa y Financiera [Administration and Finances Directorate]
DICyT	Dirección de Investigación Científica y Tecnológica [Scientific and Technological Research Directorate]
DISU	Dirección de Interacción Social Universitaria [University Social Interaction Directorate]
DPA	Dirección de Planificación Académica [Academic Planning Directorate]
DRIC	Dirección de Relaciones Internacionales y Convenios [International Relations and Conventions Directorate]
DUBE	Dirección Universitaria de Bienestar Estudiantil [University Student Affairs Directorate]
DUEA	Dirección Universitaria de Evaluación y Acreditación [University Evaluation and Accreditation Directorate]
EBT	Empresas de Base Tecnológica [Technology-based Companies]
EDIU	Estructura de Interfaz Universitaria [University Interface Structure]
ESP	Entorno Socio Productivo [Socio-productive Environment]
EUPG	Escuela Universitaria de Posgrado [University Postgraduate School]
FOICyT	Fondo Institucional de Ciencia y Tecnología [Institutional Fund for Science and Technology]
FONUCyT	Fondo Nacional Universitario de Ciencia y Tecnología [National University Fund for Science and Technology]
R&D&I	Research, Experimental Development, and Innovation
DHT	Direct Hydrocarbon Tax
OTRI	Organismos de Transferencia de Resultados de Investigación [Offices of Research Results Transfer]
PDC	Plan Departamental de Cochabamba para Vivir Bien 2013–2017 [2013–2017 Cochabamba Department Plan to Live Well]

PDES	Plan de Desarrollo Económico y Social 2016-2020 [2016-2020 Economic and Social Development Plan]
PIC	Programas de Innovación Continua [Continuous Innovation Programmes]
PNCTI	Plan Nacional de Ciencia, Tecnología e Innovación [National Plan for Science, Technology, and Innovation]
PNCTI-SUB	Plan Nacional de Ciencia, Tecnología e Innovación del SUB 2017-2026 [2017-2026 SUB's National Plan for Science, Technology, and Innovation]
RCU	Resolución del Honorable Consejo Universitario [University Council Resolution]
HR	Human Resources
RSU	Responsabilidad Social Universitaria [University Social Responsibility]
RUE	Relación Universidad Empresa [University-Business Relationship]
SBCTI	Sistema Boliviano de Ciencia, Tecnología e Innovación [Bolivian Science, Technology, and Innovation System]
SEP	Sistema de Ejecución Presupuestaria [Budgetary Execution System]
SICTI	Sistema de Investigación Científica, Tecnológica e Innovación [Scientific and Technological Research and Innovation System]
SIGESPI	Sistema de Gestión de Proyectos de Investigación [Research Project Management System]
SINUCyT	Sistema Nacional Universitario de Ciencia, Tecnología e Innovación [National University System of Science, Technology, and Innovation]
SNICyT	Secretaría Nacional de Investigación, Ciencia y Tecnología [National Secretariat for Research, Science, and Technology]
SPIE	Sistema de Planificación Integral del Estado [Integrated State Planning System]
SUB	Sistema de la Universidad Boliviana [Bolivian University System]
ICT	Information and Communication Technology
UEI	Unidades Ejecutoras de Investigación [Research Units]
UMSA	Universidad Mayor de San Andrés
UMSS	Universidad Mayor de San Simón
UPSI	Unidad de Provisión de Servicios Información [Information Service Unit]
UTT	Unidad de Transferencia de Tecnología [Technology Transfer Unit]
VCyT	Viceministerio de Ciencia y Tecnología [Vice-Ministry of Science and Technology]

INTRODUCTION:

The United Nations Summit (General Assembly, 2015), in its document "Transforming our world: the 2030 Agenda for Sustainable Development," proposes universal, comprehensive, and indivisible goals and targets to channel *sustainable development* in three dimensions: economic, social, and environmental. The Summit also aims at contributing to attain Human Rights for men and women, and gender equality. Through global *partnerships*, it seeks *prosperity*, without affecting the *planet*, to balance human development indexes (*people*) in peaceful societies, bridging the gap between so-called developing and industrialised countries. UNESCO also asserts that the rise of knowledge societies elicits the economy of knowledge and innovation, which points to the social, cultural, and economic transformations underpinning sustainable development.

On the other hand, the term "development" in some currents of Evolutionary Economics is tied to knowledge-based growth. Accordingly, (Vega, 2013) emphasises the presence of innovation as the driving force of economic growth. Equally, (Castro & Fernández, 2013) mention the desirability of understanding that knowledge and the capacity to learn and innovate are complementary aspects at the core of advanced societies' development. Knowledge generation via R&D&I has also been observed to accelerate economic and social growth rates in developed or developing countries. This is the case of South Korea, China, and Brazil, the production structures of which have made or are making quantitative leaps.

This new shaping of sustainable human development demands important transformations in science, technology, and innovation systems at national and regional levels, as well as a dynamic evolution in how universities are organised and operate. Universities are the main generators of R&D&I, which must be transferred and placed at the service of society at large as University Social Responsibility (RSU), particularly if universities are public.

The Universidad Mayor de San Simón (UMSS) is not exempt from this reality. Since 2000, it has been updating its Scientific and Technological Research System. The present document, prepared by the Scientific and Technological Research Directorate (DICyT) as per university regulations[1], is based on the principle of a continuous construction of the research system, making a qualitative leap towards fulfilling the third mission of universities, understood in Latin America as interaction and not as actual technology transfer. Therefore, several agendas and plans have been systematically analysed: the 2030 Agenda at the **international** level; the 2025 Agenda, the 2016-2020 Economic and Social Development Plan, and the Ministry of Education's National Plan for Science, Technology, and Innovation at the **national** level; the National Science, Technology, and Innovation Plan for the Bolivian University System at the **sectoral** level; and the 2014-2019 Development Plan, and UMSS' 2012-2021 Concept Note in Research at the **institutional** level. This analysis aims at understanding the current dynamics in several scenarios that tries to structure corresponding science, technology, and innovation systems; and has also helped buttress the new proposal to develop the Scientific and Technological Research and Innovation System (SICTI) (UMSS, 2017), addressed in the following chapter (Background).

Subsequent chapters pose (main and specific) objectives and the next 5 years of results. The Action Plan chapter discusses how to reach those objectives and obtain those results, and proposes actions in 4 areas (Science Policy, Regulations, Functional Organisation, and Finances). The Action Plan also defines UMSS' priority axes in Scientific, Technological, and Innovation Activities (STIA) for the next 5 years. Next, we discuss how to assure quality research and postgraduate studies in science; the budget needed for the next 5 years of actions; how the present proposal was built, and a critical analysis considering, inter alia, sustainability, environmental impact, and gender. Lastly, actions to coordinate partners and donors are described, as well as the internal evaluation of the Concept Note.

[1] Arts. 91 and 92 of the UMSS Organic Statute, and Art. 14 of the UMSS General Regulation of Scientific and Technological Research.

1. BACKGROUND

Bolivia lies at the centre of South America. Its current population is over 11 million, 49.6% of which are women. Children under 15 are 32.4% of the population; the 15-29 age group is 27.2%, the 30-59 age group is 31.4%, and older adults are 8.9% of the population. In conclusion, the population is mostly young, according to the National Statistics Institute (INE for its Spanish acronym, 2017). Bolivia occupies 1,098,581 Km^2, with 4 inhabitants per km^2. Its territory has three predominant geographical areas: the Andean area (over 3,000 meters above sea level); the Sub-Andean area (valleys and yungas, 2,500 meters above sea level in average); and plains and low plateaus (under 2,500 meters above sea level). Bolivia is politically divided into 9 departments, 112 provinces, and 339 autonomous municipalities.

The Department of Cochabamba has 1,762,761 inhabitants (49.3 % are men and 50, 7 % are women), and covers a surface of 65,089,666 Km^2. Its strategic geographical position renders it the heart of Bolivia and an articulating centre where the nation converges (by land, air, and rivers). This department has many altitudes and ecological floors, and a diversity of climates and micro-climates (Cochabamba Government, 2013).

1.1. What does economic and social development hold for Bolivia and Cochabamba?

The national government proposed the *Economic and Social Development Plan* (PDES)—based on the *2025 Patriotic Bicentennial Agenda* and led by de-patriarchisation and de-colonisation principles—to guide the actions of any economic and social policy implemented by the Central Government, territorial organisation governments, the private sector, social organisations, and public and private universities in the country. PDES aims at "Living Well" by respecting "Mother Earth"[2] and the sustenance of "Life Systems."[3] Thus, it follows the Integrated State Planning System (SPIE) approved by Law of January 21, 2016.

The 2025 Agenda, its second edition published by the (Ministry of Communication, 2013), poses 13 pillars and 68 goals to build a Dignified and Sovereign Bolivia; and to erect inclusive, participatory, and democratic society and state, free from discrimination, racism, hate, or division[4]. In 2018, Bolivia's president *"announced he would prompt adjustments to his 2025 Patriotic Bicentennial Agenda to include the demands of the country's growing middle class."*[5] On the other hand, PDES explains the 13 pillars, and becomes the strategic framework that prioritises goals, results, and actions to develop by 2020.

According to the (Ministry of Development Planning, 2015), launching PDES will help:

- Deepen processes that transform the production matrix, i.e., strengthen conditions for the country to become the centre of regional energy (**energy**) and road integration (Infrastructure/ **construction**). Besides, the country will make an important leap in economic diversification, industrialisation, and the growth of income generated by **hydrocarbons, farming, mining, tourism,** and **industrial** processing (production complexes/technological-production centres of innovation) with an environmental vision. The role of small and medium-sized producers and of community economy will be enhanced, while developing a society based on knowledge and on its own creative economies.
- Advance social policies, mostly to eradicate extreme poverty and its feminisation, with greater and better access to **education**, **health**, and **basic services**.
- Industrialise natural resources protecting Mother Earth, and reduce environmental pollution to preserve Mother Earth as an inheritance for future generations' enjoyment and wellbeing.

[2] Mother Earth houses, sustains, and reproduces all living beings, ecosystems, biodiversity, organic societies, and all individuals comprising it.
[3] Life Systems complement Mother Earth's community of beings that live in harmony and equilibrium.
[4] Bolivia has ratified international treatises and conventions, such as the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW 1979), and the Santo Domingo Consensus in the Twelfth Session of the Regional Conference on Women in Latin America and the Caribbean (2013). The latter stressed on the import of gender equality in the debate over development, expressly stipulating that gender equality must be mainstreamed in all State actions as a key factor in strengthening democracy and moving towards a more participatory and inclusive development model.
[5] https://mundo.sputniknews.com/americalatina/201801251075746546-bolivia-finanzas-poblacion-desarrollo/.

The Department of Cochabamba has a development tool called *2013–2017 Cochabamba Department Plan to Live Well* [PDC for its Spanish acronym], with the vision, objectives, strategies, programmes, and projects that align its actions with the 2025 Patriotic Agenda. The Plan prioritises 284 strategic department projects and at least 19 projects of nationwide impact, defined in seven strategic axes[6] that will be jointly executed by the Department Autonomous Government and municipal autonomous governments. An important feature of this Plan is that it clusters 47 municipalities into **five regions**[7] (territorial planning and development management areas – Appendix 1) by their cultural, economic, and geographic similarities. Based on these regions, Economic and Social Regional Councils (CRES) are formed to overcome the fragmentation and dispersion of public investment.

1.2. Where is national and regional research headed?

Science and Technology Sovereignty, 4th pillar of the 2025 Agenda, plans to drop science and technology dependence in order to foster a plural economy and change the country's production matrix and primarily export pattern. Therefore, it poses 5 goals: *i)* ***Research and Technology Development*** includes technology transfer to production complexes and enterprises, State information management in a Sovereign Cloud, the implementation of the Knowledge Citadel, and the installation of a Pharmaceutical Industrial Complex; *ii)* ***Technological Innovation of Nutritional Food*** should consider risk management and climate change to increase productivity, capacity, and the processing of nutritional products[8] specific to each region in the country; *iii)* ***Technology with Wisdoms*** to create inter-scientific technological packages that highlight agricultural production; *iv)* ***Ancestral and Natural Medicine*** to develop natural products and Bolivian pharmacopoeia by tapping into its biodiversity while respecting Mother Earth; and *v)* ***Professional Education and Specialisation in Science*** will receive a percentage of the resources that entities or companies will assign to R&D, and provide public companies and national technology innovation centres with professionals.

The Vice-Ministry of Science and Technology (VCyT, 2013) built the *National Plan for Science, Technology, and Innovation* (PNCTI), within the framework of current policies and sustained by three pillars: i) ***Inclusive science and technology*** is included in the three clauses of Art. 103 of the Political Constitution of the State (CPE) that assert the State's political will to develop research and innovation processes; ii) ***Shaping talents*** for science and technology—as per CPE's Art. 97 and the Law of Education's objectives—tackles postgraduate qualification; and iii), ***Science and technology sovereignty*** as summarised above.

The **Bolivian Science, Technology, and Innovation System** (SBCTI), defined in PNCTI, comprises three sectors in a functional manner: those who demand science, technology, and innovation;[9] those who generate knowledge;[10] and the government.[11] The system is articulated by three types of tools: ***regulatory***, including CPE, the 2025 Agenda, PDES, and others ruling the System; ***articulators***, including the *National Science and Technology Organisation* (ONCyT, for its Spanish acronym) that channels resources for R&D projects and postgraduate education in science through the *Science, Technology, and Innovation Fund*; and *Research Results Transfer Agencies* (OTRI) that offer knowledge or technology, among others; finally, ***operational*** *tools,* including *Research Networks and Innovation Platforms* and the creation of *Technology-based Science Parks and Incubators* that boost and strengthen SBCTI, geared to (government, public, and private) *research centres and institutes,* and *Plurinational Centres of Excellence in Productivity* (CEPAP) that seek to promote and foster solutions for regional needs and production niches among (public and private) knowledge sectors.

Neither the Cochabamba Department Government nor municipal governments in the region have approached STIA topics. According to (Gutiérrez and Zurita, 2016), the Cochabamba Innovation System

[6] 1 dignity and integrated security; 2 identities and cultures; 3 wisdoms, science, and technology; 4 production and industry in a plural economy; 5 water and food security; 6 Mother Earth; 7 political, autonomous, and institutional.
[7] 1 Andean, 2 Southern Cone, 3 High and Low Valleys, 4 The Tropics, and 5 Central Valley
[8] Potatoes, quinoa, maize, wheat, coca, tarwi, azai, amaranth, millmi, cañahua, and chia, among others.
[9] Society at large, from farmers and indigenous peoples to public and private (micro and large) enterprises
[10] Universities and their research centres, and public and private institutes creating knowledge, technology development, and innovation.
[11] Entities specifically geared to create, regulate, promote, and implement policies for the country's scientific and technological development.

(SIC for its Spanish acronym) is weak and maintains insufficient and isolated relations, whether among or within environments. Existing relations owe to the knowledge environment's outreach activities mainly supporting micro and small business demands; whereas large and medium-sized enterprises have no explicit demand for Science and Technology. This proves that the demand sector does not invest in R&D and clearly reflects the legal void weakening SIC's institutional and cultural framework.

1.3. The situation of Higher Education in Bolivia and of Research in the Bolivian University System

In Bolivia, according to the (Ministry of Education, 2016), higher education is offered by 62 universities: 11 autonomous public universities, 46 private universities, 3 indigenous universities, and 2 special-regime universities. Of these 62 universities, 15[12] comprise the Bolivian University System (SUB), represented by CEUB as per CPE's Art. 92, clause II. Likewise, according to 2015 data from (CINDE [International Education and Human Development Centre], 2016), 147,578 undergraduate students are enrolled in private universities (25%) and 441,736 in public universities (75%). Among public universities, UMSA (La Paz), UAGRM (Santa Cruz), and UMSS (Cochabamba) concentrated 51% of undergraduates' enrollment nationwide, according to (CEUB, 2016). Regarding the faculty, 26,062 were teaching undergraduates in 2014; of these, 14,911 (57%) were in SUB and 11,151 (43%) in the private sector (CINDE, 2016).

As the body coordinating, planning, and programming SUB activities, CEUB has an Organic Statute, and regulations and provisions to guide member universities' regulations. At present, CEUB has 9 Secretariats[13], including the National Secretariat for Research, Science, and Technology (SNICyT) in charge of *strengthening scientific research, technological development, and innovation activities by formulating policies, strategies, and plans*; the National Secretariat for Postgraduate Studies and Continuous Education responsible for *programming, organising, coordinating, planning, and evaluating policies and activities to strengthen the Bolivian University's Postgraduate System*, as well as for improving the quality of postgraduate programmes with evaluation-accreditation processes; finally, the National Secretariat for Evaluation and Accreditation, of which the main objective is to *coordinate, plan, and bolster evaluation and accreditation processes in SUB careers and/or programmes, and to foster quality improvement and education relevance in teaching-learning, research, and social interaction processes*.

The XVI RENACyT [National Meeting of Science and Technology] Resolution Nº 02/17 approved the *Plan for Science, Technology, and Innovation of the 2017-2026 SUB* (PNCTI-SUB). This Plan (PROMAQ R&D, 2017) proposes regularising and institutionalising the National University System of Science and Technology (SINUCyT) with the participation of stakeholders in the government, academia, the production sector, and civil society. SINUCyT adopts the quadruple helix model and an open innovation system with three levels of responsibility: i) *Strategic*, comprising the governing board[14] and the council[15] of research and innovation policies; ii) *Tactic*, comprising the *National Agency for Science, Technology, and Innovation* (ANUCTI), regional innovation systems in the 9 Departments; and iii) *Operational*, comprising those who undertake their own R&D&I activities.

To realise this model, core elements are proposed: the National University Fund for Science and Technology (FONUCyT), a university pouch to fund projects, train talents, and strengthen research centres; ANUCTI, which will manage and channel FONUCyT and foster the creation and/or strengthening of transfer units; and the Institutional Science and Technology Fund (FOICyT), a set of resources for each university to fund its science and technology activities.

[12] Of these 15 universities, 11 are public, 2 are private, and 2 are special-regime universities.
[13] National Secretariat: 1 Executive; 2 Academic; 3 Administrative and Financial; 4 Institutional Development; 5 Evaluation and Accreditation; 6 International Relations; 7 Postgraduate Studies and Continuous Education; 8 Research, Science, and Technology; 9 Social Interaction and University Outreach
[14] The Governing Board is a collegial entity seeking to establish national policies for SINUCyT research and innovation processes, as well as broadly evaluating work done in several system instances.
[15] It is a staff instance that assists the governing board in establishing policies to promote or boost SINUCyT research and innovation processes and other studies that inform the board's decision-making.

Equally, as this Plan recognises the import of the experiences of UMSS and UMSA in research management and capacities, it assigns them the role of transferring such experience in implementing, managing, and funding STI programmes and projects to sister universities and to ANUCTI. The Plan proposes to develop a transparent high-quality management model in order to execute research and innovation projects, gathering and enhancing experiences—in eight Calls (2003-2017)—in UMSS' R&D project management.

Given the heterogeneity of development and research in SUB universities, in PNCTI-SUB, research areas and lines have been identified and prioritised, such as: i) Health and Life Sciences; ii) Agriculture and Forestry; iii) Biodiversity, Natural Resources, and Environment; iv) Climate Change Mitigation and Adaptation; v) Integrated Water Management; vi) Mining, Energy, and Hydrocarbons; vii) Economy, Social Development, Education, Law, State, and Society; viii) Knowledge Management and New Technologies; ix) Transportation, Roads, and Communication; x) Industrial Development, Technology, and Innovation.

1.4. Degree of Research and Innovation Development at UMSS

1.4.1. The Background of Scientific, Technological, and Innovation Activities

Founded in 1832, the Universidad Mayor de San Simón is one of the 15 autonomous public higher education universities. It is ruled by the Bolivian University's Organic Statute, its own statute, and specific regulations (faculty, class load, assistantship, research, etc.). Autonomy and teacher-student co-government are the basic principles of the three fundamental activities: *education, research, and interaction*.

The *University Council* governs UMSS between congresses, pursuant to each congress' statutory principles and resolutions. The Council includes the rector, the vice-rector, faculty deans, university directors, and faculty and student delegates. The *rector and vice-rector* are authorities elected by teacher-student votes on an equal footing. The rector represents the university and directs its activities, while the vice-rector directs university academic and scientific activities, among other roles.

UMSS's executive structure comprises the rectorate, the vice-rectorate, and 8 university directorates, 3 of which respond to the rectorate: The Administration and Finances Directorate (DAF), the University Student Affairs Directorate (DUBE), and the International Relations and Conventions Directorate (DRIC). Three directorates respond to the vice-rectorate: The Academic Planning Directorate (DPA), the University Social Interaction Directorate (DISU), and the Scientific and Technological Research Directorate (DICyT). Two units are particular: The University Evaluation and Accreditation Directorate (DUEA) responds to the University Council albeit administratively dependent from the rectorate, and the University Postgraduate School (EUPG)—strictly speaking not a directorate—at the organic directorate level, responds to the vice-rectorate.

UMSS' academic structure includes **14 Departments[16] offering 50 undergraduate careers and 25 university technician programmes** to a community of about 70,000 students; and around 1,800 faculty members. In 2014, UMSS postgraduate offer included 67 diploma courses, 23 specialties, and 18 "professionalising" master's degrees for 5,222 postgraduate students. Unlike government-subsidised graduate studies, "professionalising" postgraduate studies are funded by students' enrollment payments. Full-time research-based postgraduate courses were recently launched, and are momentarily subsidised by Sida and ARES [Academy of Research and Higher Education,] (Belgium).

Within the framework of lawful duties, the Bolivian University's Organic Statute, and its own regulations, UMSS has built a 5-year Development Plan as a planning tool with a mid-term strategic vision. The 2014–2019 Development Plan (UMSS, 2013) poses four policy and/or strategy areas: Education for Excellence

[16] Departments have academic freedom, and department governance is analogous to university governance, where the top government body is the Department Conference and the policy decision-making body is the Department Council. Department governance authorities are the dean and the academic director, with attributions like those of the rector and vice-rector but at department level, and who are also elected by teacher-student votes on equal footing.

(commitment with its students), Research (knowledge generation and management for science, technology, and social development), Interaction (commitment with economic and social community development), and Support Management (commitment with excellence and transparency). In its four areas, this Plan has potential to impinge on reducing gender inequality[17] and improving women's quality of life. RR Nº 152/2008 of May 7, 2008, established UMSS' University Infrastructure and Environment Commission (CUIMA) as the sole institutional environmental agency that realises proposals for the financially-based sustainable protection of natural resources.

1.4.2. The development of Scientific, Technological, and Innovation Activities

Until 2002, research programmes and projects had been the concerns and answers to opportunities offered by international and national cooperation, i.e., research units were typically atomised and unarticulated. It was only with the *Action Plan to organise and develop UMSS' Scientific and Technological Research System* that Scientific and Technological Activities (STA) were articulated. This 10-year vision plan (DICyT, 2002) defined a series of short and mid-term strategies—within the Regulatory, Science Policy, Financial, and Organisational Frameworks—to help improve the quality, effectiveness, efficiency, and impact of research activities, including their combination with other substantial university roles as expressed in institutional development plans. The evaluation of this plan and the expertise accrued by 2011 gave way to the 2012–2021 Research Conceptual Framework at UMSS as reference for a planning and construction process.

Currently, **32 Research Units (UEI)** have enough infrastructure (buildings, labs, equipment, and instruments) and personnel (researchers, technicians, and support personnel) to execute R&D&I programmes and/or projects (Appendix 2). Additionally, 20 other department and programme units submit research reports from time to time.

Concerning research personnel (Appendix 3), following the Frascati Manual's nomenclature, 515 people are engaged in STA (35% are women[18]): 287 are researchers, 39 are R&D grant holders, 60 are technicians, and 129 are support personnel. Out of 326 researchers[19], 65 hold a doctoral degree, 186 a master's degree, and 75 are licentiates, according to data from a 2016 survey of research units. The DICyT Plan (DICyT, 2002) shows that in 2000, 6% of the research community held a doctoral degree, 47% a master's degree or its equivalent, and 46% a *licenciatura* [bachelor degree]; whereas now 20% hold a doctoral degree, 57% a master's degree, and 23% a *licenciatura*. This shows a 16-year growth that may not be quantitatively but rather qualitatively significant.

Historically, research development has been associated with international cooperation funds from Sweden, Belgium, The Netherlands, Switzerland, Germany, Spain, etc. Cooperation was also agreed with international organisations, inter alia, CyTED, FAO, OAS, WB, and NGOs. At national level, funds for STA (save for salaries) were made available for public universities by Supreme Decree 28421 of October 2005, which makes Direct Hydrocarbon Tax (DHT) funds accessible to **scientific research, technology, and innovation**, among others. Based on this decree, UMSS built the *Framework Programme for DHT-funded Research Advancement,* approved by RCU Nº 33/08, assigning 25% of DHT to research. Lastly, in May 2017, RCU Nº 24/17 approved "[t]he allocation of 25% to research and to the Programme to Improve Academic Quality and Performance" (researcher training).

In 2000, UMSS' STA planning helped prioritise institutional thematic areas and axes (agriculture and animal husbandry, health, biodiversity, etc.) to be strengthened by programmes, projects, and capacity training. In the first 10 years, *Organisations Associated to Research Projects* (OAPI for its Spanish acronym) were established to connect R&D projects, in a non-systemic manner, with the Socio-Productive Environment (ESP). In 2012, subjects in thematic axes were substantially changed to meet

[17] Gender gaps show differences between women and men concerning opportunities; and access, control, and use of resources, goods, services, and institutions.
[18] A participatory diagnosis of inclusion/non-discrimination habits and practices in UMSS' research and development projects, carried out by DICyT (2012) and led by Olivia Román, M.Sc., concluded that the gender breakdown in DICyT centres for research and scientific and technological development showed quantitative and qualitative gaps. This diagnosis found that the higher the academic degree, the greater the gender inequality, especially among researchers/faculty members.
[19] According to the Frascati Manual, R&D grant holders (39) are researchers.

socio-economic objectives, like food security and sovereignty and health protection and improvement, and solve problems or respond to needs and propitiate the transfer of research results to ESP, without neglecting projects' scientific quality.

The Research Fund was strengthened in 14 years (since 2003). It now has resources from Sida and DHT and aims at adding (international, national, and local) resources. Through the Research Project Management System (SIGESPI), this fund was able to support 182 R&D projects from eight periodic calls. SIGESPI's philosophy, competitive in terms of scientific quality and social relevance, responds to institutional priorities and is open to UMSS' research teams, under transparent streamlined procedures that encourage planning.

Similarly, STAs were fostered and promoted by the Horizontal Programme. This programme funded the attendance of 225 proposers or lecturers to international science events, 55 scientific books/journals, 44 research-disseminating projects, and 22 international science events. The Horizontal Programme also endorsed the scientific community's qualification with 53 training workshops, 55 specialisation/updating internships, and 39 outside researchers' stay at UMSS research centres. Even so, the programme divulging component showed that few researchers published in international journals or books.

An (SCImago Research Group, 2014) analysis of sciencemetric data for 2008-2012 shows UMSS' number of indexed publications below UMSA's. However, considering qualitative variables like high quality publications, specialisation index, and others, UMSS is above UMSA. Moreover, in Sida's Self-evaluation Workshop of June 2009 in Bolivia, UMSS reported 242 researchers as opposed to UMSA's 467. Although this does not justify the lower number of publications, we need to bear in mind that UMSS' population of researchers is 52% that of UMSA's.

In the Sida-UMSS Programme, 42 professionals (by 2018) received doctoral degrees (PhDs) in the sandwich modality, 79% of which were employed in research centres, and 23 are now (2019) being trained in the sandwich modality. Conversely, 10 doctoral candidates are being trained with ARES cooperation under the same conditions of Sida-grantees and in complementary topics. At last, since 2015, 6 local master's degree programmes in science have been designed and completed, with 62 master students.

The University-Business Relationship (RUE) includes two Technology-based Companies (EBTs)—SEFO-SAM and CIFEMA-SAM. These EBTs work in the agricultural sector under favourable conditions, both for the University and for groups of small farmers who are company members. With this triple helix model, the INNOVA-UMSS Project is being implemented, and has become a national reference of innovation that ties university scientific research with production and government social agents, giving way to food and leather clusters at the Technology Transfer Unit (UTT). There have also been experiences in generating spin-offs promoted by graduate students to participate in events like INNOVA-BOLIVIA. Finally, DICyT has defined a University Interface Structure with the mission of *"planning, managing, and promoting the relationship between the University and ESP, as well as between researchers and the Innovation System of Cochabamba and Bolivia, in order for the socio-production environment and the entire society to appreciate the value of UMSS' knowledge- and capacity-based research and the opportunities environments offer."*

Regarding UMSS research facilities, the first steps were taken to build a Metrology Centre. Specialised type 1 and type 0[20] equipment was bought with DHT funds. In regards to CIT, the Information Service Unit (UPSI) is currently implementing a master plan throughout the university to restructure the Intranet, Internet, and network support services, and then offer efficient services in topics like clusters and computer repositories for several centres, and a Workstation for simulation. This will also enhance access conditions to indexed journals offered by the Academic Consortium on Access and Use of Information Resources for Research (CAAURII), of which UMSS is an active member.

[20] High precision instruments that measure (physical, chemical, etc.) magnitudes for scientific equipment calibration

The implementation of all initiatives aforedescribed has shown research in national and international contexts and placed UMSS as reference in the academic and scientific community in Bolivia. For instance, COSUDE is currently using SIGESPI as a management model for nationwide R&D projects, and DICyT assists in evaluating scientific quality. Incidentally, 2016–2027 PNCTI–SUB has adopted several strategies implemented by UMSS to extend them nationwide, and some intruments and tools—like the Scientific and Technological Potential, or the Budget Execution System (SEP for its Spanish acronym)—have been transferred to UMSA as part of a commitment with mutual growth.

1.4.3. The Shortcomings of Scientific, Technological, and Innovation Activities

Despite significant progress in these last years, shortcomings are evident. The following are examples of these deficiencies, according to (Millard, Tedre, Thulstrup, Muñoz, & Velasco, 2017): an insufficient critical mass of doctorates; weak institutional promotion of training to generate competencies in management, administration, leadership, research and tutoring skills, etc.; the lack of research incentives hinders scientific production; scarce impact of scientific output on the international context; a fragile systemic link with ESP; little application of the gender/non-discriminatory perspective[21]; inadequate annual growth rate of the research community (1.9% annual[22] compared with the 3.3% growth rate of the teaching community[23]); de-linkage in postgraduate training between research units (Ståhle & Millard, 2017); and a weak culture of continuous evaluation of research and researcher training.

Moreover, self-reflection points to the insufficiency of support services for knowledge management, and the need to improve product quality (metrology services) and continuously strengthen its infrastructure.

Regulations in force since the 90s are decontextualized, and removed from current processes to create, foster, and transfer scientific and technological knowledge; lack of research incentives hinders scientific production; unclear ruling to allocate UMSS general budget's resources to research; the appropriation of General Regulations for SUB research and researchers at UMSS; and an outdated Science and Technology Law. Then, any standard, regulation, guideline, etc. should propitiate stakeholders' participatory work to legitimise stakeholders, encouraging the university council and the rectorate to further their approval.

We need to improve the way SICTI is structured and operated, coordinating postgraduate studies in science, interaction, and research. A high degree of autonomy and competence decentralisation still lingers in all departments, preventing stakeholders from organising and operating, and remaining unresponsive to planned institutional research. Research units are organised by disciplines in most departments, countering all current trends to obtain scientific and technological knowledge through inter- and transdisciplinary movements that can start associating in research networks.

[21] According to United Nations (1997), by including the gender perspective, we can evaluate the implications for women and men of any planned action, be it in legislation, policies, or programmes in all areas and levels. It is a strategy that turns women's and men's experiences, needs, or interests into a comprehensive political, social, and economic dimension.

[22] We have taken 2000 as the starting point, with 1103 faculty members, according to UMSS' 2002 *Universidad en cifras* [The University in Figures], and 1800 faculty members by the end of 2016, according to data from Academic Personnel.

[23] We have taken 2000 as the starting point, with 238 researchers, according to the *Action Plan to Organise and Develop the Research System of the Universidad Mayor de San Simón*, and 2016 data.

2. OBJECTIVES

The new scenario in international (2030 Agenda), national (2025 Agenda, PDES, PNCTI), regional (PDC), sectoral (PNCTI-SUB), and institutional (2014-2019 Development Plan and 2012–2021 Research Conceptual Framework at UMSS) (UMSS, 2011) contexts helps us set the ***general objective***:

> *Favour development processes in the Cochabamba Department and in the country by generating new, useful, and transferrable knowledge for social and/or production sectors. Contribute to advance universal knowledge and develop postgraduate studies in science in order to join scientific research, technological development, and innovation activities acknowledged by society.*

To attain the general objective, UMSS' SICTI must count on the committed and effective participation *of managers and researchers* in enabling knowledge generation in Mode 1 and Mode 2[24]. SICTI must also create a dynamic, effective, comprehensive, and socially responsible environment of processes, means, and products that have scientific quality and social relevance. Therefore, as in the 2012-2021 Conceptual Framework, two **specific objectives** are proposed according to their action area:

1. *Execute programmes and projects in areas of institutional, regional, and national interest, with results acknowledged and used by the scientific community and ESP. Simultaneously, execute national postgraduate studies in science in UMSS research centres, in cooperation with associate organisations, within the Research Training Agenda, and nationally and internationally acknowledged.*

By the end of the period, most R&D&I projects will have been executed along institutionally prioritised lines, and their products will have been disseminated and transferred by the most adequate means. Similarly, as part of research training, doctoral degrees will be granted to researchers with UMSS and with other institutions in the country through postgraduate studies in science. In the best-case scenario, two doctoral degrees will be granted, one of them from a Swedish university.

2. *Generate a propitious environment for the Science, Technology, and Innovation System to allow for research activities, researcher training, and innovation in favourable conditions, with the support of a proper and efficient management system that includes planning and quality assurance principles.*

In the period's mid-term, a **favourable environment** for SICTI will have been strengthened with structural, operational, and support reforms that make SICTI functional; linking research and postgraduate studies in science, and advancing **quality assurance**. Moreover, programmes to promote and foster SICTI among researchers will be running, as well as a university-ESP relation model that bonds UMSS with regional and national innovation systems, considering its public-university rights-holders[25]. This model could serve as benchmark for sister SUB universities.

[24] "**Mode** refers to the *way knowledge is produced; a compound of ideas, methods, values, and standards* that have grown to the point of controlling the dissemination of the Newtonian model to an increasing number of research areas, thus ensuring these areas concur with what is considered a healthy scientific practice" (Gibbons, 1997) [Our translation]
Mode 1. Purely disciplinary knowledge production stimulated by an academic interest to further science in general.
Mode 2. Production of applicable knowledge, transdisciplinary, and socially responsible to attend to the explicit needs of any external agent.
[25] Natural or legal person benefitting from the almost free transfer of UMSS' research results as an expression of University Social Responsibility.

3. RESULTS

As the efforts to develop a regulatory, organisational, and functional environment are still deficient, Sida-sponsored consultancies in Sida Programme's Impact on Bolivia, Quality Assurance, and the recent Evaluation of Master's Degrees in Science, will largely help us improve SICTI. By the end of this period, we anticipate that all SICTI management and implementation units will have taken on their roles naturally as part of the system, with clear and concrete interrelations.

Concerning the first specific objective, linked to scientific research and technological development activities in research units, the Action Plan detailed below will be effective if:

- Researchers have been trained in at least 3 doctorate and 6 master's degree programmes in science in UMSS research units.
- At least 12 new PhDs have been trained in the sandwich modality in prioritised research areas, fields, or disciplines.
- At least 15 researchers have developed their research as part of their post-doctorate studies at UMSS.
- At least 30 R&D competitive projects for prioritised research are in place.
- At least 16 induced inter-disciplinary projects have been executed, addressing axis topics and in cooperation with regional or national agencies.
- The research community has increased its science production for national and international publication, transfer, and dissemination.

In regards to the second specific objective—generating an environment favourable to research and innovation development—we understand that the Action Plan leads us to a formalised STIA organisation, the structure of which follows the new SICTI model[26] (Appendix 4), that is:

- Programmes to publish and divulge research findings are in place.
- Programmes to promote researchers nationally and internationally are in place.
- At least 10 researchers were granted master's degrees in Ethics and Bioethics.
- A permanent training programme for faculty members and tutors of postgraduate courses in science is in place. The programme includes topics such as Supervision, Tutoring, and Didactics.
- A short training programme to generate skills and competencies among researchers and managers is in place.
- A University Interface Structure (EDIU) is fully operative, linking UMSS with regional and national innovation systems in favourable conditions.
- Quality assurance policies and guidelines for postgraduate studies in science were developed as per the European Area (ESG).
- The structure and application of the Framework Plan for University Environmental Management (PMGAU for its Spanish acronym) was institutionalised upon 3 pillars: Integrated Plan for Infrastructure Regulation (PIOI for its Spanish acronym), Environmental Adaptation and Management Plan (PAMA for its Spanish acronym), and University Environmental Management System (SGAU for its Spanish acronym).
- Adequate infrastructure in common use (buildings, science installations and equipment, metrology unit, and maintenance) is in place, guaranteeing research quality.
- The Master CIT Plan is periodically updated and implemented.
- Policies and guidelines for gender equity, non-discrimination, inclusion, and Human Rights have been developed.

These findings involve the responsibility of UMSS authorities, researchers, and managers to undertake the proposal herein; as well as Sida commitment to:

a) Continue researcher training programmes

In these last years, Sida's presence at UMSS has generated anticipated capacities in Engineering and Technology. It has launched a local doctorate programme in Chemical-based Technologies in 5 UMSS research units, chiefly addressing its researchers, SUB university staff, and outside workers. In other words, resources needed to complete this programme have been planned.

[26] The new model underscores the connection with innovation systems, and includes researcher training in postgraduate studies in science.

Likewise, resources needed to complete the master's degree in Innovation and Development have also been planned in this new phase. This specific and somewhat exceptional case implies Sida-backed support grants for students of master's degree courses.

Finally, in this phase close to its end, some doctorate courses in the sandwich modality did not develop as planned. We are in the process of estimating the time and cost of completing such training.

b) Support when facing new challenges

In this new phase, the cooperation of Swedish universities is likely in local doctorate and master's degrees in science; and with faculty members, supervisors, consultants, and, in some cases, with the stay of R&D grantees in Swedish universities. Similarly, given Sida's openness, doctorate degrees in the sandwich modality are proposed for still weak axes. Requirements in both cases are described in Section 4.3.

On the other hand, DICyT requires a counterpart to build and develop its local master's degree in Ethics and Bioethics. Concerning the University-ESP relation, the advisory of a Swedish institution is anticipated; its experience can contribute to proposals laid out in Table 1. Quality Assurance, at the core of UMSS' postgraduate studies in science, also requires the advisory of a Swedish institution to develop the Quality Management System. Finally, all programmes and actions established to create a favourable environment require Sida as counterpart to strengthen a competitive fund for the research community and the 8 axes.

4. ACTION PLAN:

4.1. Rationale

The Action Plan to attain the results herein proposed is based on the principle of continuing to advance in the construction process begun in 2000. Progress achieved so far is indebted to cooperation, mainly Sida's institutional cooperation of (UMSS – DICyT, 2011) and, lately, ARES. The Action Plan also considers agendas and plans, and the recommendations of the two Sida-commissioned consultancies.

The set of actions rescues elements recognised as success factors for the future, i.e.: resource allocation according to institutional priorities for projects that seek to solve problems (induced projects), and the competition of relevant quality R&D projects; support for the permanent training of faculty staff and supervisors in local postgraduate studies in science; the association of UMSS research units in 8 axes and cooperation with Swedish university partners; infrastructure refurbishing and optimal use; massive national and international dissemination of results; joint work, mainly by DICyT, EUPG, and DUEA, to elicit a favourable environment for quality assurance; independent administration of research resources through the Research Fund; and systemic connection with ESP. Then, this new conceptualisation, given results and potentials, aims at developing each element to its utmost capacity.

Elements that also help us meet the plan include, inter alia, more researchers with PhD—a significant percentage of which will be women as an institutional policy based on RCU Nº 24/17; DHT funds allocated to the Research Promotion Framework Programme; the government's openness to fund R&D projects as per its Basic Pre-Investment Regulation; and the opportunities offered by Agendas.

4.2. Action Areas

What needs to be done to reach greater volumes of quality research results? Or which elements of the university system must we act on to meet objectives? To answer questions such as these, we must start by the notion that there are four frameworks for decision-making that will help us organise this plan's "collective" actions. Frameworks are interrelated and support each other transversally to meet the general objective and the two specific objectives. In other words, actions for the Regulatory Framework, Organisational Framework, Science Policy Framework, and the Financial Framework are defined to respond to RSU, understood from the Lüneburg University approach[27] (García y Lozano, 2013).

Actions proposed in the four frameworks do not rule out what has been achieved so far, i.e., they improve what is not working properly and stress on posing actions for this new period, **considering that the State, as constitutionally mandated, is underpinned by values such as equal opportunities, social and gender equity in participation, non-discrimination, inclusion, human rights, ethics, and environment, all pointing to Living Well**. Similarly, framework actions propose a more mature system, which is why the model described in Appendix 4 is very similar to the model proposed in the previous phase, incorporating postgraduate studies in science as part of researcher training. On the other hand, these actions not only seek an articulated system, but also one that allows its roles to be fulfilled without delay, relations to be fluid, and administrators to guarantee that resources reach research implementors timely.

4.2.1. Actions within the Regulatory, Functional Organisational, and Science Policy Framework

Actions within the Regulatory, Organisational, and Science Policy Framework converge in achieving 6 action lines that advance a greater regulation in building performance indicators, with the Financial Framework as a supporting platform for the 3 abovementioned frameworks.

[27] RSU: "as integration of the university's impacts on its milieu to contribute to human development." According to this definition, (public or private) university social responsibility should meet its human development objective, and assess the degree in which its essential activities (research, teaching, technology transfer, and governance and organisation) contribute to such objective.

Table 1: Actions in the three frameworks

Action Lines	Actions within the Science Policy Framework	Actions within the Regulatory Framework[28]	Actions within the Functional-Organisational Framework
Researcher Training	▪ Certify UMSS researchers in 12 doctorate programmes in the sandwich modality. ▪ Certify Bolivian researchers in 3 doctorate programmes in UMSS research units. ▪ Process the inclusion of UMSS personnel (with PhDs obtained in foreign universities) as faculty members, tutors, or members of the academic committee of postgraduate studies in science. ▪ Organise an academic network of national postgraduate alumni. ▪ Certify UMSS researchers in doctorate programmes.	▪ Build the regulatory framework of postgraduate studies in science that will be developed in UMSS research units. ▪ Update regulations to include PhD holders trained thanks to international cooperation. ▪ Upgrade regulations for scholarships and the Commission Declaration with paid leave for UMSS researcher training (RCU Nº 24/17) to include scope and guarantors of UMSS' affirmative action policy. ▪ Build guidelines for post-doctorate grants.	▪ Propitiate an effective and efficient use of infrastructure (buildings, equipment, input, software, etc.) and human capacities in research units.
Develop R&D&I projects	▪ Select, execute, and evaluate at least 30 short-duration R&D&I projects within prioritised institutional axes and/or programmes. ▪ Select, execute, and evaluate at least 16 long-duration R&D&I projects to provide scientific-technological solutions to ESP demands or opportunities. ▪ Generate capacities in R&D project planning and management among researchers.	▪ Update SIGESPI procedures and tools	▪ Promote the organisation of permanent multi-, inter-, and transdisciplinary research teams for R&D&I projects.
Promote and foster researchers and STIA	▪ Evaluate and update continuous researcher training programmes with short-duration skill/competency training in research leadership, education, supervision, research team management, public management, etc. ▪ Evaluate and update programmes to divulge and popularise research results in the most adequate media, promoting the indexing of UMSS journals based on international data. ▪ Build new programmes promoting mobilisation (North-South, South-South, and South-North, as set in the 2030 Agenda) among faculty members/tutors and R&D grantees. ▪ Build a permanent short-duration training programme for faculty members and tutors in topics like New Didactics, Research Leadership, Supervision, etc. ▪ Generate an UMSS researcher ranking to acknowledge, honour, and reward researchers.	▪ Build a procedure manual to implement and run promotion programmes. ▪ Build a strategic institutional framework to disseminate UMSS scientific and academic production. ▪ Rule categorisation and the Researcher Ladder. ▪ Rule acknowledgements, rewards, and benefits for scientific production and/or usage of Intellectual Property.	
University-Socio Productive Environment Relation	▪ Strengthen EDIU as manager of the UMSS-ESP relation. ▪ Place UMSS scientific capacities at the service of ESP. ▪ Offer ESP the knowledge and/or technology generated by UMSS. ▪ Systematise ESP demands/issues, so they may be solved, if applicable, by the UMSS science community. ▪ Promote and manage the university community's ventures. ▪ Implement the Circular Economy Programme and product redesign. ▪ Create human capacities in protection, valuation, marketing, and transfer of research findings according to regulations (UMSS Intellectual Property). ▪ Create an enterprise incubator based on university ventures.	▪ Update the Technology Management Department's duty manual. ▪ Periodically upgrade the Intellectual Property regulation. ▪ Build rulings and procedures to manage and run clusters, spin-offs, and EBTs at UMSS. ▪ Build regulations to manage the Circular Economy.	▪ Create, organise, and include competencies for the University-ESP relation. ▪ Create the University Experimental Lab for Redesign and Circular Economy.

[28] Regulatory Framework actions promoting researcher training, developing R&D&I projects, and promoting and fostering researchers will include guidelines to bridge gender gaps that consider generation changes. With these parameters, the feasibility of including specific programmes that further gender equity with family and female-headed household grants will be assessed.

Quality Assurance for researcher training	▪ Build quality assurance policies and guidelines in accordance with ESG.[29] ▪ Define the means to assess the technical-academic feasibility of a postgraduate programme in science, based on available human capacities, infrastructure, equipment, institutional and social relevance, critical mass of R&D scholarship-holders, and financial feasibility. ▪ Establish self-evaluation processes, reporting, external evaluation, and accreditation of national post-graduate studies in science during their execution and when completed. This work will be informed by the 6 master's degree courses with Swedish academic peers, in the case of programme execution and completion. ▪ Start accreditation processes for master's degrees in science, and guidelines for the accreditation of doctorate candidates.	▪ Build the regulatory framework for the evaluation and accreditation of postgraduate programmes in science in order to grant joint degrees with Swedish universities, in accordance with ESG.	
A favourable environment for STIAs	▪ Promote an efficient and effective use of STIA infrastructure, equipment, and financial resources. ▪ Provide better infrastructure and equipment to research units involved ▪ Upgrade and implement the Master CIT Plan. ▪ Regularise the Framework Plan for University Environmental Management (PMGAU) ▪ Socialise and apply PMGAU throughout UMSS, especially in research units/institutes, pursuant to Environmental Law 1333 and Risk Management Law 602. ▪ Build policies and guidelines of gender, non-discrimination, inclusion, ethics, and bioethics. ▪ Carry out a feasibility study to organise doctorate schools at UMSS.	▪ Regulate the common use of science equipment by specialised research units. ▪ Build a regulatory framework to organise UMSS Science, Technology, and Innovation Research System. ▪ Build and approve regulations to apply and comply with UMSS internal procedures for PMGAU. ▪ Build protocols and procedure manuals on Environmental Good Practices for research labs, and service and production units. ▪ Build protocols with means for efficient prevention, management, and protection against harassment, violence, and discrimination. ▪ Build operational regulations for (inter alia, science, editorial, intellectual property, ethic/bioethics) committees. ▪ Rule the use of DHT resources to execute R&D projects, and the mobilisation of staffs inside and outside the country.	▪ Prompt the organisation of university research units in Energy and Water, complementing capacities already generated in Departments. ▪ Create the University Environmental Quality Management unit (UGCAU for its Spanish acronym) as UMSS supervising agency. ▪ Create a Metrology unit to guarantee measurements made with scientific instruments lie within an acceptable range of error. ▪ Form institutional research networks on topics defined in Section 4.3 ▪ Organise university advisory committees in parity[30] to coordinate DICyT.

[29] Standards and guidelines for quality assurance in the European Higher Education Area (ESG)

[30] Parity is a Bolivian democracy principle upholding gender equity and equal opportunities for the public exercise of representation and decision-making posts. This principle is enshrined in Electoral Regime Law 026 (2010).

4.2.2. Actions within the Financial Framework

The main import of working in these framework actions is to seek **financial sustainability for SICTI**, enabling the implementation of the other frameworks' actions. Thus, UMSS' counterpart share is the salaries of STIA-related personnel, the critical mass of researchers, the infrastructure of research units, and DHT resources. We seek to:

Actions

- Strengthen and increase the UMSS Research Fund with DHT resources, international cooperation, the University General Treasury (salaries), and royalties or profits from transferred inventions.
- Support the allocation of national and international funds to STIAs. These funds come from FONUCyT for all SUB universities; ONCyT-managed Science, Technology, and Innovation Fund; resources from agencies and enterprises, as stated by PDES in its 4th pillar[31]; and Horizon 2020 and Research Councils UK funds for collaborative projects.

Conversely, one of the weaknesses lingering since 2009 is the incorporation of cooperation resources to administrative public management, giving way to a cumbersome and delayed running of administrative and financial matters, as reported by (Millard, Tedre, Thulstrup, Muñoz, & Velasco, 2017).

Actions

- Re-engineer administrative process to optimise them (eliminate unnecessary or redundant controls, authorisations, and documents), complying with NB-SABS.
- Establish administrative mechanisms to facilitate R&D project implementation and the national and international mobilisation of personnel with DHT resources.

4.3. Socially Useful Scientific Research and Technological Development

Actions proposed in the 4 frameworks are aimed at establishing favourable conditions to undertake institutionally and socially relevant research activities, considering quality assurance for the 8 prioritised axes[32], the construction of which is described in Section 8.

Each axis is briefly described below (issue, objective, and components) to enable their joint realisation with Swedish universities; 12 doctorates in the sandwich modality, prioritised to strengthen emerging axes and those axes that still do not need a critical mass of PhDs; and the realisation of 3 doctorates and 6 master's degrees in science in UMSS research centres.

4.3.1. Agriculture and Forestry

Justification

In Bolivia, rural poverty is about 40% (INE, 2012), due to low productivity of the production systems, erosional soils and some in the process of desertification (Zimmerer, 2010). Therefore, it is essential to improve alimentary conditions of the population in general and to reduce vulnerability levels to alimentary insecurity. That's why it is important to invest in research in order to generate knowledge which can be transformed in technology, with interdisciplinary work, adding up capacities and experiences in order to achieve sustainable production and generate resilient agricultural and forestry production systems. Previous knowledge joined by validated local knowledge must be incorporated with the new in order to create sustainable impact in society.

[31] 4th pillar: *"Any agency and enterprise engaged in production, water, environment, telecommunications, health, and others shall assign a percentage of its resources to scientific research and technological development."*

[32] Thematic objectives and priorities should not lose sight that research lines in UMSS' academic production centres and units ignore the gender approach and differentiated indicators—according to the participatory diagnosis of habits and practices of inclusion/non-discrimination in UMSS' research and development projects (DICyT, 2012)—, particularly in research done in exact sciences and technology, less so in the environmental and social science areas. Therefore, to impinge positively on a social, political, economic, and technological transformation that can subvert the disadvantage experienced by women and other vulnerable groups, we recommend (transversally or specifically) including this perspective in prioritised research lines of the eight areas posed herein. This would thereby respond to Law 348 (Art. 24), compulsory for public academic agencies.

The axis pretends to generate and develop knowledge by means of disciplinary and trans disciplinary research, searching for adequate technologies in order to strengthen food security and sovereignty of the population, conserving biodiversity and the natural productive basis (soil, water, flora and fauna) in favour of answering the growing food demand and improving the quality of life.

Installed capacities and incidence of Sida in the axis development

SIDA currently supports four colleagues who are pursuing their Ph.D. studies under the sandwich mode. In the past, SIDA financed examined projects which were successful but of reduced scope; that's why now, objectives of a wider range are being proposed in order to strengthen the team of researchers and postgraduate study.

Lecturers / researchers with Ph.D. degree: 11, lecturers / researchers with Master's degree: 40, scholarship holders (ARES program: 3, SIDA cooperation: 4) total 7. The axis identified the research topics which show deficiencies. The axis is multidisciplinary where about 20 academic entities work together between laboratories, departments, research centres and institutes.

Activities and requirements to Sida

The axis has got infrastructure, equipment, and human capacities, however, funds are needed to strengthen them, in the research topics prioritized by the research entities. These topics are:

- Management of agricultural and forestry production systems
- Small and medium scale producers
- Sustainable animal production emphasizing good livestock practices
- Processing and added value of products and by-products
- Innovation of industrialization of agricultural products
- Sustainable farming and climate change
- Local development and diversified economy
- Conservation and sustainable use of agro biodiversity
- Risk management and adaptation to climate change

The axis plans a Master's program in Agricultural Production in the UMSS contemplating a common basis and three specialties: Sustainable plant production, sustainable animal production, and agro industrial technology. We apply to SIDA for support in the development of the Master's program, with lecturers in disciplines of Agricultural Sciences, subjects: Integrated agriculture; Crop farming and climate change; Social and cultural aspects in livestock development; Topics on quality control and management in agroindustry; Technologies of maintenance, containers and packaging of agro industrial products. Furthermore, we apply for specialized laboratory equipment.

4.3.2. Water and Soil

Justification

In Bolivia and in particular in Cochabamba, severe processes of degradation of water and soil resources are evidenced in different forms and at different scales. This results in their unproductiveness, in the instability of the ecosystems and in situations of risks for the population and their livelihoods. Such processes become critical in spaces such as the Rocha river basin, which gradually loses its capacity for regeneration and production, generating in turn increasing socio-environmental conflicts due to limited and inequitable access to resources or basic services or to unequal distribution environmental burdens.

In the perspective of facing and preventing the mentioned problems, the network formed around the research axis Water and soil aims to address the relationships between the use and management of surface and groundwater and their impacts on livelihoods, water availability, access to water and water quality, together with the analysis of land use change processes, and their effects on the soil, on environmental deterioration and on situations of risk for the population. These are strategic issues prioritized by the Rocha River Basin Plan and introduced within a common research agenda discussed between the UMSS and the regional government of Cochabamba since 2018.

Installed capacities and incidence of Sida in the axis development

The Water-Soil network is composed of 11 research units of 3 faculties (Agricultural Sciences, livestock and forestry, Sciences and technology and Economics Sciences) which have infrastructure and equipment installed and with around 75 researchers (45 MSc. And 18 PhD.). IWRM and HABITAT research programs (UMSS-SIDA agreement 2013-2017) have been developed around the Pucara river basin (as part of the Rocha river basin) helping to define the research strategy of the Water and Soil axis. Nine doctoral studies (sandwich mode) and 11 MSc. graduates have been executed within this collaborative framework.

Activities and requirements to Sida

The Water-Soil network has prioritized 5 thematic work areas that emerge from the described problem: i) Environmental management of water and soil; ii) Water and soil governance; iii) Evaluation of the water and soil resources; iv) Technology for water and soil use; v) Risk management and climate change.

With the objective of strengthening the research capabilities of the UMSS in response to the demands and regional problems, it is proposed:

Two versions (cycles) of a scientific master's program on "Sustainable management of water and soil". This program seeks the collaboration of Swedish universities on issues related to: Sustainable management and soil recovery; water degradation and treatment; water resources development and planning; geohydric risks; integrated watershed management; irrigation engineering.

The formation of two new PhDs in the sandwich modality, to strengthen the research areas in "Hydrogeophysics" and "Development of water resources".

Financial support is required to strengthen the "Water Observatory - UMSS", undertaken in the previous phase to implement a knowledge management system and as a space for debate on issues relevant to the region and the country.

Finally, an important research strategy is to contribute to the implementation of the Rocha River Basin Plan through three "induced research projects" in collaboration with the government and organizations (regional and local). The new Master's and PhD (Sandwich) theses will contribute directly to these projects.

4.3.3. Biodiversity, Natural Resources, and Environment

Justification

The axis is based on the principle of sustainable use of natural resources, the mitigation and / or restoration of anthropic impacts on different ecosystems, and the adaptation of ecological-social systems to global changes, including climate change, responding to the felt need of Bolivia to establish and develop methodologies according to the region for the restoration and conservation of services provided by different ecosystems, according to the needs of society and to build ecologically resilient cities and towns.

Installed capacities and incidence of Sida in the axis development

The axis has 8 research units, belonging to 2 faculties, made up of several professionals with different academic backgrounds (disciplines: biology, chemistry, agronomy, social, health, biochemistry, physics), with doctorate and masters degrees in different areas, with experience in the area of environment, natural resources and biodiversity.

Although the axis of biodiversity, natural resources and the environment was not favoured with the ASDI-UMSS Programs as such, the new structure of research in the UMSS is beneficial for the axis as it has research centres that were strengthened with the support of ASDI (CTA, Bioprocesses, Biotechnology, Food and Natural Products Centre, Non-Metallic Materials Centre).

Activities and requirements to Sida

The axis aims to conduct research in the following priority areas:

- Study of ecosystems functionality,
- Valuation of biodiversity and natural resources, and
- Development of technology applied to environmental problems.

Based on these priorities, the axis proposes to develop, with the support of Swedish universities, a **scientific master's degree in the UMSS on the theme of Nature-Based Solutions (NBS)** for the restoration / adaptation of different ecosystem services. The master's degree will address four thematic priorities: i) Urban resilience to global changes, ii) Agroforestry systems for the maintenance of ecosystem services, iii) Secondary metabolites and ecological networks as a tool for pest control in urban and peri-urban areas, iv) Innovation technology for management alternatives in degraded ecosystems.

The proposed master's degree requires the participation of Swedish, professors and / or researchers, for the following topics:

- Conceptual bases of the principles of Solutions Based on Nature
- Theory of urban ecological resilience
- Green and blue infrastructure in urban and peri-urban areas
- Principles and actions for the maintenance of ecosystem services
- Conceptual bases of environmental services and ecosystem services oriented towards global and national policies (e.g. objectives and scope of IPBES, IPCC, millennium objectives)

The scientific expertise in NBS will contribute to the training of professionals who propose technological-scientific alternatives for the solution of the country's needs, through a multidisciplinary work that will allow the integration of public policies, science and society, which guarantee the maintenance of ecosystem services fundamentals in urban and peri-urban areas.

4.3.4. Social Sciences and Humanities

Justification

In the first decades of the 21st century, Bolivia undergoes through some important political, economic and social changes that include the adoption of a new State Political Constitution. The establishment of several levels of autonomous government, a mixture of democratic forms (representative, direct, participatory and community), new economic and social proposals (participation of citizens and social movements), environmental and cultural, among others. These changes challenge the social capacity to process them and reveal the mismatches existing between social structures, political culture and social relationships that actually occur in practice and the population's expectations related to economic, educational or political achievements. This situation requires to develop researches in order to discover its causes and to propose alternative ways of orienting paths, in the framework of harmonious coexistence and some viable development proposals which could be undertake through public policies, as well as through the initiative of civil society and economic agents. In this sense, it is necessary to achieve a permanent training process of new generations of researchers, capable of responding to the demands of public institutions, society and the market, as well as, qualified to reveal and explain problems and possibilities that are not recognized by any of the subjects that operate in these areas.

Installed capacities and incidence of Sida in the axis development

The axis is based on a network formed several years ago by researchers from ten university centres. There are about 30 researchers with a PhD. degrees and a similar number dedicated to teaching in other UMSS units. In addition, it has some established facilities as libraries and basic infrastructure for research.

The impact of ASDI is decisive, not only because most of the mentioned doctors were formed within the framework of the first three phases of the SIDA-UMSS Program, but because, during the last phase, the University Program of Research in Social Sciences (PUICS), was created which resulted in the creation of a shared training and a research agenda which promoted the development of a collaborative academic culture within the different centre in the UMSS. In the framework of the PUICS, was developed the first Master's Program in Social Science Research, MICS, an interdisciplinary program with a high

graduation rate, which facilitated the exchange between academics from the social sciences, humanities and technological areas.

Activities and requirements to Sida

The axis defined five lines in which to develop research and training activities: i) Economic and social development, ii) Population, territory, environment and climate change, iii) Processes and sociopolitical dynamics: State, society and social agents iv) Processes and sociocultural dynamics: imaginaries and heritage, and v) Social and human sciences epistemologies.

The principal aim implement a collaborative and interdisciplinary Local Doctorate Program, with gender equity based on the above mentioned five lines of research. In its first version, the program will seek for the cooperation of colleagues from Swedish universities, who will participate in teaching (distance or blended learning) and the co-direction of doctoral thesis, in order to enrich local approaches with international views upon the research problems. Since the local institutional conditions are still insufficient to fulfil this purpose, resources are also required to support the logistical aspects of fieldwork, thesis writing follow-up and support of research infrastructure (e.g. access to bibliographic databases and

4.3.5. Industrial Development, Production, Technology, and Innovation

Justification:

The productive bases are structurally weak in developing countries. In particular, weak knowledge demand is a serious problem for social and economic development in Bolivia. For a long time, development strategies have always depended on importing knowledge. But this is not sufficient, because applying knowledge efficiently usually also requires building capabilities to generate knowledge. Local industries in Bolivia are mostly specialized in primary goods and low knowledge-intensive activities, contributing to systematically reproduce the underdevelopment condition.

From the university side, the present research thematic research area aims to strengthen strategic institutional capacities to systematically support the development of the local industry. Thus, improving industry productivity and competitiveness, while at the same time UMSS' participation within processes and systems of innovation for inclusive and sustainable development is enhanced.

Installed capacities and incidence of Sida in the axis development

The bases of this thematic area are the wide, but disperse, research capacities and innovation experiences generated at UMSS. In particular, during the last decade, the Technology Transfer Unit (UTT-UMSS) has built institutional capacities and competences to actively foster processes and systems of innovation from below, in collaboration with diverse socio-productive agents. Nowadays recognized as a national reference in the field. The main innovation initiatives developed by UTT were part of its UMSS Innovation Program, supported by SIDA and SICD's experts, Sweden.

The main results, lessons and capacities built highlighted came from sectorial cluster experiences (e.g.: foo, leather, mathematics and others). "Learning by doing" was a successful methodology as well as an adaptation of an innovation system approach to the Bolivian context. To date, actively collaborate about 150 local SMEs, a multidisciplinary team of 35 researchers, pre-graduate students, and representatives from the public and private sectors. Such experiences were also followed by innovation systems research capacities development through a PhD program in collaboration with the Blekinge Institute of Technology (sandwich mode) and a local MSc program (in progress) studying Innovation Systems and Development issues.

Activities and requirements to Sida

Cluster development and their socio-economic impact generated, are the empirical bases fundamental for our future research, in a context of application and implication. Therefore, to keep these experiences operating and amplify their impacts are some central challenges for our future work. Accordingly, we require the support of Swedish universities for the training to 3 researchers of the UMSS with doctoral

degree (sandwich model): i) Systems of Innovation and Development, ii) Systems of Advanced Manufacturing, and iii) Systems of clean and sustainable production.

i) Systems of Innovation and Development is oriented to develop dynamic interactive learning spaces and university capacities to participate in process and systems of innovation in Bolivia. This doctoral program will have 2 candidates, one of them taking a gender perspective. The University of Lund, SICD, is the partner university of this program.
ii) Systems of Advanced Manufacturing will allow design and develop new technology, machinery and plants of production for the development of sustainable industries in Bolivia. This program will have one candidate and is looking for a partner Swedish university.
iii) Systems of clean and sustainable production will be focused on developing management models, optimization of production processes, to enhance productivity and competitiveness of the Bolivian industry. This program will have one candidate and is looking for a partner Swedish university.

4.3.6. Energy, Mining, and Hydrocarbons

Justification:

The growing energy demand and global warming have introduced new challenges in the energy systems. These challenges are related to the insertion of renewable energies, energy efficiency and distributed generation. In this context, the axis proposes an integral work in the optimal, sustainable and efficient use of different energy sources.

Installed capacities and incidence of Sida in the axis development

The axis has different research centres, laboratories and academic units: i) Energy Research Centre, ii) Materials Centre - Non-Metallic, iii) Biotechnology Centre, iv) Department of Physics, v) Applied Technology Research Program, vi) Metallographic-welding Laboratory, and non-destructive tests, vii) PESEE Program, viii) ELEKTRO Program, and ix) Materials Resistance Laboratory. There are researchers with PhD degrees in Biomass, heat and power generation and modelling, experts in the synthesis of nanostructured materials, in addition to 7 doctoral students in polygeneration, hybrid systems, biofuels, energy planning, evaluation of wind and solar energy. It is estimated for 2019 two PhD students will conclude their PhD and all of them for 2020.

Activities and requirements to Sida

The axis proposes as a strategy the strengthening of the research infrastructures and the increase in the number of researchers with PhD degrees, in the following fields: i) Modelling of energy systems, ii) Materials science, iii) Bioprocesses, iv) Energy efficiency analysis and v) Development of methodologies for decision making regarding energy projects. This doctoral program aims to have periods of training in Bolivia and a stay of up to 8 months in Sweden and it will be developed in research centres of the UMSS, with the collaboration of Swedish universities.

The research topics proposed for the **Local Doctorate Program**, with the participation of Swedish partners are: 1) Techno-economic and environmental potential of the biomass as an energy source in Bolivia, 2) Short and long term energy planning including the sizing and operation of polygeneration systems, 3) Smart cities from the energy perspective, 4) Production of biodiesel using biotechnological and materials technologies, 5) Generation of electricity/energy from Biogas and other gaseous fuels using different types of biomass and, 6) Multi-criteria analysis to support the decision making on hydroelectric generation in a context of developing countries. It should be noted that these topics already have local supervisors and Swedish partners are requested.

The training of three doctors in the “sandwich” mode is also required, in new fields of importance to our country: 1) Computational physics applied to materials science, 2) Welding and degradation mechanisms at high temperatures, and materials properties, finally, 3) Development of models for generation and optimal transmission of electricity and power systems analysis.

4.3.7. Health and Life Sciences

Justification:

In the last years, understanding health beyond biomedical risk factors requires thinking about scientific integration with other fields of knowledge that analyse the life-health-disease-action process as a social phenomenon that should be studied in specific contexts.

In Bolivia, infectious diseases (including emerging and re-emerging diseases) continue affecting a large part of the vulnerable population, and despite the efforts made over time to control them, they continue to represent a serious problem.

At the same time, chronic non-communicable diseases have become the new public health problem in the country and information about them is insufficient and also there is little real knowledge of the levels of environmental pollution and its impact on the environment and sustainable development, so there is a need to train professionals in different disciplines to identify and unify a new way of addressing problems: multidisciplinary, interdisciplinary and trans-disciplinary going beyond the biomedical and social model, building an integrating knowledge of health including all its components.

Installed capacities and incidence of Sida in the axis development

In the Faculty of Medicine of the UMSS, the Institute of Biomedical Research and Social Research - IIBISMED, since 2014, has been developing postgraduate training programs (3 Doctorates and the scientific Master in Public Health and Epidemiology with cooperation of ASDI (Sweden) and ARES (Belgium), as well as high-level research projects, in which the research units have been strengthened with training, professional training, equipment and specialized laboratories in the health area. Since 2017, it has led the creation of the **Health and Life Sciences Network**, with the purpose of developing research and human resources training processes in which health-related areas participate, with a trans, inter and multidisciplinary approach that allows generating and have scientific evidence and influence decision-making, responding to the needs and demands of society, from a systemic, comprehensive and intersectorial perspective.

This axis brings together 14 academic units of the UMSS, guaranteeing the necessary multidisciplinarity and intersectoriality.

Activities and requirements to Sida

In this new work perspective, it is considered necessary and pertinent to continue developing the following areas:

- Infectious diseases
- Chronic non-communicable diseases
- Environmental pollution and toxicology

The continuity of the **doctoral training in the sandwich modality in Public Health** is also important to improve the staff of professionals involved in postgraduate research and training activities, as well as the training and updating of the axis researchers.

Finally, note that the axis has installed capacities that will allow you to develop **two masters**: 1**) Life Sciences: Public Health - Focus "One Health"** and **2) Food pollution, environmental pollution and toxicology.** The development of these programs will require financial support and technical assistance in the academic area, for curricular development: professors, tutors, assessors, as well as updating and training courses for researchers from Sweden. The complementary equipment requested will strengthen the laboratories and research units of the UMSS that are part of the Health and Life Sciences Network.

4.3.8. Telecommunications and Information Communication Technology

Justification:

The 2030 Agenda of the United Nations recognizes the enormous potential of ICT for the achievement of the 17 sustainable development objectives. Statistics, including those related to ICT, are an essential element when choosing the right political and investment options, according to Houlin Zhao General Secretary of the International Telecommunications Union (ITU), echoing the call of the Nations United in favour of a coordinated effort to mobilize the information revolution in aiming to a more sustainable development.

The axis proposes to promote the application and use of high performance computational tools, as well as the insertion of technology for modelling, control, prediction, simulation and precise measurements to carry out research in science and engineering of scientific and / or social impact in favour of sustainable growth of cities, studying aspects of pollution, radiation, telematics, artificial intelligence, big data, transport systems, smart roads, etc. which are among others a component of the 11th Objective: *To make cities and human settlements inclusive, safe, resilient and sustainable.*

Installed capacities and incidence of Sida in the axis development

The new challenge of working concurrently, requires the participation of some Academic Units that have been developed mainly for the bachelor degree courses. Four departments are part of this axis: i) Physics, ii) Electrics and Electronics, iii) Systems and Computing, iv) Civil Engineering, with their respective infrastructures (laboratories, cabinets, equipment, etc.). The axis as such, being an emerging theme within the SIDA-UMSS Program, did not receive financial support to strengthen its research capabilities and does not have enough human resources with a doctoral degree to generate high-level research. In this sense, through DICyT an ICT Master Plan has been implemented, which focuses on activities to improve the technological conditions for an optimal management of ICT in the UMSS.

Activities and requirements to Sida

The axis has prioritized to empower the research units involved, with human resources and research infrastructures (facilities and scientific equipment) to carry out research in the following areas: Software engineering; Robotics, perception and learning; Theoretical and computational physics; Telematics; Roads and Transportation systems; Environment, based on which it is proposed to develop, a scientific master course in "Computer Science with a focus on smart cities".

As part of the strengthening to generate a critical mass of researchers with a Ph.D. degree, who develop research and high-quality scientific production, in addition to solving the needs and demands of society by obtaining simulations and / or accurate measurements for the development of smart and sustainable cities, strategically considers the training of 3 doctors in the sandwich mode in the following lines: Software Engineering; Robotics, perception and learning; Theoretical and Computational Physics. However, to enhance the capabilities of the axis, it is requested the inclusion of a fourth sandwich doctorate in the line of Roads and transport systems[33].

Due to the characteristics of the Sandwich Modality within the SIDA-UMSS Programs, the academic units involved will be strengthened in the established lines, being at the same time, the seed for a new current within the country as declared in the Agenda 2025 with the implementation of the Electronic Government as part of the administration of the information of the State in a Sovereign Cloud and that in addition, the Major University of “San Simón”; forming a fundamental part of the denominated Citadel of the Knowledge, will be the referent to realize projects at local level.

[33] As an emerging research axis, support is requested for the formation of a fourth sandwich doctorate, if there is availability of resources for it development.

5. QUALITY ASSURANCE:

The education system is subject to quality monitoring, measurement, evaluation, and accreditation by an independent specialised public institution in accordance with CPE's Art. 89. Therefore, Education Law 70 created the Plurinational Agency for the Evaluation and Accreditation of Higher University Education (APEAESU), with a board of directors and a specialised technical team subject to the rulings of a supreme decree (in preparation).

Governance in Latin American universities unduly hinders the path to high performance, in the words of (Jamil Salmi, 2017),[34] "*[t]he reality is that the current governance model supports the collective decision-making process that imposes the immediate interests of stakeholders over the academic excellence that society needs … the processes are always too long, complex and riddled with bureaucracy and inefficiencies.*" Although UMSS is not alien to this reality (See Section 1.4.1), quality assurance of university education has been furthered with the accreditation of 58%[35] of its graduate academic units, with the technical and academic support of the University Evaluation and Accreditation Office (DUEA) in self-evaluation processes for improvement and accreditation.

In general, there are three types of evaluation processes: self-evaluation or internal evaluation, external evaluation by academic peers, and synthesis evaluation. Therefore, academic units in Bolivia are evaluated by two systems: MERCOSUR's ARCU SUR System and the SUB System, both of which have generated experience in Bolivian public universities concerning evaluation and accreditation of degree programmes.

The ARCU SUR System has four dimensions[36] to accredit graduate academic units. As per methodological regulation, they accede, prior call, to the Network of National Accreditation Agencies (RANA for its Spanish acronym), managed in Bolivia by the National Committee for the Accreditation of University Degrees (CNACU for its Spanish acronym). In the case of UMSS, the calls include engineering areas: Civil, Mechanic, Chemical, Electric, Electronic, Industrial, and Agronomic; as well as bachelor degrees in Architecture, Medicine, Veterinary Medicine, and Nursing. Accreditation entails the recognition of academic studies, degrees, and certificates, and not so of professional practice.

Once the National Congress of Public and Special-Regime Universities approves general regulations to evaluate academic graduate and postgraduate units, and institutions, the Bolivian University System disseminates these regulations to all universities in the country by means of CEUB's National Evaluation and Accreditation Secretariat. Evaluations for graduate academic units and postgraduate programmes include 10 areas[37] of dissimilar variables and indicators. These evaluation processes begin on a voluntary basis and are intended to progressively improve the quality of university education management.

SUB's evaluation system is considered less stringent than the ARCU SUR system, judging by Lennart Ståhle's report.[38] The former places emphasis on voluntary participation and on defining a flexible evaluation agenda, whereas the latter is subject to calls and has set times for each process stage until it is completed and the Opinion of Accreditation is issued or postponed.

The University Quality Assurance System for postgraduate programmes has in its Postgraduate School a first internal filter. The School's academic actions follow guidelines set out in SUB's General Regulations for Postgraduate Studies and in its own internal regulations approved by the Rector's Office resolutions. Based on these guidelines, the self-evaluation and evaluation experiences of the Sida-UMSS master's programmes in science and the Research and Postgraduate Quality Management System

[34] Member of the Governing Board of the International Institute for Educational Planning, the International Advisory Network of the UK Leadership Foundation for Higher Education, and the Editorial Committee of OECD's Journal of Higher Education Management and Policy.
[35] 2017 Executive Report of the University Evaluation and Accreditation Directorate.
[36] 1. Institutional Context, 2. Academic Project, 3. Infrastructure, and 4. University Community, each of them with its evaluation and accreditation components.
[37] *Considers: 1: Juridical and Institutional Regulations, 2: Mission and Objectives, 3: Curriculum, 4: Administration and Academic Management, 5: Faculty staff, 6: Students, 7: Research and Social Interaction, 8: Education Resources, 9: Financial Administration, and 10: Infrastructure.*
[38] External Evaluation of quality assurance systems in research and postgraduate training at Universidad Mayor de San Andrés (UMSA) and at Universidad Mayor de San Simón (UMSS) in Bolivia, as well as the national system through the Bolivian University Executive Committee (CEUB)

(SGCIP for its Spanish acronym), operating since late 2018, DUEA, DICyT and EUPG plan to construct and validate evaluation indicators to strengthen a postgraduate and researcher training quality management system that will rule future master and doctoral programmes in science.

Regarding the master's course in science on Chemical-based Technology, Food, and Bioprocesses, developed in the Science and Technology Department's research unit, Lennart Ståhle asserts: "*The structure and content of the plan imply that the conditions for good quality are there.*" This assertion evinces the actual start of quality assurance for postgraduate courses in science, an emerging topic in the university's institutional revival. (Axelsson, Peñarrieta, & Tollefsen, 2018) Have recently corroborated this assertion: *"Local doctorate programme may generally be based on master's degree programmes. In some cases, the quality obtained is even higher to the one required…"*

Through the above framework actions, the present plan establishes that only by implementing the University Quality Assurance System in all academic units, with emphasis on research and on master's and doctoral degree programmes in science, will we be able to achieve useful research acknowledged by the scientific community and by society. The cooperation of Sida and ARES is a fundamental opportunity to strengthen this quality assurance system. Initially, we have Lennart Ståhle's advisory, as well as 2 doctorate candidates working in this area with ARES, and preliminary documents done by DUEA, EUPG, and DICyT.

6. BUDGET:

The following budget includes local training in 3 doctorate and 5 master's degree programmes in science. Of these, the Doctorate in Chemical-based Technology and the Master's Degree in Innovation and Development are under way, and their budget has been included in this proposal. In the case of postgraduate courses and training under the sandwich modality, the budget follows Sweden's administrative guidelines for stays/internships in Swedish universities.

Funds needed for the R&D projects proposed herein—mobilising programmes targeting researchers and faculty members for postgraduate courses in science—concur with UMSS' DHT and funds required at this time. Together, these funds will become a Research Fund enabling action lines to promote RUE and generate a favourable environment that considers quality assurance.

Table 2: General Programme Budget (in SEK)

Action Lines	Detail	TGU**	DHT	Sida	Total
Researcher Training	Complete doctorate training from previous phase	160.000.000	960.000	2.600.000	3.560.000
	Doctorate training in the sandwich modality		5.760.000	31.900.000	37.660.000
	Training in local doctorate programmes*		5.100.000	27.900.000	33.000.000
	Training in local master's degree programmes in science*		1.700.000	7.600.000	9.300.000
	Post-doctorate training		1.000.000	4.900.000	5.900.000
Implement R&D projects	Competitive R&D projects		1.000.000	6.000.000	7.000.000
	Induced R&D projects		2.000.000	16.000.000	18.000.000
Promote and foster researchers and managers	Divulge and popularise research findings			750.000	750.000
	Promote researchers nationally and internationally			750.000	750.000
	Brief trainings to generate skills and new competencies among researchers and managers			750.000	750.000
	Postgraduate trainings in Ethics and Bioethics		100.000	1.400.00	1.500.000
	Permanent training for faculty members and tutors in local postgraduate courses in science			750.000	750.000
Promote RUE	Projects to generate innovations			2.000.000	2.000.000
	Boosting the University Interface Structure		2.000.000	6.000.000	8.000.000
Quality assurance in researcher training	Quality assurance policies and guidelines with ESG criteria and guidance			500.000	500.000
	Generating an environment that elicits quality assurance with ESG criteria and guidance		12.000.000	3.000.000	15.000.000
Favourable environment for STIAs	Continuous implementation of the CIT Master Plan		1.000.000	1.000.000	2.000.000
	Environmental Management System for research processes		1.000.000	700.000	1.700.000
	Politics and guidelines in gender equity, non-discrimination, inclusion, and human rights		500.000	500.000	1.000.000
Unforeseen expenditure			880.000	10.000.000	10.000.000
Total		**160.000.000**	**35.000.000**	**125.000.000**	**320.000.000**

* Includes expenditure in fieldwork trips, input, reagents, bibliography, etc.

** The University General Treasury (TGU) includes salaries of personnel involved in STA (Researchers, technicians, and support personnel), the running costs of units involved (electricity, water, phone, Internet, and others), and infrastructure maintenance.

7. COORDINATING PARTNERS AND DONORS

Even making the most of capacities generated at UMSS will not suffice to meet all objectives and planned actions. Therefore, one of the pillars of the proposal for this period is the participation of national and international academic partners.

At the national level, to contribute to what has been called Science and Technology Sovereignty, we seek to socialise this proposal among SUB universities and government agencies in order to generate interest and have them join UMSS National Partners. These partners will play a **passive** role when sponsoring the participation of a member of their personnel as R&D scholarship holder, and will invest in their scholarship holder's support and transportation. They will be active partners when their research units and researchers become involved in developing research and postgraduate courses in science.

At the international level, we will mostly seek partners in Swedish universities and institutions interested in being part of this new way of working and in becoming UMSS International Partners.

On the one hand, we will seek partners to set up strengthening programmes for research infrastructure associated with doctoral training (in on-site and sandwich modalities) in prioritised axis topics—the least strengthened axes. First, a critical mass of researchers with PhDs is necessary before proposing national postgraduate studies in science. We will also seek partners to train researchers in already strengthened axes, both at UMSS and in national entities, through technically and academically feasible MSc and PhD programmes in science—which still need mobilising foreign teachers as part of the academic personnel of such postgraduate studies.

To coordinate national and international partners, UMSS will set up the following structure:

- The Vice-rector's Office oversees the entire Cooperation Programme; and the DICyT director supervises and coordinates the programme.
- DICyT commits its four departments to the action lines: STIA and Researcher Promotion, University–ESP Relation, Favourable Environment for STIAs, and the CIT Master Plan.
- A board of directors formed by EUPG, DUEA, and DICyT will oversee Quality Assurance of Researcher Training, and Researcher Training.
- Committees by axis will ensure researchers are involved in preparing axis programmes and R&D&I Project Development.
- Each axis will have one coordinator as valid interlocutor representing members' interests before DICyT and national and international partners.
- There may be coordinators in doctorate and master's degree programmes who will respond to the axis coordinator.

8. FORMULATING THE CONCEPT NOTE:

Sida's invitation to join a new cooperation period began a series of internal DICyT meetings, as well as meetings with the 2013-2017 Sida-UMSS programme coordinators, joined by some researchers interested in joining a new cooperation period. In the first meeting, we decided to update the 2012–2021 UMSS Research Conceptual Framework for a new 10-year period, as new documents had been emerging in international, national, regional, sectoral, and institutional contexts since 2014.

After analysing the above documents and the experiences shared by coordinators in later meetings, a model for the Process of Conceptualising Priorities in Research and Postgraduate Studies in Science (Appendix 5) was built. As agendas and plans were found to create problematic nucleus, meeting attendants offered to implement development policies from their perspective, area, or sector, considering Life Systems that promote a balance among i) sustainable production systems, ii) extreme-poverty eradication, and iii) protection of environmental functions[39] according to PDES (p. 62). Initially, a comparison between sectors and research unit capacities helped identify 8 areas in which UMSS may somehow help to achieve the policies described by such plans (Appendix 6).

These 8 opportunity sectors or areas, plus researcher training, were approached in several participatory internal workshops in each department, and later in institutional sectoral workshops (Appendix 7), joined by several Departments interested in the topic. These workshops led to the strengthening and prioritisation of 8 research axes to generate Mode 1 knowledge (discipline and multidiscipline in point 5.3). Moreover, the workshops elicited axes representatives (3 members per axis) who, in a joint workshop (Appendix 8), established 6 research axes (programmes) to generate Mode 2 knowledge (inter- and transdisciplinary).

The core objectives of each sectoral workshop were: validate the name of the axis proposed initially, identify sub-axes to be prioritised, define efficiency principles and actions for research activities, identify proposals for postgraduate studies in science, and identify researchers' interest in working around thematic axes. In the case of postgraduate studies in science, the enthusiasm to work for the first time in inter-department workshops prompted the proposal of 77 MSc and 23 PhD courses around the 8 axes.

As part of the responsible drafting of this document, in this specific case, we built a tool called Form: Technical-Administrative Considerations to Develop UMSS Postgraduate Studies in Science (Appendix 9). Its immediate application helped filter short, mid, and long-term feasible postgraduate studies in science with the minimum considerations needed to ensure ESG quality assurance guidelines. In 5 years of cooperation, we intend to start and/or execute 3 doctorate and 6 master's degree studies in science.

These axes and programmes, plus the human and infrastructure capacities of installed research units, will allow for a Research and Innovation Agenda (10-year Conceptual Framework, 5-year Concept Note for Sida, and complete proposals).

Finally, to build the component that poses a favourable research environment (management) and the above bibliography, we read several UMSS documents and internal regulations to have an insider's view. The external perception was given by the 2 Sida-commissioned consultancies (2007-2016 Impact Assessment, and External Revision of Quality Assurance Systems); the evaluation of the 6 completed master's degree programmes in science; and the 3 recommendation consultancies for Impact Assessment and Environmental Adaptation Study for Research Centres and Labs at UMSS (UMSS-DICyT, 2016), Mainstreaming Inclusion/Non-Discrimination Indicators and Criteria in R&D Projects (UMSS-DICyT, 2016), and Intellectual Property Policies and Guidelines at UMSS). All these, and the experiences in African universities shared in its Concept Notes, have informed this proposal, which sets the direction intended for SICTI with actions described in the 4 frameworks.

[39] The 2030 Agenda sets three dimensions for sustainable development: economic, social, and environmental, related with PDES' description.

9. INTERNAL EVALUATION OF THE CONCEPTUAL FRAMEWORK:

Universidad Mayor de San Simon's precepts as public university and RSU, understood from the University of Lüneburg's Sustainable Human Development approach, have allowed for this proposal's foundations. On the other hand, the sustainable development concept (understood as social, economic, and environmental in the 2030 Agenda), tied to the knowledge society from the Evolutionary Economics approach, grants a fundamental role to universities in the development of humanity. Thus, Socially Useful Scientific Research and Technological Development (Section 5.3), and its 8 priority axes based on available (human, economic, and infrastructure) capacities generated within UMSS, coupled with the execution of induced projects and the University-ESP relationship, implies giving **relevance to the development** of Cochabamba and Bolivia.

Relevance from a scientific perspective is pursued by increasing scientific production via incentives; training researchers with PhDs (both in Swedish universities and in UMSS research units); and by the results of competitive and induced R&D projects, for which several actions are planned in SICTI's four frameworks.

Using scientific UMSS-generated knowledge and technological development, national, department, and municipal governments, with ESP, will be more likely to generate wealth and pour it into the entire Bolivian society to aim at general wellbeing. Therefore, the Concept Note enhances the innovation concept and the UMSS-ESP bond, considering INNOVA-UMSS Project's progress, and the creation and full operation of an EDIU. Hence, fulfilling this proposal is a necessary albeit insufficient condition for **poverty reduction**.

Elements that guarantee the proposal's **academic sustainability** include: applying the Action Plan through organically recognised executing units and steadily employed researchers; graduate and postgraduate students' involvement; the execution of training programmes for researchers using the installed capacity of UMSS research units; and the inclusion of R&D&I projects in units' annual operative plans.

In terms of **institutional sustainability**, scientific and technological research is an indivisible part of university academic life, as per the Bolivian University's and UMSS' Organic Statute, which guarantee the constitution of research units with researcher and infrastructure capacity. A retrospective look at the research institution in recent years clearly shows the transition from wilful to institutional research, enhancing its management and capacity to take on commitments, as UMSS has done in international cooperation agreements despite authority turnover. Likewise, this proposal is a vital part in building the 2019-2023 UMSS Development Plan (in preparation), which entails giving STIA a favourable juridical framework, e.g., the Researcher Ladder.

We propose to increase the Research Fund and access to national and international funds for STIAs in order to render this proposal **financially sustainable**. Additionally, we posed a budget with realistic estimations, showing reasonably-growing income and expenses in tandem with the evolution of past years. The diversity of funding sources shows less vulnerability, considering that the institutional decision to assign up to 25% of DHT resources to research has also extended to research training at postgraduate level.

As the environment impinges on the quality of life and on development sustainability, in this document we have sought to minimise the **environmental impact** of any research activity as a priority, following the own conceptualisation of priority research axes. Therefore, the Regulatory Framework poses a strategy to lay the legal foundations of environmental regulation and control as an inherent element of quality science activities; and the Science Policy Framework seeks to structure an environmental management system that will start in the research ambit and later encompass all UMSS' endeavours.

To comply with the national and international regulatory framework for human rights, gender equity, and non-discrimination, UMSS is committed to bridge its gender gaps. Thus, this plan includes affirmative action policies to effectively foster the equal presence of women in directive and research posts, and in selecting scholarship programmes. The Sida-UMSS Programme is not exempt: about 46% of people holding a PhD degree are women; and women are 44% of the population of PhD candidates and 52% of MSc candidates.

Then, the broad diverse research activity for the next 10 years entails overall ethical (particularly bioethical) considerations at the core of institutional behaviour. The master's degree in Ethics and Bioethics proposed herein will promote responsible behaviour and good practices in science work at UMSS. Additionally, the Research Ethics Committee, as an Organisational Framework action, will have powers regarding reflection, reporting, and recommendations on ethical principles, and respect for life and health by avoiding experiments with humans and other living beings that put their health and life at risk.

Government intervention that undermines the recognised university autonomy principle would practically dissolve the Conceptual Framework. This is the greatest external risk, although reduced DHT resources due to fuel price cuts in the international market is also a latent risk, as well as the government's decision to cut the fuel price as part of its policy to "invest" in companies it views as strategic.

Especially while implementing Regulatory and Organisational Framework actions, the governance of UMSS and its Departments may become a major internal risk. On the other hand, units having to constantly improvise daily chores may become a risk when planning, giving follow-up, and evaluating this document. Similarly, empowered units managing financial resources may place their wellbeing before that of researchers, and avoid Financial Frameworks actions.

The intellectual property topic in UMSS is new. Rector Resolution N^{o} 1347/18 was recently approved. It rules the protection, management, and transfer of UMSS' research findings; and defines its moral and patrimonial rights and those of its dependents. Equally, the Resolution lays out the constitution of an Intellectual Property Committee and designates DICyT as its managing office.

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