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# Tuta Sindina: The Way Forward in Managing Academia at Escuela Superior Politécnica De Chimborazo

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**Abstract.** This paper addresses the acute, interconnected socio-ecological challenges facing the Chimborazo province of Ecuador, a region characterized by high rates of poverty, chronic child malnutrition, and severe environmental degradation. These challenges demand a systemic, university-led response that transcends traditional models of outreach and knowledge transfer. The institutional model proposed herein was developed using a Participatory Action Research (PAR) methodology, which integrates a Quintuple Helix framework to engage stakeholders from academia, industry, government, civil society, and the natural environment. The primary result is the Tuta Sindina ecosystem, a novel organizational model for the Escuela Superior Politécnica de Chimborazo (ESPOCH) designed to foster a regional socio-ecological transition. Key features of this model include the creation of interdisciplinary research institutes targeting regional crises, comprehensive curriculum reform based on the principles of Education for Sustainable Development (ESD), and the deep integration of ancestral Kichwa knowledge, particularly the philosophy of Sumak Kawsay (Good Living). This paper concludes that the Tuta Sindina model offers a robust and potentially replicable framework for universities, particularly in the Global South, to function as anchor institutions for regional sustainability, thereby contributing a unique perspective to the global discourse on the role of higher education in achieving the Sustainable Development Goals.

## Keywords:

Green university, innovation, sustainability, sustainable research, interdisciplinarity.

## 1. Introduction

In an era defined by escalating global crises, Higher Education Institutions (HEIs) are called to transcend their traditional roles of teaching and research [9]. Particularly in the Global South, universities must evolve into anchor institutions with a profound responsibility to address the urgent and complex socio-ecological challenges confronting their regions. This

paper presents a model for such a transformation at the Escuela Superior Politécnica de Chimborazo (ESPOCH), situated within a province facing a confluence of severe, overlapping crises that constitute a "wicked problem" demanding a systemic, integrated response.

Faced with the logic of the mono-culture of knowledge and scientific rigor, there is the possibility of a broader ecology of knowledge, where scientific knowledge can dialogue with secular knowledge, with popular knowledge, with the knowledge of indigenous people, with the knowledge of marginal urban populations, with peasant knowledge and with traditional knowledge [19]. The ecology of knowledge proposes that there is no ignorance; all ignorance is ignorance of a certain type of knowledge and all knowledge overcomes a particular ignorance.

With an academic view from the global south, from the ecology of knowledge, ESPOCH makes its academic mark in an era of the network society, of neuro-pedagogy, of interculturality, of diversity and of respect for multiple others. Therefore, the university management seeks rigor in the fulfilment of teaching, research and outreach activities in an environment of innovation, discovery and creativity.

For several decades, universities have increasingly been involved in the incubation and acceleration of ventures and in the generation of technology-based companies, which consider innovation a key element to achieve social success [20]. It is increasingly common for universities to align their objectives with the construction of safer, more sustainable cities, and whose economies are based on innovation and the generation of knowledge.

The Silicon Valley model promoted by Stanford has been replicated in many cities around the world: Leuven, Atlanta, Austin, London, Alcalá, New York, Medellín, São Paulo, Buenos Aires and Santiago, among others. These experiences have been built from the interaction between national and local governments, universities and public and private companies. Strengthening the integration of higher education with society implies strengthening entrepreneurship and innovation, supporting applied research and the generation of technology-based companies [10]. Additionally, undergraduate and postgraduate training is closely linked to research, and with that, contributes to reducing dependence on foreign science, technology, art and culture. All of this aims to ascribe value to and generate our own knowledge, to bring back our customs, our trades, our values and our knowledge.

There is an urgent need to build a knowledge society that values ancestral knowledge. Higher education and its near and far environment increasingly resemble a complex neural system; there is no learning without interrelation [11]. The University will continue to be a guide of society, assuming the role of creating connections and producing synapses with other social beings, to facilitate interaction and to promote dialogue between knowledge deposited in many spaces of society.

Globalization has to advance in the construction of a respectful, harmonious and egalitarian dialogue between different peoples [12]. This need for broad dialogue finds a very important ally in technology, and questions the current configuration of higher education. Universities are not single organizations, and they are not the only ones that accumulate, increase and propagate knowledge [13]. Higher education gives and receives from society, participates in the community, interacts with its actors and contacts with its people.

### 1.1. Generation of Knowledge, Economic Development and Well-Being

Higher education, in addition to being an opportunity for young people to generate ideas and knowledge, contributes to improving social, economic, scientific, cultural and

technological aspects. If, on the one hand, fundamental research allows us to understand the universe, on the other hand, innovation and applied research have significantly improved quality of life and have contributed to economic growth in many countries, especially in the global north. To the same extent, the arts, humanities and social and behavioural sciences, which are strengthened within universities, have had a positive impact on society.

Economic growth is also determined by dissemination and access to knowledge, which implies preserving it and transmitting it to subsequent generations [14]. These tasks have been permanently and emphatically addressed by universities and research centers around the world. Therefore, these institutions are the main source for the generation of innovation, which is reflected, for example, in the high number of patents that are based on their research, disseminated through scientific articles.

Higher education institutions extend their social mission through the application of research and technological development in the business field [15]. Examples of these centres are: TUS Holdings of Tsinghua University in China, Oxford University Innovation (OUI) at the University of Oxford in the United Kingdom, and the Vanderbilt Center for Technology Transfer and Commercialization (CTTC) from Vanderbilt University in the United Kingdom. These centres contribute to the growth and diversification of the high-tech industry and well-being in their respective regions and the world.

According to economist Joel Mokyr (2002), sustained economic growth since the industrial revolution is due to the "knowledge revolution." Mokyr also states that "scientific knowledge is the basis for technological progress, as well as its adaptability to market needs." Without this broad vision, the return generated by the development of technology will decrease, because the approach for this development could be incomplete [1].

Economics researcher Abramovitz (1986) proposes that productivity depends on variables such as the acquisition and application of knowledge in addition to labour and capital investment; he estimates that 85% of per-capita income between 1890 and 1950 in the United States could not be explained by the increase in capital or other measurable inputs, and could be attributed to technological innovation [2].

According to Etzcowitz (2008), industry drives production, government promotes stable relationships and exchange, and universities are the main source of knowledge, in a model known as the Triple Helix. The function of entrepreneurs is to reform or revolutionize the production model through the exploitation of inventions or, more generally, an unproven technology to generate new products or produce old products in a new way [3].

The conception of the Triple Helix places emphasis on the production of knowledge and innovation so that it is compatible with the knowledge economy. Additionally, a Quadruple Helix promotes the perspective of a knowledge society and knowledge democracy for the production of knowledge and innovation. The evolution of the concept in the Quintuple Helix highlights the necessary socio-ecological transition of society and the economy in the 21st century; therefore, the Quintuple Helix is ecologically sensitive [4].

Talent is consistent with the concept of a "creative class" proposed by Richard Florida (2002), who argues that economic development is promoted by this class of people, composed of artists, musicians, writers, designers, scientists, architects, engineers, and others, for whom creativity is an essential dimension of their livelihood [5]. The creative economy is an engine for innovation, employment and economic growth, which is present in several sectors, such as: knowledge generation, high technology, media, design and the arts [6].

Environments that attract the creative class are conducive to innovation. Crow and

Babars (2015) refer to innovation in a broader context to “restructure and improve the institutional order and incentives to promote innovation.” This definition is what promotes innovation at all levels in an institution [7].

## 2. Scenario

For a university to effectively lead a socio-ecological transition, its educational mission must be fundamentally reoriented. Education for Sustainable Development (ESD), as defined and promoted by UNESCO, provides the necessary pedagogical framework for this transformation. ESD is an educational approach that aims to empower learners of all ages with the knowledge, skills, values, and attitudes to address interconnected global challenges, including climate change, biodiversity loss, and social inequality. It moves beyond simply transmitting information to fostering key competencies such as systems thinking, critical reflection, anticipatory thinking, and collaborative decision-making [16].

The Superior Polytechnical School of Chimborazo has sustained an annual increase in its budget for research, going from using USD 678,410 in 2020 to a planned value of USD 2,246,971 in 2024. The budget increase coincides with the increased rigor in the process of selecting research projects to be financed by the institution and with a significant increase in high-impact scientific production.

Particularly, in the call for internal competitive funds, starting in 2022, criteria were included that promote the effective participation of researchers from ESPOCH and other institutions, as well as the obligation for proposals to have external counterparts for the financing of research projects. This last aspect aims to generate greater impact on society based on research results, as well as work in university networks to increase the quality and epistemological breadth of research.

An average annual increase in the annual budget used in research of 137% is observed as of 2020. ESPOCH has also gained external funding used in ESPOCH research projects; this is the result of competitive calls to access financing from other national or international institutions. The total external financing obtained by ESPOCH for the year 2024 reached USD 1,468,769, meaning an increase of 282% compared to 2020, where external financing was USD 520,072.

The increase in publications in scientific journals is also substantial, reaching a total of 201 in 2023, which represents an additional 55% compared to what was published in 2022 (130 articles). The increase in rigor in the evaluation of research project proposals and new requirements for the renewal of occasional professor contracts are the two main reasons for this increase.

Outreach projects have focused their attention primarily on service and extension, which has made it possible to serve the sectors with the greatest needs, mainly in the central sierra of Ecuador. The Plaza-Vida project, which has created a space to improve the quality and marketing of items from small producers, has positively impacted the lives of many people. Projects like this have been developed in accordance with an institutional commitment to serve various social sectors.

In the last two years, the Dean for Extension has made important efforts to identify research projects whose results could be marketable or generate a positive impact on the population. These efforts are a reflection of an institutional concern about the need to positively influence the construction of a society with fewer inequalities and that supports its development in creativity, generation of knowledge and innovation.

The information shows that the increase in investment in research has positive effects on the number of scientific projects and publications. However, ESPOCH still requires spaces that facilitate and promote the effective application of research results to solve society's problems. It is proposed to structure a model that facilitates the integration of research, society and innovation via entrepreneurship and the generation of technology-based companies. This integration will promote the construction of an ecosystem for creativity, the generation of knowledge and the development of science and technology.

The UNESCO framework for ESD outlines five priority action areas that are directly operationalized in the Tuta Sindina model: (1) advancing policy at the institutional level; (2) transforming learning environments into living laboratories for sustainability; (3) building the capacities of educators to teach for sustainability; (4) empowering and mobilizing youth as agents of change; and (5) accelerating local-level actions through community partnerships. Integrating ESD into all curricula is therefore not an add-on but a core strategic requirement. This approach ensures that all graduates, regardless of their discipline, are equipped to become part of a "creative class" that is conscious of and committed to sustainability.

## 3. Implementation

The development of the Tuta Sindina model was not a top-down administrative exercise but a dynamic and collaborative process rooted in the methodology of Participatory Action Research (PAR). This approach was deliberately chosen to ensure that the proposed institutional redesign was not only theoretically sound but also deeply embedded in the realities of the university and its regional context. PAR is a research method that aims to simultaneously investigate and solve a practical issue, thereby bridging the persistent gap between academic theory and real-world practice [17]. It is a highly interactive and cyclical process that empowers participants as co-researchers, making it particularly well-suited for complex social settings like a university seeking to foster community-wide transformation.

Ecosystems of innovation, research, discovery and technological development are an opportunity for economic strengthening. An environment of freedom and tolerance, fostered by these ecosystems, is ideal for promoting sensitivity to art, culture and commitment to the configuration of an environmentally sustainable, fairer and safer society [18]. These types of environments go beyond university campuses and reach cities and regions.

To meet these demands of society and from ESPOCH itself, professionals in tune with the academic culture of intensive knowledge, a characteristic of research universities, emerge as essential. This culture places emphasis on the selection, adaptation and commercialization of knowledge, tasks in which not only those who opt for a career in research, but also entrepreneurs, managers, consultants, investors and decision makers must be trained. This type of training necessarily requires interaction between different areas of knowledge.

Disciplinary and interdisciplinary are not mutually exclusive terms. Both are necessary and complementary, taking as a starting point the mutual understanding between disciplines, as well as between disciplinary and interdisciplinary areas. Increasingly and with greater force, solutions are required that involve deep and simultaneous knowledge from different areas, a situation that entails the discussion of an organizational model that reduces the barriers to interdisciplinary teaching and research.

Although, historically, the research carried out by ESPOCH has been marked by attachment to solving society's problems, with particular emphasis on attention to the sectors with greatest need, it is urgent to contribute to the configuration of an environment

(ecosystem) where public and private institutions, governments and universities intervene, with the aim of creating a scheme conducive to the development of science and technology.

### 3.1. Research, Innovation, and Extension Centers and Institutes

Institutions around the world promote a matrix organizational structure, which facilitates mobility and interdisciplinary activities. Figure 1 shows a matrix structure, in which departments, through their professors, collaborate transversally to develop research and teaching activities in interdisciplinary research centres, programs and subjects of a curricular offer.

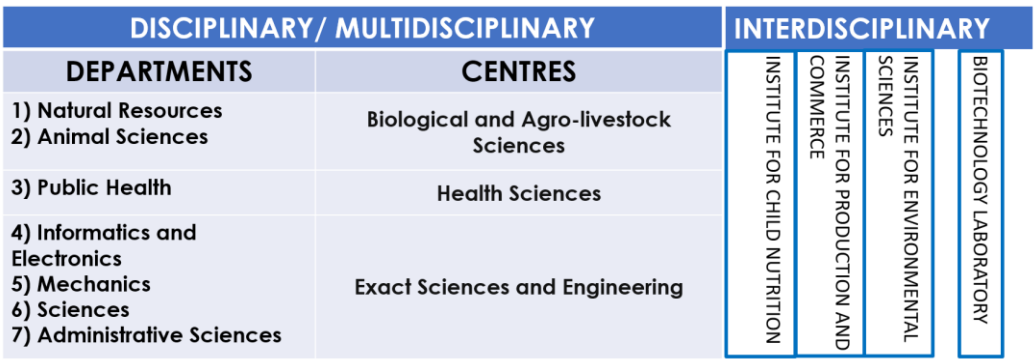


Figure 1. Matrix structure that promotes mobility and interdisciplinarity

It is proposed that, at the Superior Polytechnical School of Chimborazo, the Multidisciplinary and Interdisciplinary Centres/Institutes be composed of groups linked to academic interests of the departments, which could generate spaces that facilitate articulation with other disciplines and reduce and ideally eliminate duplication of effort. These Centres act under a matrix organization, which promotes the free mobility of teachers and students between departments and centres, which are intertwined by interdisciplinary units: research Institutes, undergraduate and graduate programs, subjects and even curricular frameworks.

In addition to articulating work between research groups and showcasing results, another of the most important responsibilities of the Centres is to promote and facilitate the development of research proposals suitable for accessing external funding to ESPOCH. This articulated work will generate the interest of other research and education institutions to jointly participate in calls to access external competitive funds.

The Institutes and Centres facilitate the definition of policies and procedures to strengthen the participation in research of undergraduate and postgraduate students, through their involvement in the tasks carried out in the projects and groups that make up these Institutes or Centres. Training in research, innovation and networking also entails the acquisition of skills and awareness of the importance of innovating, undertaking and discovering. This training of talents at undergraduate and postgraduate levels will allow a science and technology ecosystem to gradually be configured, which promotes economic strengthening.

In many international universities such as Harvard, Saskatchewan and Buenos Aires, among others, the educational model for initial subjects focuses on a common core, where students from different disciplines share classrooms. This approach allows students in the first semesters to receive comprehensive training. As they advance in their university career,

students begin to specialize, and in the upper semesters they encounter more specific subjects, taught by specialized teachers. Applying this approach at ESPOCH would optimize the time of professors, who could even dedicate themselves exclusively to carrying out postgraduate research and teaching tasks, while strengthening the institutional innovation structure.

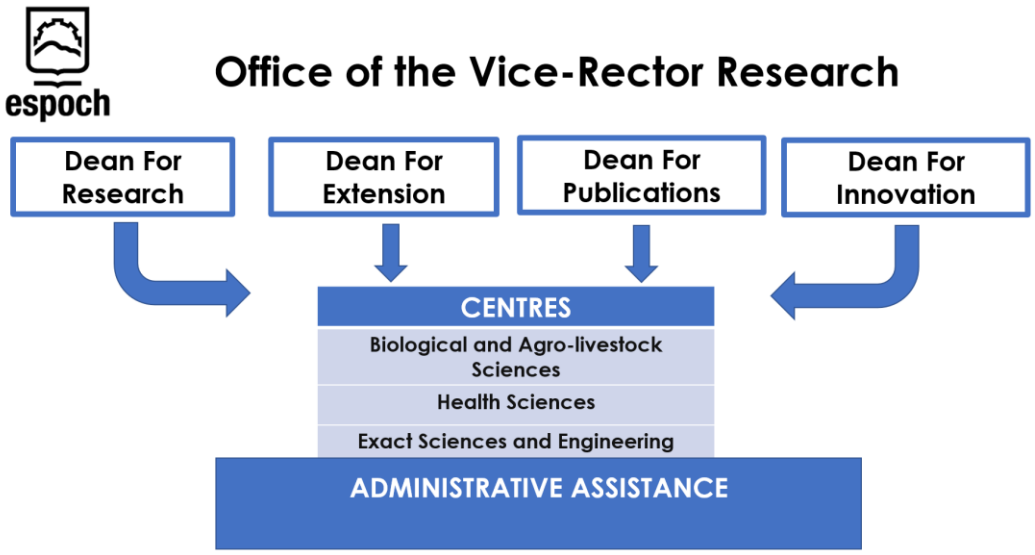


Figure 2. Articulation of the research centers with the Deanships of Research, Publication Extension and Innovation

The Institutes are platforms that make these institutional strengths of research, innovation and linkage visible, and enter into a process of innovation and continuous improvement of these strengths. The Institutes, in coordination with the Centres, will be responsible for expanding the epistemological approach, through the definition of policies and procedures to promote multi, post and transdisciplinary work.

### 3.2. Graduate Studies and Research, Innovation and Extension

The articulated work between Departments, Institutes and Centres will contribute substantially to the organization of master's and specialization programs with a focus on research, as well as doctoral programs (PhD). The articulation of the Institutes and Centres, in the scope of the organization of graduate programs based on research, may be carried out through the participation of their directors in a Doctoral School.

One of the common practices in universities and polytechnical schools is to reproduce structures such as the curriculum, which produces the homogenization of these institutions in the context of a country or a region. Increasingly, with much more emphasis, institutions design academic structures and programs that are based on their institutional strengths and vision, as well as on the confluence of several disciplines. Particular attention has been placed on the offer of postgraduate programs that simultaneously meet the demand of social actors, institutional strengths, as well as the participation of actors from various disciplines. These conditions allow the postgraduate offering to acquire its own characteristics and have a differentiated institutional brand with respect to the offer of other institutions.

The proposal for the offer of Doctorates (PhD) at Escuela Superior Politécnica de Chimborazo, has as its fundamental basis interdisciplinarity, which promotes an organization

that integrates teachers with the highest training, who contribute from their own experience and training, to guide and advise students in dealing with problems raised as part of doctoral studies. The involvement of one or another teacher will depend on the specificities of the problem to be addressed by a student, which will allow the epistemological framework to be expanded, and a deeper yet broader approach to be achieved.

### 3.3. Research, Innovation and Transfer Ecosystem

The economic strengthening of countries, in countless cases, is due to high investment improving the quality of education at all levels and the decision to configure interaction environments conducive to innovation, discovery and development of science and technology. These environments have also placed a lot of emphasis on the offer of services and social and environmental security. Examples of these models are found in New York, Route 128 in Boston, IC2 in Austin, Silicon Valley in California, Leuven Gate in Belgium, Pangyo in South Korea, Neihu in Taiwan, Guiyan in China and Vizcaya in the Basque Country.

Under the current conditions of Ecuador, which depends on the export of primary products, with weaknesses at all levels of education, little investment for the generation of science and technology and its own cultural characteristics that are not present in other countries, it is not possible to reproduce without modifications the process that has been followed for decades to configure ecosystems such as those mentioned in the previous paragraph. This process itself must necessarily consider cultural diversity, the economic gaps between different social sectors, ancestral knowledge and the potential of the different regions of Ecuador.

With this background, the need arises to generate our own model that allows us to configure an ecosystem that promotes the generation of science and technology, in an environment of innovation, as a key element for the economic development of the central sierra region. For this model to be successful, it must consider the diversity of cultures and nationalities, and therefore of visions, that coexist in this region of Ecuador and particularly in the province of Chimborazo. It is then necessary to identify the potential, needs, aspirations and vision of the people who live in this area, and integrate these people into the process of building the ecosystem model of the region. Its integration will facilitate the configuration of a system with communal power according to the indigenous vision, or of a pluralistic democracy according to development models based on knowledge.

The proposal is based on the identification of activities that are carried out in the region and could be significantly strengthened with the support of science and technology generated at the Superior Polytechnical School of Chimborazo and that could ultimately become technology-based companies (spin-offs) that are leaders in their field. One of the conditions that should be present in these companies is the possibility of becoming the impetus for the generation of other companies that can compete laterally, and provide services to continue with the permanent strengthening of leading companies.

In addition to the graduate offer, undergraduate training and other substantive research and connection activities with society must be developed within a framework of interdisciplinarity, continuous improvement and permanent innovation. To achieve this objective, our institution must undertake the application of policies that promote this scheme, considering above all that research, innovation, discovery and creativity require an environment of freedom, flexibility, and even tolerance for failure, according to Oppenheimer (2014) in his book “Create or Die” [8].

### 3.4. Tuta Sindina: Ecosystem of Creativity, Discovery and Innovation

Based on the potential of Research, Innovation and Outreach, it is proposed to establish Tuta Sindina (a Kichwa expression meaning **Lighthouse**), as the ecosystem of Creativity, Discovery and Innovation. Tuta Sindina has its genesis in two Multidisciplinary Institutes to address aspects that are of important concern for the central sierra region of Ecuador: 1) Nutrition, and 2) Production and Marketing.

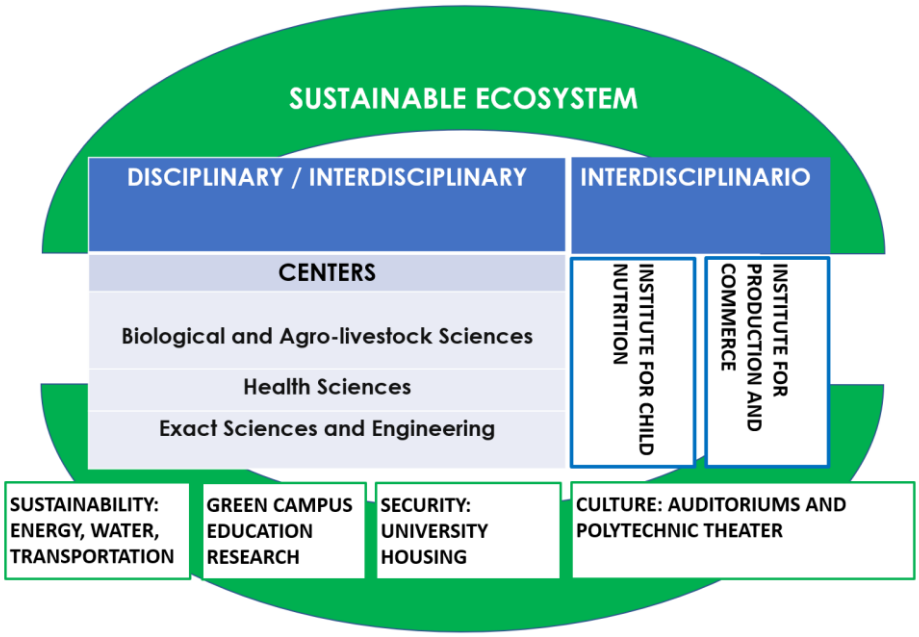


Figure N-7. Tuta Sindina: Ecosystem of Creativity, Discovery and Innovation

The Institute of Child Nutrition focuses on research and innovation in childcare during the first 1000 days after birth, and will be in charge of managing two projects: 1) Children's University Hospital, and 2) a laboratory for nutraceuticals and drugs (pharmaceutical industry).

The Institute of Production and Marketing has the purpose of researching and innovating for peasant family agriculture, and has dominion over the management of four projects: 1) Agricultural technology, 2) Technology for data processing and product traceability, 3) Biotechnology, and 4) Production of animal vaccines. In the last project, it is proposed to start with the production of medicines and vaccines for birds. For a second phase, the design and construction of a Large-Scale Direct Marketing Centre is proposed, which prioritizes the sale of products that are the result of family production.

To improve health and safety conditions on the campus of Escuela Superior Politécnica de Chimborazo, projects are proposed with the following objectives, provide sustainability to the management of energy and water on the ESPOCH main campus, design an internal mobility system to reduce vehicular emissions on the main campus, and promote a culture of well-being through physical activity, implement a Polytechnic Dormitory, which would include services to improve the living conditions of students, such as shared and restricted study spaces, laundry facilities, and food and leisure options, among others. Additionally, build common infrastructure to strengthen the cultural and academic activity of students, teachers, employees and workers of ESPOCH, including a polytechnic theatre, auditorium and basic science laboratories. The last one, develop and implement a green campus design, which includes the recovery and strengthening of green spaces, removal of old constructions that

are not friendly to human and the natural environment, as well as an urban plan for the development of the main campus.

Of this group of projects, mobility, residence and the polytechnic theatre are sustainable, which, with adequate management, could finance the execution of the other listed projects.

The following table systematically maps the core initiatives of the *Tuta Sindina* model to the specific regional challenges they address, the relevant UN Sustainable Development Goals they support; moreover, UI GreenMetric categories are also included (see in Table 1).

Table 1. Alignment of *Tuta Sindina* Initiatives with Regional Challenges, UN SDGs, and UI GreenMetric

| Initiative/Project | Addressed Regional Challenge | Primary UN SDG(s) | UI GreenMetric |
|---|---|---|---|
| **Institute of Child Nutrition** | Chronic child malnutrition (stunting) affects nearly 40% of Indigenous children. | SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being) | 1. Setting and Infrastructure<br>6. Education and Research |
| **Institute of Production & Marketing** | High rural poverty and unsustainable agricultural expansion into fragile páramo ecosystems. | SDG 1 (No Poverty), SDG 8 (Decent Work), SDG 15 (Life on Land) | 1. Setting and Infrastructure |
| **Green Campus Energy & Water** | High resource consumption and contribution to regional environmental stress. | SDG 7 (Affordable and Clean Energy), SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption) | 2. Energy and Climate Change<br>3. Water<br>Waste |
| **Green Campus Mobility System** | Contribution to local air pollution and GHG emissions from transport. | SDG 11 (Sustainable Cities), SDG 13 (Climate Action) | 4. Transportation<br>Energy and Climate Change |
| **Curriculum Reform (ESD Integration)** | Lack of professionals trained to tackle complex, interdisciplinary sustainability issues. | SDG 4 (Quality Education) | Education and Research |

## 4. Future Perspectives

The Tuta Sindina model represents more than an organizational restructuring; it is a profound reimagining of the university's role in society. By analyzing the broader implications of this proposal, its potential for replication, and the challenges it faces, we can better understand its significance as a framework for university-led regional transformation.

Collaboration with external sectors highlights the importance of synergy between academia and the community for social and economic progress. This approach represents an important step towards a more relevant higher education, adapted to contemporary needs and challenges, emphasizing the importance of self-management of knowledge and innovation in all areas of institutional work.

The integration of research and innovation is considered a fundamental element in postgraduate training. This approach seeks to generate and value one's own knowledge, reducing dependence on external sources. The intention is that the proposed will lead to the generation of an ecosystem that favours creativity, tolerance, security and a breadth and depth of academic training at the same time.

A deeper analysis of the model reveals a new and more complex role for the university. To succeed, Tuta Sindina requires bringing together a diverse array of actors who operate with fundamentally different logics, values, and languages—from the relational worldview of Kichwa elders to the profit-driven calculus of industry partners, the regulatory frameworks of government, and the methodological rigor of academic scientists. In this context, the university must become more than a generator of knowledge; it must function as an essential "translation hub" or "bridging organization."

Through its interdisciplinary centres and its commitment to a participatory methodology, ESPOCH can create the trusted space where these different forms of knowledge and worldviews can be respectfully translated, negotiated, and integrated into co-created solutions. This role aligns with the concept of "innovation diplomacy," where the university actively bridges barriers between traditionally separated actors and fields to nurture entrepreneurship and solve mutual challenges. By mediating between different knowledge systems, the university facilitates a process of "Mode 3" knowledge production, where knowledge is remixed, shared, and applied within a complex, multi-stakeholder ecosystem. This function as a facilitator of dialogue and co-creation is perhaps the model's most profound contribution to redefining the 21st-century university.

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## Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

## Authors Contribution

Both authors contributed substantially to the work. **P.V.** conceived the research idea, designed the methodology, as well as obtained the funding for the work and gave a critical revision. **R.C.** carried out the data collection, conducted the data analysis, interpretation and wrote the first draft of the manuscript. Both authors reviewed and approved the final version of the manuscript.

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