Catalyzing Biomedical Innovation in Honduras: A University-Industry Technology Park Model at the Faculty of Medical Sciences (UNAH)

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***Abstract*– A proposal for a University-Based Medical Science Technology Park (PTU-CM) for Honduras as a strategic bridge between biomedical research and market deployment. Using an exploratory design that integrates a 2009-2024 literature scan, benchmarking of five Latin-American science parks, and 12 semistructured interviews with government, industry, and university stakeholders, we outline an architecture grounded in triple-helix theory and open innovation. The park is organized into three synergetic zones: translational research, tech entrepreneurship, and specialized services; coordinated by a tripartite governance board. A ten-year discounted-cash-flow model projects an NPV of USD 3.2 million and an IRR of 18%, remaining positive under ±10% sensitivity tests. Forecasts include 30 patents, 50 certified prototypes, 25 startups, and ≈ 600 new jobs. Health-system benefits comprise a 60 → 24-month cut in technology adoption cycles and a 5% reduction in imported medical equipment costs. The framework details intellectual-property sharing (70/20/10), sustainability mechanisms, and safeguards against regulatory, fiscal, and brain-drain risks. Overall, the PTU-CM offers a replicable, financially viable model of university-industry technology transfer for upper-middle-income settings, with strong potential to advance public-health outcomes and regional economic diversification.**

Keywords—Technology transfer, Honduras, Technology Park, Public Policy, Innovation.

I. INTRODUCTION

Technology transfer and knowledge sharing between universities and industries are key pillars for the transition to learning and innovation-based economies. In lower-middle-income countries such as Honduras, the health sector faces specific challenges: scarce funding for research and development (R+D), which is estimated at 0.06% of GDP in 2024[1]; regulatory gaps, and limited articulation between the Faculty of Medical Sciences of the National Autonomous University of Honduras (FCM-UNAH) [2] and the health services of the Ministry of Health (SESAL) [3]. This disconnects leads to underutilization of academic infrastructure, delays in the adoption of clinical technologies, and near-total dependence on imports for biomedical equipment and hospital software.

In 2018, the FCM-UNAH, SESAL and the National Telecommunications Commission (CONATEL)[4], took a firm step to jointly form a technology park, based on the fact that institutional collaboration would be the ideal channel to evolve the scientific production of the FCM-UNAH to development and innovation. This is similar to what happened in the creation of other technology parks in the region[5].

Various Latin American experiences, such as the City of Knowledge (Panama) [6], Itaipu Technology Park (Brazil-Paraguay) [7] and ESPOL Park (Ecuador) [8]; demonstrate that university technology parks can catalyze regional innovation ecosystems, as long as they articulate the triple helix (academia–government–business) under clear governance and sustainable business models. However, direct extrapolation of these models is limited, as the socioeconomic realities of Honduras require the adaptation of financing, intellectual property, and talent retention mechanisms to smaller-scale contexts and greater fiscal constraints.

The objective of this work is to propose a Model of Technology-University Park (PTU) initially specialized in medical sciences that reduces the research-market gap and strengthens the national capacity to generate, transfer and commercialize biomedical knowledge. Based on an exploratory study that combines documentary analysis, interviews with key actors and *benchmarking* of six Latin American parks, an institutional and financial architecture is designed in line with the Honduran legal framework and the public health priorities defined by the National Health Plan [9].

The contribution of the article is twofold: (i) it presents a quantified business case, including estimates of NPV, IRR and high-value job creation and (ii) it offers governance guidelines and intellectual property policies that favor the balanced participation of universities, the State and industry. In addition, risks of financial sustainability and talent drain are discussed, proposing tax incentives and "*matching grants*" as mitigation.

II. THEORETICAL FOUNDATIONS AND LESSONS FROM LATIN AMERICAN TECHNOLOGY PARKS

Technology transfer (TT) is defined as the systematic process of mobilizing knowledge, capacities and research results towards actors who can transform them into useful innovations [10]. The literature distinguishes three evolutionary approaches:

1) Modelo lineal (science-push / market-pull): It proposes a one-way sequence from basic research to commercialization [11]. Although the historical basis of many policies, its simplicity ignores critical feedback and the absorption capacities of industry.

2) Interactive or linked chain model: Kline & Rosenberg propose iterative loops where R+D, engineering and the market continuously feedback [12]. This approach recognizes technological uncertainty and the need for learning cycles between actors.

3) Triple helix and expanded approaches: Etzkowitz & Leydesdorff describe the co-evolution of university, industry and government as a hybrid system that generates spaces for innovation (*spaces of innovation* o Incubators, TT workshops, parks)[13]. Later extensions include the quadruple helix (civil society) and the quintuple helix (environmental sustainability).

Under these currents are articulated key concepts such as: *(i) Open innovation*, which defines that organizational boundaries are permeable and the "*knowledge inflow/outflow*" is strategically managed[14]. (ii) *Absorption capacity*, consist of the ability of a firm or institution to recognize, assimilate and exploit external knowledge which determines the effectiveness of technology transfer[15]. (iii) *Entrepreneurial Trickle-Down Theory (KSTE)*, states that surplus knowledge generated by universities is converted into tech startups when appropriate incentives are in place[16].

Science and technology parks (PCTs) emerge as infrastructures that intentionally facilitate these flows, offering "*proximity*", incubation services and innovation-oriented governance. They gradually become a way for science and technology to take on a social facet in search of generating wealth and better living conditions [17].

The most successful science parks are characterized by adopting a smart specialization strategy, selecting niches that are consistent with the competitive advantages of their regional environment [18]. For example, a focus on information and communication technologies is observed in Panama, as well as hydroelectric power in the Itaipu region. To sustain their development, these parks employ blended financing mechanisms that combine public seed capital with private investment, as well as the reinvestment of revenues from services or royalties. In this way, they manage to reduce their vulnerability to fluctuating state budgets.

With regard to governance, these parks guarantee the formal and balanced participation of academia, the government and the productive sector in their governing bodies, which strengthens legitimacy and streamlines decision-making. In addition, they offer high value-added services that go beyond the simple coworking model and include certifications, accredited laboratories, access to supercomputing and international scaling programs [19].

Finally, in Latin America, it has benefited from the definition of clear intellectual property policies, together with transparent royalty sharing schemes and mentoring in health regulation, this accelerates the time to market of medical devices and software; in the existing technology parks in this area, following successful experiences from other geographical regions [20].

III. Methodology

The study adopts an exploratory-descriptive applied design that combines qualitative methods for the formulation of the technology park model and quantitative techniques for the estimation of its economic viability. The strategy was developed in four sequential phases:

1) Documentary and bibliometric review: Scopus databases, Web of Science and regional repositories (RedALyC, SciELO) corresponding to the last fifteen years. A co-occurrence analysis was applied using VOSviewer [21] to identify trends in technology transfer and best practices in science parks in Latin America.

2) Comparative benchmarking: Six Latin American parks with a track record of at least 10 years were selected through purposive sampling and sectoral diversity criteria. For each case, 5 indicators (finance, governance, intellectual property, services, and innovation performance) were extracted using public sources and validated internal reports.

3) Qualitative fieldwork: 12 semi-structured interviews (10 ± 5 min) were conducted with key actors: four academics (UNAH), four health officials (SESAL) and four business representatives from the industrial sector. The interviews were recorded and transcribed; the material was encoded in NVivo-14 following an inductive-deductive scheme that integrates categories of the triple helix theory and open innovation. The triangulation of data was achieved by cross-referencing findings from interviews, *benchmarking* and literature [22].

4) Synthesis and modeling of the proposal: The proposal was synthesized and modeled integrating three fundamental components. First, the Triple Impact Canvas was used [23], a tool that made it possible to articulate the academic, industrial and social value of the technology park, precisely delimiting customer segments, sources of income and impact metrics. Second, an institutional architecture was designed based on the principles of "*design science research*" [24][25], establishing the key processes of research and development (R+D), incubation, licensing and clinical certification. Finally, a ten-year projected financial model was built using the cash flow discount (DCF) method, calculating the Net Present Value (NPV) and the Internal Rate of Return (IRR) with a base discount rate of 10% [26]. Likewise, a sensitivity analysis was incorporated considering variations of ±10% in revenues, capital expenditure (CAPEX) and operating costs [27]. The simulations were carried out in @Risk v8.0 [28] using 5000 Monte Carlo iterations [29].

It was ensured through (i) *member checking* with the interviewees, (ii) *peer debriefing* with two external experts in innovation management, and (iii) independent methodological audit of the NVivo code books and financial assumptions.

The scope is forward-looking and depends on public policy and market assumptions, the evolution of which could alter financial projections. Likewise, the number of interviews, although consistent with exploratory studies, limits the generalizability of some qualitative findings. This methodology offers a solid framework for the design and evaluation of the proposal for a technology park, ensuring the integration of empirical evidence, the perspectives of the actors involved and an analytical-economic rigor.

IV. RESULTS

The bibliometric analysis was carried out on papers indexed in Scopus, Web of Science, RedALyC and SciELO between 2009–2024. After the purging of duplicates, 463 relevant documents were obtained. The time series confirms sustained growth: from 14 registrations in 2009 to 78 in 2024, equivalent to a compound annual growth rate (CAGR) of 14%. The geographical distribution reproduces the pattern indicated in previous studies: Brazil concentrates 38% of production, followed by Mexico (17%), Colombia (12%), Chile (9%) and Argentina (7%). Honduras appears with only 0.8% (four articles), which reinforces the need to strengthen local research.

The map of co-occurrences generated revealed five main thematic clusters: *university–industry cooperation/licensing* (governance of technology transfer offices - OTT), *startup/entrepreneurial ecosystem* (entrepreneurship), *intellectual property/R&D policy* (public policies), *triple helix/open innovation* (theoretical frameworks) and *biotechnology/medical devices* (innovation in health). The latter, although it represents 9% of the terms analyzed, shows the highest relative growth rate (23% per year), which suggests an emerging trend towards biomedical innovation.

At the same time, the "*2021 Snapshot of Latin American Parks and Innovation Areas*" of the IASP [30] It identified 27 active parks in the region, of which 41% have laboratories linked to the health sector and 52% operate certified incubators. Brazil concentrates more than half of these science and technology parks, while Central American countries, including Honduras, do not yet have equivalent infrastructures.

On the other hand, the co-citation analysis positions *Research Policy*, *Technovation* and *Journal of Technology Transfer* as the three core sources, concentrating 42% of the co-citation links. Authors Etzkowitz and Plonski stand out for their high *betweenness centrality*, acting as bridge nodes between governance and entrepreneurship clusters.

Various scientific-technological parks in Latin America show diverse models of governance, sustainability and institutional articulation, with significant economic and social impacts in strategic sectors. In Panama, the City of Knowledge operates under a non-profit foundation, with a focus on public health, ICT and international cooperation, generating USD 381.6 million in gross production value and 8000 direct jobs.

On the Brazil-Paraguay border, the Itaipu Technology Park (PTI) specializes in energy, telecommunications (5G) and hydroelectric simulation; ensures its sustainability through a loan of USD 30.87 million and encourages co-investment in *start-ups* through its own fund. In Brazil, Tecnosinos articulates the triple helix model (university-private sector-government) and concentrates its activities on ICT, advanced manufacturing and digital innovation; it hosts more than 100 companies and recently raised USD 2.45 million for expansion.

In Ecuador, PARCON-ESPOL focuses its actions on prototyping, technological commercialization and intellectual property, with a portfolio of 413 R+D and university governance projects. Finally, the Orion Technology Park (Mexico), oriented to business and technological innovation, has incubated more than 1000 initiatives linked to sectors such as ICT, digital health and emerging technologies, generating annual sales of more than USD 10 million and attracting venture capital, all under an incubation-as-a-service model. Table I shows a summary of the Latin American parks that in our opinion provide relevant lessons.

The analysis of the interviews by coding in NVivo-14 allowed us to identify 74 references distributed in 12 thematic nodes, organized in three main dimensions: intersectoral articulation, dynamic innovation and sustainability models. The most referenced category was "*university-business cooperation*" (n = 21), followed by "*innovation financing*" (n = 17) and "*shared governance*" (n = 13), suggesting a high valuation of the business model based on collaboration and knowledge transfer.

TABLE I
LATIN AMERICAN TECHNOLOGY PARKS

Park	Country	Sectoral focus	Key lessons
City of Knowledge [6]	Panama	ICT, public health	Flexible public-private governance; soft-landing for global NGOs
PTI-Itaipu [7]	Brazil / Paraguay	Energy, environment	Financing anchored in hydroelectric utilities; strong articulation with SDG agendas
Technosinos [31]	Brazil	ICT, biotechnology	Municipal policy of tax incentives; Robust school pre-incubation program
ESPOL-Park [8]	Ecuador	Clean energy	Use of university living labs as technological showcases; Royalty Scheme 60/30/10
ORION Tecnológico de Monterrey Park [32]	Mexico	Healthcare, Advanced Manufacturing	Hub-and-spoke between regional campuses; Co-investment with venture capital funds
UTEC-I+E [33]	Uruguay	Biomedicine, AI	Linkage with the national system of researchers; Shared intellectual property

Significant co-occurrences were observed between "*technology startups*" and "*public support*" (Jaccard similarity index = 0.46), which supports the viability of a mixed incubation and co-investment scheme to boost regional development. Likewise, 83% of the interviewees explicitly stated that the creation of multisectoral consortia would facilitate the generation of technology-based solutions in health, aligned with national priorities. These results show a positive orientation towards an open innovation model, supported by networked governance and an economic sustainability approach.

IV. Synthesis of the Proposed Modeling and Its Financing

The University Technology Park in Medical Sciences (PTU-CM) is conceived as a physical and organizational infrastructure that articulates three functional macro-zones: (i) Translational Research Zone (ZIT), (ii) Innovation and Entrepreneurship Zone (ZIE) and (iii) Strategic Services Zone (ZSE). Each of these areas responds to specific flows of creation, maturation and transfer of knowledge, favoring proximity between researchers, clinicians and companies.

A. Physical design and technological capabilities

The ZIT houses four thematic research centers: Neurosciences, Public Health, Family Medicine and Biomedical Technology. It has 2800m² of BSL-2/3 laboratories, a certified vivarium and a national supercomputing center of at least 50 TFLOPS for omics analysis and clinical artificial intelligence. For its part, the ZIE includes a 1200m² incubator/accelerator, a makerspace for rapid prototyping (CAD/CAM, biomedical 3D printing) and a Venture Studio for the scaling of *spin-offs*. Finally, the ZSE concentrates on transversal services, such as the Technology Transfer Office (OTT), a medical device certification unit, an epidemiological "*big data"* nucleus and continuous training rooms.

B. Governance and transfer processes

The PTU-CM will be governed by a tripartite Board of Directors, composed of the UNAH, the Ministry of Health and the private sector, with equitable representation and biennial rotation of the presidency. The OTT acts as an integrating node, which receives disclosures, evaluates patentability, manages confidentiality and licensing agreements; He coordinates the IDEA, prototype, clinical validation, regulation and scaling phases. This flow is supported by a digital *pipeline* (TTO-CRM software) that allows traceability and real-time tracking of project metrics.

C. Service portfolio and revenue streams

The park offers six lines of high-value services: (i) contracted research and advanced analysis, (ii) certification and clinical trials of devices, (iii) incubation and acceleration, (iv) licensing and royalties, (v) continuous training and updating of skills in the health field, and (vi) rental of spaces and coworking. Ten-year projections estimate that the distribution of income will be as follows: certification (25%), contracted research (20%), rental and shared services (20%), royalties (15%), continuing education (10%) and competitive funds/consultancies (10%).

D. Financial model

The estimated initial investment for phase I of the project amounts to 8.5 million dollars (USD), distributed in infrastructure (57%), scientific equipment (28%) and information technologies and high-performance computing (ICT/HPC) (15%). The proposed financing scheme combines several sources: public seed capital (30%) from joint allocations between UNAH and SESAL, enabled by the Innovation Law [34] and the mechanisms of budgetary competition in health; contributions from multilateral organizations (20%) through a CABEI soft loan and IDB-Lab non-reimbursable funds [35], focused on digital health; private investment (25%) through "*corporate venturing*" by regional pharmaceutical laboratories and "*family offices*" nationals with minority shareholding; finally, the reinvestment of royalties and services (25%), projecting that the profits generated from the fourth year will be used for technological expansion and updating.

The projected ten-year cash flow, with a discount rate of 10%, yields a Net Present Value (NPV) of USD 3.2 million and an Internal Rate of Return (IRR) of 18%. The sensitivity analysis, considering variations of ±10% in revenues and operating costs (OPEX), indicates high financial resilience, with the NPV remaining positive except in extreme scenarios of simultaneous reduction in revenues and cost increases of more than 12%. As a risk mitigation measure, the creation of a contingency fund equivalent to 5% of CAPEX and the contracting of technological insurance policies are proposed.

E. Sustainability strategy

Long-term sustainability is based on (i) diversification of revenue streams, (ii) clear royalty distribution policies (70% for UNAH-OTT, 20% for inventors, and 10% for the innovation fund), (iii) local tax incentives (income tax (ISR) exemption for five years), and (iv) talent retention programs that include reverse sabbatical agreements and return scholarships.

This architecture, aligned with the best practices identified in Latin American parks and adapted to the Honduran legal framework, establishes a comprehensive platform to transform biomedical research into high-impact clinical and business solutions.

V. Projected Scopes and KPIs

The ex-ante assessment of the OCT-CM was based on ten-year cash flow and a logical framework of indicators (*input-output-outcome-impact*) aligned with the Innovation Act [34]. The most relevant results are summarized below:

A. Scientific-technological performance

It is expected that, within five years, the park will generate 15 granted patents, 40 articles indexed in Scopus and 25 prototypes certified by the future Technology Transfer Office (OTT). By 10 A.D., these numbers would double (30 patents, 80 papers, and 50 prototypes), consolidating a steady stream of medical innovation.

B. Entrepreneurial skills and employment

The incubation and acceleration program foresees the creation of 25 *start-ups* in biotechnology, e-health and medical devices during the first five years, of which at least 60% will reach a technological maturity level (TRL) of 7 or higher. These companies, together with the research units, will generate 250 high-skilled direct jobs and another 400 indirect jobs in support services and supply chains. The projected survival rate for *start-ups* at five years is 65%, which is consistent with the *benchmarks* Regional [36].

C. *Economic impact*

Cumulative sales of the park's *spin-offs* and services are estimated at 120 million lempiras (approximately USD 4.8 million) at the end of year 5 and at 480 million lempiras (approximately USD 19.2 million) at year 10. In this scenario, the tax return (taxes and social security contributions) would reach 38 million lempiras in ten years, exceeding the initial public contribution. Consolidated cash flow maintains a net present value (NPV) of USD 3.2 million and an internal rate of return (IRR) of 18%, confirming financial viability.

D. *Contribution to the health system*

By incorporating accredited laboratories and a phase I/II clinical trials unit, it is expected to reduce the time to adopt clinical technologies from 60 to 24 months and save 5% of public expenditure on the import of biomedical equipment. In addition, the epidemiological *big data* platform will allow the processing of around 10 million records per month, thus improving the surveillance of priority diseases.

E. *Sustainability and governance indicators*

Own revenues will cover 90% of OPEX from the fourth year onwards; the remaining 10% will come from competitive projects and international cooperation. The campus occupancy rate is projected to reach 70% in the third year and 95% in the seventh year. To mitigate risks, sensitivity analysis indicates that even with a 10% decrease in revenues and a 10% increase in costs, the Net Present Value (NPV) remains positive, reaching US$0.9 billion, validating the resilience of the model.

VI. Risks

The projection of scientific-economic benefits of the OCT-CM must be interpreted in the light of several systemic conditions that could amplify or erode its impact. From the macroeconomic level, the budgetary instability that characterizes the Honduran public sector imposes a latent risk of underfinancing. A prolonged contraction of state investment in health or education would compromise the scaling phase and limit the generation of own revenues in the first years, when dependence on public funds is greatest. The hybrid financing strategy partially mitigates this exposure but requires co-responsibility clauses that preserve academic governance in the face of the logic of private profitability, so that the park does not become a simple landlord of spaces, but an articulating actor of R+D with a public vocation.

In the area of intellectual property and health regulation, the lack of specialized courts and the limited capacity of the national patent office may delay the granting of rights, thus the time to market of developed biomedical devices. In addition, regulatory harmonization with international agencies, a prerequisite for exporting medical technology, implies compliance costs that could be prohibitive for emerging *start-ups*. These factors demand the formalization of institutional agreements with the Property Institute (IP) and with the Health Regulation Agency (ARSA), to establish quick windows and joint advice, thus guaranteeing legal predictability in the ecosystem.

In terms of human capital, the flight of talent to research centers abroad remains a structural threat. The creation of research careers within universities and the implementation of tax incentive packages for *spin-offs* founded by returned Hondurans can strengthen talent retention, but they require sustained political will. In addition, the concentration of the science park in Tegucigalpa risks deepening the territorial gaps in innovation; therefore, the articulation with satellite nodes and extension programs, particularly on the north coast and in the west, turns out to be essential to democratize the benefits of the project and prevent the PTU-CM from being perceived as an elitist enclave.

Finally, environmental and ethical sustainability requires responsible use of health data and energy resources associated with a supercomputer. The implementation of green technology policies ("*green IT*") and data governance based on the FAIR principles [38] It will be crucial to deliver on the sustainable development agenda and safeguard social trust. In summary, although the proposed model shows technical and financial feasibility, its success will depend on adaptive governance mechanisms that can anticipate economic shocks, strengthening regulatory frameworks, and promoting territorial and environmental equity.

VII. Regional scaling strategy, market projection, and resilient infrastructure

The operating model will change from having only one campus in the capital to having a hub-and-spoke structure with satellite nodes in important parts of the country (north/Sula Valley, Atlantic coast, and west). These nodes will be connected by a virtual collaboration platform for research and development, incubation, and technology transfer. According to regional policy literature, planned decentralization, which is backed by territorial goals and performance metrics, helps close gaps and spread skills more widely. In higher education, digitalization after the pandemic has made it easier to build academic and technological networks that go beyond physical limits. These international benchmarks support the use of clear territorial governance and metrics in the program, as well as partnerships with innovation agencies and networks across Latin America.

Honduras has a small domestic market (about 10.8 million people and a GDP of about USD 37 billion in 2024) [39], [40]; so the scaling case is based on exporting knowledge-intensive services (KBS) [41] and taking advantage of trade agreements and nearshoring trends that are moving toward North America. Regional statistics and forecasts indicate potential for the expansion of KBS exports. The proposal focuses on verticals that have exportable traction, such as digital health, agro-analytics, logistics, cybersecurity, and on-demand HPC services. It also sets higher external revenue goals and builds alliances with international partners.

The sectoral focus is on digital health and analytics, which are in high demand because of the need for remote services and clinical validation. In agro-analytics, the region needs solutions for traceability and forecasting. In logistics, the rise of nearshoring and regional supply chains creates demand for optimization and visibility. Finally, in scientific computing/AI, HPC-as-a-Service is being offered to small and medium-sized businesses and universities in Central America, packaging reproducible workloads with hard currency billing. Recent multilateral reports and regional trade and innovation diagnostics back up these lines.

Phased implementation plan and talent strategy are:

i. *Phase 1 (0–6 months)*: Turn on two "light" satellite nodes with a hybrid room and a prototyping lab; introduce a service catalog that includes cloud-based HPC packages, a virtual project platform, and a public dashboard of territorial indicators.
ii. *Phase 2 (6–18 months)*: Create agreements with universities and regional universities for dual training and technology residencies; open calls for proposals with private co-investment; and consolidate a portfolio of 10–15 exportable projects, with at least 40% coming from outside the capital.
iii. *Phase 3 (18–36 months)*: Expand to four satellite nodes, make the service catalog operationally self-sufficient, and submit the operation for an outside evaluation.

A 70/20/10 mix is suggested for talent through diaspora mentors in virtual internship programs; retraining of technicians with temporary certifications; and local graduates trained in digital skills and innovation. To guarantee global traceability and comparability, monitoring will be in line with the frameworks for impact management and innovation measurement that are employed by multilateral organizations.

The percentage of projects and jobs generated outside of the capital; KBS export revenue; women's and underrepresented groups' involvement in entrepreneurship and employment; adoption of technology in public services (health, agriculture, and education); patents and utility models; interregional publications and co-inventions; and institutional user satisfaction are some of the proposed social impact metrics. In accordance with current guidelines on outcomes and impact, the selection and yearly goals will be recorded in a "*Logical Impact Framework*" that includes operational definitions, baselines, and sources of verification.

A "*design for resilience*" strategy that acknowledges the limitations of the national electrical system is incorporated into the program. The adoption of backup and hybrid operation capabilities is justified by the state-owned companies' previous difficulties. The following suggestions are put forth: (i) connectivity with multi-ISP redundancy and failover routes; (ii) uninterrupted power with double-conversion UPS, generator sets, and, where practical, microgrids with photovoltaics and batteries; and (iii) a hybrid computing architecture with workload-based computing and cloud-bursting to move tasks that are sensitive to latency or peak to the cloud while keeping data-sensitive workloads on-premises. These procedures align with current guidelines and local experiences, as well as in settings with limited power and bandwidth.

Particular contingencies, for example, in the event of extended outages, satellite nodes will prioritize "*offline-first*" operation for preprocessing and capture with deferred synchronization; in the event of bandwidth constraints, compression and batch data transfer; in the event of main hub degradation, a "*degraded mode*" will be triggered, preserving vital services (telemetry, code repositories, job queues) and directing HPC jobs to the public cloud using inexpensive, pre-negotiated instances. In parallel, the nation's ongoing transmission/distribution network financing lines and electrical system modernization projects will be used to boost reliability over the medium run.

VIII. Conclusions

Together, the key performance indicators (KPIs) demonstrate the capacity of the University Technology Park in Medical Sciences (PTU-CM) to catalyze an innovation ecosystem aimed at generating knowledge, economic value, and concrete benefits for public health in Honduras. This approach positions the PTU-CM as a regional reference model in university technology transfer, with a potential for sustained impact in the academic, productive and social spheres.

The lessons analyzed show that a specialized university technology park must respond to national health priorities through a smart specialization strategy. Likewise, it is essential to articulate a portfolio of services that include clinical certification and ethical exploitation of epidemiological data, supported by a hybrid financial model that combines state resources, private capital and international cooperation. The theoretical foundations reviewed reinforce that effective technology transfer depends on robust collaborative networks and consolidated institutional capacities, while Latin American empirical evidence underscores the need to adapt these mechanisms to specific socioeconomic realities.

Under this framework, the PTU-CM will generate cutting-edge knowledge and science-based entrepreneurship but will also contribute to reducing the gap in access to medical innovation and improving the quality of life of the Honduran population through clinical solutions adapted to the local context. The sensitivity analysis confirms the financial resilience of the project, and the proposed tripartite governance provides an ideal platform for aligning public and private interests.

As a future line of work, it is proposed to incorporate Honduran state companies, for example, the National Electric Energy Company (ENEE), Hondutel, Honducor, Tren Nacional, among others, including new special purpose companies as strategic partners of the park. Its integration would provide seed capital and early demand for services, but also logistical capacities and distribution networks that would amplify the scope of the innovations developed through circular flow and state and social benefit. This state-productive financing mechanism would complement private investment flows, generating shared economic and social returns that would reinforce the sustainability of the OCT-CM and enhance its contribution to national development.

In summary, the PTU-CM is presented as a structural intervention capable of transforming the relationship between the university, industry and the State in the Honduran health sector. The consolidation of its model will require deepening demand studies, formalizing alliances with public and private companies, perfecting intellectual property and data governance policies that ensure responsible and equitable technology transfer.

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