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# REVIEW ON BARRIERS AND OPPORTUNITIES IN EXPERIMENTAL RESEARCH: INSIGHTS FROM THE NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY IN TIMOR-LESTE

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**Abstract:** This review explores the barriers and opportunities surrounding experimental research in Timor-Leste, with a focus on insights from the National Institute of Science and Technology (Timor-Leste). The study draws upon a range of sources, including national policy documents, institutional reports, and international literature, to identify the major challenges currently being faced. These challenges are said to include limited infrastructure, low funding, inadequate researcher capacity, and bureaucratic constraints. Concurrently, it underscores prospects emanating from recent policy initiatives, international collaborations, heightened youth participation in STEM, and regional integration. The findings emphasise the necessity for a coordinated, multi-stakeholder approach to establish a sustainable and impactful research ecosystem capable of addressing national development priorities through science and innovation.

**Keywords:** Barriers; Opportunities; Experimental Research; INCT; Timor-Leste.

## **Análise das barreiras e oportunidades na investigação experimental: perspectivas do Instituto Nacional de Ciência e Tecnologia de Timor-Leste**

**Resumo:** Esta revisão explora as barreiras e oportunidades em torno da investigação experimental em Timor-Leste, com foco nas perspectivas do Instituto Nacional de Ciência e Tecnologia (INCT). O estudo baseia-se numa variedade de fontes, incluindo documentos de política nacional, relatórios institucionais e literatura internacional para identificar os principais desafios atualmente enfrentados. Esses desafios incluem infraestruturas limitadas, baixo financiamento, capacidade inadequada dos investigadores e restrições burocráticas. Ao mesmo tempo, sublinha as perspectivas decorrentes de iniciativas políticas recentes, colaborações internacionais, maior participação dos jovens em STEM e integração regional. As conclusões enfatizam a necessidade de uma abordagem coordenada e multilateral para estabelecer um ecossistema de investigação sustentável e impactante, capaz de abordar as prioridades de desenvolvimento nacional através da ciência e da inovação.

**Palavras-chave:** Barreiras; Oportunidades; Investigação experimental; INCT; Timor-Leste.

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## Introduction

Scientific research is considered a fundamental cornerstone for the attainment of sustainable development, technological innovation, and national progress. Experimental research, which involves systematic manipulation of variables to establish cause-effect relationships, is vital in fields such as health, agriculture, energy, and engineering. In the context of developing and post-conflict nations such as Timor-Leste, experimental research is a critical means of identifying pathways for addressing local challenges through the implementation of evidence-based solutions (UNESCO, 2021; World Bank, 2020).

Since achieving independence in 2002, the Democratic Republic of Timor-Leste has made significant progress in the fields of education, governance, and public health. Nevertheless, the research infrastructure of the country remains underdeveloped, with limited institutional capacity, funding, and trained human resources. The National Institute of Science and Technology (INCT), which was established under the auspices of the Ministry of Higher Education, Science and Culture, functions as a central institution for the promotion of scientific research and innovation. Despite its strategic importance, INCT continues to face multiple barriers in promoting robust experimental research practices (Decree of law INCT, 2023).

The National Institute of Standards and Technology (NIST) has promoted scientific areas and research methods for a period of four years, with the implementation of these methods resulting in benefits for higher education institutions and municipalities in Timor-Leste. The scientific areas and research methods of INCT researchers have been identified and published (Rangel, 2022). The experimental research has been funded by INCT from 2022-2024 with ten (10) scientific investigations.

INCT functions as an autonomous institution, characterized by administrative, financial, and scientific autonomy. This status confers a strategic advantage, enabling the initiation and management of research programs that are aligned with national priorities. In the period between 2020 and 2024, the National Institute of Science and Technology (INCT) identified and promoted a range of scientific research areas and methodologies. These were disseminated through institutional publications and national research forums (Rangel, 2023). From 2022 to 2024, the National Institute of Science and Technology provided financial support to ten experimental research projects, with a focus on key areas relevant to higher education institutions



and municipal development plans. These initiatives are indicative of an expanding institutional commitment to evidence-driven development.

Despite these opportunities, INCT faces a range of structural and systemic barriers that prevent it from fully realising its mission. These include the absence of contemporary laboratories, inadequate research funding, deficiencies in technical capacity, and bureaucratic inefficiencies. These limitations have a detrimental effect on the sustainability and impact of ongoing scientific investigations. The present review has been designed to provide a comprehensive overview of the current state of experimental research in Timor-Leste, with a particular focus on the barriers and opportunities that have been identified, based on insights drawn from INCT and other related institutions.

## 2. Objectives

- Identification of key barriers to the advancement of experimental research in Timor-Leste is imperative, with a focus on institutional and systemic factors.
- To explore emerging opportunities for the enhancement of research practices, capacity, and infrastructure.
- To appraise stakeholders and policymakers of the strategic actions that must be implemented to foster a research-conducive environment in the country.

## 3. Methods

The present review employs a qualitative document analysis approach, incorporating both primary and secondary sources, including:

- The national policy documents that are pertinent to this field of enquiry: the National Education Strategic Plan and the National Science and Innovation Strategy 2023–2028.
- The institutional reports that have been provided by INCT.
- The following donor agency evaluations are to be considered: the Department of Foreign Affairs and Trade (DFAT), the United Nations Educational, Social and Cultural Organization (UNESCO), and the World Bank.
- A review of the literature on research capacity in developing nations, with a particular focus on studies that have undergone the peer-review process.

- The following international benchmarks for research and development (R&D) investment and performance.

The selection of documents was conducted with a focus on three key criteria: relevance, date of publication (2022–2024), and credibility. Thematic analysis was employed to extract key insights around the core themes of infrastructure, funding, human capital, policy and collaboration.

## 4. RESULTS

### 4.1 Barriers

#### a. Limited Infrastructure and Laboratory Capacity

The lack of equipped laboratories, modern instrumentation, and research tools remains a critical constraint (Rangel, 2022). Most research conducted in higher education institutions is theoretical or observational, due to the inability to conduct controlled experiments.

#### b. Inadequate Research Funding

Government expenditure on research remains below 0.1% of GDP, compared to the UNESCO recommendation of 1% (2021). INCT depends heavily on sporadic donor funding, often limited to short-term projects without sustainability frameworks.

#### c. Low Researcher Capacity

There is a shortage of PhD-level researchers and mentors, especially in STEM disciplines. Academic staff often lack training in research design, methodology and data analysis. Furthermore, research is not yet strongly embedded in academic career progression (World Bank, 2018).

#### d. Policy and Bureaucratic Challenges

Although national strategies emphasize innovation, there are no standardized systems for ethics approvals, grant disbursement or intellectual property rights. These gaps discourage active research engagement and slow down project implementation (Government of Timor-Leste, 2023).

Despite the emphasis placed on innovation within national strategies, there is an absence of standardised systems for ethics approvals, grant disbursement, and intellectual property rights. These gaps have been shown to function as a deterrent to active research engagement and to result in a slowdown in project implementation (Government of Timor-Leste, 2023).

### 4.2 Opportunities

#### a. Policy Momentum for Science and Innovation



The *National Science and Innovation Strategy* outline a commitment to strengthening research systems, including infrastructure development, digital platforms, and regional collaboration.

### **b. Growing International Partnerships**

Timor-Leste has established academic and research collaborations with institutions in Australia, Portugal, Indonesia, and the Philippines. These partnerships offer training, equipment donations, and joint research opportunities (DFAT, 2021).

### **c. Youth Engagement in Science, Technology, Engineering and Mathematics (STEM)**

Recent data from the Ministry of Education indicates a rise in STEM enrolments, suggesting a growing interest in science-driven careers (Ministry of Education, 2023). This demographic trend could form the backbone of a future research ecosystem.

### **d. Regional Integration via ASEAN and CPLP**

Engagement with the Association of Southeast Asian Nations (ASEAN) and the Community of Portuguese Language Countries (CPLP) can offer access to regional research and development (R&D) networks, scholarships, and institutional capacity-building platforms (ASEAN Secretariat, 2022).

### **e. Eight Experimental Research Monitoring Formats Now Available**

The National Directorate of Exact and Natural Sciences, INCT, Timor-Leste, has developed and officially introduced eight standardized formats for monitoring experimental research. These formats are designed to enhance the quality, consistency, and accountability of scientific investigations across various fields of study.

Each format provides a structured framework for documenting key aspects of experimental processes – such as research objectives, methodologies, data collection techniques, analysis procedures, and monitoring timelines. By using these standardized templates, researchers can ensure greater accuracy in data reporting, improve reproducibility of results, and facilitate more effective communication among scientific communities and stakeholders.

The development of these monitoring tools reflects INCT commitment to advancing research excellence in Timor-Leste. They are intended for use by academic institutions, research centers, government agencies, and independent researchers engaged in the natural and exact sciences. This initiative not only strengthens national research capacity but also aligns with interna-

tional best practices, promoting a more systematic and transparent approach to scientific inquiry.

## 5. Discussion

The situation in Timor-Leste mirrors the challenges faced by many low-income and post-conflict nations where research infrastructure and institutional culture are still evolving (Altbach & Salmi, 2011). However, the country is uniquely positioned to accelerate research development, thanks to its political stability, international goodwill, and demographic youth advantage.

Addressing the current barriers will require a multi-stakeholder approach:

- Government must increase budget allocations for research, strengthen INCT mandate, and operationalize national policies with actionable implementation plans.
- Universities should integrate research into curricula, provide mentorship programs, and incentivize faculty involvement in experimental work.
- Development partners can offer technical assistance, long-term funding mechanisms, and access to global research communities.

By building a research-enabling ecosystem, Timor-Leste can harness the transformative power of experimental science to support economic growth, public health innovation, agricultural development, and environmental protection.

## 6. Conclusion

The National Institute of Science and Technology in Timor-Leste plays a pivotal role in shaping the country's scientific future. Although experimental research is currently limited by infrastructure, capacity, and funding constraints, there are clear pathways forward. With strong political will, targeted investments, and strategic partnerships, Timor-Leste can build a resilient and impactful research environment capable of addressing its development challenges through science.



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